MINES AND METHODS INDEX

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Mines and Methods

Vol. 3; No. 1 SALT LAKE CITY, UTAH, SEPTEMBER, 1911 Every Month

Utah Copper Servitors Assail Mines and Methods

A Few Pages of This Issue Are Therefore Devoted to Recital and Comment Touching Men, Events and Things Pertinent to the Occasion

Recent assaults upon the policy of this journal and the personnel of its contributors and supposed friends by certain publications, coupled with fulsome adoration of the management and methods of the Utah Copper Company, are but manifestations of the increased energy which is being injected into the publicity department of that corporation, with the hope that by increased volume and frequency of the "tum-tum" of the hired pipers, the tardy public may be induced to again invest in some of the treasury shares of that company and thus relieve the tired backs of the pooled interests which long since have reached the breaking strain in efforts to supply the ever-increasing demands of the "stripping fund," consolation alone being found in contemplation of augmented "deferred assets" which result from these expenditures.

The bonded and floating debt of the Utah Copper Company now exceeds the amount of all dividends paid to January 1, 1911, by nearly three millions of dollars, as will clearly be shown by the following:

It will be remembered that upon conclusion of the absorption of the property of the Boston Consolidated Mining Company, about February 1, 1910, the Utah Copper Company offered for sale to its shareholders—exclusive of those who should become such by exchange of shares of the Nevada Consolidated Company — "approximately 160,000 shares of stock at $50 per share," the quoted market price being then about $62 per share. Of the total offering Hayden, Stone & Co.—for the "pooled interests"—underwrote 75,000 shares. Of this amount only 73,437 shares were taken, yielding $3,671,850. The price of shares having shortly thereafter receded and remained below the limit ($50) stated in the offering, no further sales have since been reported, or could legally have been made, so that the sum stated ($3,671,850) includes all funds received or possessed by the company available under its peculiar financial practice with which to pay the cost of all mine equipment, stripping, improvement of its mills, purchase of rights-of-way, additional mining property, legal and all extraordinary expenses. At about that time the Wall Street Journal and other eastern papers reported a floating debt carried by the Utah Copper Company of about $2,100,000—and this was geneally understood to be the condition of the company's finances at the close of the year 1909.

As a consideration for "procuring" the consent of the American board of directors of the Boston Consolidated Copper & Gold Mining Company to an exchange of its shares for those of the Utah Copper Company the latter company—in addition to a bonus of 3,200 shares of stock of its company —paid to Samuel Untermyer, counsel of the Boston company, in cash $582,500, and also paid as expense of winding up the affairs of the Boston Consolidated company, the sum of $50,000. In addition to the above, the cost of taking several witnesses, newspaper men and engineers to New York for the purpose of securing suitable affidavits for use in the New Jersey courts, together with legal and other expenses incident to defense of an action brought by stockholders of the Utah company to prevent consolidation of the two companies, could not have been less than $100,000, no part of either of which sums have ever been mentioned in the Utah company's reports to its stockholders, and could only have been paid out of the money derived from the shares sold upon the underwriting of Hayden, Stone & Co., as before stated.

The cost of remodeling the Arthur and Magna mills has been officially estimated at $1,250,000, but will doubtless greatly exceed that sum. The company's annual for 1910 reports $101,000 paid for mining property, including $30,000 paid for the Shawmut group of claims, but makes no mention of $75,000 paid for the Barnsdall-Pay Roll group, nor of 6,650 shares of Utah Copper stock subsequently given to Barnsdall in payment for ores surreptitiously taken from his property prior to its purchase. The delivery of these shares, however, did not effect the company's immediate cash resources, and is only mentioned incidentally as of possible interest to any remaining outside shareholders. In addition to the foregoing, because of its inability to dispose of any more shares in the public market, the company borrowed $2,500,000 upon an issue of 6 per cent bonds, issued in the name of the Bingham & Garfield Railroad Co., the principal and interest being guaranteed by the Utah Copper Company, which of course is the sole beneficiary, the amount being a first lien upon all of the property of the Utah company and exchangeable for its shares at $50 per share.

An inspired item in one of the company's apparently subsidized papers—the Salt Lake Evening Telegram—of September 13, instant, and repeated the following day, gives the total cost of its Bingham & Garfield railroad as "more than five millions of dollars," which sum is doubtless several hundred thousand dollars below the actual amount which will have been consumed before complete equipment of this spectacular and unnecessary undertaking.

In addition to the foregoing the cost of "stripping" and removal of the overburden for the years 1910-11, together with the construction of several miles of switching tracks and the purchase of twelve or fourteen additional steam shovels, are yet to be provided for. The total cost of stripping, right-of-way and general expense for the year 1910 is stated in the anual report for the year at $1,260,666.31, of which amount $272,674.58 was charged to "operating" account, leaving a balance of $979,991.73 as a charge against the fund arising from the sale of shares to the Hayden, Stone & Co. "pooled interests" before referred to. The manager's report for the year 1910 states that "the total capping removed from both the Utah and Boston areas was 2,814,764 cubic yards." Therefore, by dividing the balance of $979,991.73 which remained after deducting the sum of $272,674.58 as "prepaid expense—ore stripping" from the total cost of stripping, we find that the balance of the net cost of stripping per cubic yard was a little more than 39 cents.

The second quarterly report for the current year states that "there was removed from both the Utah and Boston groups a total of 1,395,504 cubic yards of capping," and that for the first quarter of 1911 957,149 cubic yards were removed, the total for the two quarters ending June 30 being 2,352 649 cubic yards which, at 39 cents per yard, gives a total net cost of $917,533.11, all of which sums aggregate a total or $9,056,024.84, exclusive of the sum of $2,100,000—floating debt—carried over into the year 1910. At the present rate of stripping the foregoing debt will on that account—at the close of the year—have been further increased by at least $1,400,000, SO THAT AT THE END OF THE YEAR 1911 THE ACCUMULATED DEBT WILL HAVE REACHED THE STUPENDOU SUM OF $10,406 000, EXCLUSIVE OF ANY FLOATING DEBT which may have existed at the close of the year 1909.

In view of the foregoing facts it is not surprising that frantic appeals to the public should constantly arise from the quivering sheets that compose the company's publicity bureau, nor that this hungry squad should be augmented by volunteers from the impoverished field of so-called technical journalism—because, here the labor is light and compensation liberal, all "copy" being supplied from the main office.

Among the most recent recruits to the chorus of claquers is the Mining and Scientific Press, published at San Francisco, California, and controlled by T. A. Ricard—an "extinct" mining engineer—and the Mining Magazine, published at London, England, and edited by the same Mr. T. A. Ricard. The first requirement exacted of applicants seeking to enlist in the pie brigade seems to be vigorous denunciation of this journal and Col. Wall, former owner of the mining property comprising the principal holdings of the Utah Copper Company. Up to the present writing Geo. L. Walker, editor of the Boston Commercial and WALKER'S WEEKLY COPPER LETTER, occupies first place at the pie counter, he having displayed extraordinary versatility and refinement in the use of libelous expletives, as well as unctious appeals to the public to buy Utah Copper shares at any price. Ricard's opening remarks give promise that he will soon become a close second.

The following is from the pen of Mr. Ricard and appeared in his London Mining Magazine of August 11, 1911:

Among publications furnishing useful information on mining and metallurgical progress is Mines and Methods, a monthly journal published at Salt Lake City, Utah. It is now nearly two years old and is thus our contemporary in the literal as well as the literary sense. During these two years this Western American periodical has

provided a considerable quantity of technical information, which would have inspired greater confidence if obviously it had not been used chiefly as a stone to hurl at the head of the Utah Copper Company. Even a casual glance at the pages of Mines and Methods shows that its chief purpose is to attack the personnel of the management controlling the biggest copper enterprise in Utah. This vendetta is inspired by Colonel E. A. Wall, whose Improved Ore Jigger also furnishes a subject for the principal page of advertisement. Into Colonel Wall's quarrel with the Utah Copper we shall not probe, for we have no clear notion of its underlying cause, any more than that which prompted the violence of a verbal attack, duly recorded in Mines and Methods, made by the editor, Mr. Claude T. Rice, against Mr. D. C. Jackling, the general manager of the supposedly objectionable company. In the interests of technical journalism, however, we do not hesitate to say that technology ought not to be used as a cloak for a private quarrel. Notwithstanding the obvious merit of many of Mr. Rice's writings they are unreliable for the simple reason that so many of them are prepared not so much to give interesting technical data as to serve as a catapult against the Colonel's enemy; in short, they are not trustworthy. As now conducted Mines and Methods ranks with a broker's circular.

Our readers will search in vain the pages of Mines and Methods to find any justification of the allusions to Col. Wall contained in the article above, and as to Mr. Rice: his relations to this magazine were completely terminated in the month of May, 1910—seventeen months ago—which fact was published at the time in Mines and Methods. And in fairness to Mr. Rice and this journal it may be said that during his employment as editor none of the comments upon or discussions of the Utah Copper Company's mines, management or methods, which from time to time appeared in this publication were written by Mr. Rice, excepting a certain illustrated description of the Garfield mill and an account of a certain controversy which arose between Mr. Rice and Mr. Jackling in the latter's office. Mr. Rice was in the field the greater portion of the term of his employment, visiting the mines of Arizona, Mexico, Nevada and Montana, and his work was therefore almost wholly of a technical and descriptive character, in which field he has few equals and no superior.

Before his engagement with this journal Mr. Rice for several months occupied the position of assistant editor of the Mining and Scientific Press, under the same Mr. Ricard, and it now seems probable that Mr. Ricard, in the article above quoted, has taken occasion to even up some old scores or jealousies and at the same time pave the way to the favor of the management of the Utah Copper Company.

Late developments indicate that Mr. Ricard's California journal will shortly open up for the Utah company with the publication of the result of a purported personal inspection of its properties by one of its staff who recently visited the property, and which will as well supply necessary material for Mr. Ricard's London publication, thus providing real "hot stuff" for consumption of his London constituency, who are being quietly advised to "load up" on Utah, Chino and Ray Con.

It may not be amiss at this juncture to remind our English readers that Mr. T. A. Ricard, editor of the London Mining Magazine and chief owner of the San Francisco Mining and Scientific Press, is the same T. A. Ricard—late mining engineer—upon whose report the INDEPENDENCE MINE, situated at Cripple Creek, Colorado, was bought by credulous English people who paid therefor the very comfortable sum of $10,000,000. The sequel to this transaction, as told by numerous credible persons resident of Cripple Creek at the time, is briefly as follows: It appears that upon conclusion of the sale an English gentleman was placed in charge of the business management of the property with A. Chester Beatty—brother-in-law to Mr. Ricard—as assistant; that in order to insure a permanent market for the ores at a price and upon terms satisfactory to the management, a contract was made with a prominent "ore sampling and reduction company" which provided for the sale of the product of the mine to that company for a period of four years, it being specifically provided in the contract that the PURCHASER should sample and thereby determine the value of the ore and the price per ton to be paid therefor. This method, it appears, was thought to be necessary because of the fact that frequent complaints had theretofore been made by other shippers to the effect that dishonest returns had been made by this and other sampling companies, so that it was often charged that it was impossible for small shippers to secure anything like the true value of their ores; and therefore, to avoid dissatisfaction and dispute in respect to the price to be paid for the ores of the Independence mine, it appears that the entire responsibility of DETERMINING THE VALUE AND THE PRICE TO BE PAID was—by the contract—IMPOSED UPON THE PURCHASERS.

This method—according to the evidence at hand—worked to the entire satisfaction of all parties IMMEDIATELY concerned for some three years and until the fact was noticed by some of the inquisitive English owners that the grade of the ore, as shown by the report of sales, was running very much below the estimate of Mr. Ricard, upon which the property had been purchased. In fact ores indicated by the report of Mr. Ricard as having an average value of $200 per ton and over, were uniformly returned as of the value of only

$20 to $30 per ton. These allegations were naturally disquieting and finally led to open charges that the mine had been "salted," and of course the blame at once attached to Mr. Ricard who, without much delay, admitted that deception had been practiced upon the English purchasers but was able, it appears, to convince them that he had been imposed upon and deceived by subordinates employed by him in sampling the mine. As a result of the exposure, however, Mr. Ricard severed his connection with the property and publicly announced his retirement from the practice of mining engineering —a resolution which he has faithfully observed ever since. It appears that Mr. Ricadr's brother-in-law, Mr. Beatty—who had become disgruntled at his kinsman—reported inside conditions to John Hays Hammond, then in the service of the Venture Corporation, the purchaser, who at once proceeded to Cripple Creek, ousted the delinquent management (with the exception of Beatty), and declared void the contract upon which the ores had been disposed of—and to which the "sampling and reduction company" meekly submitted, although the contract had then still something more than a year to run.

It may be significant to note that, upon the assumption of the management of the property by Mr. Hammond, it is said that the grade of the ore simultaneously increased to a point approaching approximately the original value represented by Mr. Ricard. So that, as we are informed, our English friends have practically since recouped their supposed loss and are in a fair way to eventually reap a handsome profit. It is said, also, that the company which purchased the ores of the Independence mine, NOTWITHSTANDING THE HARSH TERMS OF THE CONTRACT BEFORE ALLUDED TO, were able—through the exercise of exceptional metallurgical skill—in the short space of three years to clean up about $6,000,000, besides gaining a knowledge of the treatment of low-grade ores which has enabled them to secure almost a monopoly of our newly-discovered "disseminated" porphyry ores. It is worthy of note in this connection that this little band of metallurgical wonders guard the secrets of their Cripple Creek success with more than brotherly solicitude, so that any member of the original group may command the support of the whole on any occasion, for any purpose or adventure; so solicitous are each of the members for the common weal and so fearful are they that in some unguarded moment these precious metallurgical secrets may be lost, that they never violate the compact under which they "stand together."

Upon his retirement from the profession in which he had acquired prominent distinction Mr. Ricard invested a portion of his savings in the purchase of the New York Engineering and Mining Journal, valued at some $500,000 and which, becoming unprofitable, or uncongenial, he sold. Subsequently he bought the San Francisco Mining and Scientific Press, but finding the duties of editing this small sheet too circumscribed, he took up his abode in London and began the publication of the Mining Magazine, the services of which have evidently been called for by his erstwhile metallurgical friends. We shall endeavor to keep our readers informed of the progress of Mr. Ricard's labors in behalf of the Utah Copper Company in its efforts to distribute its shares among our English friends.

FRIENDLY RELATIONS STRAINED

We regret to note that the friendly relations which for many years have existed between D. C. Jackling, general manager of the Utah Copper, Nevada Consolidated, Chino and Ray Consolidated companies, and Mr. George O. Bradley, mechanical and constructing engineer of the Ray Consolidated company have become strained and that, in consequence, Mr. Bradley has been—or will shortly be—relieved by the manager.

It appears that the Ray Consolidated mill—which in minutest detail was modeled after the original Copperton and Garfield mills—has failed to meet the expectations of Manager Jackling, notwithstanding the fact that the designs and plans upon which the mill was built were as ordered by him. It now appears—much to the surprise of the manager and "Metallurgist" Janney—that serious metallurgical complications have developed in the minerological structure of the Ray Con. "disseminated" ore which renders it stubbornly refractory and unyielding to the Utah Copper method of concentration and that Mr. Bradley is held to be responsible for the unsatisfactory conditions that have resulted therefrom. But we have good reasons for believing that Mr. Bradley is entirely blameless in this regard.

The facts are that the methods originally employed at the Garfield mill have been quietly undergoing changes in order to conform to the more modern and sane methods so persistently urged by Col. Wall previous to his resignation from the directorate of the Utah company and that the nature of these changes, which have proven to be the salvation of the Utah company—if there be any—have been concealed from Mr. Bradley as well as the public. So that, the Ray Con. mill now proves to have been constructed upon the plans of a discarded system, and therefore does not conform to the requirements of metallurgical advancements now in partial use at the Magna plant.

We shall watch further development with much interest, but offer the suggestion at this time that a solution of the difficulties probably lies in the adoption of some process of leaching, in which event, however—to insure any degree of success—it will be necessary to secure the services of a REAL metallurgist.

UTAH COPPER AS VIEWED BY ITS OWN SUBSIDIZED PRESS

We have devoted a considerable portion of this and previous issues of Mines and Methods to a review and discussion of the operations of the Utah Copper Company and have made frequent allusion to its method of spreading broadcast through the public press extravagant and untruthful statements regarding the condition of its affairs and the "matchless" genius and skill of its management. Because of these utterances we now find some of the most subservient pensioners of this powerful corporation engaged in the publication and distribution of slanderous innuendoes directed against this journal and its supposed friends, coupled with ridiculously false statements regarding the value of the company's mines, all of which publications are procured palpably for the purpose of promoting the sale of shares of its stock.

And now—in respect to the wishes of the manager of this corporation—having suspended the publication of all advertising matter and thus secured a few additional pages of room, (lest we be accused of bias in the character of information given to our readers), we have determined to reproduce from time to time some of the concoctions which are being doled out by the paid corps of writers which make up the company's "publicity bureau." In pursuing this course we shall make such comments with respect to the matter published as may seem pertinent, but will give our readers an opportunity to acquire a knowledge of the ESTIMATE OF VALUE TO INVESTORS that is placed upon shares of the corporation by the pooled interests. The following, which is reproduced under the regular heading of the document, is from the pen of Geo. L. Walker, editor of the Boston Commercial and Walker's Weekly Copper Letter, and is the assumed result of a critical, personal examination of the property, "written at Bingham, Utah:"

CHARLES T. DUKELOW. GEORGE L. WALKER.

CABLE ADDRESS, "WALDUKE," BOSTON.

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BOSTON, SEPTEMBER 8, 1911.

WALKER'S WEEKLY COPPER LETTER No. 463.

Utah Copper is almost as big as all the other porphyries combined. It will mine and treat 300,000,000 tons of ore, and possibly 500,000,000, before its property is exhausted. Should its management continue to develop new methods of economical handling and treatment, as it is doing now, it will be sending 1 per cent ores to the mill 25 or 30 years hence and still be making copper at a cost of seven or eight cents a pound.

Three or four years ago Utah Copper's concentrator was making an average recovery of 64 to 66 per cent of the value in the ore. The four sections of its Arthur mill, which have been remodeled, are now recovering 75 to 76 per cent of the values from a lower and therefore more difficult grade of ore to concentrate.

No effort is being made to mine a high average grade of ore at present. Two of its steam shovels are loading cars now from one of the lowest grade areas in the property. These areas could easily be avoided and ore that will average nearly 2 per cent supplied to the concentrator; but Utah Copper is being operated on business principles, as a permanent and not as a temporary enterprise.

There is a belt of ore extending through the center of Utah Copper's big deposit for a distance of nearly a mile, which will average almost 2 per cent copper. It is about 850 feet wide, and the deepest drill holes and other openings in it, 700 or 800 feet below the surface, were stopped in 1½ per cent ore. There is more than a possibility that this area alone will contain, when fully developed, as much ore as the management estimated in last year's report, 220,000,000 tons.

It will take Utah Copper between 50 and 100 years to exhaust its ore resources, even after it attains to a daily output of 20,000 tons. Meanwhile its operating costs will be gradually reduced and its savings, or recovery of values, increased. Undoubtedly there is at least 6,000,000,000 pounds of recoverable copper in its ore body. A profit of five cents a pound on this amount will mean an ultimate return of $300,000 000 to stockholders.

Taken as a whole, the Utah Copper company's ore area is about a mile long and a half a mile wide. Prospecting and development to date indicate that the ore averages considerably over 300 feet in thickness. As a matter of fact, however, the full depth of the ore has not been determined. Accidents stopped several drill holes when they were still in 1½ to 2 per cent ore, and no tonnage has ever been calculated below such openings by the management, except where underground openings have gone deeper. Years ago some diamond drills were stopped when they got down into the 1½ per cent horizon, as in those days even this was not considered ore at all. With the company's present facilities for handling, and its low concentrating costs, this is now good ore.

Considered in a general way the Utah Copper ore body is richer in the upper 200 feet and gradually declines in value with greater depth, and also toward the outer rims. During the first 40 or 50 years of its operations the company will mine and treat ore averaging between 1.55 and 1.75 per cent copper; and in the remaining 35 or 40 years of its career it will work on ore running from 1.15 to 1.45 per cent. There is every prospect, however, that operating costs per ton will be reduced and the percentage of values recovered will increase more rapidly than the grade of the ore will decline. With copper selling at 12½ cents, therefore, the profit realized on a ton of 1.25 per cent ore will probably be greater 40 years hence than it is on 1.60 per cent ore now.

As has been explained previously, the Utah Copper company is laboring under many disadvantages at present which will be overcome and eliminated one after another. The area from which it gets its steam shovel ore is so small that blasting and the switching of trains cause frequent delays and loss of time. When five or six times as much ore has been completely stripped, and this will be accomplished within a year, elimination of delays will reduce the cost of steam shovel mining at least 10 per cent; and there will be a further reduction in costs due to the decrease in the percentage of all the ore extracted that is mined underground.

Through the operation of its own railroad the cost of getting a ton of ore from the mine to the mill will probably be reduced 17 cents, equivalent to three-quarters of a cent per pound of copper produced. The railroad is completed from the mine to the Magna plant, 17½ miles as compared with 27 miles by the road now used. It is a magnificent line, having several tunnels, big steel bridges, a splendidly ballasted roadbed, few curves, 90-pound rails, commodious terminals and a maximum 2½ per cent grade in favor of the load from the mine down to the mill. The beginning of operations is being delayed by the difficulty the trunk lines are experiencing in transporting the immense locomotives, the largest ever built, from the shops in the East to Salt Lake City.

About 2,200 men are employed at the Utah Copper mine, and approximately 50,000 tons of capping and ore is being moved daily, or 23 tons per man. Of this amount 13,000 tons is ore and 37,000 tons is stripping. It will thus be seen that the company is working for the future more than the present, as there are three and a third times as many tons of ore in the property as there are of stripping to be removed. The thickness of the capping is so great and its position such, on the side of a steep mountain, that it cannot be removed acre by acre as the ore is needed; but it must be stripped over a very-wide area and benched back to make room for many steam shovels, and to overcome the possibility of caving such as would tend to mix the capping with the ore.

The engineers' figures indicate that 37,500,000 cubic yards of stripping will have to be removed to uncover the ore body fully and provide necessary stopes along the rims to permit of its complete extraction. Of this amount 29,000,000 cubic yards lies on the ore and 8,500,000 in the slope areas.

So far 9,385,000 cubic yards of stripping, or between 25 and 30 per cent of the whole, has been removed, equivalent to uncovering over 60,000,000 tons of ore. Only 13,500,000 tons of this ore has been excavated and treated. This means that about five times as much ore has been stripped as mined. So far this year 15,000,000 tons has been uncovered and only 2,500,000 mined, a ratio of six to one. This great amount of advance stripping is being done to prepare for a larger daily production and consequent lower costs.

The prediction that Utah Copper will be able to produce its copper at a gross cost of six and a half to seven cents a pound after another year of stripping and preparatory work are based upon actual deductions conservatively made from results now being accomplished. These figures are arrived at by subtracting the savings to be effected by operating its own railroad, running its concentrators at full capacity, the higher average recovery of values throughout that has been demonstrated on four sections of the Arthur mill, a more advantageous utilization of labor at the mine through the elimination of delays and the reduction of smelting penalties by classifying and cleaning the concentrates. Acareful summary of these several items indicates a coming reduction of more than a cent and a half per pound in the company's cost of making copper.

Reference has been made in the foregoing to underground mining. About 3,000 tons of ore is being taken out of the Boston Consolidated ground daily. It is mined in an area that will be stripped and steam shoveled later on, and sufficient broken ore is left in the stopes, therefore, to prevent the capping from caving. The pillars, also, are left intact. About 330 men are employed underground, the ratio of extraction being eight tons daily per man for all miners and surface men in this department.

Some time ago I wrote an extended article on Utah Copper in which I reviewed its financial operations from the beginning and presented figures to prove that the company has paid all its underground development and stripping expense, and its dividends, also, out of net earnings. The article was written for those who want reliable information; it was criticized by those who don't.

One critic declared there was nothing at the mine to account for the $809,251 expended on plant at the mine, including shops, dwellings, etc., but a machine shop and a few other unimportant buildings. Statements of this character are so misleading that it is difficult to credit one making them with honest intentions. When I was at the mine I saw 22 steam shovels, 400 ore cars and 45 locomotives, the first cost of which must have been $1,000,000, and beside churn and air drills, compressors and the other equipment. I assume, also, that the cost of its water works and teams went into the construction account. All these things cost a lot of money and they are not accounted for in any of the other items presented.

In every mining district where big porphyry mines are being developed I find a number of nice old gentlemen who do not believe these companies will ever make a dollar of profit. These men are pioneer miners who have spent the best portion of their lives hunting for high grade ore, rich enough to mine with elbow grease and send to market on the back of a mule. They were brought up to believe that low grade ore was worthless, and it takes more than a lot of churn drills, steam shovels and big concentrators to convince them to the contrary. Having been educated to small things, they are unable to grasp and comprehend the enterprises of great magnitude that are being worked out by younger men.

These old gentlemen are entirely harmless, except when they use the money they receive for properties they themselves could not operate, to publish newspapers or magazines for the dissemination of their circumscribed ideas. When they do this some of their few readers take them seriously for a time; but sooner or later even these learn to distinguish between disinterested information and spleen.

The Utah Copper company's property is no longer a prospect, and its methods of operating are far and away beyond the experimental stage. It owns the largest demonstrated body of copper ore in the world and the biggest and best concentrators. As yet it is in the development stage and its tremendous possibilities are only beginning to be realized. Eventually it will produce over 150,000,000 pounds of copper annually—200,000,000 pounds including its proportion of Nevada Consolidated's output—and earn $7 a share on a 13 cent metal market, and $9 when copper sells at 15 cents. Its stock is one of the cheapest and safest mining investments in the world.

Readers will note that the opening paragraph declares that "the Utah company will mine and treat 300,000,000 tons of ore and probably 500,000,000 tons." The last annual report issued by the company places the amount of ore at 203,000,000, which was a jump of about 1,000,000 tons over the amount reported at the close of the previous year and in that case—like Walker—no previous announcement had been made of any new development or of work having been done which tended toward new discoveries. The closing words of this interesting narration are: "Its stock is one of the cheapest and safest mining investments in the world."

When we come to consider that Mr. Walker's writings during the last few years have enabled him to accumulate several millions of dollars one can form some idea of the value or cost of the foregoing to the Utah company; but perhaps a more correct conclusion in respect thereto may be found from the following, which is related by a newspaper man of this city: It appears that during Mr. Walker's last annual swing around the circle of Western contributing mines he prepared and published a highly complimentary description of the property of the Mason Valley Copper company's mines at Yerington, Nevada. This happened at a time when that company was offering for sale an issue of bonds for the purpose of securing funds with which to equip their property with a smelter. In recognition of the aid rendered by Mr. Walker, it was said that the company promptly sent him a check for $1,500, which he as promptly returned with the remark that the write-up was worth to the Mason Valley company $5,000. Whether that amount was paid or not our informant was not advised, but we note that Mr. Walker's report on Mason Valley for this year is even more favorable than the last, and therefore it may be inferred the estimated value of the precious send-off was paid.

No Advertising In This Issue

Our patrons will observe that this issue of Mines and Methods appears without any advertising patronage. It has never had much and freely surrenders the little it has had. This policy will be continued in the future until such time as the shadow of the displeasure of the manager of the Utah Copper Company shall cease to bar the exercise of business judgment and independence on the part of our citizens who would otherwise gladly avail themselves of the wide circulation of this journal as a means of promoting legitimate business and industrial enterprise. In so far as the gain or loss of immediate profit is concerned, it is a matter of no concern to the publishers whether they are favored with advertising patronage or not, although we admit that a publication of the character we have sought to make of this journal must labor under pronounced disadvantage unless it can have moral and financial support of the tradespeople of the community it seeks to serve. And we confess to exceeding humiliation that a whole cityfull of intelligent, enterprising, industrious and thriving American citizens, should be so overawed by the power and will of a great corporation that they must, perforce, forego the privilege of displaying their wares in the marketplace lest they give offense. We feel grateful to certain of our patrons who had the courage to refuse to withdraw their advertisements upon the demand of the manager of the corporation mentioned, but we have determined to relieve them of further embarrassment in that regard by adopting the course before indicated.

We publish below a letter received from Mr. D. E. Burley, general passenger agent of the Oregon Short Line Railroad Company, whose advertisement was dropped in accordance therewith from our July number. Insertion of the advertisement referred to in Mr. Burley's letter was not sought by us, but was soliciated by Mr. D. S. Spencer, assistant general passenger agent of the same company, and therefore the language in which the request for withdrawal is expressed by Mr. Burley is exceedingly disingenious and unfair; but perhaps it should be excused on the ground that Mr. Burley—as we are informed—has profited greatly by investment in the shares of Utah and other mining corporations promoted by the people who control the affairs of the Utah Copper Company and was therefore desirous of manifesting his gratitude and subserviency in fitting terms. Following is a copy of the letter referred to:

Salt Lake City, Utah, June 29, 1911.
Mines and Methods Publishing Co.,
306 Tribune Building, City.
Gentlemen:

I note in a recent issue of "Mines and Methods" that you are carrying our display advertisement. As we have arranged no contract during the present year and as the copy you are carrying is obsolete, I shall be obliged if you will kindly have it discontinued.

(Signed) Yours truly,
D. E. BURLEY.

Other patrons have frankly stated that they had been warned by the manager of the Utah company that unless they ceased advertising in this magazine all trade patronage of that company would be withdrawan and therefore, as before indicated, we think it due to our friends that they be left free to struggle for a share of the crumbs that may be allowed to descend to those who are fortunate enough to secure the favor of this corporation.

Our offense consists in having questioned the engineering ability and practical experience of the management of the Utah Copper Company and the integrity of the reports of its officers to its shareholders. Every charge of incompetency or lack of candor which we have preferred has been completely verified and, as a result, many stupid blunders resulting from lack of knowledge and experience in conducting operations which by chance had fallen into their hands, have been materially improved; but the crowning absurdity in engineering mimicry still goes on with ever-increasing vigor. Twenty-four steam shovels are now required to provide the daily supply of ore for the mills, where less than half that number were needed two years ago to secure an equal quantity. And all these are supplemented by several hundred underground miners who supply nearly double the quantity of ore that was obtained from that source two years ago, at which time stockholders were assured that by the close of the year 1909 all underground mining would practically cease.

We have shown repeatedly—and the fact is apparent to every disinterested engineer who has visted the premises—that profitable extraction of this ore by means of steam shovels (because of insuperable barriers) is a physical impossibility. And we now again assert that a fair charge of all costs incident to the installation and operation of these machines, against the metal produced, would overbalance by more than $3,000,000 every dollar of assumed profit derived from the entire product of the mines from the commencement of operations to this date, and that this disparity of cost will continue and increase as long as this method is pursued.

Although we have frequently shown that the grade and quantity of ore available for extraction or known to exist in the property has at all times been grossly exaggerated and misrepresented by the trusted officers of the company in their reports to the stockholders and the public, we have consistently maintained that the property contains practically unlimited quantities of ore which—with intelligent methods—could be mined and treated at a very large profit; that, with the exception of the soil and stream gravel which occurs in depressions and flat portions of the surface, the so-called "capping," which has been removed to the extent of probably 15,000,000 tons would—if subjected to methods of crushing and concentration in use in any modern, first-class mill in Utah, Idaho, Montana or the Lake region—have yielded more profit per ton than is claimed to have been derived from the selected ores treated at the mills of the Utah company. And we have maintained, and challenge contradiction by any capable engineer, that all of the ores heretofore mined by steam shovel, and all so-called capping heretofore removed, and all known ores and capping remaining on the westerly side of the canyon stream, could have been, or can now be, mined and delivered into railroad cars at less than 10c. per ton by the very simple method known in miners' parlance as the "milling" or "gloryhole" system, such as is frequently applied to the extraction of iron ores in certain favored localities and as employed in modified form in the Treadwell mine, at Juneau, Alaska. In that instance, however, the rock is extremely hard and tough and costs are therefore comparatively high, yet infinitely lower than the cost which results from the operation of steam shovels upon the precipitous mountains of Bingham.

We have also characterized the construction of the Bingham & Garfield railroad as a reckless dissipation of the company's resources, absolutely unnecessary and indefensible from any view other than that it was expected to stimulate traffic in the shares held by the pooled interests. A few brief facts will demonstrate the correctness of our position: The assumed necessity for the construction of this road was predicated upon the pretense that the Rio Grande Western Railroad company had failed and was physically unable to transport the amount of ore required daily for the operation of their mills at their then existing capacity and that, therefore, that company could not possibly provide transportation for the increased tonnage of 16,000 to 20,000 tons which would be required to supply the mills when their capacity should be increased to that amount. At the same time we showed the fact to be that the R. G. W. Railroad company had frequently transported and delivered at the Utah company's mills more than 20,000 per day, and on certain occasions as much as 24,000 tons in one day, and that at all times, except in case of accidents or severe snow-storms, they had hauled all ore required as rapidly as the cars were filled and placed upon the receiving tracks.

During the progress of construction of the Garfield mill, when complaints against the railroad company were most persistent, we showed from actual figures that for a period of several months the railroad had actually delivered at the company's mills more than 1000 tons of ore a day IN EXCESS of the RATED CAPACITY of the completed portion of their mills—and nearly 2000 tons a day in excess of the amount claimed by the officers of the company as being treated at their mills.

But it was claimed that the rate charged per ton was high, and that a great saving would be made for the shareholder by transporting the ore themselves over their own road. This claim is wholly untenable, as we shall show: The contract with the R. G. W. R. R. Co. was for 6000 tons a day for a period of twenty years ending in 1926, and the rate for the first five years was 27½c. per ton, and thereafter 25c. per ton so that, from the close of this fiscal year, the rate will be only 25c. per ton.

A local official organ of the Utah company reports the estimated cost of transportation over the new Bingham & Garfield road at 17c. per ton. This compares with like cost of transportation by the Anaconda Mining Company, at Butte, over about the same distance but much easier grades and practically free from short curves. We predict, however, that costs on the Utah line will exceed 20c. per ton, owing to the many "switch-backs" and sharp curves to be encountered in getting down from the high mountain, where the ore will be loaded, to the main line, which itself is a succession of sharp curves and dangerous grades, as was forcibly suggested by the fact that one of the first trains consisting of some twenty odd R. G. W. cars jumped the track and as a result are now in the repair shops.

Assuming a cost of 17c. per ton over the new road, there would be an apparent gain of 8c. per ton as compared to the price paid the R. G. W. R. R. Co. A similar contract was entered into with the Boston Con. company about the same time for the same daily tonnage—6000 tons. This leaves only 8000 tons a day available to be handled by the new B. & G. R. R., provided the milling capacity be increased to the indicated amount. Working every day in the year the new road could haul only 2,920,000 tons of ore per year which, at 8c. per ton, would yield an apparent profit of $232,600. The cost of the Bingham & Garfield road is now conceded to be in excess of $5,000,000, of which amount $2,500,000 is represented by an issue of 6% interest-bearing bonds. The remaining sum cannot bear less interest. Therefore, $5,000,000 at 6% will produce an annual interest charge of $300,000, which sum exceeds the highest possible profit to be derived from the operation of the new road by $66,400. It has been erroneously claimed that the contract of the R. G. W. R. R. Co. with the Boston company is void and cannot be enforced. If this were true the new road would then have possible for transportation per year 5,110,000 tons of ore, upon which an apparent profit of 8c. per ton would yield $408,800 per annum, being $108,800 per annum in excess of the interest on the cost of its road. At this rate the investment would be returned IN A LITTLE MORE THAN FORTY-NINE YEARS providing, of course, that the supply of ore continued and that no time was lost—and also that the mills and the road should not wear out. But unless this "marvelous structure" should be exceptionally favored its entire equipment would have to be renewed every ten years, or five times during the period of forty-nine years required to recoup its original cost—all of which facts simply serve to emphasize the glaring absurdity of the whole stupid business.

In a previous issue we predicted that on completion of the Bingham & Garfield railroad it would, of necessity, be turned over to the Denver & Rio Grande Railroad Company and would thereafter be operated by that company under some form of lease which would relieve the Utah-B. & G. R. R. Company of much embarrassment and enable its officers to proclaim to the public that a rate for transportation of its ores had been secured that was even more favorable to the Utah company than would result from operating its own line—as happened in the case of the collapse of the Ray smelter fiasco, wherein it was proclaimed that a favorable rate for smelting the ore had been secured from the Guggenheims, who succeeded to the ownership of that wreck.

Our predictions have already been confirmed in the fact that a junction of the track of the supposed hostile lines has been effected and the R. G. W. R. R. Co. is now engaged in hauling Utah ores to the mills over the new Bingham & Garfield Railroad Company's lines.

MAKING MINING LEGITIMATE

Every man with a prospect to sell and every person who contemplates the purchase of mining property, or investment in new mining propositions, should read the following comment of Oscar Lachmund, taken from the Mining and Engineering World of the 16th, on "Investigation of Mining Properties:"

The condition confronting the field engineer today in his quest for desirable mining property, is usually one if high prices and unreasonable terms. In addition to this, the value of the ore and the tonnage as set forth in preliminary reports and statements, are generally overestimated, not to say purposely exaggerated. A prominent mining engineer, in speaking of conditions as at present existing in the camp of Porcupine, facetiously states that mere prospects are held at $50,000 each, and that for each speck of visible gold an additional "$50,000 per speck" is asked.

On the other hand, a certain mine in Oregon is said to have changed owners recently, and under the terms of the sale the buyers, after making the initial payment, are permitted to extract from the mine, ore of sufficient value to reimburse themselves, before another payment becomes due, and so on, until the mine is paid for. These are ideal conditions for the purchaser and are not often encountered in mining deals. Within the limits of these two extremes, many meritorious properties are found, which could easily be sold to the advantage of all interested parties, but the prices and terms are usually such that the owners will hold them a long time, unless they change their views.

A developed property with a measurable tonnage of positive ore demonstrated, may command a reasonable "cash down" payment, but the owner of the prospect must realize that, in order to get his property developed at somebody else's expense, he must allow the greater portion, if not all of the purchase price, to come out of the ground, and not out of the pocket of the purchaser.

It is apropos right here, to mention the proverbial "sucker crop;" but, fortunately, this is growing smaller each year, due to the active campaign against "wild cats," which is being carried on by the reputable mining press.

The average owner of mining property expects the prospective purchaser to take a "long chance" and assume the burden of proving up his property for him. The most equitable way is to allow him to take it over on a lease with a bond to purchase at the end of a given time, say from 2 to 5 years, with reasonable payments at long intervals. Unless an appreciable amount of shipping ore is "in sight," no cash payment "down" should be exacted. Development should be allowed to proceed until a reasonable time has elapsed, when the first payment might be made. This should be as small as consistent with the showing on the property when operations began, and the subsequent installments could be increased gradually until the entire amount of the bond had been taken up, within the life of the lease.

In the case of a developed property, the positive and probable ore reserves should show the return of the purchase price of the mine; the cost of plant installation necessary to place the property on a producing basis; the cost of extracting and beneficiating the ore, and a reasonable rate of interest on all of this capital, while the ore reserves are being extracted. If the property had met all of these requirements, it would simply be a case of "swapping dollars"; it must do more than this in order to be classed as an investment. It should earn at least 15% to 20% per annum during the entire period of production to be an attractive proposition.

This may seem unreasonable to the average prospector and claim owner, or, to owners of developed mines, but when one takes into consideration that the business man requires that a new business shall show a return of the capital invested, plus the usual interest on this money while it is being earned, plus a reasonable margin of profit each year while he remains in this business, it brings mining down to legitimate business principles, and this is where it rightly belongs.

Many complaints are heard about the difficulty of inducing capitalists to invest in mining schemes; that the times are not as they used to be, when it was only necessary to state what was "in sight," when money would be forthcoming at once, etc. Times have changed. The capitalist has been "stung" too often. He is beginning to employ technical help to advise him in his mining ventures. There is plenty of money seeking investment in the legitimate mining propositions today.

There is always a reason for wishing to sell mining property, and if the reports are flattering and the price and terms seem reasonable, there is generally a "nigger in the wood pile." This is the problem the field engineer is called upon to solve. On the other hand, if it is a large low-grade proposition needing an expensive equipment before profitable production could be expected, the reason for wanting to sell would be apparent, especially if the owner was financially unable to buy the necessary machinery.

As a rule, the preliminary report or owner's statement offered the engineer for consideration, is favorable to the property in question, and usually contains such glowing accounts of its merits that the first thing that comes to mind is the question, "What's the matter with it?" There is nothing to do but go and look at it, or run the risk of overlooking the "one chance in a thousand" of finding a real mine. But, if all these numerous propositions were to be visited, a large fortune would be required to defray traveling and other expenses, to say nothing of the engineer's time.

It is becoming the rule to insist on the seller's guaranteeing his statements and reports, by agreeing to reimburse the engineer for any expense he may be put to should he be unable to check the reports within reason. A better way would be to offer to pay the engineer's traveling expenses in advance, these to be returned by him in the event the reports were confirmed. As against this, the engineer should be able to satisfy the seller, by references or otherwise, that he is competent to make a correct mine examination.

Send a copy of this issue to some distant friend.

Mines and Methods

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TWO KINDS OF WORKMEN

The Engineering and Mining Journal very pointedly observes: "There are two kinds of workmen. One works only to get in his time; the other works to do a good job and has joy in doing it. One drops his hammer at the first pull on the whistle cord; the other finishes driving the nail, and more, if necessary. One works to do somebody; the other to do something. The second kind of workman does not have to strike for increase in pay. That matter takes care of itself, and the man is apt to become a foreman and otherwise rise in the world. The other kind is fired when business is slack and then loafs around with a grievance."

Owing to delay in receiving copy through the mails, we have been compelled to hold Mr. W. L. Austin's article on "Leaching of Copper Ore" over till next month.

MONOPOLIES OF CAPITAL AND MONOPOLIES OF LABOR

By W. L. AUSTIN.

"The Standard Oil Company is no more. Its disoecta membra are scattered over a continent. Each of the thirty octopean tentacles is now a separate entity. The great central trust is 'busted' into thirty smaller trusts. There are thirty boards of directors instead of one board, and thirty presidents instead of one president. Each stockholder in the Standard Oil Company will have an equal number of shares in each of the thirty companies. The thirty companies will not be apt to compete with each other as at present constituted, for there is no instance on record of a man competing with himself. The question now arises, where does the public come in? Will coal oil or gasoline be any cheaper?

Where does the public come in? Well, for one thing there will be more men employed by the thirty separate trusts than found occupation under one gigantic corporation. More clerks, more artisans, and more laborers, for it will be necessary to keep up at least the semblance of conducting thirty separate businesses. More money will be distributed among the working class and less will go to those whose disregard for the laws of the land has enabled them to amass more than that to which they are rightfully entitled, for it has been decided by the Supreme Court of the United States that the Standard Oil Company was an unlawful combination. The prices of the articles manufactured and sold may not be reduced; but the profits that formerly went to the particular trusts which have been ordered to resolve themselves into their component parts, will be less, and much of the cash that found its way into the pockets of the few will now go into more general circulation, because it will not be practical for pre-existing "economies" to be exploited to the same extent as has been done.

It would be well, (now that a way has been found to de-organize monopolies), if the good work were carried forward until the power to work evil, of gigantic business combinations of whatever nature, corporate and incorporate, is given its quietus. If all the trusts in the country were compelled to disintegrate into the units out of which they were formed, it is manifest that many more opportunities would be available for those who are at the present time relegated to idleness on account of being deprived of their former occupations, through contractions (economies) enforced by the aforesaid trusts.

The railroads are complaining that business is light and that therefore retrenchment is necessary. Naturally, what else is to be expected? Men are being laid off at the iron mills and factories of all kinds; everywhere the ranks of the unemployed are being augmented, those of the workers decreased. As the number of spenders is reduced, the seriousness of the situation is aggravated. The American people are extravagant as a rule; but how can men spend money when they are not permitted to earn it? A mill-hand when thrown out of employment through stagnation in the iron trade, (due to lessened demand for the product of his handiwork because others who need it have not the means to pay for it, owing to similar stagnation in their particular lines of business for like reasons), cannot at once turn his hand to farming, nor can a miner start in growing cotton when the property with which he is connected closes down. Each individual has his trade, and when some huge combination is made, and economies are started which deprive him of ability to earn a livelihood at the occupation in which experience has made him proficient, he is usually placed in sore straits. The West to which, when undeveloped, any man could go and find something to do, no longer affords the same opportunities. Times have changed and enforced idleness exists there as elsewhere, for great combinations have stifled individual effort to a great extent there also.

One point appears to have been overlooked by those who advocate trusts, which is, that to make business, opportunity to earn a living must be extended to the mass of the people of a country, and not be confined to a select few: that the buying capacity of the many is at least as essential to general business prosperity, as is the ability to produce cheaply through combination and contraction. Artificially sustained monopolistic production, combined with exorbitant prices, is fatal to the prosperity of the country as a whole—when a large percentage of the spenders have to practice close economy. This patent fact is evident to such as possess the faculty of foreseeing coming events, and accounts in a great measure for declining values on the stock exchanges. Reducing expenses by throwing men out of employment is likely to be followed by reduction or suspension of dividends on the part of the great corporations, in order that they may be in a position to meet necessary operating expenses later.

We are told that the great combinations of capital, and those formed by a portion of the working men, the so-called trusts and the modern labor unions, have come to stay; that the country during the past two decades has undergone an economic revolution and that the result might as well be accepted as an accomplished fact. This may or may not be so: it is too soon to jump to conclusions. Where in the past whole communities have been affected by any kind of a revolution, often a considerable period has elapsed before popular sentiment became clearly established. In these days of rapid communication events transpire more quickly, but still consume time; the great public is not organized, but public sentiment when it finally reaches expression will be the deciding factor in the monopoly question as in all others.

It is true that during recent years there has been a great change in economic conditions in this and other lands, but the world-wide unrest which has thereby been occasioned warrants the entertainment of a reasonable doubt as to whether the existing state of affairs will be permitted to endure. Whether the masses will acquiesce in the retention on the part of those who have the grabbing faculty highly developed, of all that they have been able to gather unto themselves. In any event, conditions which have brought about the elimination of a large part of the spenders will require adjustment before the railroads and other industries are able to resume business on the old basis.

One of the principal claims made for "big business" is the economy effected through elimination. It is said that whereas previous to the formation of a given industrial combination there may have existed some thirty separate institutions, through centralization and elimination the same work can be carried on more advantageously by one organization. A necessary corrollary to this proposition is that some of the erstwhile separate institutions are either closed altogether or are operated with reduced forces. A few such combinations would probably not be seriously felt in a large country such as the United States; but when it comes to making combinations in every line of trade and business occupation, the number of families thereby thrown into the discard becomes a matter of very great importance even to the trusts themselves—it means enforced idleness and attendant suffering on a very large scale, with corresponding decrease in business.

Nor are salaried employees alone affected by these combinations with monopolistic tendencies, for the result of combination of industries in fewer hands is that many who previously had occupation for their capital find themselves debarred from engaging on their own account in lines of business with which they are familiar. Who, for instance, no matter how well posted in the copper business, would at the present time venture his capital in the development or exploitation of a moderate sized copper prospect? All mines were at first prospects, and the mining business has reached its present importance through the efforts of individuals in the face of discouragements which trusts do not care to encounter. The development of new mines in the United States has almost ceased as an industry because of the trusts; for even when such ventures turn out well, how is an individual to compete with large established monopolies which have the financial strength to continue producing enormous quantities of metal, if necessary at a financial loss for the time being—a financial loss, when all the factors which enter into the cost of production are taken into account, as is customary in ordinary commercial transactions.

The aim of the great combinations of labor is the same as that of the capitalistic trusts—the elimination of competition, and curtailment in the number employed. These combinations are particularly menacing towards the body politic because they are irresponsible. They are not incorporated and therefore cannot be held financially accountable for their acts. They are great powers for good or evil, and when led by unscrupulous men, are capable of inflicting great wrongs on the public, as was recently demonstrated in England. The natural desire of every good workman to excel at his craft is done away with by the principle of the closed shop, and through this agency inefficiency is tolerated and the number employed is lessened. With both classes of monopolies the final outcome of the principles advocated is the same, decrease in the opportunities of the many who seek to earn a livelihood—the elimination of the spender and consequent decrease in the volume of business.

It must be evident to every thinking person that at the present time there is something radically wrong with our economic system. There is abundance of capital in the country awaiting profitable employment, and men generally are willing enough to apply themselves at their respective callings; but still the wheels of industry lag. Various reasons have been advanced to account for existing conditions, all of which probably have some bearing upon the subject; but the fact of the matter is that paramount among the causes of trouble are the combinations in restraint of trade which have shut the door of opportunity to all but a favored few, and that the mass of the people has been unwillingly forced into making economies on its own account, because of inability to find profitable employment for its capital, or in the respective callings of its individuals. Nowadays whichever way a man turns he is confronted by monopoly in some form, which bids him move on to other fields. If he is young and hopeful he will be kept moving; if he is advanced in years, he is apt to become dependent upon the efforts of others, who may perhaps have all they can do to sustain themselves and families in the struggle.

In addition to considering ways and means for deserving the artificial conditions which have assisted in building up the great monopolistic combinations, it would be well to reflect on what is to be done with the large number of people thrown out of employment by the very economies effected by these combinations which are being extolled Geologists tel us that in Tertiary times creatures of mammoth proportions roamed over the earth. The pictures they give us of these beasts show them to have been large enough and sufficiently terrifying in appearance to have exerted considerable influence in their respective spheres of action. They possessed, however, one fatal defect: they were too bulky to serve any useful purpose, and they perished one and all down to a few surviving representatives of no particular importance. Is the fate which overtook the iguanadon, the tyrannosaurus, and the triceratops to find modern exemplification in the case of the trusts?

The existing depression in general business is acutely felt by those connected with the mining industry. The smelting business of the country has gone into the hands of a very few large corporations, and small concerns have to a great extent been absorbed or forced to close. One of the shining lights in the mining world, (who reached prominence by dint of much advertising), is quoted as recently advising young mining engineers to apply themselves to farming as a profitable field for their energies. Now, cultivation of the soil is a noble occupation, possibly the best of any still open at the present day; but, like everything else, to achieve success experience and knowledge of the special requirements of the industry are essential. If a young man is to take up the vocation of a farmer, would it not be better for him to attend some one of the institutions properly equipped for imparting instruction along agricultural lines, and thereby save the time expended in obtaining a M. E. degree, for which he will have small practical use when engaged in, let us say—raising cabbages? "Back to the land" by all means; but first obtain some practical knowledge of the essentials which every farmer's boy absorbs in the days of his apprenticeship, or else results are likely to be disastrous. The best preparation would be, of course, to hire out to some farmer for a few years before assuming individual responsibilities.

There is still another calling which has not yet been trustified—a case is known to the writer where one young mining engineer is studying to become a dentist, convinced that aching teeth are likely to bring more clients than his M. E. diploma.

It is not with theories that we have to deal—the trusts are painful realities. At a time when everybody should be prosperous, business throughout the country is receding, and many are already experiencing the pinch of necessity. The country is not threatened from any outside source, and it is difficult for the two great political parties to find separate platforms which may assist the outs in getting in and the ins in keeping the outs out. And yet business exhibits symptoms of distress, as though it were in the strangle-hold of some unseen monster!

We are told that the artificial conditions which have produced this state of affairs have come to stay!

UNDERGROUND WATERS

Water is found in some amount in all formations below the earth's surface, from the loosest and most porous sands and gravels to the hardest slate and granite. The amount varies from the merest trace chemically combined in the molecules of the rocks to immense reservoirs which supply wells flowing hundreds of thousands of gallons a day. Some waters are so pure that a refined chemical analysis shows only minute traces of organic and mineral matter; others are so heavily charged with minerals or other impurities as to be unsuitable for use.

The slope of the surface at any point is one factor determining the amount of water absorbed by the ground. The direction and amount of slope also determine the form of the water table—that is, of the upper limit of saturation. Except where the surface is flat the water table is generally not parallel with the surface; it is almost invariably farthest from the surface on the summit of hills and mountains and nearest to it in valleys and along the coast, reaching the surface in swamps and along rivers, lakes, and beaches. The surface of the water table is always in motion, its higher portions flowing toward the lowest outlets along rivers or the sea. This direction of flow explains why fresh water is usually found when a well is dug in a sandy beach.—From Water-Supply Paper 223, United States Geological Survey.

REAL OVERPRODUCTION

In 1908, the total of new securities issued in London up to the end of July was $654,000,000, which broke the previous record. In 1909, for the same period, it was $707,000,000; in 1910 it was $1,034,000,000. It was then that Lombard Street began to talk of undigested securities. Up to this date in 1911, the issues have been only $650,000,000, which shows that the warning has begun to have effect. In the three years, ending with 1904, London absorbed $1,925,000,000 new securities; in the three ending with 1907, it took $2,055,000,000; in the three ending with 1910, the unparalleled total of $3,210,000,000 was reached. Now comes the other side of the story.—Boston Financial News.

The dance has been held and enjoyed and now the fiddler wants his money. The lesson being taught is properly rated as severe, but it needs to be severe to have any lasting effect on the class which delights in having every bag of hot air recognized by the "investor" and money-lender as a "security." Let us quit talking about curtailment of the copper output and devote a little more attention to clipping the wings of the birds of prey who capitalize dollars for millions; who sell the stock and issue bonds convertible into new stock and then repeat the performance. It is not an overproduction of copper that is raising hob in the mining stock market. It is a failure to find "suckers" enough to absorb the loads of water-logged "securities."

SMELTING WITH OIL FUEL

In July Mr. Thomas Kiddie, metallurgist, of Vancouver, B. C., made a brief report to the Dominion Oil Smelting Co., Ltd., Vancouver, relative to a recent additional test of the use of oil as fuel in smelting copper ore, as follows:

"In compliance with your request, I proceeded to Van Anda, Texada Island, accompanied by Mr. Carlsrud, general manager, for the purpose of making a further demonstration with the oil-burning furnace. Two days were there occupied in overhauling water pipes, machinery, furnace engine, blower, and water and oil pumps, all of which were tested before the demonstration was begun.

"The ore mixture smelted consisted of Boundary district ore, iron ore as a flux, and copper slag from a previous operation. The furnace was started at 11 o'clock a. m., using two burners until it became sufficiently heated, when two more were started. Everything went along satisfactorily and slag began to flow at 12 o'clock, noon. The slag was hot and increased in quantity until it ran a pot of slag in one minute of time up to 2.30 o'clock p. m., during which time it smelted without trouble or interruption.

"Allowing one hour for the heating up of the furnace—a very conservative allowance—we used 157 gallons of oil in 2.33 hours, and 60 gallons for heating up the furnace, or 217 gallons in all. This gives an average of 14.6 gallons of oil per ton of material smelted, equal to 43.8 cents per ton of ore. The rate of smelting was 110 tons per 24 hours, an increase of more than 100 per cent over the results obtained during the best previous demonstration.

"I have no hesitation in saying that these conditions can, and will, be much improved upon after certain changes shall have been carried out, so that full advantage may be taken of better and more complete combustion of the oil, when the cost of oil consumed per ton of material smelted should approximate 30 to 35 cents per ton of ore. The saving of labor costs at the furnace I estimate at nine cents per ton of ore.

"As a result of this and previous demonstrations, I strongly recommend that the furnace be remodeled along the lines already submitted by me to your company, and endorsed by at least two metallurgists of the highest standing in British Columbia."

The company decided to proceed at once with the remodeling of the furnace, as recommended by Mr. Kiddie.

Drill steel having a high carbon content should not be heated above a clear red heat and in an ordinary forge care should be taken that drill bits are well covered by the fuel. The blast should not impigne directly upon one drill or parts of it so as to cause local overheating. Drills should be constantly turned in the fire. Inasmuch as different steels require to be heated and tempered in differnt ways, it is well that the man at the forge have but one grade of steel to work with at a time.

Depth of some of the main shafts in the Kalgoorlie, Australia, goldfield is as follows: Great Boulder Proprietary, 2,800 ft.; Sons of Gwalia, 2,440; Ivanhoe, 2,270; Great Boulder Perseverance, 2,100; Golden Horse Shoe, 2,100; Chaffers, 2,100; Asscociated, 2,000; Lake View & Star, 2,000; Kalgurli, 1,850; South Kalgurli, 1,800; Associated Northern, 1,100; Hainault, 950; Golden Ridge, 500.

IN PALMY DAYS OF LONG AGO.

ONTARIO SILVER MINING COMPANY BECAME WORRIED WHEN MILL TAILINGS CARRIED VALUES OF $33 PER TON.

In these days of intricate, painstaking work on the part of metallurgical, mining and mechanical engineers, to solve problems that will permit of profitable operation of mining properties the resources of which are measured in ores the metallic contents of which range from $2 to $5 or $6 a ton, it seems almost unreal to read and hear about matters and problems that worried the operators of mines and mills in days long gone by.

Thirty-three years ago the Ontario Silver Mining Company, operating at Park City, Utah, became so worried over the fact that "owing to the rapid increase in the proportion of base to free ore, *** the value of the metal left in the tailings has risen from $3 and $11 to $12 and $33 per ton, which is anything but satisfactory." Just think of that, you present-day metallurgists; just think of tailings from a stamp mill running $33 per ton and the president of the company reporting that the condition had become so unsatisfactory that he had taken the precaution to employ a metallurgist "to inquire into the defects of our methods and to suggest remedies." That seems like a tremendous loss, does it not?

Following these introductory remarks we are reproducing the letter of President J. B. Haggin of the Ontario company and the report of Mr. Frederick Gutzkow, the San Francisco metallurgist who made the investigation and suggested a remedy, confident that the papers will be found interesting and educational, and particularly so because the tremendous losses sustained in milling the silver ores of the Ontario were, after all, no greater in percentage of value than those being sustained by many of our low-grade mines of the present day—and nothing like as great, for instance, as those prevailing in the treatment of low-grade copper ores—at the Utah Copper, for example. While the Ontario's losses reached $33 per ton, that was only 24¼% of the total contents of the ore, as against 35 to 45% of losses by the Utah Copper Company, with all its boasting and all the laudation of its chief sponsor as "the greatest mining engineer in this or any other country."

The accompanying reports will be interesting, also, as indicating what a wonderful mine the Ontario has been. The ores near the surface were "free milling"—that is, they contained little lead, zinc, or other mineral in sulphide form to interfere with the making of good recoveries by the old amalgamation process. In those days there was no hesitancy at all in burning out the lead that began to appear in the ore in order to save the silver and, even when Mr. Gutzkow made his report, April 30, 1878, it was a matter of concern that the silver bars produced be given as good an appearance as possible, as that had a bearing on their market value.

Incidentally, and for the benefit of lay readers, it may be stated that the Ontario company has paid nearly $14,000,000 in dividends, while the gross production of the mine cuts close to $40,000,000. The prospects also are that it will yield a great deal of silver, lead and copper in the future as there are great quantities of low-grade ores in the deepest levels that are yet practically untouched.

PRESIDENT HAGGIN'S LETTER.

"The results obtained from the base ores of the company by the use of a Stetefeldt furnace during the first six months of 1877 were very good, but owing to the rapid increase in the proportion of base to free ore during the past fifteen months, the value of the metal left in the tailings has risen from $3 and $11 to $12 and $33 per ton, which is anything but satisfactory. As, however, the latter figures have been touched only since the development of the ore body on the 500-foot, or lowest level of the mine, it is reasonable to suppose that no worse results will be obtained, even should we fail to make any improvement in our methods of working until we sink deeper.

"Knowing from the past history of the Ontario that, while its ores were constantly increasing in richness as they were developed in depth, they were also getting more and more base, it has been my constant endeavor to ascertain wherein our processes are defective, and to have the improvements in them keep pace with the change.

"My last effort in that direction was the employment of Mr. Frederick Gutzkow, metallurgist, to inquire into the defects in our methods, and to suggest remedies. I enclose herewith, for the information of those interested, a copy of his report.

"Mr. Gutzkow is now engaged in making thorough anaylses of our ores and bullion, from which we expect to derive information of material importance.

"After a complete and more thorough investigation of the subject, I shall adopt some plan to remedy the present defective system of working our ore."

GUTZKOW'S REPORT.

J. B. Haggin, Esq., Dear Sir: Having returned from my journey to the Ontario mine, I present in the following my report on the two questions into which you desired me to examine:

1. The causes of the apparent increase of loss in tailings. The ore of the Ontario mine has been and is still divided into the "Free Ore" and the "Base Ore," both being worked separately and in about equal quantity, that is, thirty tons a day of each kind.

The "Free Ore" is gradually giving way to the base, being in fact nothing but the partial decomposition of the latter in the upper levels of the mine, and will be worked out probably already toward the end of this year. Even now, its quality as a milling ore has deteriorated. It is much intermixed with base ore and appears to be in character similar to the ore which was formerly called base and subjected to roasting. As is natural under these circumstances the returns from the working of free ore have become less favorable. Whilst in the last year the tailings from the latter have rarely exceeded 9 per cent of the value of the ore, the average for the first eighteen days of April, 1878, has been 12½ per cent, namely, $11.67 in the tailings, to $96.70 in the ore. As this result is still favorable enough, and as the "free" ore will soon give way to the "base" anyhow, I directed my examination principally to the latter.

The "Base Ore."—The loss in silver by the higher value of the tailings from the "base" ore dates from the beginning of this year. The assay book of the mill shows a sudden and unmistakable rise in the value of tailings from the 1st of January to date. Whilst in December, 1877, the tailings were only 7-8 per cent of the silver value of the ore, they average during the first eighteen days of April, 1878, 24¼ per cent, namely, $33 to $136 in the ore. Fortunately, there is a corresponding rise in the value of the ore, so that the returns in bullion are not affected.

These changes coincide with the opening of the 500-foot level of the mine. The ore shows itself there, whilst not yet free from signs of partial decomposition, contracted into a mass of sulphurets, which is a favorable indication of the continuity of the lode. As the stoping from the 500 to the 400-foot level has barely commenced and the "base" ore furnished to the mill during the last month came principally from the opening of the 500-foot level, it is obvious that for a time—that is, until a still lower level has been opened—the ore has shown its basest character, and a further deterioration need not be expected.

EXPERT'S FINDINGS.

The change in the proportion of silver which the base ore yields in the mill coincides, however, not only with a change in its character but also with a change in the working of the roasting furnace. The weekly chlorination tests made in December, 1877, show that the silver was converted into chloride to the extent of 80-70-77 per cent in the shaft, and 87-90-86 per cent in the flue of the roasting furnace, with correspondingly good results in the pans, as stated above. In April, 1878, they have dropped to 55-32-28 per cent in the shaft, and 81-77-63 in the flue, and the value of the tailings has risen in direct proportion therewith. Considering the low chlorination of the last months, the pan work was satisfactory enough, and proves that the roasting did good work in preparing the ore for the pan process, even if a less high chlorination was reached than formerly.

In studying up the reasons why the chlorination has dropped off, I commenced by separating and assaying the minerals which join in giving the ore its base character. I found the following minerals to be present in considerable proportion, and to contain, according to the assay of Mr. Gallagher, in silver per ton:

Iron Pyrites	$ 13.56
Zinc Blende	35.43
Antimonial Copper Ore	54.29
Galena	174.96

Of these four minerals I found that in the shaft of the Stetefeldt the iron pyrites is entirely decomposed; the zinc blende to a very large extent; the antimonial copper ore to at least one-half; the galena not at all.

The galena is easily distinguishable in nearly every piece of rock as well as in the roasted ore. This, coupled to the fact that the bullion contains no lead, and to the richness of the galena, shows where the increase in the value of the tailings comes from. From assays made by Mr. Watkis as to the percentage of lead in the ore, I deduct that about $10 per ton of tailings is carried away by the undecomposed galena. It is a matter of course that the difficult roasting of one mineral, of which there is at least 5 per cent in the ore, prevents also the complete roasting of other and perhaps richer minerals with which it may be mixed.

The question now arises how the decomposition of the galena may be effected.

The Stetefeldt roasting furnace has many advantages. It works cheaply in fuel and labor and surpasses all others in capacity and durability. But its greatest virtue is at the same time its disadvantage—I mean its unalterableness. A bad management cannot spoil, a good one cannot improve it. As long as the feeding machinery is kept in order, the fire maintained and the ore properly withdrawn, the most shining metallurgical star and the darkest ignoramus are about on the same level. Still, although I consider a change in working the Stetefeldt furnace, as it stands, a difficult and risky task, I think in building a new furnace an improvement might be advisable. It consists in this: To dispense with the present method of drawing the red-hot ore into a cart and dumping it on the cooling floor, but to allow it to fall directly from the furnace on a covered hearth, say 30 ft. long, 8 ft. wide, 2 ft. high, pitching under an angle of about thirty degrees to the cooling floor. As it is now, the ore is withdrawn from the furnace in the very midst of the roasting process, steaming off copiously sulphurous gas, to the great annoyance of the furnace-men. By the improvement which I suggest the ore gets a chance to finish, as it is kept on the inclined hearth red-hot with free access of air for one or two hours. I cannot see any increase of costs for fuel or labor in the new arrangement, and the natural slope of the hill on which the new furnace would be erected favors it. If it works well at the new furnace it may easily be adapted to the old one.

If the ore is allowed only time enough, there is no trouble in bringing the ore to the proper state of chlorination. The same "battery-samples" which on the large scale were chloridized only 30 or 40 per cent, yielded in the muffle of the assay furnace in three experiments respectively 66-74-80 per cent to the chlorination test, and by increasing the proportion of salt I got 90 and 85 per cent.

In connection with a new furnace, I propose another change. I refer to the drying-kiln. The present arrangement is not only very expensive in its first construction, but also costly to work and a dangerous nuisance to the men, who have to be induced by high wages and short hours to work there. Not to mention the disagreeable necessity for the men to walk on hot plates all day long, there is much danger to their health from the arsenic which the ore contains, and which begins to roast off at a very low temperature. The garlic-like smell of arsenious acid is occasionally quite noticeable and may give rise to bad accidents any day. Besides, the cleaning of the labyrinth of flues underneath necessitates a stoppage of the whole mill for a week or more every three or four months. The view of saving the fine ore-dust has been here carried out too far. From the flues under the drying-kiln there are gathered about 50 tons every three and one-half months, assaying considerably under the average ore, and representing for about 3,000 tons roasted during that period barely 1 per cent in value.

IMPROVEMENT SUGGESTED.

The improvement which I propose is: To conduct the waste heat from the roasting furnace to the chimney, which this time ought to be placed higher up on the hill, through an ascending flue, covered with iron plates about 8 feet wide. This flue will connect the ore-chute directly with the battery-hopper. Thus the wet ore will move gradually to the hottest place, can be discharged to the hopper as soon as finished, and the man may work the kiln from the outside. There is only one place—at the bottom of the incline, where the hot gas enters—that might possibly get overheated, and here a wooden hood and chimney could be placed to carry the deleterious gas through the roof. As the flue can easily be reached from the outside for its whole length, there need be no stoppage of the mill in order to clean it.

With regard to the loss in tailings—still referring only to the "base ore"—I found that the loss is currently overestimated. It has been assumed that one ton of ore gives one ton of tailings. This is not so. By repeated experiments I determined the following facts:

(1) The dry ore, as it comes from the battery to the furnace charged with 15 per cent salt, loses in the furnace 17 per cent in weight by volatilization. I do not refer here to the loss in flue-dust.

(2) The roasted ore loses 3 per cent more in the pan by the dissolving action of water.

In summer, the loss is 25 per cent in weight, that is four tons of "battery-ore" yield only three tons of tailings.

Calculated for the average assays of $136, and $33 for ore and tailings in April, 1878, the returns would be—

Four tons of "base ore," at $136 ....$544

Yield three tons of tailings, at 33 99

Extracted 81 8 per cent.

And not

Four tons of "base ore," at $136 ....$544

Yield four tons of tailings, at 33... 132

Extracted 75.7 per cent.

If this new calculation is correct, then the percentage of silver in the roasted ore ought to be higher than in the "battery ore," because its weight is so much less. And such is the case. The average of the first eighteen days in April, 1878, shows the assay of the ore, from the shaft, to have been $150 against $136 in the "battery ore."

The circumstance that the "battery ore" loses 15 per cent salt by treatment with water, whilst the "roasted ore" loses only eight (and the largest portion of those 8 per cent is sulphate of soda, the final product from the decomposition of the salt), combined with the fact, that in numerous experiments in the assay-muffle, I always obtained higher chlorination by the addition of more salt, proves that there is either an insufficiency of salt, or an enormous loss by volatilization.

I had no time to follow these points up. They show, however, that there is plenty of room for analytical work of practical value.

I have to suggest, that the actual weight of the "base ore," put through the mill, be more closely determined. At present, the "battery ore," although daily assayed, is not weighed at all. The roasted ore, as it goes to the pans, is weighed, but it is mixed with the roasted "fine ore," which assays differently, and is, besides, sprinkled with a varying amount of water. The weight of the ore, as brought from the mine, furnishes no criterion at all, as it changes daily in the proportion of water which it retains, and just now, owing to some very wet stopes, arrives frequently literally swimming in water. It would be an easy matter to keep the roasted ore from the shaft and flue, which are daily assayed, separate, and take note of their weight. The moisture ought also to be occasionally determined. The weighing of the "battery ore," though not so easily effected, would be greatly preferable, as it would show how much ore has actually gone in, and the out-turn in bullion would allow you to strike a surer balance than by any other calculations.

CHAMBERS' GOOD IDEA.

Mr. R. C. Chambers explained to me an idea of his, which will doubtless work well, namely, to determine by a series of assays, which tailings are poor enough to be allowed to run to waste (say from the upper two plugs in the settler), and to save only those above a certain average assay. Thus, a concentration of the tailings could be effected in the cheapest possible manner, and their bulk greatly diminished, a consideration of much importance, as there are certain local impediments to catch the tailings in spacious reservoirs. Those assays might, at the same time, be used to control the present method of sampling the tailings, and prove whether my doubts as to its correctness, and the preference I give to the method in use at the Comstock mills, is well founded.

In the melting room, I had many improvements to suggest regarding the proper way of skimming and toughening the bullion, of smoking the moulds, pouring the bars, and so forth. The melters ought not to be restricted in the use of more borax and nitre; the first, in order to get a more fluid slag on the metal, and, consequently, to get less grains into the skimmings. Not to mention the bad plan of keeping so much valuable matter out of circulation —the grains from last year's work gave more than four large bars—its stamping up in the battery passes it altogether through too many hands. Nitre ought to be used, in order to remove the iron, which always spoils the appearance of bars. A proper mixing and stirring of the metal in the crucible is imperative. No carefulness of assay will prevent reclamations, as long as the bar itself it not thoroughly uniform. The molten bullion ought to be covered with powdered charcoal, as soon as the assay is taken, and the melter be supplied with that article. The mould ought to be smoked with rosin, and not with the engineer's refuse and coal-oil. The metal ought to cool down before pouring, otherwise the bar will never have a smooth surface. The bars themselves ought to be covered with charcoal, as soon as poured, in order to prevent oxidation of the surface. All this extra trouble costs the company very little, and repays itself by the higher price which well-made bars invariably fetch in the market, giving the buyer more confidence in the correctness of weight and assay.

Whilst I had much to suggest in the melting, I found the retorting well and carefully done. The retorts are not overcrowded, as is frequently the case, and they need, consequently, no overheating. Owing to its baseness, the amalgam is very wet, there being six parts and more of quicksilver to one of bullion. Wrapping a piece of it in canvas, and squeezing it in a vice, I could easily remove nearly one half of the quicksilver. A hydraulic press, such as used at the mint, for compressing the spongy gold and silver, would give still better results, and allow the work of three retorts to be done in one.

RAISING BULLION STANDARD.

The bullion produced at the Ontario mill averaged, in March, 1878, 812 in silver. That obtained from the "free ore" is mixed with that from the "base ore," the former assaying 950 and over; the latter, 611 and less. The metal is, according to Mr. Trelan's analysis and my own observation, nearly exclusively copper. The amount of copper in the "base ore" is small, only one-quarter per cent, or five pounds per ton, by Mr. Watkis' assay. There being about ten pounds of silver per ton of ore, of which about seven and one-half pounds are extracted, which require for a fineness of 611, four and three-quarter pounds of copper, it is obvious that nearly the entire copper in the ore is going into the amalgam. I ought to add, that lately no blue-stone is used on the "base ore." There is fully as much copper in the "free ore," but it is in the shape of oxide and carbonate, both insoluble in water, and not acted on in the pan process. Now, it would be an easy matter to convert the soluble copper-salts in the roasted ore into the same insoluble compounds as exist on the "free" side, by the addition of a little carbonate of soda. But as long as the chlorination is low, the soluble metallic compounds, especially those of copper, are required to do much work in opening the undecomposed sulphides, and I have no doubt that they do the work, or the results from the pan-work would be less favorable.

The cheapest possible way of refining your bullion, that of preventing the copper to enter the amalgam, being thus precluded, I examined into the next cheapest process, that is, to make the copper, which has entered the amalgam, available and valuable, to defray the parting-expenses by converting it into blue-stone, and I am glad to state that I do not anticipate any particular difficulty in doing so.

PROCESS PROPOSED.

The process, which I propose, is very simple. It consists in dissolving part of the retorted bullion (previous to melting) in strong sulphuric acid; to pour the solution in water, and add to it the rest of the bullion. The metallic copper, in the latter, will precipitate the dissolved silver into metallic silver, and be itself dissolved instead. The result will be a spongy mass of fine silver, which is washed, dried, and melted, and a solution of sulphate of copper, which, when brought to crystallization, will yield crystals of the commercial blue-stone. The blue-stone, thus obtained, will be of a superior quality, as there is no method in existence by which a purer article can be manufactured. A roasting of the retorted bullion (that is, keeping it red hot, with access of air, for some hours) will facilitate the operations, and save acid, but it is not necessary. There is no silver lost in this process, nor any other by-product but blue-stone obtained.

The two questions which I had to settle by actual experiments were: (1) Will the retorted bullion dissolve in strong sulphuric acid, and (2) is it in the shape as it comes from the retort porous enough to allow the other reaction?

In experimenting on pieces of retorted bullion, between 700 and 800 fine, of the size of a walnut in the laboratory, I easily and repeatedly obtained a silver-residue which, after melting, showed a fineness of 991.

I then operated on large pieces as they actually came from the retort assaying 800, and obtained from 21 pounds a bar assaying 940.

For a second experiment I roasted 50 pounds bullion from the base side, assaying 611, and extracted the oxydized copper by dilute sulphuric acid (metallic copper requires strong, oxydized copper only weak acid) melted one half of the residue down and obtained a bar 835 fine. This showed me how far the copper could be removed by roasting alone, to-wit:

In bullion 611 fine are mixed, 611 lb silver with	389 lb. copper
In bullion 835 fine are mixed, 611 lb silver with	121 lb copper
Removed by acid after roasting	268 lb. copper

That is more than two-thirds of the copper.

Of the bullion of the original fineness of 611, of which one-half had yielded the bar of 835, the other half was "finished" in the manner described above, that is, a portion of it was dissolved in strong acid in an iron kettle and boiled in a lead-lined tub with water and the other portion. The result was a bar. The assay was not finished when I left, but from the appearance I think it will be high enough.

As I made the three bars under favorable circumstances and from pieces as they are actually obtained on the large scale, these three experiments were sufficiently convincing for myself. The test of considerations, the plant required and the method of working are perfectly familiar to me, not differing essentially from the usual refining operations.

Taking as a basis the product of March, 1878, I find that the Ontario mill shipped:

166,332 oz. bullion with 135,100 oz. silver and 31,232 oz. copper.

Equal to 11,392 lb avoirdupois with 9,253 lb. silver and 2,139 lb. copper.

Or per day 379 lb bullion with 308 lb. silver and 71 lb. copper.

This represents an average fineness per month of 812. Now, it will be necessary, if working the above process.

(1.) Without roasting: To dissolve in strong acid 40 per cent of 379 lb. bullion with 123 lb. silver and 28 lb. copper, and to precipitate the silver by 60 per cent of 379 lb. bullion with 185 lb. silver and 43 lb. copper—100 per cent—379 lb. bullion with 308 lb. silver and 71 lb. copper.

The 123 lb. of dissolved silver will be precipitated by 43 lb. metallic copper.

Acid Required:

To dissolve 123 lb. silver,	123 lb. com l con acid
" " 28 " copper,	93 " " " "
	216 " " " "
Add 25 per cent for loss	54 " " " "
	270 lb. of acid.

The yield in blue-stone will be 4 pounds for each pound copper—4x71—284 lb.

Expenses per Month:

1. Wages, 1 man at $150	$150 00
2. ½ cord wood per day = 15 cords at $4	60 00
3. ½ ton coal in steam-boilers = 15 tons at $9	135 00
4. 30 barrels for blue-stone at $1 25	37 50
5. Sundries	100 00
6. 30x270 = 8,100 lb. sulphuric acid at 2¾ cts in S F	222 75
7. Freight on Acid 8,100 lb. Acid. 1,350 lb Packages = 1-6 of 8,100 1,350 lb. Packages to go back empty 10,800 lb. at 5 cents	540 00
	$1,245 25
Income: 30 x 284 = 8,250 lb. blue-stone at 11 cents	937 20
Net Expenses	$ 308 05

(2.) With roasting:

To refine per day as above, 379 lb. bullion with 308 lb silver and 71 lb copper.

Converted into Oxide by roasting, 35½ lb bullion with 308 lb silver and 35½ lb. copper.

Remains for "finishing", 343½ lb. bullion with 30 lb silver and 35½ lb. copper.

To dissolve in strong acid 30 per cent, 103 lb. bullion with 92½ lb silver and 10½ lb. copper

And to precipitate the silver by 70 per cent, 240½ lb. bullion with 215½ lb. silver and 25 lb. copper.

The 92½ lbs. of dissolved silver will be precipitated by 25 lbs. metallic copper.

Acid Required:

To disol 35½ lb. cop. as oxide,	59 lb of con. acid.
" 10½ " " " metal,	35 " " "
" 92½ " " " silver,	92½ " " "
	186½ lb.
Add 25% of 35x92½ = 127½ lb. =	31½ lb.
	218 lb. of sul. acid.

The yield of blue stone is as above—284 lb. per day.

Expenses per Month:

1, 2, 3, 4, 5, as above	$ 482 50
6. 30x218 = 6,540 lb Acid at 2¾ cts. in S. F.	179 85
7. Freight on Acid 6,540 lb. Acid. 1,090 lb. Packages = 1-6 of 6,540, 1,090 lb. Packages to go back empty, 8,720 lb. at 5 cents	436 00
	1,098 35
Income, 8,520 lb. blue-stone as above at 11 cents	937 20
Net Expenses	$ 161 15

If a refining room is built at the mill, it should be constructed, however, with a view, that the "free ore" bullion will soon be replaced by "base ore" bullion. Assuming the same returns in silver as in March, 1878, and the fineness of all the bullion at 611, as the "base ore" bullion runs now, the account will stand:

Produced per month, 15,144 lb. bullion with 9,253 lb. silver and 5,891 lb. copper.

To refine per day, 505 lb bullion with 308 lb. silver and 197 lb. copper.

Converted into oxide (as per exper.), two-thirds of the copper = 131 lb copper

Remains for "finishing," 374 lb. bullion with 308 lbs silver and 66 lb. copper.

To dissolve in strong acid 40 per cent = 150 lb. bullion, with 123 lb. silver and 27 lb copper.

And to precipitate the silver by 60 per cent = 224 lb. bullion with 185 lb. silver and 39 lb copper.

The 123 lbs. of dissolved silver will be precipitated by 30 lbs. metallic copper.

Acid Required:

To disol. 131 lb. copper as oxide,	218 lb. sul. acid.
" 27 lb. " metal,	90 lb. " "
" 123 lb. silver,	123 lb. " "
	431 lb. sul. acid.
Add 25% of 90x123 = 213 lb. as loss	53 lb. " "
	484 lb. sul acid.

The yield in blue stone will be 4x197—788 lbs. per day.

Expenses per Month:

2 men at $150 and $120	$ 270 00
1 cord wood per day = 30 cords at $4	120 00
15 tons coal at $9 in steam-boilers	135 00
80 barrels for blue-stone at $1.25	100 00
Sundries	100 00
30x484 = 14,520 lb. acid at 2¾ c. in S. F.	422 40
Freight on Acid, 14,520 lb. Acid 2,430 lb. Packages = 1-6 of 14,520, 2,530 lb. Packages to go back, 19,380 lb at 5 cents.	960 00
	$2,116 40
Income: 30x788 = 23,840 lb. blue-stone at 11 cents	2,600 40
Net Profit	$ 484 00

It appears, therefrom, that the lower the bullion the higher is the yield in blue stone. Mr. Chambers anticipates no difficulty in selling a car-load or two a month to the mills in Utah or the northern territories. In case of need, Virginia City will take all.

The main point, which will decide on the rentability of the process, is the freight on sulphuric acid. I have to leave it to yourself to see what arrangements can be made either at the Central or the Union Pacific railroads' headquarters. I figured up 5 cents per pound. Deducting 1 cent for freight from Ogden to the mill, there would be left 4 cents per lb., or $800 per carload of ten tons for the distance, San Francisco to Ogden or Omaha to Ogden. The freight from Omaha to the nearest acid works would be covered by the lower price of the acid.

The acid ought to be shipped in sheet-iron drums or cylinders, say 3½ ft. long, 2½ ft. diameter, with a hole for discharging secured by a screw plug. This kind of package is successfully used by the acid factories of this city since some years, to take their acid to the Giant or Hercules powder works. That is no experiment, therefore. To secure the railroad still more against damage, the car might be covered with sheet lead, so as to form an acid-proof tank, into which the drums are placed, plug-hole up. A package or drum of this description weighs about 300 lb., and holds nearly a ton of concentrated sulphuric acid.

Regarding the best site for a refining room at the Ontario mill, I held consultation with the superintendent and the head carpenter. The room would adjoin the retort room, be on the same level with it, and measure 60 by 38 feet, the roof sloping like that of the retort room. Mr. Chambers estimates cost of building and grading, at $2,000.

A rough but liberal estimate of the cost of plant gives me:

13,000 lb. sheet and pipe lead at 13 cents (freight included)	$1,690
Castings	1,000
Carpenter's work and material	500
Mason's work and material	500
Plumber's work	1,000
Sundries not foreseen yet, say	1,310
	$ 6,000

Within the building should be left a place for a brick vault, to lock up the bullion (badly needed now) and for a reverberatory furnace for the case, that at some future day the bullion should become more impregnated with lead and require a cupellation of the refined silver. Each of these two additions would cost about $1,000 extra.

Respectfully yours,
FREDERICK GUTZKOW.

No. 18 Columbia Street, S. F., April 30, 1878.

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The beautiful tints which distinguish gems and ornamental minerals are due to "impurities," usually the oxides of the common or rare metals. The clear sapphire is said to owe its colour to iron oxide, while the fine blue of the Oriental gem is ascribed both to iron oxide and titanium oxide. This latter conclusion is indicated by analysis and synthetic experiments.

---o---

The Caylloma silver mines in Peru have an altitude of from 12,000 to 17,000 feet. They are believed to be the highest mines in the world.

PRESERVATION OF CORES IN DIAMOND DRILLING

By A. H. MEUCHE*

The volumes of the Lake Superior Mining Institute contain many articles on diamond drilling. Most of these papers deal with the curvature of drill holes and methods of observing the true angle of dip. As a result of these papers the diamond drill operators are supposed to test the angle of their holes at frequent intervals and then the angle etched on the bottle is corrected for capillarity. I am heartily in accord with this survey of bore holes but often wonder, inasmuch as no attempt is made to determine their lateral deflections, if these surveys and corrections are really worth while.

Besides these, there are many matters which should be considered by anyone having lands explored by means of diamond drills. Two of the most important are the preserving of the bore holes and the preserving of the records. In the copper country, where I have had most of my experience, the usual practice is to pull out the stand pipe when the hole is completed, thus making it impossible to reopen the hole and continue to a greater depth, if the occasion should ever arise when it might be advisable to do so. Of course, this question must be answered separately for each and every drill hole, as it becomes necessary to consider the policy of the parties having the drilling done, the cost of leaving the casing compared to the total cost of the hole, and whether or not for geological reasons it is definitely known whether any occasion may ever arise for deepening the hole. By this I mean that you know definitely that ore does not lie at any greater depth.

In the Copper country geological conditions answer the question many times. Here, as most of you know, the beds usually have a pretty steep dip and cross-sections are made by drilling a series of holes in a line at right angles to the strike and placing these far enough apart so that the bed exposed in the bottom of one hole is also found in the top of the adjacent hole.

There are two methods in which cross-sections are drilled. The most logical is to start at the extreme eastern limit of your property or at the limit of the copper bearing range, and work west. In this method it is necessary to bore the holes until you are positive of having a lap. The objection to the method is that it is not always possible to bore the holes as deep as you wish to go and then it is necessary to put down an intermediate hole. The other method is to start from the west and drill your hole as deep as you can, or desire to, compute the horizontal distance covered by the hole, deduct a little for tap and locate your hole to the east. This method works fairly well, especially for two drills, but is open to many objections. Suppose you find a fairly rich copper bearing lode, near surface, ine one hole and would like to examine it at depth. It may only be a few feet below the bottom of your preceding hole, but if it has been discontinued and the pipe pulled out, these examinations would necessitate a new hole, duplicating largely work which has already been done. Again, you may make a mistake in your computations, or the dip may be steepr than you thought it was. Under these circumstances you may have a gap in your section. Another trouble lies in the fact that even though the holes do lap, you may not be able to recognize them.

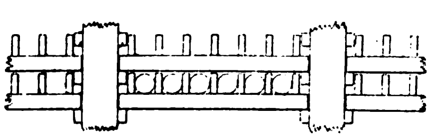
All these objections and troubles occur quite frequently and have come within my own observations. Ordinarily the first method is the better one to follow, but there are many times when it is advisable and sometimes necessary to use the second. If the latter method is used, I strongly advise leaving the stand pipe.

Another matter which has become a sort of hobby of mine is the care and preservation of drill cores. Perhaps this is due to the fact that I have examined in the neighborhood of 100,000 feet of drill cores during the last few years. I have seen cores kept in a limited number of boxes; when these boxes became full the cores were dumped out and the boxes refilled. I have seen core boxes kept in a cold, wet cellar, one box piled on top of another, forming a high stack. Often the lids are nailed down tighter than the bottom is nailed to the box, so that in trying to pry off the lid the box falls to pieces. I have climbed upon racks, pulled out boxes (not having covers) that were slipped in sideways, balanced them on my finger tips and tried to get down. Once or twice the boxes turned upside down.

With these experiences you can readily perceive why the method used by the Victoria Mining Co., and later adopted with some minor changes, by the Mass

*Proceedings of Lake Superior Mining Institute, Houghton, Mich., August 22-24, 1911.

Consolidated Mining Co., appeals to me. In both cases they have rigged up a sort of cabinet, using the core boxes without lids as drawers. The boxes slide lengthways into a rack or cabinet. The boxes or trays are stacked so close together that the bottom immediately above acts as its cover. At the Victoria, a strip the full length of the box is nailed on either side, forming the slides for the drawer. A drawer-pull and a label giving the number of the hole and the depths of the hole from which the core was taken is fastened to one end of the box. At the Mass they have overcome the necessity of nailing strips to the sides of the box by allowing the bottom of each box to extend about half an inch on either side. The boxes are made about 5 ft. long, which is a convenient length to handle, and holds enough core for ordinary purposes. The cabinet itself is made very similar to any ordinary cabinet, holding drawers, except that it is not necessary to put a piece of wood under each drawer as a stiffener. If the sides are made of 2-in. material, a stiffener need only be introduced about every 10 boxes. Sides or partitions are made for each stack of core boxes and as high as desired. These had better be made pretty heavy, as they must support the entire weight of all the boxes in each stack, and in order to make the construction as slow burning as possible, I would suggest a tight partition. Strips are nailed on both sides of these partitions to catch the strips on the boxes, thus supporting them. These strips should be placed just far enough apart to allow easy and free sliding of the boxes.



The accompanying sketch will explain the construction fully. The advantages of this system are the convenience in referring to the cores at any time and small amount of space required. Each box occupies a space of 10⅞x2 3-16 ins. Allowing one stiffener for every 10 boxes, 30 boxes can be stored in a stack 5 ft. 9 ins. high. As each box holds 30 ft. of 1⅛-in. core, which represents approximately 40 ft. of drilling, one stack would represent 1,200 ft. of drilling. Ten such stacks, representing 12,000 ft. of drilling, would only occupy a space 6 ft. high, 10½ ft. long and 5 ft. deep. I do not believe that the same number of boxes with covers screwed on could be gotten into the same space, and I question if the lumber and screws used for a cover would cost as little as would this scheme. The only objection to the scheme is the trouble involved in transporting the boxes from the drill. The Mass Mining Co. solved this by making boxes with hinged covers and locks which would just hold one core box. The core box was then placed in the box, which was then locked and sent to the mine office. For shipping, the core boxes could be crated readily enough.

I wonder, with such a convenient method as this of storing cores, if as much core would be thrown away as is now done. After so much money has been spent in obtaining the records it seems too bad to see the true records destroyed. I often encounter the argument "Of what good are they?" They usually are no longer of any use to you, but someone else may examine them and see something of great scientific or practical value. There is some excuse for a person holding merely an opinion on a piece of land to throw away the cores, as he may not have any place to store them but in those cases I truly believe that the Geological Survey should make an attempt to preserve the records.

CONSERVATION SHAM

The much used term "conservation" has come to mean, in the minds of politicians, the prevention of private ownership of anything that has thus far escaped this destiny, says Mining Science, of Denver. In their moments of professed frankness, such "conservationists" intimate a desire to prevent the monopoly of the resources of Alaska and other western regions. But the fact is that the proposals cited are clearly in aid of "monopoly." Only highly concentrated capital will be able to reap benefit from the restrictions that the government is asked to impose upon Alaskan development, for it alone will be able to meet the conditions.

MYSTERIOUS SALT SPRINGS

Geologists have as yet given no satisfactory explanation of the origin and occurrence of the very interesting salt springs (sodium chloride) at Salinas, San Luis Potosi, Mexico, about fifty-five miles northwest of the capital, says Mining Science of Denver. In the rock formation of the vicinity there is no indication of salt deposits and there is no evidence of the local origin of the saline waters. The springs are at an elevation of about 7,600 feet above sea level in a small basin of sand and calcareous matter. The surrounding hills are of cretaceous limestone and the basin is evidently an old lake bottom. All sub-surface water for many miles around is highly salty. The subterranean salt stream is charged with 1½ to 2 per cent of salt, but the ground is thoroughly saturated and adds to the salinity of the water of the springs. It is thought that the stream comes from the north, possibly as far a Chihuahua under some pressure. The springs discharge from a depth not exceeding twenty feet into a shallow lagoon, the spring region comprising some 600 acres. The lagoon is never more than ten inches deep and at times entirely dry with a surface crust of saline matter.

A TOAST TO LABOR

Here's a toast to every man,
Of every race, and creed and clan,
Who
By his manhood strong and free,
Digs from the earth, wrests from the sea,
Their treasures,
And whose arm and mind,
Leaves to his fellows—all mankind,
His heritage—his work.

So, here's to the man who digs the gold,
And here's to the man who makes the
mould,
And here's to the man who mints the
rim,
And here's to the man—good luck to him,
Who
By his strength of arm and mind,
Leaves to his fellows—all mankind,
His heritage—his work.

Here's a toast to the woman, too,
Man's comrade staunch, man's comrade
true
Who
By her womanhood soft and sweet,
Coaxed into light from its dark retreat,
Man's treasures,
That his arm and mind
Might leave his fellows—all mankind,
His heritage—his work.
So, here's to the man who digs the gold
Who fashions its shape into wealth untold,
With water or wine—filled to the brim
We'll drink this toast—good luck to him
Who
By his strength of arm and mind,
Leaves to his fellows—all mankind,
His heritage—his work.

—HARRY IRVING GREENE.

In Houghton (Mich.) Mining Gazette.

Graphite can be distinguished from molybdenite, which it closely resembles, by the slightly greenish tinge of the streak of the latter and its sulphur reaction, when fused with soda before the blowpipe.

ORE SIZING WITHOUT SCREENS

McKESSON'S NEW SCREENLESS DEVISE IS CALCULATED TO CAPSIZE MANY PRECONCEIVED IDEAS AND PRACTICES IN MILLING.

By CHARLES J. DOWNEY*

To avoid quarreling with terms, the usual processes of separating fine sands and highly comminuted particles of ore may be divided into two broad categories: separation according to size and separation according to specific gravity. The other characteristics of minerals, especially of an electric or magnetic nature, which may be applied to the same purpose, are here disregarded. The first category is, generally speaking, that of sizing; and the second, that of concentration. Between the two, so to speak, is a complex of both: namely, separation according to both size and specific gravity; in other words, according to actual weight. In general, this receives the name classification. In the case of a homogeneous material, no differences of specific gravity existing, the functions of a classifier is that of a sizer; whereas, in the case of certain mixtures of minerals, it may approach the functions of a concentrator. Both pulp classification and concentration are commonly effected by the agency of water, while sizing, which usually means screening, is carried out by both wet and dry methods.

The elimination of water as a medium of classification and concentration, which is very desirable in some mining regions, has often been urged, but seldom without the substitution of air as an agency of separation. The reason for the substitution of air currents is that some such medium is considered desirable to produce the results incident to differences of specific gravity in the particles and differences in actual weight. In the province of screen sizing, where specific gravity is not the essential factor, the presence or absence of water is, roughly speaking, of immaterial consequence. If, however, the work of sizing is to be undertaken without screens, the natural assumption would be that the agency of water or air is necessary in some respect. The sizing of talc, for example, is now carried out by a pneumatic process† while, as already indicated, the function of a water classifier is partly that of a sizer, when not altogether so.

It has been found that the substitution of air for water as a medium of separation according to specific gravity, that is, for concentration, requires a high velocity of air as compared with that of water. "The effect of density in water," says Dr. Richards, "is equivalent to the effect of velocity in air."‡ Hence, to produce a sizing process in which screens are eliminated, without at the same time accomplishing classification according to actual weight of particles or the mere differences of specific gravity, the advantage of using neither air nor water as a medium would seem to follow as a corollary, provided the requisite mechanical conditions are present and some mode of agitation is provided to take advantage of mere differences of size. In other words, the elimination of a floating medium is desirable in order that the process may be restricted solely to sizing. While air would certainly be present in the atmosphere, it possesses no practical influence when at rest.

The McKesson Screenless Sizer is the name given to a new device which apparently overturns much preconceived opinion, for, while resembling a concentrating table, the process of concentration is non-existent, and its function is, for all practical purposes, confined to the separation of particles according to size. Differences of specific gravity exercise such a very small influence that the machine aroused unusual interest among those who have seen the first demonstration in Denver; though, after reflecting upon the principles which require a floating medium, either water or air, to effect concentration according to specific gravity, the absence of both would seem to me, negatively at least, to account for the results from the McKesson invention as a sizer, without the confusion that would result from any other kind of separation. The McKesson table uses no floating medium whatever.

In usual screen sizing it is well known that there is an absence of desirable efficiency when dealing with very fine material, and for this reason, in ore mills, water classification is adopted to accomplish results not to be secured by mechanical means. While the McKesson sizer has not been fully tested or its possible applications and limitations determined, it is evident that the machine as it now stands and operates produces very favorable results in the separation of the finest pulp, where it grades off into dust that would necessarily be collected by a suction fan, if present at all.

The sizer, it is stated, can be adapted to granular material of any size or mesh from rock and gravel to the finest pulverulent material. The sizer which I saw is adapted to material from 6 or 8 mesh up to the finest granular product. There is special provision made to cut out all over-size material so that it can be returned for regrinding.

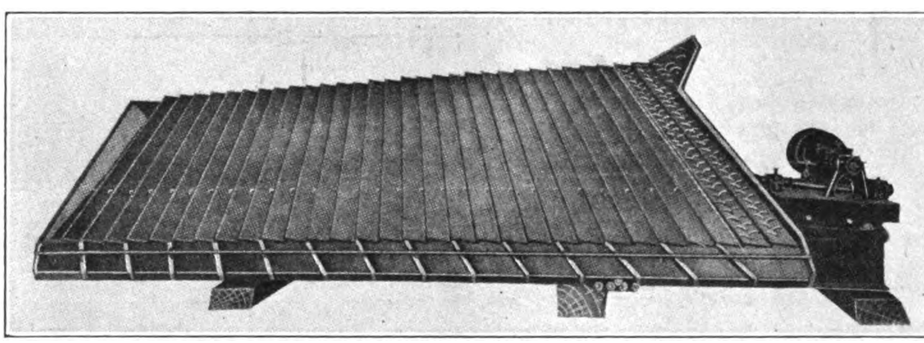


Fig. 1. Showing Deck of the McKesson Sizer

In the demonstrations that have been made of the invention, fifteen products are turned out, ranging, according to the character of the material, from a possible minimum of 8 mesh to more than 200 mesh. This is accomplished on an inclined surface having a horizontal and sharp vertical movement, the separation being, in general, the result of mechanical agitation.

Inasmuch as this invention is either based upon some new principle, or has thrived upon the rejection of principles that are serving well in other directions, a description of the mechanism and its operation will doubtless prove of value. The sizer is the invention of C. L. Mc-

*In Mining Science, Sept. 14, 1911.

†"Talc Milling and Pneumatic Classification." J. S. Diller; Mining Science, August 24, 1911.

‡Ore Dressing. Vol. II, second edition, page 826.

Kesson and B. F. Rice of Colorado Springs, and the patents are controlled by the McKesson Separating Co. The consulting engineers for the company are Lippincott & McClave of Denver, and the machine has lately been publicly exhibited at the ore testing plant of Henry E. Wood & Co., Denver.

The accompanying cuts, Figs. 1, 2 and 3, represent sectional drawings of the machine, a front view in perspective, showing the deck, and a rear view in perspective showing the driving mechanism.

The deck of the machine is supported by agitating mechanism which will be described after the deck itself is considered. In general, this resembles a concentrating table, but it is inclined at an angle of 38 degrees from the horizontal. This angle of incline bears upon the narrower of the two dimensions, or the width, of the deck. There is no dip in the direction of the longer dimension, but the surface is broken up into what may be described as steps, called deflectors because of their function of distributing the successive sizes of pulp after the fashion of channels. These steps or deflectors cut across the narrow dimension of the deck and follow approximately the dip of the table; though, to be exact, the lines of the edges correspond to radii of a circle, the center of which should be found at a point several yards above the highest border of the plane. Thus the lower border of the deck would tend to assume the shape of an arc of this imaginary circle, if there were any practical object in making it so. The horizontal dimension or width of the steps is 5¼ ins. at the top of the deck, and they are 1 in. wider at the bottom.

The effect of the circular measurement is noticed when one considers the surface of the deck, which consists of a covering of rubber matting containing grooves or corrugations. The matting is so cut and laid upon the steps that the grooves follow a course across the table parallel to the circumference of the imaginary circle. That is to say, at the feed end of the table, the grooves incline downward toward the center of the bottom; at the center of the deck, the grooves run parallel with the horizontal motion of the table, while, at the farther end, the grooves dip up with respect to the horizontal movement. The steps themselves have a drop of 1½ inches.

While we do not forget the circular nature of the measurements as applied to the corrugations of the deck, that is to say, the radical character of the steps and the curvilinear arrangement of the grooves in the rubber matting, the deck as a whole is, for all practical purposes, almost rectangular. It is 6 ft. in width at the feed end and 15 ft. in length. It tapers to 4½ ft. in width at the end opposite the feed. As already stated, it sits at an angle of 38 degrees. The matting grooves are very regular corrugations, approximately V shaped, and they are about ⅛ in. in depth. In none of the illustrations accompanying this article can these grooves be distinguished. The length of the deck is sufficient to contain 30 steps, each of which may, in theory at least, be made to contribute a sized product. In practice, however, the deflectors are operated in pairs, or nearly so, and at the bottom of the deck, where the successive products are cut out, the cutters are so arranged as to be adjustable during operations.

The deck has a progressive horizontal movement, aided by a sharp upward motion, which produces a sort of dancing effect among the particles of pulp. This result is produced by the bearings and the driving mechanism. There are four toggle supports set at an angle of 55 degrees, and the sharp vertical action is due to them. In other respects the movement is similar to that of a concentrating table, the horizontal motion being toward the left in the design and the perspective views of the deck (Figs. 1 and 2).

At the upper right hand corner of the deck is the feed spout, and from this point the pulp distributes itself to the left across the deck with a tendency toward the horizontal direction. The separation, however, is noted when the pulp begins to distribute itself in sized particles along the dip of the plane, that is, by way of the deflectors or steps, through which the sized products roll out at the bottom in successive receptacles. The pulp thus takes two directions, between which there is a median area, representing the general domain of agitation in which each size selects its outcome.

The upper border of the pulp line, along which the fines take their course, follows the corrugations in the rubber. That is, the fines descend slightly at the feed end and then ascend towards the upper edge of the deck and discharge from the top to the bottom of the final deflector at the end of the deck opposite the feed. The over-size particles are carried down the first two deflectors by means of a series of baffles, and discharged at the lower edge of the deck slightly back of the final spout. The baffles serve the purpose of keeping the oversize, coarse particles from bounding and rolling down the deck under the force of gravity.

As the pulp distributes itself to the left, the successive steps interrupt the process and aid the agitation in such a way as to cut out the particles of uniform size, beginning with the larger on the right and ending with the smallest on the left.

The selective action is assisted by the changing position of the deflectors and the corrugations in the rubber on the deck. The cutters at the bottom of the deck can be adjusted so that any required number of sizes up to 30 can be collected at one operation.

At a demonstration which the writer attended last week the machine was run at 320 r. p. m.

Concerning the theory of the McKesson method, I have no disposition to enter into a discussion of it, beyond what has already been said. An outline of the laws governing the selective action, in which differences of specific

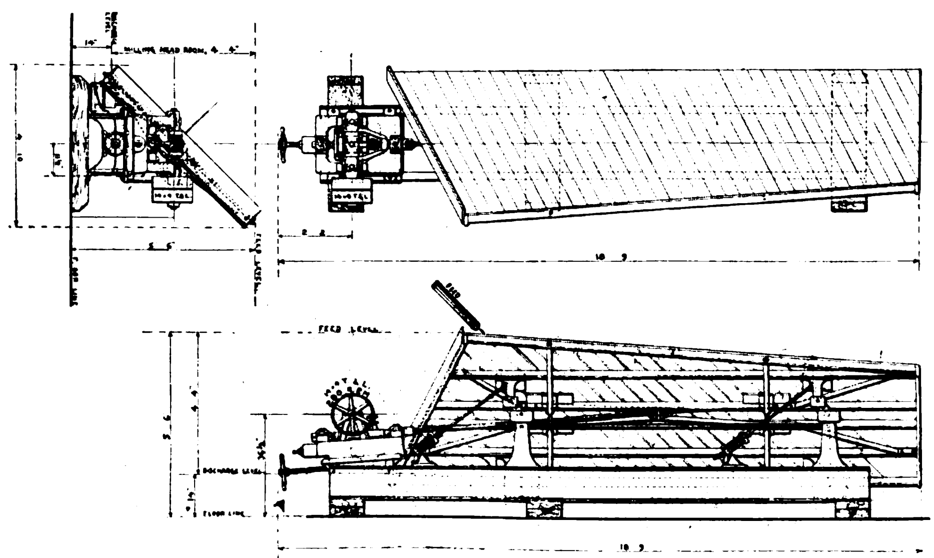


Fig. 2. Showing Rear Elevation, Horizontal Plan and Cross-Section.

gravity play but a very small part (and then only in the case of widely different minerals, according to the engineer), will be the result of systematic and prolonged experiment. That the sizing is effected to a high degree of efficiency is apparent to an observer, while the operation of the machine has all the aspects of simplicity.

Recent tests under the supervision of the company's engineers, some of the results of which have been available for the writer's inspection, indicate that the operations at average speed require about one horse-power. The length of horizontal movement and the toggle stroke determine largely the capacity, which has varied from 6 to 15 tons per 24 hours. After proper adjustments have been made on a given feed, the capacity can probably be increased, and it is estimated that from 20 to 25 tons can be handled commercially.

Screen tests of the several products have shown as high as 96 per cent efficiency, though at other points in the gamut the degree of efficiency may have fallen as low as 62 per cent. Such a low percentage is taken to indicate a faulty adjustment; in other words, that the under- or over-size at that particular point has not been satisfactorily diverted, either forward or backward. As the knowledge of the machine has increased, the tests have shown an average efficiency throughout the 15 products of 86.5 per cent, this being an expression of the degree of uniformity within commercial limits. It is clear, moreover, that a departure from uniformity of size should mean for the most part the presence or inclusion of under- or over-size from the grade next below or next above, the sizer itself disposing of the separation beyond the limits named. I offer this general statement rather as an indication of the problem to be considered than as a conclusion concerning what the machine may be expected to accomplish.

As a matter of general interest, it may be said that the method of sizing by this deck shows no concentration. In a mixture composed largely of galena and quartz, the over-size at a given point tends to show that the particles of galena are a little larger in sizes than the particles of lighter material, but there would be in case of a tendency to concentrate. The slight tendency to distribute larger, heavy particles in the zone of smaller, lighter particles becomes very interesting from the fact that this is a reversal of the effect of water classification, wherein small heavy particles report with large light particles. Theoretically one might expect the sizer to follow the hydraulic classifier in any variation from perfect sizing, but instead of doing that it entirely reverses that process. This fact excites much interest, as well as that of the closeness of diametric sizing done by the machine.

It shows that the mere mechanical agitation, effected both by the dual movement of the sizer, on the one hand, and by the stepping process and the grooves on the inclined surface, on the other, without the presence of a floating medium, either water or air (the latter being only the inactive atmosphere), produces a sizing result which is practically uncomplicated by differences of specific gravity among the particles.

It would be out of place at this stage of development to expect that the sizer has reached its highest degree of perfection, or that the range of usefulness of this new application of the principles here embodied should be fully known, but it appears that the sizer can successfully be used in many industries other than the milling of ores. The emphasis should be laid on the fact that the inventors and the engineers have developed a machine along entirely new lines and one that will supply wants not hitherto satisfied.

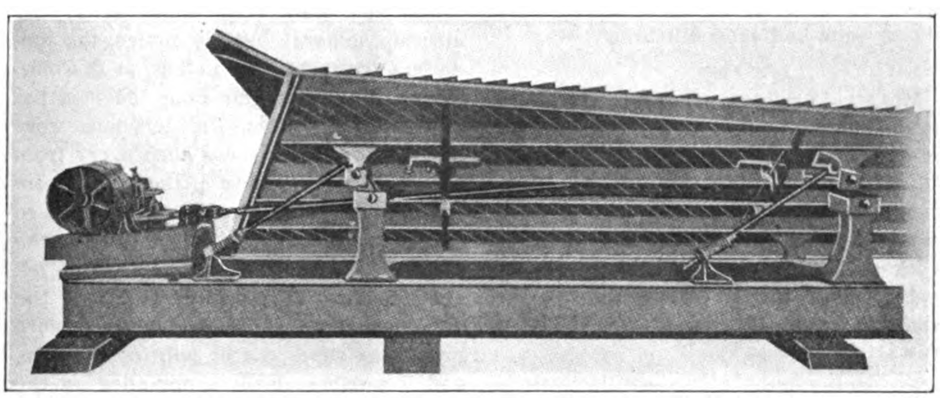


Fig. 3. Rear View of McKesson Table.

COPPERETTES

Walker's Weekly Copper Letter, Sept. 16. (Copyright, 1911, by Dukelow & Walker Co.): "I figure that Utah Consolidated has ore profits in sight which are worth, together with its treasury surplus, at least two-thirds the present market value of its capital stock. The prospects of all the undeveloped western portion of its property, the bottom of the mine and the equipment, therefore, are selling for only a little over a million dollars. In view of this, and the fact that dividend payments are quite sure to be resumed in the near future, I feel that a fair price for the stock would be at least twice what it is selling for now.—Geo. L. Walker."

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The price of Utah Consolidated at the time mentioned above was $12.50 per share, two-thirds of which—the actual value—would be $8.16. A fair price, according to Walker's method of determining values, would therefore be $25 per share. Thus we have a very simple method of determining the price the public investor should pay for the shares of any particular stock. Easy is it not? Not long ago, when the same shares were selling at $80, Walker advised purchases up to $150.

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Apprehension has been expressed by timid people lest the Utah Copper Company should run short of cash to meet the cost of removing the capping from its orebodies. Such fears are evidently groundless, for the reason that the management still has authority to issue and offer for sale approximately 937,500 shares of treasury stock, about 76,000 shares of which are limited in price to $50 per share; but the balance may be sold at any price that may be deemed satisfactory to the management.

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On the surface a new steel gallows frame and a waste bin have been completed and machinery for timber framing put in place. Extensive cross-cutting and timbering is being done in 2090 tunnel.—Item from Ray, Arizona, concerning Ray Consolidated, in Boston Financial News, Sept. 12, 1911.

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The important feature of the foregoing bit of news is that in relation to the completion of the new "waste bin."

It is refreshing to know that the management of the property, "which is practically the same as that of the Utah Copper Company," recognizes the importance of saving the "waste" at the Ray. At the Utah Copper they scatter the "waste" all over the country round about, just as though it was valueless.

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Mount Aetna is throwing out more lava in a week than it did in a month during its former eruptions. Maybe it has caught up with the times and is using steam shovels.—Chicago Daily News, Sept. 19.

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It is evident, from the news contained in the above item, that the Chicago News has heard of Utah Copper, which is probably the only real rival that Aetna has.

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To the engineer of imagination the scene at Bingham at night, with the shovels at work beneath the glare of the searchlights placed upon the hills opposite is dramatic in the extreme; indeed, the whole work which D. C. Jackling and his associates have carried on is a striking example of creative imagination applied to engineering work.—Salt Lake Daily Tribune.

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CURTAILING PRODUCTION. — The Utah Copper Company, having completed Janney-izing six of the thirteen sections of its Arthur mill, and having run short of available cash, without encroaching upon the dividend fund, and at the same time being unable to secure the quantity of ore necessary to supply further increased milling capacity because of the lack of sufficient number of steam shovels to keep the capping removed in advance of the ore shovelers, discharged about 450 men and suspended indefinitely all work of construction on the remaining sections of that plant, thereby evidencing their proverbial good faith in observing last year's "gentlemen's agreement" to curtail production.

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In the last Babson financial letter very favorable treatment is received at the hands of this prominent statistician by the Utah Copper and the Utah Consolidated companies of Bingham; also the Chino Copper company of New Mexico, Babson believes that these coppers are among the list mentioned that are deserving of consideration from an investment standpoint, and he believes that the time is here to lay in some of these copper issues, but according only to the Babson method. This method contemplates the purchase of twenty or thirty stocks instead of one or two.—Salt Lake Tribune, Sept. 1.

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Some time ago Mines and Methods expressed the opinion that Babson had become attached to the Utah Copper's publicity staff and the foregoing reference to his work at least tends to strengthen that opinion. But, if Utah Copper and the other stocks mentioned are such good buys at prevailing prices, why should Mr. Babson advise the purchase of twenty or thirty other stocks at the same time? Does Babson also feel insecure in his evidently purchased expressions concerning "the world's greatest copper mine"?

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ADVANCED ENGINEERING THOUGHT—As early as 1908 Manager D. C. Jackling, in his annual report to the president of the Utah Copper Company—in his customary quiet and unassuming manner—gave utterance to the following brilliant thought: "There are some advantages in continuing underground mining in some portions of the property, because the ore mined in this way is taken from the orebodies lying directly beneath the capping, resulting in the capping caving into the open stopes and BREAKING ITSELF, so that it is not necessary to blast it for steam shoveling." Salt Lake Evening Telegram and Walker's Weekly Copper Letter will please copy and send bill to us.

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MIAMI.—The fine grinding in one-half of the fourth section is being done with an 8-foot Hardinge pebble mill instead of Chilean mills used in the first three sections. One Hardinge mill has been found capable of doing the same amount of work as a Chilean mill. The other two and one-half sections probably will be equipped with Hardinge mills.—Boston News Bureau.

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From Walker's Weekly Copper Letter, (Copyright, 1911, by Dukelow & Walker Co.): "When there comes to be a full public appreciation of the immense demonstrated value and earning capacity of the Utah Copper company its stock will be sought as an investment at prices ranging between $75 and $100 a share. At its present price it is one of the safest investments and surest speculations in the mining world.—Geo. L. Walker."

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The tenth annual edition of the Copper Handbook by Horace J. Stevens, of Houghton, Mich., is now being issued from the press. Eighteen months have been spent in an absolutely complete revision of the mine descriptions and statistical section of the book. The new edition, Vol. X, contains 1902 octavo pages of text, and lists and describes 8,130 mining companies, mines and so-called "mines," this being much the largest number of titles given in any work of reference on mines. As in preceding years, there are several hundred pages of preliminary chapters, devoted to the history, technology and uses of copper.

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The appearance of Mr. Stevens' latest volume will cause much speculation in copper mining circles. The boys will all want to see the book to learn just what sort of a "rating" or "berating" Mr. Stevens gives them.

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From an inside authority comes some interesting, though belated, information concerning the plans for a giant copper merger. This information is positive that the project is definitely shaped, but held up indefinitely. The plans for the merger, along the Steel Corporation lines, were perfected in New York some time before the Supreme Court decided the Standard Oil and Tobacco Trust cases. The full details and the papers in the merger were carried to Washington and submitted to Attorney General Wickersham and others in authority there, and were fully approved by the attorney general, but, on advice, the promoters withheld final action on the merger until the Supreme Court decided the Trust cases. When the decisions were handed down there was such a cry from the press, or one class of them, and from the public, that it was deemed unwise to spring another gigantic trust upon the public at that time. Washington advised against it, and suggested that the announcement be deferred until a more propitious time. Later politics came in, and Republican leaders prevailed on the copper men to hold off their merger until after the next Presidential election. And that, it is claimed, is the present status of the big copper merger.—Butte correspondent in London Mining Journal, August 28.

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Great preparations are evidently being made to work the English investors when the time is ripe. It is a "lost hope" of saddling off on to someone the big things in copper which are too good to keep.

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Returns to the Ontario Bureau of Mines for the first six months of the current year are more than usually gratifying. Whilst the production of copper and nickel has fallen off, the output of silver is greater by 2,417,142 ounces than it was during the corresponding period last year. The amount of iron ore mined is 94,803 tons, or 55,306 tons in excess of the quantity mined during the former half of 1910. Gold once more appears on the list, 2,276 ounces having been extracted up to June 30th, 1911.—Canadian Mining Journal.

INFORMATION DEMANDED BY MINING INVESTORS

By AL H. MARTIN.

As the basic principles governing the mining industry become more intelligible to the investing public, the examining engineer's report occupies a position of ever-increasing importance. As in every other human industry, capital is required to win the golden rewards from the mines of the world. Consequently, the more intelligent the information diffused to inquirers, and the higher the knowledge possessed by the seeking individual, the more satisfactory will be eventual results. Legitimate mining offers opportunities for wealth possessed by few other lines of human endeavor, but the operations of fake promoters, and the gross ignorance displayed by hordes of so-called investors, has perhaps affected the mining world more seriously than any other pursuit. The mind of the average investor is fired by dreams of speedy and easily-acquired riches and in the mad scramble for wealth the ordinary precautions are totally disregarded. But slowly the great mass of the investing public is beginning to realized that mining is an industrial enterprise, and not the fabled wheel of Fortune. With this discovery has come the inevitable reaction, and hundreds of meritorious mines are lying inactive for lack of capital for their operation.

Accordingly the leaders of the mining world have come to realize that the public must be educated to understand the difference between legitimate mining and stock-gambling, also to distinguish the vast gulf existing between mining and prospecting. The average investor in the past has been influenced principally by the stock market, instead of by the physical worth of the property. Given a stock that displayed great animation on the Exchange the investor was satisfied, and scarcely a thought was given to ore reserves, management or the hundred and one other things that involve the development of a successful producer. Consequently heavy losses were generally incurred, and the misinformed buyer denounced the industry as an unmitigated swindle. Usually the fault has been his own, due to his lack of understanding; his failure to exercise ordinary precautions; his total disregard of all that is imperative in the selection of a desirable mine investment.

But with the new era has come a more perfect conception of the merits of the industry. And with this conception has developed a paramount interest in the report of the examining engineer. The intelligent investor no longer purchases stock in a company of which he knows nothing, and for preliminary information he turns to the engineer's statements. Consequently the report of the expert is attaining an importance that has attracted little attention in past years.

As the investor studies the report to gather information, it necessarily follows that such report should be sufficiently lucid and detailed to contain all the data possible. The investor is interested in the details, as he realizes the greater his knowledge of the property in question, the more likely is he to direct his steps aright. Every property of merit affords the examining engineer an ample field for the collection of data, and the report should be prepared in such a way that its analysis is readily feasible.

In analyzing a mine report, particular attention is devoted to the quantity and quality of the ore, as upon this resource depends the success or failure of the mine. But simply because a mine may have 100,000 tons of $10 ore is no guaranty of its dividend disbursing probabilities. If the ore is highly refractory, necessitating the employment of costly metallurgical processes; if power and labor costs are abnormally high; if transportation facilities are of such a nature that shipping costs are excessively costly, the mine may be practically valueless as far as future profits are concerned. Consequently the discriminating investor must take all these factors into consideration before arriving at a final decision. If the report does not contain these essentials, it remains for the prospective stock purchaser to secure them from other suorces, reports of the U. S. Geological Survey frequently affording the desired information. But when the report lacks the essential data, it is hardly probable that the proposition is as meritorious as its promoters would indicate. And in making this analysis it should be borne in mind that the future of the property from an assured standpoint depends absolutely on the developed orebodies, not on which may be later discovered in undeveloped territory.

Strictly speaking, a mining investment means the purchase of a developed mine in a proven district. When the property is a prospect the purchase naturally becomes speculative. Indications may be extremely encouraging, but the element of chance is so pronounced that the project ceases to bear the investment feature. Likewise any property in a new and unproven district is a speculative venture. Consequently the man desiring to make his mining investment a paying one, must confine himself exclusively to properties that are either paying profits, or are on the eve of doing so. And again, because a mine is paying profits at the present time is no warranty of its merit. The orebodies may be nearing exhaustion, or the veins passing into the territory of other owners. In some cases the prosperous mine of today may be the worked-out memory of tomorrow. In his analysis of the reports the prospective investor must take these points into consideration. Thus he must be familiar with the district and possess a good knowledge of the property which has excited his interest. In other words, in selecting mining investments he must exercise the same keen, trenchant judgment he would display in obtaining an interest in a manufacturing establishment, or in buying a home or piece of real estate. The sooner the fevered dreams of early riches are eliminated from the mind of the average mine investor, the sooner will the mining industry be realized for what it is—a sane and safe investment, with chances of great profits.

It is natural for any company to make the most of the good points of a property and pass lightly over the disadvantages. This rule is exercised every day in all lines of business. But it does not follow that the purchaser should close his eyes to these obvious facts. Accordingly, in his examination of reports he should cultivate an ability to read between the lines, to ferret out and study little items that are given scant attention. He should note whether values are improving or depreciating with depth; whether operating costs are increasing or decreasing. And always he should balance one point against another so as to gain a correct appraisement of the whole. Thus, while the value of the ore may show a falling off as depth is gained, the dimensions of the vein may be increasing sufficiently to offset the decreased worth. In one of the foremost of California gold mines the vein in the upper level averaged $25 per ton, while in the lower workings it runs $14 per ton. But in the upper workings the vein shows a width of only two feet while at depth it widened to six feet. And this was done without any marked change in the character of the ore. Consequently, the property is disbursing profits from the lower-grade ore that were impossible from the higher-grade. It is a little point like this that must be duly considered in making the analysis.

In the case of a property that has been in operation for some years, the monthly statements of the manager, if sufficiently detailed, offer a rich and satisfactory field for analysis. By means of these the lowering or increase of the operating expenses, and the physical changes of the mine are easily followed. Coupling the information thus secured with the amount of the developed ore and other immediate data, the prospective investor has a fair knowledge of the property under consideration.

Through the columns of the mining press, and the reports of the various geological bodies, he is enabled to gather information relative to the geology of the district, and the character and value of the veins. This in itself is a point that often marks the line between success and failure. Finally, it must be remembered that a poor manager can easily ruin a good mine, while not even a sterling manager can transform a worthless prospect into a revenue producer.

QUALITATIVE MINERAL TESTS

By A. L. SWEETSER.*

By the proper use of the blow pipe two very different chemical reactions take place in the ore under examination, namely, oxidation and reduction.

The oxidizing flame is produced by holding the jet of the blow pipe just above the wick of a candle, lamp or gas burner and inserting the same into the edge of the flame and blowing strongly and steadily. This makes a long, pointed blue flame, and the object to be tested is held beyond the point of the flame.

In the reducing flame the blow pipe is not inserted in the flame and the object tested is held in the yellow part of the flame.

All ores must, if possible, be reduced to a fine powder before a test can be attempted. A small quantity of this powder, mixed with a little sodium carbonate, is then placed in a slight cavity, on charcoal, of about one-half inch wide and of the same depth, and treated with the reducing flame. All odors and colors that appear while the substance is hot and when it is cold should be carefully noted.

*Mining engineer, Denver, Colo., in Mining Science.

The presence of arsenic is shown by a garlic odor, and the smell of sulphur denotes the presence of a sulphide. The character of the metallic globules of the reducible metals and the colors of the coatings on the charcoal are as follows:

		Coatings.	
	Globule.	Hot.	Cold.
Bismuth	Brittle	D'k O'ge	Lem. Yel.
Antimony	Brittle	White	White
Silver	Malleable	D'k Red.	White
Tin	Malleable	Pale Yel.	White
Lead		O'ge Yel.	Yellow
Zinc		Yellow	White
Cobalt		Red B'rn	Red B'rn

If the end of a platinum wire is bent into a loop, heated to redness in the oxidizing flame of a blow pipe and then dipped into some borax and reheated a clear borax bead will be formed. Such a bead, when dipped into powdered ore and heated, will show the presence of certain minerals by the colors imparted to the borax bead. The test should first be made in the oxidizing flame and then in the reducing flame, and the colors, both hot and cold, in each case should be carefully noted.

BORAX BEADS.

	Oxidizing Flame.	
	Hot.	Cold.
Copper	Green	Blue
Cobalt	Blue	Blue
Nickel	Violet	Red Br'n
Iron	Red	Yellow
Manganese	Violet	Amethyst
Molybdenum	Colorless	Colorless
Chromium	Green	Green
Uranium	Yellowish	Green
Vanadium	Colorless	Colorless

	Reducing Flame.	
	Hot.	Cold.
Copper	Colorless	Red
Cobalt	Blue	Blue
Nickel	Gray	Gray
Iron	D'k Green	D'k Green
Manganese	Colorless	Colorless
Molybdenum	Green	Green
Chromium	Green	Green
Uranium	Green	Green
Vanadium	Green	Green

For the benefit of those who are unable to acquire the habit of breathing through the nose while blowing through the mouth, without stopping, and also as a check on the blow-pipe results, the following liquid tests will prove of value. Unless otherwise stated, always use nitric acid to get an ore in solution after it has been powdered.

Silver—To the solution of the ore add a little hydrochloric acid. If a heavy, white, curdy, precipitate forms and this turns a dark color on exposing it to the sunlight, silver is present.

Gold—Make a mixture of one part nitric acid and three parts of hydrochloric acid and dissolve the ore. To this solution add some stannous chloride, and if a purple color is produced, gold is present.

Platinum—Dissolve the ore in a mixture like that used for gold and then add some more hydrochloric acid and evaporate the solution almost to dryness. Pour a little ammonium chloride and some alcohol on the above and a heavy yellow precipitate will indicate the presence of platinum.

Mercury—Stannous chloride added to a solution of the ore will yield a white precipitate of mercurous chloride.

Copper—Liquid ammonia added to the solution will give a deep blue color, which is the characteristic test for copper.

Lead—A deep yellow precipitate is formed on the addition of potassium dichromate.

Bismuth—To the solution add sulphuretted hydrogen and filter off the liquid. Dissolve the precipitate in nitric acid and boil it with ammonium carbonate. Then add sulphuric acid, and if bismuth is present potassium iodide will cause a dark brown color.

Arsenic and Antimony—Dissolve the substance in hydrochloric acid, evaporate almost to dryness and then add water and filter the solution into a platinum dish. In this dish place a piece of zinc. If arsenic is present it will be deposited on the zinc, and if antimony is in the solution the dish will be stained black.

Solutions of nickel are green; those of cobalt are pink.

Zinc—Add sodium hydrate to the solution and then filter. To the filtrate add ammonium sulphide and sulphuric acid and boil the mixture. If zinc is present potassium ferrocyanide will give a white precipitate when added to the hot mixture.

Tin—Dissolve the substance in the same mixture as required for gold and platinum and then add sulphuretted hydrogen. A yellow precipitate indicates the presence of tin.

Molybdenum—If a blue color that soon changes to brown appears on the addition of sulphuretted hydrogen to an ore solution, molybdenum is present.

Tellurium—Purple color when the ore is dissolved in strong sulphuric acid.

Titanium—Deep brown color on adding a mixture of hydrochloric acid and barium peroxide to an ore solution.

Tungsten—Dissolve in nitric acid and add hydrochloric acid and stannous chloride. If tungsten is present a deep blue color will form when this mixture is heated.

Vandadium—After dissolving the ore add liquid ammonia and sulphuretted hydrogen. The result may be a deep red color. Filter this and to the filtrate add hydrochloric acid, and if a brown precipitate is formed vanadium is present.

Uranium—A yellow color produced on the addition of liquid ammonia to a solution.

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CONTENTS:

Iron rails make better sluice riffles than any other material and are laid lengthwise on a 4 by 6 scantling. The gold settles admirably in the space between them.

Carbon monoxide, CO, is a product of the incomplete combustion of fuels containing carbon. It is very poisonous, small quantities when breathed producing death.

The application of the barometer for measuring altitudes depends upon the fact that the atmospheric pressure decreases as the altitude increases.

PRACTICAL HINTS ON ORE DRESSING

The somewhat recent development of fields of low-grade copper ores has greatly enlarged the demand for that class of ore-concentrating devices theretofore in use in the treatment of the finely divided portions of the mineral contents of ores of all classes which from times almost immemorial have been subjected to some form of hydrous concentration. And whilst these new developments have, either by accident, good fortune or otherwise, caused to appear upon the horizon of the so-called technical world, many aspirants for primigenial honors the appearance of the new ores was not attended with any new or vexing metallurgical or mechanical problems except alone such as naturally arise from a rapid increase of a very familiar commodity, which in this case has imposed no serious burdens upon our splendidly equipped machinery manufacturers.

The copper mineral contents of these ores occurs, almost exclusively, in small sharply-defined grains disseminated throughout an exceedingly soft and friable gangue-stone, or in thin hard plates and films occupying fracture-planes therein, and readily yields to slight pressure from any form of crushing device capable of reducing the mass to about thirty-mesh, standard wire screen, from which it will be seen that the entire product becomes of that class which is amenable to successful concentration only by some form of bumping or jerking table, or by the buddle, or some type of traveling belt, long in common use. Of course, in the preparation of any ore for concentration, whether a portion of the constituent mineral be massive, and susceptable of recovery in coarse particles by means of jigs, as in case of the older mines, or whether the entire mass as in case of these new ores, must be reduced to a consistency adapted to treatment only by tables or buddles, it is of the utmost importance that the crushing be done in such manner as to avoid as far as practicable the abrasion or destruction of the chrystaline or granular form of the mineral particles.

Owing to the comparative softness, friability and law of specific gravity of the rock-gangue of the new ores, recovery of the mineral contents presents far less difficulties than does the correspondingly fine pulp which results from reduction of the more massive sulphide ores of the older mines. So that, in selecting concentrating as well as crushing machinery for equipment of the new mines, it was only necessary to ascertain what type of machines were employed in any one of the standard concentrating mills in Montana, Idaho, Arizona, or in fact any locality where successful concentration was being conducted. No one need to have made a mistake in this respect because—if we except the Wilfley and kindred tables and certain unimportant modifications of the old Frue vanner—practically no important or material change or improvement had been made in crushing or concentrating machinery for thirty years.

Therefore, in view of these facts, the silly slush which from day to day has burdened a certain class of truckling publications during the last five or six years—whereby extraordinary genius, skill and foresight has been attributed to every act and movement of those individuals who have had the good fortune to become attached in a managerial or even subordinate capacity to any of these new enterprises—is but nauseous drivel. It is true, however, that these obsequious parasites, whilst acting as the paid servants of unscrupulous market fakirs have, by persistent subtle flattery so inflated the pliant egotism of the executive heads of some of these new enterprises as to render intelligent progress upon established lines impossible. They have been unconsciously placed upon a pedestal of scientific intuition which comprehends all essential knowledge of the art of ore dressing without having been subjected to the humiliation of having to inquire how others before them had proceeded in similar undertakings. What wonder, then, that millions of dollars should have been swallowed up in the construction of mills totally unadapted to the purpose designed, and that, immediately upon the completion of each of these costly structures, the work of replacement and reconstruction should follow with such close step as to tread upon the heels of the workmen who had laid the foundations of the original structure. Usually the original machine was superceded by another less fitted for the duty required, but occasionally a step was unconsciously made in the direction of established practice. But just why one kind of a machine should produce better results than another in the stubborn process of ore concentration will probably NEVER BE KNOWN TO EVERYBODY and need not be discussed here. But there are certain elementary principles and fixed laws which prevail in any successful process of ore concentration which it would be well that every mechanical engineer should understand who undertakes to design or construct an ore concentrating mill. However, such knowledge is not so essential if the engineer has the sagacity and courage to restrain his pride and adopt the design of a first-class plant which is in successful operation. With a mill so constructed it is only necessary to employ a crew of men who have been seasoned in the practical work of operating similar machinery in a similar mill, care being taken to secure an intelligent foreman of experience in the work. Never employ a NEAR RELATIVE OR CHUM as superintendent of concentration because, in the first place, they will never learn the business and think they don't have to; and then you can't discharge them because they always have "something on you."

With appliances and methods which for many years have been in successful use in the older mines—as before indicated—the concentration of these new ores becomes at once extremely simple and a comparatively high recovery of the copper contents should be easily attained. And yet, owing to lack of experience and elementary knowledge of the basic principles upon which successful results depend, the operators in case of all of these new enterprises—with the possible exception of the Miami—have fallen far below results attained in the treatment of similar ores of the old-fashioned mines.

In the near future Mines and Methods will discuss the theory and principles of scientific and practical ore concentration, in which we shall take the position that screen sizing, as employed in general practice, is carried to harmful extent, and that water classification in any form is absolutely destructive of best economic results.

TRUTH IS FINALLY OUT

It will be recalled that a deal was consummated two months ago by which the American Smelting & Refining Company took over the smelter proposition under contract to build. There has been marked activity at Hayden ever since the A. S. & R. acquired the smelter concession. The site that had been laid out by the Ray Consolidated and partially graded, was slightly changed and men and teams and steam shovel are now being worked night and day excavating for the new site on the north side of the gulch, near the Ray Con. power house. Surrounding the works has risen a tent city within the past few weeks where the workmen are housed. Commodious office quarters have been opened up, the entire second floor of the McIntyre store building being used. There are 200 teams, a steam shovel and near 300 men employed. —Arizona (Hayden) Copper Camp, Oct. 11. 1911.

Of course the publisher of the little paper at Hayden did not dream, when he published the above item of news, that he was the first to tell the truth about the progress that had been made in the building of the Ray Consolidated smelter. For many months last year and early in the present year the "market builders" for the Utah Copper, Ray and Chino companies, were working overtime telling of the big things that were doing in Ray Con. smelter construction. Finally they had to "back up," as the money was not forthcoming to build the plant. They squeezed out by announcing that the Guggenheims would take over the "partially completed smelter" and would "PAY BACK ALL THE MONEY THE RAY HAD INVESTED IN ITS CONSTRUCTION AND EQUIPMEN TO DATE."

Like everybody else, we had imbibed the impression that the Ray Consolidated had really undertaken the building of a smelter—and we even thought it must be well under way when its sale to the Guggenheims was made, something over two months ago. But, as disclosed in the item from the Ray paper, we were fooled again—and so has been the public. The smelter had not even been started and only a small amount of grading for the site had been done. The Guggenheim engineers at once decided to go on the opposite side of the gulch to prepare ground for the contemplated plant, and thus they helped to clinch Si. Eccle's declaration that D. C. Jackling is "one of the greatest and most competent engineers in this or any other country," for there is no doubt that Mr. Jackling as manager of the Ray Con., selected the original site for the new smelter.

"BEFORE AND AFTER"

The Utah Copper property was purchased about six years ago on a tonnage basis of 10,000,000 tons actually developed and 10,000,000 tons of probable ore, averaging about 2% copper, and the stock sold at 24 on this tonnage basis.

Today the company has 203,000,000 tons of reserves, the $7,000,000 cost of plants and equipment has already been paid back in dividends in three years, and with a present production rate of over 100,000,000 lb. copper per annum, and dividends of over $4,500,000 a year, the stock sells around 40.

Could anything be more dishonestly misleading than the paragraphs quoted above? They are taken from the News Letter, published by Thompson, Towle & Co., October 11. In the first place when Utah Copper was selling at $24.00, as stated, the company's capitalization was only 450,000 shares, and its indebtedness was insignificant by comparison. Today, with the stock selling around $41, there are 2,500,000 shares to conjur with —quite a difference when you come to think about it. At $24 the market value of the company's holdings was $10,800,000; at $41, the market value is $100,250,000. Had the capitalization remained at 450,000 shares the money now being disbursed as dividends would have yielded more than $12 per share per annum, instead of $3. This conclusion of course is based on the supposition that the company would have continued to maintain its widely-heralded position of a "self-contained manufacturing proposition" and have kept within reasonable bounds in the matter of financing.

But there is where one feature of the company's campaign of deception crops out. At the time its management was most glib in recital of the "self-contained manufacturing proposition" idea it was practically at the end of its rope, so far as steam shovel operations were concerned, and this magazine called attention to the fact that inside of three years, unless the company secured additional ground, it would necessarily have to cease operations—through the plan inaugurated—for lack of available ore. Inside of six months—not three years—the company proceeded to show the falsity of the declarations it had made by opening negotiations for the purchase of Boston Consolidated and soon thereafter the deal was closed. That transaction substantiated our claim and left the management in an equivocal position insofar as its being able to convince the investing public of its honesty of purpose was concerned.

About the same time this magazine took up other features of the company's campaign of deception. It showed with what utter recklessness of cost, lack of care and disregard of established practice in the construction, equipment and methods applied to recover the copper from its low-grade ores, the company was proceeding. And every claim and charge along these lines that has been made has been verified times without number by facts and figures that the company has never disputed or challenged.

But we have told all these things so many times, and we have more recently so clearly shown into what financial staits the company has drifted, that it is hard to believe that the investing—or even the speculative—world will be led into the trap that has been baited for them by the hired press and brokerage representatives of the pooled interests crowd that is only waiting the chance to let the public "hold the sack" while they "cash in;" because, to assume for a monment that representations heretofore and now being made in respect to the value of this property, are true, is to assume that the owners and managers of this professedly-great mine are a band of lunatics, seeking to dispose of tremendously valuable assets at a mere tithe of their worth.

THE ABSURDITY OF IT

The Salt Lake Eevening Telegram tries awfully hard to keep saying things that will please the Utah Copper and other "new porphyries" managers. In its anxiety to prove its loyalty "to the cause," it frequently makes a spectacle of itself. On the 12th of the present month it had two articles—original or pilfered—in the same column from which the following brief quotations are made:

Sherwood Aldrich, president of the Ray Consolidated Copper Company, is scheduled to reach here about October 23, and in company with General Manager D. C. Jackling he will make a trip to the company's properties in Arizona.

A supporting factor in the copper metal market situation has come to light since the first of the month. The supposition has been that with the new porphyries coming in there would be a greatly increased supply of the metal, and contrary to this view it has been demonstrated that it will be some time before these new properties reach the point where they will become an important factor in the metal production of the world.

Ray's new mill is easily handling all the mine product at this time, and the management is very much pleased with results obtained, which is now showing a considerable profit on operations.

This gives some idea of the ultimate capacity of the mill plant, as the four sections now in operations are treating close to an average of 900 tons daily.

At times a high grade run will be put through, and naturally a large percentage of recoveries will be shown in the concentrates.

Within less than a year it seems highly probable that the directors of this company will be considering the proposition of paying dividends.

The three more important mines which are figured on increasing the supply of copper metal are Ray, Miami and Chino. Miami is not expected to produce more than two-thirds of its ultimate output; Ray may not make more than three-eighths of its capacity and Chino is just getting its new plant into commission and will hardly output more than one-third of its capacity for some time.

While these mines have been expected to reach a minimum output of 170,000,000 pounds of copper during 1912, it seems now probable that they will fall far short of that quantity.

And as Brother Higgins, of the Salt Lake Mining Review, would say: "And there you are; and then some."

WALKER MAKES DENIAL

To the Editor of Mines and Methods,
Salt Lake City, Utah.

Sir: In the September issue of Mines and Methods I find the following statement:

"When we come to consider that Mr. Walker's writings during the last few years have enabled him to accumulate several millions of dollars, one can form some idea of the value or cost of the foregoing to the Utah company; but perhaps a more correct conclusion in respect thereto may be found from the following, which is related by a newspaper man of this city: 'It appears that during Mr. Walker's last annual swing around the circle of Western contributing mines he prepared and published a highly complimentary description of the property of the Mason Valley Copper company's mines at Yerington, Nevada. This happened at a time when that company was offering for sale an issue of bonds for the purpose of securing funds with which to equip their property with a smelter. In recognition of the aid rendered by Mr. Walker, it was said that the company promptly sent him a check for $1,500, which he as promptly returned with the remark that the write-up was worth to the Mason Valley Company $5,000. Whether that amount was paid or not our informant was not advised, but we note that Mr. Walker's report on Mason Valley for this year is even more favorable than the last, and therefore it may be inferred the estimated value of the precious send-off was paid.'"

There is not one iota of truth in your statement. If you will prove that I was either offered or accepted $1,500 or $5,000, or received and accepted or refused a check for any other amount, I will give $5,000 to any Salt Lake City charity you may select.

You will confer a favor if you will publish this letter in your forthcoming issue. GEO. L. WALKER.

Boston, Mass., October 20, 1911.

THE COPPER SITUATION

The New York correspondent of the Mining and Scientific Press (Oct. 21) comments entertainingly—and with evident understanding—on the copper situation as follows.

"Copper producers in general appear to be tightening belts and preparing for a further indefinite period of low prices and decreased consumption. Unsettled conditions abroad must cut down the real export demand, and, while it is said on all sides that stockyards are as bare as they can be so long as business continues at all, yet there is no incentive, either in general business conditions or in the copper situation itself, to induce consumers to take on copper. * * *

"Some of the market developments of the week have been aptly illustrative of the absence of public interest. Tuolumne failed to declare its regular quarterly dividend since which announcement the shares have been advanced and the market held apparently strong, mostly because there was no attempt by the public to make market capital out of the cessation of dividends. Another instance was the advance in Chino and in Ray Consolidated immediately upon the appearance of the monthly figures of the Producers' Association. In neither case was market action logical, nor would it in either case have been possible with a public in the market."

TECHNICAL PUBLICATIONS

So many weekly, fortnightly, and monthly periodicals are published nowadays which contain articles of importance to the mining fraternity, that it is quite out of the question for an individual to regularly subscribe to all of them, or even to more than glance through the files when a fairly complete library is available.

To obviate this difficulty the Engineering indices which appear in Engineering & Mining Journal, Mining & Engineering World, and Engineering Magazine are of great assistance, especially to the engineer so situated that technical libraries are out of reach. The Engineering Magazine alone regularly reviews and indexes monthly the contents of 173 publications, which does not include those devoted to geology and ore-deposits.

The Geologisches Zentralblatt, appearing fortnightly, contains abstracts of leading articles from publications in many languages, translated into German, French, English or Italian. Even articles appearing in the Russian language are reviewed, and at a glance one is able to see what of importance has recently come out, (on the subject of economic geology, for instance), in every land.

These indices make it unnecessary to subscribe regularly to a large number of technical publications, because with their help the marooned engineer is able to locate and acquire immediately any articles of special interest to himself. What is of importance to one reader may be of minor interest to another, and at the present day when technical matters are so highly specialized it is impossible that articles of permanent value should be confined to a limited group of publications or to any one language. Many will of necessity seek the light along lines of least resistance, and only through technical indices become known to engineers to whom they may be of interest.

No one can feel sure that he is posted on any particular subject until he has looked through the technical indices mentioned, and has ascertained what has recently appeared under that heading. When an engineer neglects this precaution the complaint is unwarranted that he was uninformed because some article came out in what he is pleased to term a "backwoods magazine." Such an individual, if he inspects the lists regularly reviewed by prominent technical publications, will probably find many that are to him of the backwoods variety, but not necessarily so to others.

A plan that works well is to keep a small deposit with some house that makes a specialty of technical publications, so as to be able to send a post-card order for any desired book or periodical as soon as notice of it has been received. One engineer of our acquaintance has had dealings of this kind with a Leipzig house (Th. Stauffer, Universitaetsstrasse 26, Leipzig, Germany) for over thirty years.

MEETING OF A. I. OF M. I.

(Excerpts from Mining & Scientific Press Report.)

The San Francisco meeting of the American Institute of Mining Engineers was opened Tuesday morning, October 10, with an informal reception to the visiting delegates in the Red room of the St. Francis hotel. In the evening the Sierra Madre Club members were hosts at a cleverly appointed dinner in their clubrooms at 313 West Third street. The spirit of the occasion was well borne out by the invitation cards, a reproduction of a placard announcing, in straggling letters.

"NOTICE.

"This is the Camp of The Sierra Madre Club. It is Open to all Mining Men & Prospectors. The Flour and Bacon are cached on the Roof and the Water Hole is just back of the Cabin. Let Those who pass on this Trail help themselves."

Below was inscribed a further greeting and welcome to the members of the Institute by the Sierra Madre Club.

The evening, however, was not wholly devoted to merely lighter matters, and a lecture on the Los Angeles aqueduct by William Mulholland, chief engineer in charge of the project, was both interesting and instructive. The lecture was illustrated with many lantern slides showing different features of the work.

On Friday, October 6, the delegates were guests on an extended trip to points of interest near Los Angeles. The oil-fields, the Soldiers' Home, the Redondo power house of the Pacific Light & Power Co., and the pleasure resorts at the famous beaches clustering about the city were some of the places visited. The trip was in charge of B. L. Dowell, traveling passenger agent of the Pacific Electric Railway company. The dinner was served in the unique "fish restaurant" of Hopburn & Terry at Redondo.

The first business session of the San Francisco meeting was called to order Tuesday afternoon, October 10. W. C. Ralston, as chairman of the local committee, in a few well chosen words welcomed the visitors, for whom Robert W. Hunt, vice-president of the Institute, responded happily in a short speech. The first official act of the delegates was the despatch of a telegram to President Kirchhoff expressing their regret at his absence, and their sympathy in his trouble, with their hopes for the prompt recovery of his mother, whose illness prevented Mr. Kirchhoff from attending the meeting.

The first paper read at the meeting, presented by E. B. Durham, was a well-prepared description of the electrolytic refining methods used in the United States Mint at San Francisco. This was followed by a paper by Bernard McDonald, who in his account of the "Parral Tank System of Agitation," gave a particularly interesting description of the improvements in practice he had worked out in the Mexican mills recently erected under his direction.

The geology, equipment, and method of working at Newport iron mine, Ironwood. Michigan, was described by B. W. Vallat. At this mine the sub-slicing system of mining is employed and in 307 working days in 1910 a total of 1,074,800 tons was hoisted through one shaft, an average of 3500 tons per day. The highest record was 6652 tons in one day, the average hoisting distance being 2150 ft., the maximum hoisting speed being 2200 ft. per minute, and the production was secured from four different levels. In discussion of this paper Gardner F. Williams called attention to the similarity of the mining system to that adopted at the Kimberley mine in South Africa in 1887, though at the latter no timber is used to form the top mat. The upper slice is caved as at the Newport mine, but the waste follows the ore directly. At Kimberley the hoisting is all done from one level, the material being dropped through winzes as much as 500 ft. to reach that level. There are two 10-ton skips for hoisting, these being run in balance. In separate compartments are cages for handling the 4000 natives employed. On August 4, 8514 tons were hoisted in 12 hours from the 100-ft. level, and August 11, 9098 tons. The highest previous record was 8433. In six days 48,000 tons has been hoisted. Material is brought to the loading station in one-ton cars hauled by an electric locomotive. The cars are dumped by the natives and trains of 32 cars have been handled without stopping the train which moves slowly over the bin.

In his treatise on the "Electro Deposition of Gold and Silver from Cyanide Solution," S. B. Christy gave a scholarly review of the work of the last dozen years on this highly technical subject. The paper contained much interesting material, but too complex to be summarized in the space available in this issue.

The technical session on Wednesday morning was opened by an intensely interesting paper on "California Oil," by Mark L. Requa, to which the secretary emeritus, Dr. Raymond, added pertinent and interesting discussion in which several other members joined. A representative of the Panama-Pacific Exposition welcomed the members of the Institute to San Francisco and requested their aid in making the forthcoming exposition a success. Tre papers on dredging by Messrs. Charles Janin and Francis J. Dennis were read by Mr. Dennis in the absence of Mr. Janin, and a brief discussion of dredging problems followed. This was followed by an interesting paper on the gold production of California, by Charles G. Yale, who has been so closely identified with the development of the mineral industry of California, and many of the members joined in the discussion which followed.

The secretary read a telegram announcing that a research scholarship would be established at Columbia University as a memorial to Sameul Franklin Emmons, as noted in the editorial pages of this issue. E. H. Benjamin announced that A. D. Foote, whom it was hoped would be present at the meeting, was undergoing a serious operation, and a resolution expressing the hopes of the members present for his safe and speedy recovery was unanimously carried. The morning session was brought to a close by an informal talk by Thomas T. Read on the mineral industry of China, illustrated by lantern slides, which aroused much interest.

At 2 p. m. Wednesday afternoon the party left the City by special train for a trip down the peninsula and a visit to Stanford University. At Palo Alto they were met by the Stanford members of the Institute and the students in mining, and taken by special cars and autos across the beautiful campus of the University. The shops, laboratories, libraries, and museums were inspected, after which on the roomy porches of the Delta Upsilon house the visitors were served light refreshment and informally met the men of the departments related to mining.

In a paper on the "Fritz Engineering and the Coxe Mining Laboratories of Lehigh University," Joseph Daniels, associate professor of mining engineering in that institution on Thursday morning told of the founding and equipment of the two laboratories. He remarked that the new ore-dressing laboratories of Lehigh are in the natue of a new departure, as, on account of its proximity to the Pennsylvania coalfields, the principal interest of the university has been in coal mining. With the new facilities it has been found that in spite of the fact that 90% of the students are drawn from coal-mining districts, only 10% of the students after graduation return to the coal-mining industry, the majority preferring metalliferous mining. R. W. Hunt, who was chairman, spoke at the dedication of the Fritz laboratory, remarked Mr. Daniels. In this laboratory, tests were made of concrete material, for the city of Scranton, and it is proposed to provide facilities for testing road material.

In a technical but intensely interesting paper on "Slime-Filtration," George J. Young, professor of mining and metallurgy in the Mackay School of Mines, told of the data he had collected.

Reiji Kanda, a consulting engineer of Tokyo, a member of the American Institute of Mining Engineers, arrived on the Chiyo Maru on Thursday and spoke at the session as a representative of the Mine Owners' Association of Japan. He bespoke a warm welcome for the American engineers on their coming trip, in which he will act as escort.

A paper by H. Foster Bain, in which he advocated the leasing system of the Alaska coal-lands, and the opening of one mine by the Government, aroused some of the keenest discussion of the Institution. J. W. Malcolmson asked why it would not be advisable to permit the development of Alaska on the individualistic lines which existed during the development of the West. Mr. Bain pointed out some differences in the two problems and asserted that the men most interested in the coal-lands of Alaska were not residents there throughout the year. Edward W. Parker gave some interesting statistics regarding the consumption of coal in the United States and the production of coal in Alaska.

Dr. R. W. Raymond, who was acting as chairman, strongly disapproved of the course advocated by Mr. Bain. He affirmed that the United States Government is not capable of conducting the fuel business with the same certainty of method as private individuals, and said that the Government has no maps which show the mineral land still the property of the United States. The aim of the Government, he continued, has been to give every man a chance to own 160 acres of coal land, and not to interfere with his disposal of the land. But the Government lately has undertaken to add commandments to the decalogue, and to create crimes for which none need blush because denounced by some demagogic reformer. The United States, he asserted, in regard to the Cunningham claims, failed in its trust in not granting title to the claims. The main feature of the new law, he said, had been disregarded, in that stockholders in one coal company could not hold stock in a rival company. In the future some "Glavis Junior" might discover such ownership and associated stockholders would lose without appeal title in the lands. Federal taxation of any natural resources would subject citizens utilizing the resources to a handicap not experienced by the citizens of Texas, where the State of Texas and not the United States has control of natural resources. The people of the United States are drifting into a policy of opportunism, and the multiplicity of laws has made it impossible for industrious and ambitious citizens to know whether or not they are criminals under the law. We now have a lot of impossible cures for imaginary evils through recent legislation in individual States, but such legislation at least indicates that individual States can be persuaded to remedy evils, while it would be impossible to get a majority of the States to agree on any change in the Federal policy. Mr. Raymond's speech was interspersed with witty stories, and was greeted with applause.

Thursday afternoon the delegates visited the University of California. Dr. Raymond gave in the Greek theatre some "Reminiscences of the Beginning of the Institute," and G. T. Becker gave a biographical notice of S. F. Emmons.

On Friday many of the delegates went on an excursion to the gold dredges at Natoma. There they were entertained at a pleasant luncheon by the Natomas Consolidated company. After luncheon the dredges were visited and the rock-crushing plant at Fair Oaks inspected. On the return the delegates were guests at dinner of the San Francisco committee in the dining-car. Many of the ladies and delegates as well were visitors to many factories about the bay, where a cordial welcome was given them.

On Saturday afternoon the delegates left the St. Francis hotel at 1:30 p. m. in special sightseeing automobiles for a three-hour trip, stopping at Golden Gate Park to witness the ground-breaking ceremonies for the Panama-Pacific International Exposition in 1915.

On Sunday the members of the Institute and their guests, to the number of about 200, made an excursion to the Bohemian Grove, on Russian river in Sonoma county. After an hour spent in strolling about the grove, lunch was served, followed by an hour of music in the leafy amphitheatre.

On Monday evening the local members of the Mining and Metallurgical Society entertained the visiting members and prominent members of the Institute at a dinner at the Fairmont hotel. The dinner was followed by a discussion of the Alaska land laws, which was opened by H. Foster Bain, and in which Dr. Raymond, George Otis Smith, E. W. Parker, W. R. Ingalls, Charles G. Yale, M. L. Requa, W. C. Ralston, and W. L. Saunders joined.

On Tuesday morning, Oct. 17, the members of the Institute who are to visit Japan sailed on the SS. Manchuria, to return early in December, Joseph Struthers, the secretary, being in charge of the party, which is accompanied by Reiji Kanda, who came to San Francisco as the representative of the Japanese mine owners' association.

OPENING MINE LEVELS

It is now considered good practice to open mine levels 150 ft. apart, the distance being measured on the vein. In earlier years the distance seldom exceeded 100 ft. and was often less, but where the vein is found to be persistent in depth it has been found less expensive to increase the distance between the levels, the economy being in the saving of the increased cost of driving the levels at more frequent intervals, timbering them where necessary, and also the cost of the more frequent cutting and equipment of stations, where the mine is operated through a shaft. These are all more expensive than stoping.

It is obviously less expensive to open and equip eight levels than twelve, in going down a distance of 1200 ft. At one time the objection was urged that great distance between levels resulted in a greater expense in cribbing and keeping the mill-holes in repair, as the timbers of the cribbing would be completely worn out by the falling rock, and these had to be replaced at considerable expense and loss of time in the consequent interruption of the work, not to mention the danger to the men. Shrinkage stoping has largely remedied this difficulty and levels may now be 200 ft. apart as well as less.

Black powder is exploded by combustion, while dynamites must be detonated.

THE ELIMINATION OF OIL FROM RETURN FEED WATER

By C. E. CROCKER.*

It is well known that any considerable amount of oil allowed to enter boilers with return feed-water is dangerous and destructive to the tubes and plates, but it is not perhaps so generally realized that oil is destructive even if admitted in very small quantities, and, by accumulating on the heating surfaces, it greatly reduces the efficiency of evaporation. It has been determined that the transmission of heat through a boiler-plate will be retarded more by a film of grease 0.001-in. thick than by ⅛-in. of scale. The oil also assists other deposits from the water to adhere to the surfaces, and necessitates more frequent cleaning. In most cases the cost of removing the oil before the water enters the boiler will be more than saved by the reduction in boiler-cleaning expense; but even if this is not so, the treatment is justified by the better evaporation obtained and the protection it gives the boiler.

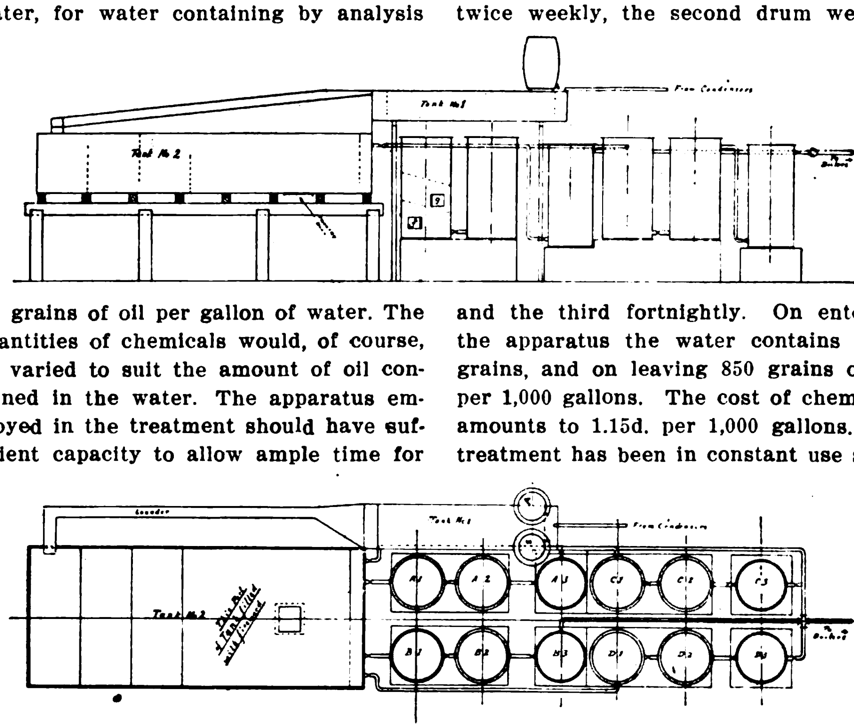
Most of the free oil present in exhaust steam can be removed by one of the types of mechanical separators on the market; or where jet condensers are in use, the oil will float on the water in the tail pit or tanks and may be skimmed off, but that part of the oil that becomes emulsified and gives the water a milky appearance is more difficult to deal with, and cannot be separated even by passing through filter-paper. It is necessary to treat the water chemically, or otherwise to cause the oil to coagulate before it can be separated by filtration.

At the plant of the Kalgoorlie Electric Power and Lighting Corporation, Limited, several methods and arrangements of filters were tried, but they were found to be either ineffective or unworkable, on account of difficulties in dealing with the filters. An electrical method, which consisted of passing the oily water through a tank containing iron plates as electrodes, and submitting it to an electrical current equal to about 1.1 kilowatts per 1,000 gallons, was very effective in causing the oil to coagulate, but it had to be abandoned owing to the corrosion set up in the feed pipes and in parts of the boilers. This appeared to be due to electrolysis, although every care was taken to insulate the electrical portion from pipes, etc.

*In Monthly Journal, Chamber of Mines Western Australia.

The treatment now in use has proved to be very effective and cheap in working, and although it is not considered in any way novel, a description of it may be of interest to others who have similar conditions to contend with. The method consists of treating the oily water with alum and common soda in the proportions of approximately 0.35 lb. of alum and 0.30 lb. of soda per 1,000 gallons of water, for water containing by analysis 3.5 grains of oil per gallon of water. The quantities of chemicals would, of course, be varied to suit the amount of oil contained in the water. The apparatus employed in the treatment should have sufficient capacity to allow ample time for the chemicals to act on the oil. In the plant referred to about 50,000 gallons per 24 hours are treated. The capacity of the tanks and filters is such that five hours are required for the water to pass through. A longer time would probably be an advantage, and would reduce the consumption of alum and soda. As the precipitant formed is very light and easily broken up, it is desirable that the plant should be so arranged as to reduce the agitation of the water, as much as possible, in its passage through the tanks.

The alum and soda are each dissolved in the barrels A and S respectively, and the solutions are allowed to drip from the barrels and mix with the incoming greasy water in Tank 1. The water passes under and over baffles in Tank 1 an 2, and through a quantity of rough filtering material or firewood in part of Tank 2. Each of the drums in the four sets of filters, A, B, C and D, contains a bed of filtering material between the perforated trays indicated by dotted lines on one of the drums. This filtering material may be coke, charcoal, wood-wool, shavings, or any fairly open or porous bed. Sand is most effective, but clogs up too quickly to be used in the plant mentioned. The Tank 2 has a cleaning door in the bottom, through which, after the water is drained off, the accumulation can be discharged. This tank requires cleaning monthly. The filter-drums are provided with drains and cleaning-doors, through which the filter-bed can be quickly removed and renewed. The first drum in each set is cleaned twice weekly, the second drum weekly, and the third fortnightly. On entering the apparatus the water contains 3,500 grains, and on leaving 850 grains of oil per 1,000 gallons. The cost of chemicals amounts to 1.15d. per 1,000 gallons. The treatment has been in constant use some two years with satisfactory results, and the boilers are in excellent condition, requiring considerably less frequent cleaning than they did formerly.



Apparatus for Eliminating Oil from Return Feed Water—Elevation and Plan

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The theoretic percentage of metallic copper contained in the various principal ores of copper, when pure, is as follows:

	%
Cuprite (red oxide)	88
Chalcocite (copper glance)	78
Malachite (green carbonate)	62
Azurite (blue carbonate)	61
Bornite (peacock sulphide)	58
Chalcopyrite (copper pyrite)	34

Official figures show the value of silver, silver lead, zinc concentrates, copper, tin, and coal exported from New South Wales during the first half of this year to have been £3,659,166, showing a net increase of £579,169 compared with the corresponding period of last year.

COPPERETTES

It is stated in the east that a pool composed of southern bankers has been formed to finance the cotton crop and it is suggested by the Pittsburg Gazette Times that this means to hold the crop until 13 cents can be secured. If such a financial measure is possible in cotton, why not in copper also?—Exchange.

* * *

A bright idea; why not? For additional information consult one Secretan.

* * *

Nothing is quite so characteristic of the writings of Horace J. Stevens as the manner in which he compels the word "circa" to do overtime. He makes it stand for just "about" everything that is inaccurate or "approximate" in his Copper Hand Book, and which he does not personally care to "stand for." Therefore we should say that, had he been less biased or "boodled" in his nearly nine pages of Tom Lawson-George L. Walker "market letter" material concerning Utah Copper, the investing public might have been disposed to agree with "circa" all that was said. As the story looks and reads it is quite evident that "circa" all the data, as well as much, if not "circa" all the language of the recital, was supplied by the Utah Copper Company's own publicity bureau. But then—it costs money to issue works like the Copper Hand Book.

* * *

The Boston Financial News of the 17th instant says: "Bingham—Shipments amounting to 11,000 tons a day are now going forward over the Bingham & Garfield, the new Utah Copper railroad from this camp to the smelter at Garfield. The Denver & Rio Grande is carrying 7,500 tons also, a total of 17,500 (18,500) tons. The Utah Copper today is making the heaviest ore shipments in the history of the company."

On the same day, Oct. 17, Thompson, Towle & Co., in their News Letter, said: "We are in receipt of advices from the west stating that the Utah Copper Company is now shipping to its concentrators 15,000 tons of ore daily, one third of which is going over the company's new Bingham & Garfield railroad."

Mr. W. B. Thompson, senior member of the firm of Thompson, Towle & Co., is a member of the Utah directorate and reputed large holder of pooled shares, and therefore no doubt receives his information from first hands, whereas the Financial News, like other members of the publicity bureau, must print whatever is supplied to it by the local office. Readers will, of course, take their choice, but we suggest that any one doubting the accuracy of the higher figures will be regarded as a "knocker."

* * *

"I figure that the world's output will increase about 8 per cent in 1912 over 1911, 5 per cent more in 1913, and not over 2 per cent annually in 1914, 1915, and 1916. If consumption increases again as it did from 1901 till 1906 copper may sell at 30 cents or higher in 1915 or 1916.—Geo. L. Walker's Weekly Copper Letter. (Copyright by Dukelow & Walker.) Cable address, "Dukelow," etc.

* * *

This carries the inference that the public should get into the Copper shares without delay. Walker is evidently trying to wear the hot-air pumps discarded by Tom Lawson, but he is yet a little timid and uncertain in his stride. To "figure" copper at 30c. a pound five years hence certainly gives the public ample time in which to forget just what Mr. Walker has said.

* * *

A great service has been rendered legitimate mining industry by J. R. Finlay through his disinterested report on the actual worth of individual Lake Superior mines. The value of this report lies in the fact that it was made by an experienced engineer to the Board of State Tax Commissioners of Michigan, and deals with facts: it can very well serve as a type of report which investors in mining stocks should insist upon having from mining districts.

* * *

Of course, many holders of stocks issued by Lake Superior mining corporations resent having the truth told about the particular properties in which they are interested, and publicly voice their dissatisfaction. This was to be expected: no one likes to be told that he has been separated from his money through the machinations of clever promoters But then there has to be an awakening from roseate dreams sometime!

* * *

If during the period of sixteen months, which elapsed from the close of its fiscal year 1909, to the date of issue of its annual report for 1910, the Utah Copper Company had actually developed—as shown by that report—over a hundred and ten million tons of ore, the existence of which was theretofore unknown to the shareholders, and which newly discovered ore was—according to its own rating—of the value of nearly a hundred million of dollars; and if, during the period in which this stupendous development was being made, all knowledge of the fact was carefully concealed from the public and the small shareholders until practically the entire capital stock issue had been gathered up by the inside or pooled interests, as stated by this journal at the time, what assurance can present investors have, that, as soon as the holdings of the insiders are unloaded on the public, the entire alleged supply of ore may not as suddenly disappear, or cease to yield profitable returns until such time as the insiders may again gather in the floating shares at greatly reduced prices, and so continue to repeat the process ad infinitum?

* * *

"Mines and Methods," pulished in Salt Lake City, comes to us without one single advertisement. It states that its criticism of the Utah Copper Company has caused that concern to go after its patrons and force them to withdraw their patronage.—Los Angeles Mining Review.

* * *

Yep! And we are not going to file a petition in bankruptcy, either.

* * *

The Mining & Scientific Press is irritable because Mines and Methods presumes to present its readers with high class technical information and at the same time boldly criticise the methods of those who pose for pelf as great engineers, mine managers and metallurgists. All we can say in reply at this time is: "Don't worry yourself sick on our account, dear old Sister Press; everything will come out right in the end. "For our part," we must insist on presenting information on subjects that interest and concern our readers in our own way. When we get ready to do things in the old, stereotyped fashion followed by the Mining and Scientific Press and other self-styled 'technical' journals, we'll call in a new doctor."

* * *

There has been no denial of the statement published in the last issue of Mines and Methods, "that the closing down of the work of enlarging the Arthur plant of the Utah Copper Company, after completing only six of the thirteen sections, was due entirely to lack of funds with which to continue the work." We therefore call the attention of Walker's Weekly Copper Letter to this trivial omission. It will be remembered that all work of reconstruction of the Arthur plant, as indicated above, was suspended about

September 15th and that the manager explained shortly thereafter in effect "that the work would not be resumed during the winter months or until the supply of available ore should render increased milling capacity necessary." Perhaps this explanation makes it unnecessary to undertake to show the presence of a large surplus where none exists.

* * *

Complaints are appearing in the press that while Utah Copper and Ray Consolidated Copper shares have been marked down fifty per cent, still the public is taking them very sparingly. We would respectfully suggest to the sales-agents of the syndicates that perhaps the servant girl class would become more interested in their wares if they were advertised for sale on easy payments. Might try five per cent down and fifty cents per month until paid for.

* * *

It is not a popular occupation—telling the truth about mining schemes. It arouses in particular the enmity of wealthy promoters, and of sales-agents employed to distribute their engraved share-certificates of incorporated dreams. There is more pecuniary profit in assuming the role of promoting-engineer, and in assisting the distribution of stock through getting interviewed by newspaper reporters, and in other ways. For this reason the position taken by Mr. Finlay will meet with approbation by honest men generally.

* * *

It is said that at the great packing houses in Chicago there are animals which lead an easy existance by acting as decoys for their fellows, cheerfully heading the procession destined for slaughter, but effecting their own escape at the proper moment. Such conduct is not pleasing even in the lower animals: what can be said about human animals, who knowing better themselves, publicly boost the sale of engravings which represent fictitious values (at the price asked)? Mr. Finlay, through his report on the Michigan mines, demonstrates that he occupies a position over and against the decoys.

* * *

Mr. Finlay says: "Stock-market valuations are not considered. It will be observed that this method (of camputing worth of properties) makes no mention of quoted values. * * * Mining stocks do not represent anything definite. Some pay dividends, in which case their quotations are comparable with those of other securities, but in the majority of cases mining stocks represent nothing more tangible than hopes." Then continuing, and possibly having in mind some of the porphyry coppers, Mr. Finlay's report reads: "Still it is doubtful if much of these stocks is sold to a gullible public. They are mainly bought and sold by seasoned gamblers with whom it is a case of "dog eat dog'".

* * *

"The placing in commission of the (Utah Copper) company's railroad comes at a very opportune time, as the work of enlarging the concentrator has proceeded to such an extent that an increased tonnage can now be handled, and this tonnage transported over the company's lines, thereby resulting in a considerable saving in freight."

"Under the new contract of the Utah Copper Company with the D. & R. G. W. Ry., 7,500 tons (daily) will be hauled by that line. Any tonnage OVER AND ABOVE this amount will be handled by their own railroad. The additional equipment and rolling stock which has been ordered for the new line should be at the property in sixty to ninety days, at which time the company will be in a position to handle any tonage required by the concentrator."—Thompson, Towle & Co. News Letter, Oct. 17, 1911.

At the present claimed rate of shipment of ore from the Utah company's mines—15,000 tons a day—the new Bingham & Garfield railroad would have available for haulage 7,500 tons per day, upon which there would be a possible profit, according to official estimate, of 8 cents per ton or $600 per day, and $219,000 per year. The cost of the road and equipment is conceded to be in excess of five million dollars, the annual interest on which, at six per cent, will amount to $300,000, being $81,000 per annum in excess of net earnings. It is hoped, however, that the prestige of owning its own railroad will more than compensate this apparent loss by the impetus it will afford manipulation of the share market.

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UTAH INCREASES COAL OUTPUT

The value at the mines of Utah's coal production in 1910 was $4,224,556, with an output of 2,517,809 short tons, according to E. W. Parker, of the United States Geological Survey.

Compared with 1909, when the coal production of Utah amounted to 2,266,899 short tons, valued at $3,751,810, the output in 1910 showed an increase of 250,910 short tons, or 11.07 per cent, in quantity, and of $472,746, or 12.6 per cent, in value. Utah's production in 1910 was affected only indirectly, if at all, by the coal strike in the Middle West—that is, by the demand created on the mines of Colorado and New Mexico, which possibly reduced the competition of coals from those States in markets to the west and southwest reached jointly by them and the coals from Utah mines. This increased production of Utah coals is looked upon as only an indication of normal growth that may be expected to continue as the country develops in population and industrial enterprises.

The year was one of general prosperity, says Mr. Parker, to both operators and miners. Production increased, prices advanced, and although there were no strikes for higher wages or changed conditions, some of the coal-mining companies voluntarily gave an advance of 5 per cent in the wages of their employees. During August and September, when the crops were being moved, there was a shortage in car supply, but as a general thing throughout the year transportation facilities were adequate.

The number of men employed in the coal mines of Utah in 1910 was 3,053, and that they were kept steadily employed is shown by the fact that each man averaged 260 working days. The average quantity of coal mined by each man employed was 824.7 tons for the year, or 3.17 tons for each working day.

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Tempering of copper is popularly supposed to be "one of the lost arts," but as a matter of fact is one that was never possessed to any higher degree than at present. It is safe to say that copper has never been tempered at any time by anyone, as it does not possess the necessary properties. Copper can be hardened in a number of ways; the easiest being to plunge the finished article into molten antimony or arsenic; the resulting alloy formed on the surface is exceedingly hard and brittle. Recent research in Mexico has shown that the tools there supposed to be made of hard copper were made by smelting mixed ores of copper, nickel, and cobalt; the resulting alloy, something like monel metal, was naturally hard. None of these old tools are of a quality equal to those which can now be made.—Mining and Scientific Press.

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For the benefit of those who may search for phosphate rock the following simple test is given: Place a small crystal of ammonium molybdate on the rock to be tested, then drop a little dilute nitric acid on the crystal. If the crystal turns yellow, it indicates the presence of phosphorus. The deeper the yellow, the higher the phosphate cotent.—Mining Science.

"RECENT PROBLEMS IN COPPER PRODUCTION"— "AN EDITORIAL REVIEW"

Under the above caption, as foretold in the September issue of Mines and Methods, Mr. T. A. Ricard's San Francisco publication, the Mining and Scientific Press, in its issue of October 7th, devotes five full pages to what it terms "An Editorial Review" of "Recent Problems in Copper Production," but which, in fact, is palpably designed as a defense of the operating methods of the Utah Copper Company. The writer wades into his subject boldly, and with the apparent purpose of engaging in a general review of facts and economic conditions which bear upon the production of copper throughout the United States and Mexico, but—as was to be expected—soon drifts into an elaborate eulogium and defense of the methods of the Utah Copper Company against the wholesome exposures which this journal has from time to time made public. This being the first real effort of the Press since its enlistment in the service of the Utah company's publicity bureau, and the result of the writer's first visit to "headquarters," he labors under the disadvantage of having been compelled to "compile his piece" from matter which had become threadbare from long service in being bowled back and forth between local dailies and Walker's Weekly Copper Letter and other Eastern publications which constitute the Utah company's promotion vehicles.

It should be here observed that the Scientific Press professes to be exclusively a "technical" journal and that the writings of its chief Editor on this occasion, therefore, necessarily embrace the very technique of steam shovel, as well as metallurgical and mechanical science, in so far as the same could be adapted to the material supplied by the management of the Utah company. But the writer was equal to the occasion. In fact, it appears that he was so skillful in polishing up the old "junk" and pandering to inordinate personal egotism that the manager became so charmed and bewildered in contemplation of the exquisitely scientific character of his own operations—as rehashed by this editor—that he allowed some ugly truths to escape "censor," because of the excessive technical character of the terms employed, the real import of which was evidently not understood.

The article opens so general in its treatment of the subject of its text and glides so gently into the task in hand and withal handles the matter with such exquisite skill that we feel sure that those who are interested in the efforts that are being made to market Utah shares will be pleased with the aid thus tendered by us in further promoting its publicity. Following are extensive excerpts from the article referred to and our own comment:

RECENT PROBLEMS IN COPPER PRODUCTION—AN EDITORIAL REVIEW.

It is not too much to say that development during the last decade has completely revolutionized the copper situation. How sweeping the changes have been may be seen from a comparison of the tables below.

Fifteen most important copper producers, 1901 (As given in Mineral Industry for 1902):

		Pounds.
1.	Anaconda, Montana	101,850,000
2.	Calumet & Hecla, Michigan	82,520,000
3.	Butte & Boston, Boston & Montana, Montana	58,029,000
4.	Copper Queen, Arizona	39,781,000
5.	United Verde, Arizona	34,520,000
6.	Montana Ore Purchasing Co., Montana	29,899,000
7.	Quincy, Michigan	20,540,000
8.	Arizona Copper Co., Arizona	20,535,000
9.	Tamarack, Michigan	18,001,000
10.	Butte Reduction Works, Montana	17,970,000
11.	Detroit, Arizona	17,535,000
12.	Osceola, Michigan	13,723,000
13.	Parrot, Montana	10,168,000
14.	Old Dominion, Arizona	10,094,000
15.	Colorado S. & M. Co., Montana	7,465,000

Fifteen most important copper producers, 1911 (Estimated):

		Pounds.
1.	Anaconda, Montana	250,000,000
2.	Phelps, Dodge & Co.	133,000,000
3.	Utah Copper	94,000,000
4.	Calumet & Hecla	74,500,000
5.	Nevada Consolidated	63,000,000
6.	Calumet & Arizona	50,000,000
7.	Greene-Cananea	47,000,000
8.	Copper Range	32,500,000
9.	North Butte	28,000,000
10.	Quincy	21,500,000
11.	Granby	21,500,000
12.	Ray Consolidated	20,000,000
13.	Miami	15,000,000
14.	Shannon	15,000,000
15.	Tennessee	13,000,000

Ten years ago the important factors in the situation were the comparatively rich sulphide ores of Montana and the Southwest, the native copper ores of Lake Superior, and pyritic ores in various places. Some years since the latter were objects of great interest and attention, and were expected to have great influence on copper production. Later experience has gone to show that this importance was perhaps overemphasized. Large masses of pyritic ores are not everywhere available and with those known to exist it is not at all easy to maintain thesulphur content at the high level necessary for carrying on pyritic smelting, and when this Ultima Thule is attained the smelter manager is likely to find himself in the toils of neighboring agriculturistis, as the problem of avoiding damage suits when smelting with over 30% of sulphur on the charge is by no means a simple one.

The advent of the so-called "porphyry coppers" has been the most significant event of recent years, and the important place which they have already taken is evidenced by numbers 3, 5, 12, and 13 in the table given above. To describe them somewhat epigrammatically, material not previously classed as ore is mined upon a larger scale and at a lower cost than before, by novel methods, and the resulting ore is milled with a greater recovery than previously deemed possible, with the final result that deposits which until recently had no value are now a source of great profit. SO MUCH ILL-CONSIDERED AND MISDIRECTED CRITICISM HAS BEEN LEVELED AT THESE ENTERPRISES THAT IT SEEMS DESIRABLE TO REVIEW BRIEFLY THE PROBLEMS MET IN THEIR EXPLOITATION. (Capitals are ours.) The following has been prepared after a brief study of the operations of the two most notable enterprises of this kind, the Utah Copper Company and the Nevada Consolidated Copper Company. To the officers of these companies we are indebted for the facilities afforded in the study of their operations. Further details of much interest, contributed by C. B. Lakenan, manager for the latter company, appears on p. 458.

In dealing with these recent problems of copper production, we have to do not with new species alone, but new genera. IT IS REMARKABLE, THEREFORE, THAT SOME HAVE FOUND THEMSELVES UNABLE TO BELIEVE IN THE RESULTS ACTUALLY ATTAINED. (Capitals are ours.) A rough but not inapt comparison is to say that these new methods of work bear to the older methods much the same relation that a street railway system bears to stages and omnibuses. In other words, it is the relation between a large volume of work carried on at a uniform rate with a low unit cost, and a smaller volume of work to which a larger degree of individual attention and effort is given at a higher unit cost. Where work is carried on at the rate of ten thousand or fifty thousand tons per day it permits the use of methods which eliminate the factor of individual attention which makes high unit costs. The "porphyry coppers" are large masses of igneous rock which carry small amounts of copper ore, fairly uniformly disseminated throughout the mass. Size and uniformity of content are, then, the essential factors. The problems are to determine the size and uniformity of content of the deposit, to mine it as cheaply as possible with a daily production of many thousands of tons, to mill the product with a high percentage of saving and at a low cost, and then to smelt the concentrate as cheaply as possible. * * *

The cost of smelting Utah Copper concentrates is SEVEN DOLLARS PER TON, whereas the Ohio Copper Company, for treating precisely similar concentrates at the same smeltery pays ONLY FIVE DOLLARS per ton. The "rake off" apparently goes to the Guggenheims and is equal to about half a cent a pound on all copper produced.

MINING.

Practically only two types of mining methods are applicable to such deposits: (1) stripping and removal by steam-shovels when the deposit lies near the surface, and (2) some form of caving method when deeper seated. The latter methods have been developed in dealing with the iron ores of Lake Superior; their use in this connection has been so fully discussed elsewhere and their application to copper ores is so recent that no further discussion of them will be attempted here. Steam-shovel mining was also developed in handling the Lake Superior iron ores and has been applied with notable success in stripping and mining the "porphyry coppers," where with overburdens of one hundred feet or less in thickness and with three or more tons of ore uncovered per ton of capping handled, this method of mining is capable of yielding large daily tonnages at a low unit cost. * * *

The thickness of overburden on the Boston Con. section of the Utah—which embraces at least 80 per cent of the ore bearing area available for shovel mining —is given in the last annual report at 160 feet in thickness. True, Manager Jackling by an ingenious system of averages reduced this to 105 feet; but strange as it may appear, the shovels still have to plough through the 160 and more feet of capping regardless of the fact that 35% of its volume was averaged off and should have disappeared.

It is impossible in the limited space at our command to take up a detailed analysis of all the features of this work; nor does it seem desirable to do so; yet some points should be briefly alluded to. The contour of the ground has an important influence on this work. It is necessary to carry on the work in successive benches, separated by slopes of a height and steepness varying according to the sum of the conditioning circumstances. In our issue of March 4, E. E. Barker discussed in detail this question of permissible slopes, concluding that under the conditions obtaining in the Copper Flat pit of the Nevada Consolidated the most desirable slope for economical operation is 1.75 to 1. The Utah Copper, having steeper natural slopes and greater differences of elevation counts on using 1 to 1 slopes, and the high bank now carried on the edge of the big pit has a height of 250 ft. and a 50° slope, upsetting previous ideas as to the maximum permissible slopes. It is obvious that where the natural topography is steep it will be necessary to carry a large number of slopes, with a correspondingly great increase in the amount of trackage required, and of steep grades in order to reach the necessary elevations. On the other hand, some degree of compensation is found in the greater number of working faces afforded, thus allowing an earlier completion of the stripping of the orebody, and the more ample dumping ground for waste available upon a steep surface.

This explanation is extremely lucid—perhaps we should say "technical"—and evidently contemplates dumping the waste back in the low ground after the ore is removed.

As seen from the foregoing figures, the maintenance of tracks is a question of much importance; where these are greatly curved in the effort to "make grade" the cost of the increased wear and the added delays due to derailments and other mishaps are a not unimportant factor. Drilling and blasting are carried on by separate crews, and the separation of capping from ore is effected by drilling through the capping until the ore is met, the capping is then blasted off, and the ore later drilled and blasted. The ore surface is a warped one, and in passing from capping into ore a working face will at some period be partly in one and partly in the other. **This offers no difficulty where the transition occurs horizontally**, as the ore may be loaded into one set of cars and the overburden into another, but where the dividing line occurs part way up the slope it is impossible to prevent the overburden from sliding down and becoming mixed with the ore as the latter is being removed. This is not a serious matter, however, as no ore is lost thereby, and even if 10% of barren waste should become mixed with the ore its total effect would be to decrease the grade of ore from 1.50 to 1.37% copper, for example. At Utah Copper not over 4 or 5% of waste containing copper is mixed with ore while mining ore next to capping, and after the capping is completely removed the ore will be mined clean. On the whole work this is of but slight importance, but in every case there will be a period during which the slopes are passing out of overburden into ore when this will assume an exaggerated temporary importance. In an ideal mine it would be easy to plan the work so as to minimize all the factors which militate against economy in steam-shovel mining, but in any actual case disturbing factors cannot be avoided. For example, it may be necessary to work at a disadvantage in order to obtain an immediate regular supply of ore for the mill and smelter, where greater economy in mining could be obtained by postponing the removal of ore until stripping was farther advanced. For this reason the ore supply at the Utah Copper has at present to be supplemented by ore broken underground at a cost approximately four times that of open-cut work. A portion of this extra cost will eventually be returned by the saving in drilling and blasting charges when the filled slopes are afterward mined by steam-shovel.

The last sentence evidently is intended to corroborate the statement of Manager Jackling contained in his annual report, dated January 24, 1908, p. 14, wherein he says: "There are some advantages in continuing underground mining in some portions of the property because the ore mined in this way is taken from the ore bodies lying directly beneath the capping, resulting in the capping caving into the open stopes and BREAKING ITSELF. So that it is not necessary to blast it for steam shoveling."

This increased cost of mining of a portion of the ore may legitimately be regarded as a charge against the mill for keeping it in steady operation; in other words the cost of shutting down or operating the mill at part capacity is borne by the mine. It will readily be perceived that to an even greater extent than in ordinary mining the early operations are conducted at a disadvantage. Though the great capital expenditure for stripping is distributed over the life of the mine it necessarily, as a 'factor of safety,' imposes a heavier burden upon the early life of the mine when operating costs are higher than in the later work and the securing of the economies of full-scale operations are difficult. * * *

An important problem in milling is the loss of copper in material finer than 200 mesh. This is always more than half of the total loss, and would seem to be a strategic point of attack to secure an increase in saving. Unfortunately milling methods have, until recently, ignored this class of material, which is commonly designated as 'slime' and regarded as an impossible subject for treatment. Where its quantity and value are small this is a justifiable attitude, but where it represents the loss of millions of pounds of copper per year a closer scrutiny becomes necessary. Two lines of attack suggest themselves; to crush and separate the valuable mineral with the production of as little slime as possible, and to secure a better saving from the slime. The former method of attack has probably been pushed nearly to its limit in the mills of the Utah Copper Company, where practice in this regard exhibits a high degree of perfection. It is obvious that minerals cannot be separated in a coarse state which are present in a fine state of dissemination, nor can any ordinary ore be reduced to a fineness of 40 mesh by any known method of crushing without the production of large amounts of 200 mesh material.

Making a good recovery from material finer than 200 mesh is a disheartening task. That it is not an impossible one seems to be indicated by a screening analysis of the tailing from these mills, which shows that the tailing between 100 and 200 mesh has the lowest copper content of any. There seems no reason to believe that at 200 mesh an arbitrary line is overstepped, beyond which good recovery is impossible. But this may be looked at in another way; if the material approximately 200 mesh in fineness is low in its copper content, while all the material finer than 200 mesh shows a fairly high average, it follows that the finest material must have a proportionately high content of copper, or as it is ordinarily expressed the copper minerals have 'slimed' in crushing. There is much difference of opinion over the proper definition of slime, but it may be defined for the present purpose as material which does not settle quickly. As the machinery used for making the separation of valuable minerals from gangue utilizes their relative settling ratio in some form or other, it is powerless to deal with material which will not settle.

Why will not fine material settle in water? The rate of settlement of solids in water depends chiefly on: (a) the relative density of the solids to the water; (b) the sizes and shapes of the particles; (c) the velocity of flow of the water; (d) the nature of the solids; (e) the ratio of solid to water; (f) the presence of electrolytes. The mass of the given particle is acted on by gravity, tending to make it fall in the water, while opposed by the various resistances indicated above. It is not clear at first why the size of the particle should affect its rate of settlement, but when taken in conjunction with the other factors the effect is clear. In dealing with a mineral particle consideration must also be given to what may be called its 'extraterritoriality,' an area immediately adjacent to the particle which exhibits phenomena as though it were actually a part of the particle. In other words, when a mineral particle falls through water the line of separation is not between the mineral and the water, but between the water which adheres to the mineral and the water through which this water-mineral aggregate is falling. This concept immediately introduces a highly complicated series of relations which are as yet imperfectly understood.

Suppose there is a series of perfect spheres of equal size made of different minerals, will each sphere control an equal 'extraterritorial' area, or will they be unequal? And, in dealing with spheres of different sizes of the same material, will the ratio between mineral area and extraterritorial area be equal for all sizes? It is not known, but the weight of present evidence inclines to the belief that they are unequal in both cases. Accepting this view, it may result that with small equal-sized particles of valuable mineral and gangue, the difference in extraterritorial area may so alter their relative settling ratios as to make a separation by any method based on settlement impossible. A further important point is the character of the solid. During fine-grinding some of the minerals present are converted into collodial hydrates and silicates, as pointed out by R. E. Ashley in the Mining and Scientific Press of June 12, 1909. It seems probable that these colloids attach themselves to the sulphide particles, much as oil does, the resulting aggregate having a structure similar to that of an egg divested of its shell, the sulphide particles corresponding to the yolk and the colloids to the white. It is readily seen that this action would so increase the effective area of the sulphide particles as to militate strongly against their recovery by ordinary ore-dressing methods. Possibly the addition of milk-of-lime during crushing would be of service in preventing the formation of colloids. The effect of the presence of electrolytes has been studied in cyanidation, but little is known of its influence on ordinary ore dressing. Enough has perhaps been said to indicate that the problems involved in the milling of these copper ores yet requires much study and experiment. The operating staff is naturally jubilant over the securing of much better results than ever previously obtained; the management properly keeps its attention fixed upon the saving still to be made. Indeed, with tailing losses amounting to nearly three million dollars per year, this is a matter worthy of all the thought and experiment now being devoted to it. On the other hand, the old story of the superintendent who upon being asked why his recovery was not higher replied, "Copper is the cheapest thing I've got," is not without its point. * * *

Herein we have a full and complete corroboration of our most severe criticism of the Utah company's practice of grinding its ores with "Chile" mills, as a consequence of which nearly one-half of the recoverable contents of its ores have been reduced to an amorphous slime which renders concentration impossible by any known process and—as indicated by the Press writer—mineral of the value of millions of dollars have every year been allowed to drift away in the tailrace and thus become completely lost, and all because an abandonment of the stupid practice would have discredited the management and thereby have caused a collapse in the share market.

Our readers will recognize the "old story" quoted in the closing paragraph and attributed to an unnamed superintendent as an expression of Manager Jackling frequently made use of by him in answering criticism upon the excessive losses which persistently followed the excessive grinding and consequent sliming and loss of the valuable minerals.

WHERE WE STAND

Our technical neighbor, the Mining and Scientific Press, in its issue of the 14th inst., whilst conceding enviable qualities of excellence to this journal, adopts the gratuitous suggestion of Mr. Ricard of the London Mining Magazine, and confirms our consignment to the class of publications called "Market Letters." This is an unexpected distinction, but perhaps the Press is right. At all events we have deemed it to be the duty of this journal to keep the investing public informed of the tricks of unscrupulous vendors of over-valued shares, and expect to continue that policy, and if that be the office of a "Market Letter," perhaps we should not complain of being so designated. But we must insist that our position has at all times, and in every particular, been scrupulously and "technically" accurate, notwithstanding the assertion of our learned contemporary that IT does "not feel that it is the function of a technical journal to discriminate." But if a "technical" journal may not discriminate in respect to fraud and deception in matters of public concern, we fail to perceive any concern the investing public should feel in so-called technical journalism.

THE COPPER HANDBOOK

Vol. X, the tenth annual edition of the Copper Handbook, has just been received. The new issue of this work, which has heretofore been considered a standard authority on the subject of copper and copper mines for the entire globe, has 1,902 actavo pages, containing nearly 1,500,000 words, and, in addition to the miscellaneous chapters, lists and describes 8,130 copper mines and copper mining companies, in all parts of the world, this being the largest number of titles ever listed by any work on mining. The descriptions range from two or three lines, in the case of dead companies, wherein reference is made to detailed descriptions in past volumes at the period of their activity, up to twenty-one pages in the case of the Anaconda mine which yields one-eighth of all the copper made in the world.

The miscellaneous chapters of the book, twenty-four in number, treat the subject of copper from all possible viewpoints, there being chapters on the history, chemistry, mineralogy, metallurgy, brands and grades, alloys and substitutes for copper, with a copious glossary, and a chapter of statistics ending the book that contains forty odd tables, thoroughly covering copper production, consumption, movements, prices, dividends, etc.

The Copper Handbook is sold on the unique plan adopted nine years ago, the publisher sending the book by mail, prepaid, to any address ordered, without advance payment of any sort, and subject to return after a week's inspection. The price is $5 in a strong green buckram binding with silk headband and gilt top, or $7.50 in full library morocco. Anyone interested in copper, as a producer, consumer or investor in shares, should write the author and publisher, Mr. Horace J. Stevens, Houghton, Michigan, ordering a copy of the new Copper Handbook sent prepaid, subject to approval.

MINING POSSIBILITIES OF ISLAND OF CUBA

By H. H. NICHOLSON*

Cuba offers great possibilities to the prospector and to the miner. Its mineral deposits comprise a great variety of metallic and non-metallic substances. It has an ideal climate; labor is cheap and transportation facilities, both within the island and to the world at large, are good. Why these resources have remained for 400 years undeveloped is difficult to say.

The early Spaniards were seeking, primarily, gold and silver. They began sending gold from Cuba to Spain as early as 1512. When, a few years later, the richer spoil from Mexico and Peru began to appear, Cuba and the West Indies, as a source of mineral wealth, became a negligable quantity. It is possible that the Conquistadores, in exploiting those richer fields, overlooked and forgot that which at first seemed so attractive. Be that as it may, Cuba became an outfitting place, or half-way station between Spain and her other American possessions; a place for good supplies chiefly, and cattle, sugar, tobacco and coffee became the great sources of wealth, while Mexico and the West were being ransacked for gold, silver and the precious stones.

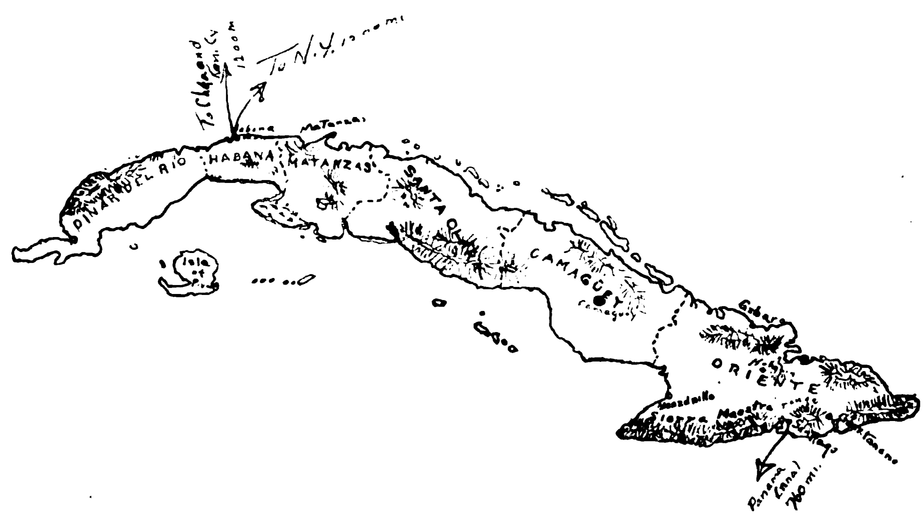
A noted Spanish geologist, lamenting the lack of a general knowledge of the mineral resources of the island, said: "Human attention clings by preference to customary objects, and since agriculture has from the beginning given constant and lucrative employment to the people, they have grown unmindful of and forgotten the exploitation of the rocks for the riches they might contain."

The Mexican peon is a born prospector and miner. He has as keen a nose for ore as the best of his American confreres north of the border. There is not a corner of Mexico that the gambucino has not scratched. This Cuban brother, on the other hand, is by nature and practice a farmer and cattle man. He picks up the "float" mineral that comes in his way; he may even wash gold from the river sands, but they excite no thrills and he returns to his "bohio" with as placid a mind as when he left it.

It is said that prospecting is not easy in the tropics, because of the rapid and luxuriant growth of vegetation. Quite true, yet prospecting is "no snap" anywhere. In Cuba, as in Alaska, every mountain stream cuts out its rocky gulches and concentrates their contents in its sands and gravels. Whatever the causes for it are, the fact remains that Cuba possesses a wealth of mineral resources that today remain practically untouched.

The ores of iron are at present the best known. They are of good grade, widely distributed, easily mined and shipped. Though known, in a general way for about 400 years, it is only within the last 30 years that they have been commercially mined.

Recognizing the potential value of the mineral resources of the island, the Spanish government, in 1883, decreed that: "For a period of 20 years mining companies should be exempt from all taxes on their land; that ores should be exempt from all export duties; that coal brought in by mining companies, for their own use, should be free from all import duties; that combustibles and ore should be exempt from the 3 per cent duty on raw material, and that mining and metallurgical companies should be free from all other imports; that for a period of five years, mining companies should be exempt from the payment of duties on all machinery or material for working and transporting ores; that vessels entering in ballast and sailing with ore should pay a duty of but 5 cents per ton navigation dues, and that vessels entering with cargo for mining companies should pay but $1.30 per ton navigation and port dues."



Island of Cuba

MILLIONS INVESTED.

Under this most liberal charter several American companies became interested in 1884 and later in the development of the rich iron deposits in Oriente province, near Santiago. The Jurugoa company, with mines about 16 miles east of Santiago, and the Spanish-American Iron Co., with extensive mines at Daiquiri, 20 miles east of Santiago, and at Mayari, on the north coast, near Nipe bay, are the principal iron companies in active production. The investments of these companies represent many millions of dollars and their plants are among the most extensive and up-to-date in the world. Their ores are quarried rather than mined, in the ordinary sense, and are handled from mine to steamer in the most economical manner. Steam shovels and gravity do the work. No ore is smelted on the island, but all is shipped to the United States. This means that mining costs and shipping charges are low and that ores are of a high quality.

The ores on the south coast are mostly magnetite and hard hematites in massive form enclosed in porphyry while those on the east and north coast, at Moa and about Nipe bay are, in general, limonites. They occur in blanket formation, carrying little or no overburden and overlie massive serpentine and related rocks. In some cases the surface deposits are in nodular or spherical form, interspersed with scraps and masses like broken furnace slag. The natives name these deposits tierra de perigones, "partridge shot" soils, and muco de herrero, "blacksmith slag."

These ores, besides a high iron content, sometimes carry a small per cent of nickel or chromium and are, as a rule, below the Bessemer limit in sulphur and phosphorus. Shipments from these mines in 1909 amounted to about 1,000,000 tons. Apparently the supply is practically inexhaustible, as immense beds of ore of a similar character have been discovered near Moa bay and in the province of Camaguay, in the Cubitas mountains, near the north coast.

Iron ores of a good grade are known to exist in other parts of the island; not-

*Mining Engineer, Lincoln, Nebraska, in Mining Science.

ably through the Sierra Maestra mountains, on the south coast; near Trinidad and throughout Santa Clara and in the mountainous region of Pinar del Rio in the extreme west.

There is and can be no question of the great economical importance of Cuba as a producer of iron. Even now American and English prospectors are seeking out and denouncing the iron-bearing territory adjacent to these going concerns. As noted above, the wide dissemination of the ores of iron opens a fruitful field in this direction.

Although, at present, the iron minerals are the best known, most thoroughly prospected and most extensively developed, they really represent but a small fraction of the mineral resources of the country. Copper has been mined at Cobre, near Santiago, for nearly 400 years. The Cobre mines were discovered and, in a manner, opened in 1514. Systematic mining, though, was not begun until 1530, since which time these mines have been worked, with varying fortunes, until today.

The surface and oxidized ores were phenomenally rich and even the sulphides of the deepest workings has had a shipping grade. This mine has had a checkered history. Tradition has it that copper was produced here even before the coming of the Spaniards. This idea is based on the fact that copper implements and images found in the ancient Indian mounds of Florida, have been identified as having been made from Cobre copper.

COBRE'S GREAT RECORD.

Be that as it may, historical evidence points to the fact that the rich deposits at Cobre were known to the Spaniards as early as the founding of the city of Santiago, about 1514. One of the earliest official reports states, among other interesting facts, that "out of the veins of the nearby mountains comes copper at the rate of 55 to 66 pounds in a hundred of earth mined." For some three centuries copper was produced from these mines, in a desultory manner. About 1830 an English company came into possession of the property and for a number of years operated it in a systematic and scientific manner. They developed the ore bodies through a number of shafts, to a depth of 1,000 ft. or 1,200 ft. vertically, and by drifts and crosscuts, to a lateral extent of several miles. The troubles of the Ten Years War and the difficulties in handling the water caused this company to suspend operations.

After the close of the Spanish-American war, an American company came into possession of the property. They have partially unwatered it, possibly to a depth of 500 ft. or 600 ft., at present. After some expensive and unprofitable experiences in the way of smelting, leaching and concentrating, they have apparently settled down to mining and shipping the higher grade ores.

By official reports, they shipped about 60,000 tons in 1909 and are now shipping about 6,000 tons monthly. Their superintendent states "that all ores of copper are found from the red and black oxides in the gossan, to native copper in considerable quantities in the top of the sulphides and all varieties of sulphides down to clean chalcopyrites." The depth of the enriched zone of the sulphides has never been determined. It occupies, at least, the area from the 100-ft. level to below the 650-ft. level. In this area occur large lenses of 3½ per cent ore containing shoots of very rich sulphides. One stope on the 550-ft. level yielded 22 per cent ore. As, at the time when the lowest workings were mined, only ore of a high grade could be handled, it is safe to assume that the zone of enrichment extended this far. Official records in Santiago show that from 1830 to 1860 this mine is credited with a production of some $50,000,000.

COPPER WIDELY DISSEMINATED.

At present, Cobre is the only producing copper mine in the island, yet ores of copper are abundant and very widely disseminated. Throughout the Sierra Maestra range and in general in all of the mountain districts copper float is abundant. A few miles to the eastward of Cobre, boulders of amygaloid basalt occur with native copper amygdules. This formation is of the same character as that of the Lake Superior region of the United States.

In the province of Santa Clara nuggets of native copper are sometimes turned out in cultivating the fields. In one district of considerable area in this province, are numerous old workings, some of which, a generation or so ago, produced a large amount of high grade ore, most of which was shipped to Wales for sale and treatment. The high cost of transportation and the troublous times caused their abandonment.

On the north coast rich float and many old workings are found, especially near Sagua de Tanamo and Gibara, in Oriente; near Minas, in Camaguey, in the mountain and hill country in the northern part of Matanzas province.

At San Diego de los Banos, in Pinar del Rio, I had brought to me samples said to have come from the adjacent hills, which assayed 65.25 per cent copper.

Next to iron, copper seems to be the most abundant and widely scattered metal. From the report of the Cuban Department of Agriculture, Commerce and Labor, there was exported in the year 1909, by the one operating company, 59,430 tons of copper ores.

Third in importance, by reason of their abundance, are the ores of manganese. These ores also are widely distributed and are often of a sufficient manganese content, as mined, to pay a profit over and above mining and shipping charges.

The only operating mines, at present, are at Ponupo, near La Maya, a few miles northeast of Santiago, though there are two or three prospects near Cristo and Dos Bocas, between La Maya and Santiago that ship a little ore from time to time.

In Santiago province croppings and float are reported along the line of the Sierra Maestra range, from Guantanamo to Manzanillo. Manganese ore also occurs near Trinidad, in Santa Clara, and near Bohia Honda, in Pinar del Rio provinces. The official reports give the exportation for 1909 as 2,500 tons.

Lead and zinc, though not mined at present, are not infrequently brought to notice among samples submitted by the natives. I have heard of, though I have not seen, a lead-silver mine opened some years ago in the mountains west of Santiago.

GOLD IS ALSO THERE.

If one speaks of gold in Cuba he is apt to provoke discussion. Even some of those who are otherwise well acquainted with the island are more or less skeptical in regard to its mineral resources, and especially so in regard to gold. A few years ago these same people would have scouted the idea of Cuba ever being a source of iron to be figured in the world's production. Yet within that short time her export of iron has become a large factor in the total of the world's supply, and experts say that her iron ore now "in sight" can keep the pace for 100 years to come.

As to gold, the Spanish historian, *La Sagre, says: "It is probable that the exploitation of gold by the Spanish discoverers of the Antilles was limited to the simple washing of the sands in which the metal was found. Nevertheless, they were not long in finding profitable mines of gold, the existence of which was divulged by the Indians. * * *."

In a note concerning gold sent from Santiago to Spain in 1512, the statement is made that the shipment comprised a certain amount of gold which had come from Cuba, and in 1514 a letter from Diego Velasquez mentions that he had examined the localities from which the gold had been extracted, in the province of Guanabaya (probably now Oriente), and that he had also obtained gold that had been gathered by the Indians from

*La Sagra, Historia Fisica, politica y natural, de la Isla de Cuba, Madrid, 1842.

certain rivers, particularly in the neighborhood of the port of Jagua (Cienfuegos).

Between the years 1515 and 1534, according to records in existence, many consignments of gold were shipped from Cuba to the mother country.

About this time consignments of gold and silver bullion began to arrive from Mexico and Peru by ship loads and the adventurers in Cuba and enroute hastened to the newer El Dorado, abandoning the prosaic washing of river sands for the more glorious despoliation of the Indian kingdoms to the west. As the argonauts of '49 passed over the riches of the Rockies in their haste to reach the golden sands of Sutter creek, so these earlier argonauts passed by and forgot the riches of the Antilles.

I know of but one operating gold mine in Cuba today. This, by methods somewhat antiquated and uneconomically carried out, gives satisfactory returns to its owners. I have no doubt that, with up-to-date methods and the application of technical skill, its net returns could, at no great expense, be doubled.

On the north coast of Oriente province is a region some 10 by 30 miles in area, that is undoubtedly gold-bearing. In this region are many ancient workings, some of which antedate the coming of the white man.

Again, over a wide area in Santa Clara, are unquestionably gold-bearing formations. Good samples of auriferous rock have been given me, said to come from the Organos mountains in Pinar del Rio. In general, wherever one finds basic intrusive rock in Cuba, he will find more or less of gold-bearing ores.

Besides the economic and precious metals, Cuba possesses a great variety of non-metallic minerals: Asphalt, petroleum, graphite, asbestos, cements, clays, building stones, marbles and salt are some of her natural products.

ASPHALT, PETROLEUM, ETC.

Bituminous deposits (asphalt and its congeners) are found in abundance throughout the island. The most striking of these are the submarine asphalt mines in the Bay of Cardenas, and the tar wells of Hato Nuevo, about 30 miles east of Cardenas. The methods of mining—if it may be called mining—at these points, is unique. At Cardenas a lighter or barge, is moored over the submarine beds and a heavy iron bar, chisel pointed, something like the bit of a churn drill, is played up and down on the bed of asphalt by means of a winch on board the boat. This asphalt is about as brittle as cannel coal and has much the same appearance, except it is more dense and glossy. When a sufficient amount has been chiseled off, a diver is sent down, who fills it into a scoop net, by which it is raised to the boat. In this way they obtain from a ton to a ton and a half daily. This asphalt is of a very fine quality and brings from $80 to $125 per ton in New York.

At Hato Nuevo is a well, about 80 ft. deep, into which oozes a thick mineral tar. This tar is drawn out, by hand power, by means of a bucket and windlass. This well produced about 20 barrels of tar per day.

Petroleum wells and springs abound in Matanzas and Santa Clara provinces. One boring near the city of Santa Clara produces an oil of great purity. "It is colorless, transparent as water, easily inflammable and leaves no residue after combustion. Its density is 0.754; it dissolves asphaltum and resins."

These, of the numerous places where bituminous products are obtained, are mentioned to show the kind of development and the crude methods in use ev n after years of operation.

No coal beds of economic importance have yet been found. Small seams, from widely separated localities, have been reported.

Samples that came to me from near Trinidad assayed:

Volatile combustible	46.32%
Moisture	13.68%
Fixed carbon	34.00%
Ash	6.00%
	100.00%

Good building stone is abundant, marble, plain and variagated, of a fine quality and taking a high polish, is found in the eastern end of the island and in the Isle of Pines.

Lime and cements of excellent grade exist. The following analysis of raw cement rock from an extensive deposit near the south coast of Santa Clara, approximates very closely to the correct proportions for a Portland cement mixture:

	Cuban.	Portland
Lime $CaCO^3$	79.88	65.13
Silica SiO^2	14.96	20.42
Magnesia MgO	.72	.58
Iron and aluminum oxides	4.44	13.87
	100.00	100.00

In juxtaposition are clay beds whose mixture with this material would reduce the proportion of lime and increase the proportions of silica and iron.

There is but one cement factory in Cuba at present. It has a capacity of 1,000 bbls. per day and is said to produce a good quality at a cost of from 90 cents to $1.20 per barrel. Yet Cuba imports large amounts of cement from abroad. The importation for the year 1909 exceeded 500,000 bbls.

A FIELD FOR SMELTING.

The fact that all Cuban ores now mined are shipped to foreign countries for treatment, is a high tribute to their quality. This fact further signifies that here is an open field for smelting operations.

Virginia coal can be laid down in Cuban ports for from $5 to $6 per ton. Pennsylvania coke ought not to cost more in Cuba than in the western mining states, as the shipping distance is much less and Cuba has the further advantage of water transportation. In this connection I will call attention to the fact that Cuba has a great abundance of otherwise waste timber that makes the hardest and finest charcoal in the world. At present charcoal is the universal fuel in the island. The value of the charcoal consumed last year was upwards of $6,000,000. With one or two minor exceptions, all of this fuel is now made by the old uneconomical pit method by which all of the by-products are lost. With modern distilling plants these by-products will more than pay all operating cost and yield an unsurpassed smelting fuel at a minimum of cost.

The Cuban mining laws are liberal and progressive. Being of Spanish origin, they are similar to those of Mexico. The unit of concession is the pertenecia, 300 meters (984 ft.) long by 200 meters (656 ft.) wide, equivalent to 14.8 acres in area, for the precious metals and 500 meters by 300 meters (37 acres), for iron, coal, asphalt, etc. Claims are bounded by vertical planes and carry no extra-lateral rights. To the owner belongs all the mineral within the box enclosed by the boundaries of his claim.

There is no limit to the number of claims one person may take. His title is perpetual and he may work his claims, or not, at his option. The only cause of forfeiture established by the law, is failure to pay the annual tax. This tax, on mines of the precious metals is $30 per annum; in all other cases it is $12 a year.

The island is 750 miles long and has an average width of 50 miles. It is about two-fifths as large as Colorado; a proportionally large mineral area; a great variety of products, and equally favorable transportation facilities. Railroads traverse the island from end to end and from side to side. Numerous lines of steamers connect its various ports with all ports of the world.

The climate is unsurpassed: Average annual temperature, 78° F. Average annual variation, 12° F. Average annual rainfall, 52 in. The population is about 2,000,000, only 29 per cent of which is colored; the balance are Europeans and Americans.

LEACHING APPLIED TO COPPER ORE*

ELEVENTH ARTICLE REVIEWING RESULTS ACCOMPLISHED, WITH FURTHER REFERENCE TO UTILIZATION OF WASTE FURNACE GASES

By W. L. AUSTIN†

In the previous article of this series it was shown (Table IV) that using insoluble anodes and a sulphate solution, the results obtained by Reinartz indicated an approximate cost of $0.06 per pound copper deposited electrolytically. This cost, however, was based upon an expense of two cents per kilowatt-hour for current, which was assumed to be a conservative estimate for outlying districts where such a process would be likely to find adoption. In the subsequent experiment it was shown that under identical conditions, but employing sulphur dioxide as a depolarizer, the cost was reduced to $0.017. These figures, however, did not take into account the value of the sulphuric acid produced in the operation, which reagent is available for further ore-treatment.

Mr. William E. Greenawalt of Denver, Colorado, has also ingeniously applied sulphur dioxide to the reduction of ore carrying copper and other metals, and manufactures a powerful solvent almost wholly from waste furnace-gases—the very substance which is causing the clash between the mining and agricultural interests at so many points. In this connection it might be mentioned that the discharge of a moderate amount of sulphur dioxide into the atmosphere (0.75 per cent by volume of the exit gases) is legally permissible*, so that the removal of a portion of this deleterious compound from the escaping gases would fulfill the conditions necessary for continued operation at some of the plants now closed. Any metallurgical method, therefore, which makes advantageous use of sulphur dioxide, and at the same time converts sulphuric acid into insoluble salts while extracting a high percentage of the valuable content of an ore, must sooner or later find commercial application.

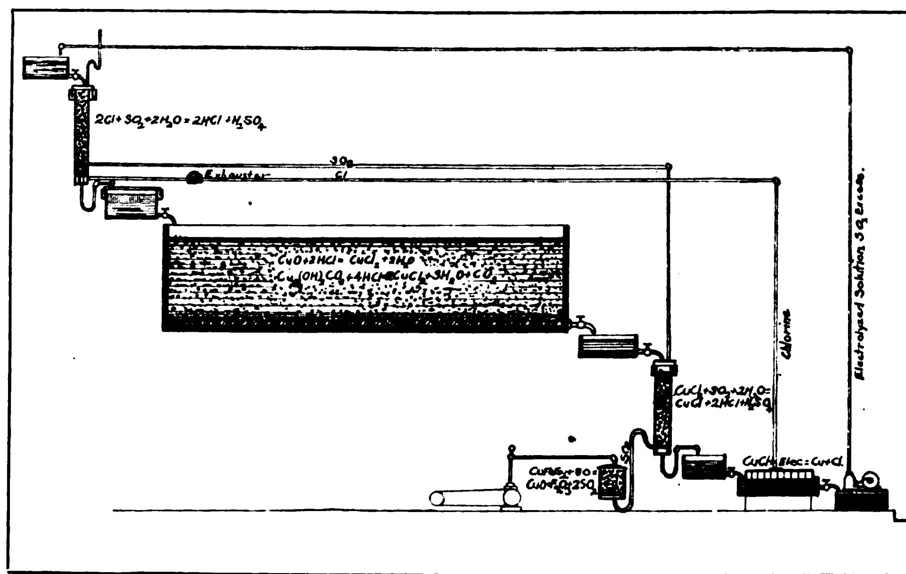
† Mining Engineer and Metallurgist, Riverside, California.

*The minimum of noxiousness in the case of spruce trees has been established at the density of one part sulphur dioxide per 500,000 parts of air, or 0.0002 per cent by volume, or 0.0071 gram sulphur dioxide per cubic meter.

The Greenawalt process is described in Engineering and Mining Journal of November 12th and 26th, 1910, and also in U. S. patent specifications Nos. 968,651, 968,652, 968,845, all patented under date of August 30th, 1910, and No. 973,776, patented October 25th, 1910. As set forth in the patented claims, it is a process of extracting copper from its ore which consists in leaching the ore with an acidified solution of sodium chloride, followed by electrolysis of the cupreous solution and regeneration of the solvent. A study of the papers referred to above is recommended as affording information of value to anyone interested in the application of wet methods to the reduction of copper ore.

The solvent employed in this process is generated by introducing chlorine and sulphur dioxide into an aqueous solution, which results in the formation of hydrochloric and sulphuric acids*. These two reagents naturally attack the metallic oxides present in the ore, carrying them into solution as chlorides and sulphates. The acid solution is constantly being regenerated in the course of the operations at the expense of sulphur dioxide derived from roasting sulphide ore, and it is stated that the consumption of chlorine is covered by the addition of two ounces common salt to the solutions for each pound of copper produced.

*Chlorine can be combined with sulphur dioxide to form at least two compounds, thionyl chloride ($SOCl_2$) and sulphuryl chloride (SO_2Cl_2). Both these are decomposed by water, forming in the first case hydrochloric acid and sulphur dioxide, and in the second, hydrochloric acid and sulphuric acid. The use of sulphuryl chloride in the treatment of ore of the precious metals has recently been made the basis of a patented process (British patent No. 13,488 of 1910).



Greenawalt Electrolytic Copper Process—Dirgramatic Sketch

A short time back the use of chlorine as such in the reduction of low-grade copper ore, would have been an economic impossibility, because of the expense attending the production of this element by chemical methods; but with the efficient apparatus now available for its electrolytic generation this powerful auxiliary is procurable today at small cost in almost any locality. The advance in electrolytic methods of producing reagents has wrought a great change in the scope of hydrometallurgical processes, the importance of which is not as yet fully appreciated. The Greenawalt process would thus appear to provide a means by which leaching with strong acids might be taken advantage of in regions where such materials are otherwise unattainable at a reasonable cost. Theoretically there should be no loss of chlorine in the process; but in practice some of the gas escapes, in addition to the loss of solution sustained by entanglement in the tailings.

There is in Denver a plant for handling ten-ton lots of ore by the Greenawalt process, and a number of tests have been made there; but as yet the process is not known to have been placed in continuous commercial operation at any point.

In carrying out the process the ore is crushed, and when not already oxidized, is roasted. Roasting may not always be necessary even when sulphides are present: some of the chalcocitic ore of the Southwest yields its copper readily to a number of solvents, both acid and basic, without roasting.

When sulphur dioxide is passed into water at 68° F. one volume of water absorbs 39 volumes of the gas, forming sulphurous acid. On the other hand, chlorine is absorbed by water to a much less extent (one volume water at 46° F. absorbs three volumes chlorine gas, and when chlorides of the alkalies are present in quantity its absorbent capacity is less*). As stated above, when chlorine gas is passed into water which has been saturated with sulphurous acid, a series of reactions takes place which results in a portion of the water being decomposed, its hydrogen combining with chlorine to form hydrochloric acid, and its oxygen with sulphurous acid to form sulphuric acid. In this manner a large quantity of these two acids can be brought into solution. The following formula indicates the reactions:

$2Cl + SO_2 + 2H_2O = H_2SO_4 + 2HCl.$†

It will be noted in the above formula that by employing two molecules of chlorine, a molecule of sulphuric acid is produced in addition to two molecules of hydrochloric acid. Herein lies one of the advantages of introducing sulphur dioxide into the treatment, because both of the acids dissolve respectively a molecule of cupric oxide, whereas if chlorine alone were applied, without the intervention of sulphur dioxide, only half the amount of copper would be brought into solution. This is made clear by the reactions indicated in the following formulae:

$H_2SO_4 + CuO = CuSO_4 + H_2O.$

$2HCl + CuO = CuCl_2 + H_2O.$

$2Cl + CuO + H_2O = CuCl_2 + H_2O + O.$

As sulphur dioxide is a waste product and is usually available in large quantities, its consumption adds but little to the expense of operation, and with its help the pound of chlorine generated is made to go twice as far as when that reagent is employed per se, which gives this method a decided advantage over any relying solely upon chlorine as the active reagent.

After the ore has been crushed and roasted it is placed in suitable vessels for leaching, and the acid lixiviant described above is allowed to flow on to it. The copper oxide is, of course, immediately attacked by both acids, but in the presence of sodium chloride, which is an ingredient of the lixiviant, whatever copper sulphate may be formed is altered to chloride, so that practically all of the soluble copper is finally converted into cupric chloride, and the lixivium is then ready to go to the precipitating vats.

One of the objections urged against wet methods of reducing copper ore is, that in most processes the precious-metal content of the ore is left in the tailings. In the Greenawalt process it is aimed to extract both the silver and the gold along with the copper.

We know from the old pan-amalgamation method of treating silver ore that the addition of "bluestone" (copper sulphate), and salt (NaCl), to the charge of raw or roasted ore, resulted in the formation of cupric chloride, and with the assistance of this reagent the rapid chlorination of certain silver minerals was brought about, thereby facilitating the extraction of the metal. As both cupric chloride and sodium chloride are present in the lixiviant employed in the Greenawalt process, silver minerals will be attacked to a greater or lesser extent and carried into solution, the amount depending upon the form of mineralization in which the silver exists, when the ore is treated in the raw state. It is claimed for the process that in the manner indicated from eighty to ninety per cent of the silver in the ore may be extracted. With sulphate solution alone it is not practical to get the silver into solution, unless a very careful roast is made (Ziervogel's process), which is entirely too delicate an operation for use in the treatment of large quantities of low-grade copper ore.

That portion of the silver which goes into solution may be recovered by passing the lixivium through finely divided metallic copper, upon which it will be precipitated, or it may be extracted in the electrolytic vat together with the copper, as the chlorides of the precious metals are readily electrolyzed. Theoretically both silver and gold should be deposited on the cathode before the copper, but when present in very small quantities all three metals may appear simultaneously.

If gold is present in the ore it is proposed to dissolve it by increasing the quantity of free chlorine in the solution.* This amounts practically to utilizing the old method of chlorination (Plattner's process) which has long been employed in California for recovering gold from roasted pyritic concentrates. It is a slow though efficient means of extracting the metal, albeit at considerable expense. In the Plattner process the pulp is treated cold, and remains under the action of chlorine for some days, while in the extraction of silver it is best to heat the solution containing the cupric chloride. It would seem, therefore, that the separate recoveries of silver and gold have to be carried out disconnectedly, as indicated in patent specifications No. 968,652, pages 3 and 5. First the tracted with the application of heat, and copper and silver would have to be exthen the pulp allowed to cool before the introduction of the chlorine to dissolve the gold. The length of time that the pulp has to remain in the leaching vats pending the solution of the gold would be a factor in the economy effected by this method of treatment. In the Plattner process chlorine was usually passed to the moist pulp in the gaseous state, and not in aqueous solution as proposed by Greenawalt. An advantage in leaching with chlorine instead of cyanide of potassium is, that the acid present in the pulp does not have to be neutralized.

After the copper has been leached out of the pulp as far as practical, it is present in the solution in the form of cupric chloride. This lixivium can go at once to the electrolytic vats, but Greenawalt recommends converting the cupric into cuprous chloride with the help of sulphur dioxide as indicated in the following formula:

$2CuCl_2 + SO_2 + 2H_2O = 2CuCl + H_2SO_4 + 2HCl.$

There are several objects gained by this conversion. In the first place the electric current deposits double the amount of metal from the univalent copper in the cuprous salt than it does from the cupric compound where the copper is bivalent, and the energy* required per unit of copper to electrolyze a

*A cubic foot of chlorine weighs approximately three ounces; a cubic foot of water at ordinary temperatures can hold six ounces of chlorine. In making tests upon a large scale at Denver, no difficulty was experienced in bringing from 0.5 to 0.75 per cent chlorine into a chloride solution.

†As set forth in patent specification No. 973,776, preference is given to combining chlorine with sulphur dioxide outside the electrolyzer. The reaction indicated in the formula can only be realized in the electrolyzer with exceedingly small current densities, whereas fifty amperes per square foot have been used in depositing. This increases the power expended per pound of copper produced, but gives better results—another exemplification of the fact that only in rare instances is it possible to carry on two metallurgical processes in the same apparatus simultaneously.

*If a cold solution is used in leaching then the three metals (gold, silver and copper) are extracted simultaneously. This could only be done, however, when the silver content is low; should it be high, the ore might be given a chloridizing roast, as in the Longmaid-Henderson process, and then leached cold. If gold values predominate, the solution should be charged with free chlorine, and as much as possible of this metal extracted in the beginning.

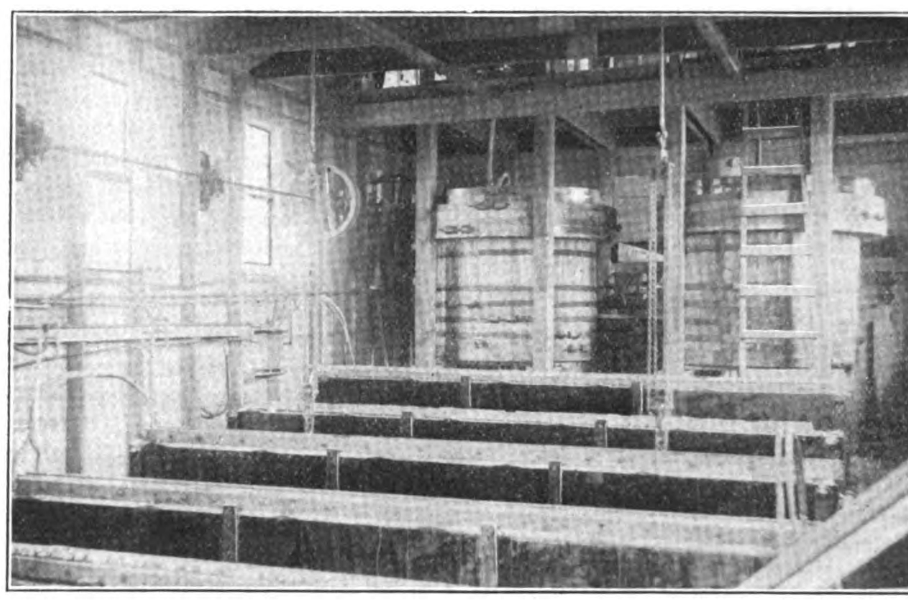
*The theoretical voltage necessary to decompose copper sulphate is 1.27; for cupric chloride 1.114; and for cuprous chloride 1.419. Although the voltages required for the two chlorides are nearly the same, the amount of copper deposited in the case of the cuprous salt being twice that of the other, the energy required is only about 65 per cent.

cuprous salt is less than that for a cupric. Secondly, as shown in the formula, the acid lixiviant is regenerated by this method of treatment, and additicns are made to it, increasing its strength. When current is subsequently applied to reduce the cuprous chloride, still further quantities of the active reagents are produced. An advantage claimed for chloride solutions in electrolytic processes is, that the insoluble anodes used are less subject to deterioration when the copper is deposited from salts present as chlorides than is the case when they are in the form of sulphates.†

It is apparent from the reactions indicated in the above formulae which take place during the several stages of this method of ore-reduction, that additions are constantly being made to the acid-content of the solutions. Sulphuric acid is generated from the sulphur dioxide introduced into the liquors, and this in turn acts upon the salt (NaCl) present, producing hydrochloric acid. As there are always other bases in a copper ore besides the metal sought, such as lime, ferric oxide, etc., these are of course to a great extent brought into solution, but subsequently thrown down as insoluble sulphates. In this manner an accumulation of large quantities of acid solution is prevented, and innocuous products which are formed may be discharged with the tailings. In most cases insoluble calcium sulphate, and the equally insoluble basic salts of iron, will remove most of the excess-acid generated. Should there still remain an undesirable excess of acid in the solutions, it can be neutralized by the caustic soda formed in the electrolytic cell in which the chlorine is produced. In the latter case chloride of sodium will be to some extent regenerated after all of the sulphuric acid has been neutralized.

After the cupric solution has been reduced to the cuprous state through treatment with sulphur dioxide, the latter salt, (held in solution by hydrochloric acid and chloride of sodium), is passed through the cathode compartments of electrolytic cells, where the copper is deposited in metallic form. The solution issuing from the cathode cells is treated with sulphur dioxide in scrubbing towers, and then passed through the anode compartments of the same cells. The object of the further application of sulphur dioxide to the solution is, to insure an excess of sulphurous acid that it may react with the chlorine liberated at the anodes due to decomposition of the cuprous chloride, thereby forming additional acid. The liquor issuing from the anode compartments is then ready to be returned to the ore-dissolving vats to be employed in the treatment of a new batch of ore. This cycle of solution, precipitation and regeneration may be repeated indefinitely.

It will have been noted that in the Greenawalt process not only is the acid radical employed being constantly regenerated, but FRESH SUPPLIES OF THE SAME ARE CONTINUOUSLY ADDED TO THE SOLUTIONS AT THE EXPENSE OF WASTE FURNACE GASES. This feature is manifestly of the greatest importance, because no leaching operation can be carried out without the consumption of some active reagent, and when the source of the latter is a waste material, which, if permitted to escape into the atmosphere does positive harm, its utilization in the manner described, in itself commends the process to careful consideration.



Depositing Room Greenawalt Electrolytic Copper Extraction Experimental Plant. Denver, Colorado

The average results from a number of tests made with this process at Denver afforded a basis for assuming that a deposition of one pound copper could be counted upon per kilowatt-hour for the energy expended in electrolysis. Better results than this were obtained in some instances, reaching as high as 2.6 pounds copper per kilowatt-hour; but the former figure was assumed in the estimates published in the articles cited above as a basis for computing the cost of producing copper. The following estimate of costs of ore-treatment by the Greenawalt process is taken from Engineering & Mining Journal of November 26th. 1910, page 1066:

TABLE SHOWING COST OF MILLING ORE

	Per ton ore.
Crushing to eight mesh	$0.20
Leaching	0.15
Electro-deposition and regeneration, not including power	0.25
Power, electro-deposition, 420 kilowatts	0.58
Repairs, renewals, etc.	0.10
Melting and casting into ingots	0.05
Superintendence	0.10
Interest on investment, $120,000 at 6 per cent	0.20
Amortization, $120,000 at 10 per cent	0.33
Total per ton of ore	$1.96
Cost per pound copper extracted, assuming extraction 100%	$0.0196

These figures include the cost of extracting the precious metals, if such are present in an ore, and are based upon the metallurgical treatment of 100 tons of five per cent copper ore in 24 hours, with power* at $50.00 per kilowatt-year ($0.0057 per kilowatt-hour) and a deposition of one pound copper per kilowatt hour. Roasting is not included, but an addition of $0.75 per ton is made to the estimated cost where this is necessary, bringing the total estimated milling cost per pound copper for sulphide ore up to $0.0271.

The approximate cost of a 100-ton Greenawalt leaching plant was estimated as follows in the article referred to:

Power installation	$ 50,000
Motor-generator set; 5000 amperes, 110 volts	10,000
Electrolytic department, electrolyzers, cables, etc.	25,000
Leaching department, eight 100-ton vats, pumps, etc.	10,000

†Carbon electrodes, even the best of them, go to "mush" very quickly in sulphate solutions.

*According to statements made by practical hydroelectric engineers a water-power plant in the west can be installed for about $150.00 per kilowatt, and power produced for about $25.00 per kilowatt-year. With power at $25.00 per year, and two pounds of copper per kilowatt-hour, the cost of extracting copper from a suitable ore should be low.

Crushing department, crushing to 6 or 8 mesh	15,000
Miscellaneous	10,000
	$120,000
Roasting department	30,000
Total	$150,000

Returning to the cost of milling as given above, the figures have reference only to expenses incurred after the ore is delivered in bins at the mill, and do not include cost of mining, nor is anything allowed for shipment of the crude metal to market, refining and selling expenses, etc. It is assumed that electrolytic copper is sufficiently pure to enable it to find a market close to the point of its production, but such is rarely the case. Some metal might be disposed of under exceptional circumstances for casting purposes, but the amount would be small. Attempts to find a local market for California copper have been made from time to time but have not met with success, nor are conditions in British Columbia different, where also electric power is sufficiently cheap to warrant refining. All copper, wherever produced, seems to gravitate to the large Eastern refineries, to be worked up and returned to points often close to those of its origin. Even Mexican and Japanese copper is shipped to our Eastern seaboard for refining.

Formerly copper made by the natives in certain parts of Mexico was hammered by local artisans into the form of large copper kettles and other useful articles, but the industry was of small dimensions. When making estimates of the probable cost of production it will have to be assumed that in the present state of the copper industry all metal produced in any considerable quantity will have to bear the expense of a trip across the continent, which, with refining and other charges added, will increase the cost from two to four cents per pound. This is not as it should be and is one of the artificial conditions imposed on the country by the great capitalistic combinations. The time will come when crude copper bars will not be hauled 3,000 miles to Eastern refineries, and then shipped back another 3,000 miles at an additional expense of two cents a pound to Western consumers; but for the present, estimates will have to be made on this basis.

For the purpose of instituting a comparison between the costs of producing copper in a leaching plant and in a large concentrating mill, the following figures are given, being the costs at the Boston Consolidated mill in the month of September, 1909, shortly before that company was absorbed by its neighbor.

Table showing cost of producing copper at the Boston Consolidated mill in September, 1909:

	Per lb. refined copper.	%
FOB reduction division	$0.0479	41.01
Reduction division	0.0415	35.53
General expense	0,0110	9.42
Marketing	0.0164	14.04
	0.1168	100.00
Credit for precious metals	0.0050	
Total cost of the copper	$0.1118	

The amount $0.0415 assigned to the reduction division includes all metallurgical treatment, crushing, concentrating, smelting concentrates, and converting matte to crude copper. This amount ($0.0415) should be compared with $0.0218, the estimated cost of producing metal by the Greenawalt process ($2.71 less $0.53, the sum allowed for interest and amortization). In comparing the two sets of figures allowance must be made for the facts that Boston Consolidated figures are actual working results, whereas those relating to leaching are estimates; and furthermore, the latter are based upon an extraction of 100 per cent, which is inadmissible;* but still the difference is striking, considering the basis of comparison—100 tons per diem as against 2400.

Boston Consolidated ore averaged in the month given 1.58 per cent copper. The recovery in the form of concentrates was 68 per cent, with a further deduction of five per cent from the content of the concentrates at the smelter, and 26 pounds additional per ton of converter copper handled at the Eastern refinery. The mill treated on the average 2400 tons of ore in 24 hours.

The expense of extracting copper from an ore after it has been delivered at the mill is only a minor part of the total, a matter which is often overlooked in making estimates. This important fact is illustrated by the figures given in the following table:

Table showing cost of treating ore at the Boston Consolidated mill in month of September, 1909:

	Per dry ton.	%
FOB reduction division	$0.967	41.06
Reduction division	0.837	35.54
General expense	0.221	9.39
Marketing	0.330	14.01
Total cost per ton	$2.355	100.00

There is a further point to be considered in comparing leaching with concentrating operations, which is, that the percentage of metal extracted from an ore is higher in lixiviation. Assuming a five per cent copper ore and ninety per cent extraction in leaching as against 65 per cent in the usual concentration mills, the ratio of metal produced per ton of ore would be as 90 to 65 pounds. Even if the costs of the two operations were the same, the 25 extra pounds of metal would very materially reduce the mining and general expense charges, while the others remained the same.

*It is expected with the Greenawalt process to get an extraction of 98 to 99 per cent from carbonate ore, and 90 to 95 per cent from sulphide ore.

COPPER IN IRELAND

A $73,000 company is being formed to acquire a mining lease of the Ardtully mines of copper, silver and lead situated between Kilgarvan and Kenmare, in the county of Kerry, Ireland, writes Consul Geo. E. Chamberlain of Cork (Queenstown). The property consists of 14 acres of land and the mining rights of adjoining property, comprising 265 acres.

An analysis made in the laboratory of Trinity College, Dublin, shows the mines are rich in copper, sulphur and arsenic, and the quality of the ore is stated to be superior to that of the Cornish mines, the average value exceeding $53 per ton. Assays show copper ore from 22 to 49%, and silver-lead from 18 to 75 ozs. of silver to the ton. A considerable amount of development work has been done, and the first ton of ore raised was sent without being concentrated, to Swansea to be smelted, the assay being 15 ozs. of silver, net value $7.74, and 15% of copper, valued at $30.84. Another sample sent shows as high as 61% copper.

Copper mining in Ireland in recent years has been of but little importance, chiefly on account of the low-grade ore, and the result of this new development will be watched with a great deal of interest.

Some important developments are reported from Copeton Diamond Fields. At the Deep Shaft mine, on 22nd July, very rich wash was encountered, no less than 65 carats of diamonds being obtained from less than half a load, and 42 diamonds were picked from the face. The diamonds are said to be of excellent quality, averaging nearly half-carat, and one weighing 2½ carats was discovered. Black diamonds have been found in this mine, weighing up to 4½ carats. It is estimated that this rich diamond deposit, which is 2 ft. in thickness, will yield 150 carats to the load. By these recent developments the permanency of the Copeton field as one of the richest diamond-producing centers in Australia. has been assured.

The dynamo is a machine for converting mechanical energy into electrical.

DISSIPATION OF DUST AND FUMES

EXPERIMENTS MADE AT BALAKLALA AND SELBY WORKS WITH THE COTTRELL ELECTRIC PROCESS

Up to date the Cottrell system of fume condensation has been given its most thorough test at the Balakalala smeltery at Coram, Cal., which was recently closed by order of the U. S. Circuit Court, says the Engineering and Mining Journal in submitting abstracts of papers on the subject. However, in the trial which led to this adverse decision, the apparatus is credited with removing 72.8 per cent of the total solids, including sulphuric acid and sulphur trioxide, and it appears that at present the sulphur dioxide is the chief source of trouble.

The underlying principle consists in the discharge of high-tension currents through the gas to be treated. In a quiet body of any fluid, where the particles to be precipitated electrolytically need only to be agglomerated, alternating currents may be used, but in a swiftly moving body of fluid, such as flue gases, direct current is far preferable.

HIGH TENSION DIRECT CURRENT.

The first problem was to find some means of supplying this high-tension direct current, as the common mercury-arc rectifier used with alternating current was found unsuitable for this work, in which the electrodes in the flues are placed close together and worked near the potential of disruptive discharge. The process adopted consisted in stepping the ordinary alternating current up to about 20,000 or 30,000 volts, and commutating it into an intermittent direct current by means of a rotary contact maker, driven by a synchronous motor.

The electrodes consist of a smooth conducting plate and a series of points. The final form of the latter was due to the observation that a piece of cotton-covered wire leading to the discharge electrode showed a purple glow along its entire length. Discharge electrodes made of this material proved more effective in precipitating sulphuric-acid mists than any system of metallic points. To form the more durable electrodes required in practice, asbestos and mica were twisted with wire, the slight deposit treatment before placing in the flue, furnishing the conductivity for the slight amount of surface leakage necessary.

APPLICATION TO CONTACT ACID PLANTS.

The first experiments on a commercial scale were made at the Hercules plant of the du Pont Company, at Pinole, Cal. Contact gases from a Hannheim sulphuric-acid plant, containing about 4 per cent by volume of dry SO_3 were worked on.

The apparatus consisted of two concentric wire-screen cylinders serving as discharge electrodes; a third cylinder, intermediate in size, resting on the lead bottom pan of the apparatus, and an outside leaded-glass cylinder, served as the collectors. Current was supplied by three 1-kw. 110-2200-volts transformers in series to give 6600 volts. The interval between the screens was about 1 1-4 in. About 100 to 200 cu. ft. of gas per min. were treated at a power consumption of about one-fifth kilowatt. This installation has since been supplanted by one on a commercial scale handling the entire output of a Mannheim unit.

PARTING PLANT FUMES CONDENSED.

The next installation was that at the Selby Smelting and Refining Company. The first problem attacked here was that of the fumes from the parting kettles. These were passed through a lead flue 4 ft. square in which were placed a number of lead electrodes 4 in. wide by 4 ft. long. Between each pair of these electrodes was hung a lead-covered iron rod, carrying the asbestos or mica discharge material, the latter being more effective in a highly acid atmosphere. These discharge electrodes were supported on a gridwork of busbars, which extended over the heads of the lead plates and through apertures in the sides of the flue to insulators on the outside. When the parting kettles were running at full capacity a stream of about 2 gal. per min. of 40-deg. acid issued from this flue. The current was taken from the regular works power circuit of 460 volts, 60 cycles and transformed to 17,000 volts, then sent through the synchronous-contact maker to the electrode system. At first a glass-plate condenser was connected across the high-potential line in parallel with the electrode system, in order to assist in maintaining the potential of the electrode between the intervals of contact, but this was found troublesome and unnecessary. The power consumption for this installation was about two kilowatts, including the driving current for the synchronous motor. The installation has been in successful operation for over three years and costs for labor and repairs less than $20 per month.

The next undertaking was the extension of this process to the treatment of the gases coming from the roasting furnaces of the same plant. It is impossible to treat these gases in a bag house owing to the corrosive action of the large amount of sulphuric acid in them. The material to be removed consisted of a mixture of solid dust and fumes with liquid sulphuric acid. The final apparatus consisted of a sheet-lead flue 6x6x32 ft., containing 38 rows of 16 lead plates each, each 6 ft. long by 4 in. wide, with corresponding discharge electrodes between each pair. This flue, 6x6x36, treated about 50,000 cu. ft. of gas per min., or about the same volume of gas as would be treated in a baghouse measuring about 55x98x125 ft. A test with such a baghouse showed that the woolen bags are completely destroyed by these roaster gases in less than half an hour. In this case the power consumption was between 10 and 15 kilowatts. The material precipitated upon the plates was a grayish mud, easily washed off and drained out through the bottom of the flue to settlers. For this purpose it was necessary about once every four to six hours to bypass the gases, shut off the electric current from the flue and wash off the electrodes from above.

GASES MUST BE PRECOOLED.

In order to insure the complete precipitation of sulphuric acid and arsenic from these gases and to protect the lead construction from softening, it was found necessary to cool the gases down below 150 deg. C. To accomplish this a system of water sprays was used in the mouth of the lead flue just before the electrode. These served the purpose well as long as clean water was available, and successful test runs for a week or more duration were made with this system, but as the general circulating and cooling water is derived from the Sacramento river, which is often muddy, the difficulties of keeping the sprays clean determined the management of the plant to resort to cooling through radiation by a long flue before the precipitator. This has not yet been done, as it seems that the present litigation with farmers has resolved itself into a question concerning the sulphur dioxide which, of course, is not precipitated by this system.

THE BALAKLALA INSTALLATION.

The next installation was that of the Balaklala smeltery, which treats from 700 to 1000 tons of ore, carrying about 30 per cent. of sulphur per 24 hours. The great proportion of this is handled in blast furnaces, but everything smaller than one inch goes through the MacDougal roaster and an oil-fired reverberatory. The plant also has two converter stands. The gases from all departments passed into a common flue 18 to 20 ft. in cross-section. The volume of gas passing through this flue varied from a quarter to a half a million cubic feet per minute, which means a linear velocity in the flue of from 10 to 20 ft. per second.

A system of nine electrical precipitation units was built. Current was taken from the company's three-phase power circuit at 2300 volts, 60 cycles, and was transformed to from 25,000 to 30,000 volts and distributed to the electrodes. The collecting electrodes were grounded and were each 6 in. wide by 10 ft. high made of No. 10 sheet iron. The discharge electrode consisted of two iron-wire strands, between which was twisted the discharge material, both asbestos and mica preparations being used in this plant. Each of the nine units contained 24 rows of 24 electrodes of each type. The collecting electrodes were carried by bars connected directly from the chambers themselves, while the discharge electrodes were held by springs between a system of busbars carried on externally placed insulators.

MECHANICAL SHAKING TRIED.

Originally a cam and shaker rod extended across the middle of the units, for vigorously shaking the electrodes. In practice, though, it was found that a slight shaking by hand was quite sufficient and the entire operation of cleaning, including cutting the units in and out of the system, and the removal and the replacement of its covers, required only about 10 minutes; this having to be repeated every six or eight hours, depending on the dust content of the gases. The precipitated dust and fume as it falls from the electrode is carried away by a mechanical conveyer in each unit to a common longitudinal conveyer, which in turn discharges into cars. Under operating conditions at the smeltery from six to eight tons of precipitate were collected per 24 hours. The entire cost of the installation up to the time when it was first put into operation was $110,000.

The total average power consumption for the preciptation was in the neighborhood of 120 kw. One man can readily control the whole operation in the rectifier house, while two laborers and the foreman are employed on the precipitating units and the dust-handling system.

One of the greatest difficulties met with in this system has been the maintenance of conductivity in the fine fibers of asbestos and mica of the discharge electrode. At ordinary temperatures these materials readily take on enough moisture from the air to afford sufficient surface leakage for all the discharge necessary, and the same is true at higher temperature to the gases containing traces of sulphuric acid or other conducting matter, but in the particular gases met here with a high and variable amount of zinc oxide, which at times robbed them of all conductive matter, the conductivity of the fibers of the electrode is seriously reduced.

PRESENT STATUS OF PROCESS.

The Balaklala smeltery is now closed until it can conform to the original decree of the U. S. Circuit Court, which is that all solids must be removed, that there must never be over 0.75 per cent of sulphur dioxide in the exhaust gas and the gases must do no damage. Unfortunately the solution of the sulphur-dioxide problem is one which does not yet seem to be in sight.

It is proposed also to try the Cottrell system of condensation on the problems of the collection of dust arising from portland-cement plants, which are always serious annoyances to their neighbors. The process is also being tried in the cleaning of iron blast-furnace gas for use in gas engines. Outside of the poisonous and combustible nature of these gases and the consequent necessity for keeping the whole apparatus gas tight, there would appear to be no new difficulties here, and the matter is now being tested on a practical scale.

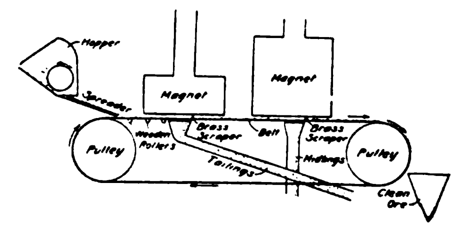
MAGNETIC ORE SEPARATION

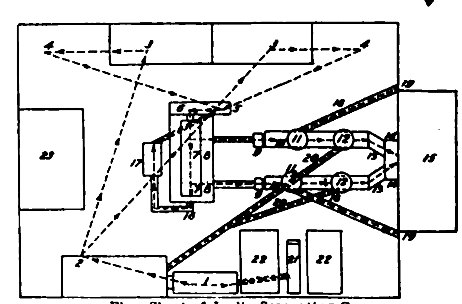
The following is a description of the method employed by the Joplin Separating company, of Joplin, Mo., of treating low grade iron-zinc ores, so as to produce a high grade zinc concentrate. It was written by Lucius L. Wittich and appeared in last month's issue of Mines and Minerals:

The ore is first cleaned of sand, chatts, galena and other foreign matter in jigs and on ordinary tables; but where this has already been done the ore goes direct to the roasting ovens (3) instead of to the sizing screen (1) and the jigs (2).

The roasting ovens, of which there are two, consist of one firebox and three eyes each. In the first eye, nearest the furnace, one charge of 1,500 pounds may each may be roasted in 12 hours; in the second eye from the furnace, two charges of 1,500 pounds each may be roasted in 12 hours; in the third eye from the furnace, one charge of 1,500 pounds may be roasted in 12 hours.

From the eyes the roasted ore is wheeled in barrows to the cooling floors, (4) and when cooled is ready for the separator, first being wheeled to the receiving hopper (5), from whence it is elevated by a cup elevator (6) to a revolving screen (7). The upper half of the screen is equipped with wire mesh with openings one-eighth inch square. The ore that passes through this feeds into a large hopper (8), which is divided into two parts by a partition running crosswise through the center. At the lower end of the revolving screen is a perforated iron mesh, the holes being one-sixth inch in diameter. Ore passing through this also falls in the other part of the hopper. The object of the different sized mesh is to secure different sizes of ore for the two separators with which the plant is equipped. The oversize from the screen (7) passes to the rolls (17) via the launder (16) and thence back to the elevator (6) after it





Flow Sheet of Joplin Separating Co.

has been ground. In this manner the ore continues to circulate until it will pass through one or the other sections of the screen.

From the hopper the ore descends by gravity through launders to the distributing hoppers (9) at the upper ends of the belt conveyors (10). At the base of the distributing hoppers are spreaders on to which the ore falls and is conveyed in an even layer to the slow-moving belt conveyor beneath the magnets (11) and (12). One of these belt conveyors is 12 inches wide; the other 18 inches. They operate over wooden pulleys about eight feet apart, and are prevented from sagging in the passage beneath the magnets by wooden rollers.

The magnets consist of cylindrical soft-iron shells which cover helices of copper wire. The shells are 20 inches in diametear, but differ in height, the first magnets beneath which the roasted ore passes being 10 inches high, while the second magnets—the more powerful ones—are 20 inches high. The magnets revolve slowly and the iron oxide is attracted to their surface is scraped off into launders by means of brass knives, which cause it to fall vertically.

As it is imperative that the recovery of blende be thorough and yet contain as little iron as possible, a careful regulation of the electrical current is required. The iron oxide scraped from the first magnets (11), beneath which the belt conveyer passes, goes direct to the waste pile and is of not further value save to be used in road making, sidewalk building, etc., and even for such purposes it is in little demand owing to its unattractive color. These weaker magnets range in power from 2 to 5 amperes, the variation being due to the different kinds of ores treated. Some ores will respond to a slight magnetism while others require a more powerful force.

The object of tne weaker magnets therefore is to attract only the iron particles that are virtually free from zinc ore, although a small percentage of ore is bound to escape with the waste through the launders (18) to the tailing piles (19).

As the belt conveyor passes beneath the revolving magnets its surface is about three-quarters to one inch beneath the surface of the magnet, and across this space the iron particles rise to the magnetized zone of the apparatus. This zone is five-eighths of an inch wide, is near the extreme outer edge of the round face of the magnet extends entirely around the magnet, and represents the gap between the positive and negative poles, this narrow strip being the one point of the entire surface to which the iron particles are attracted. As the magnet swings around, bringing the clinging particles of ore against the brass knife, the product is scraped loose.

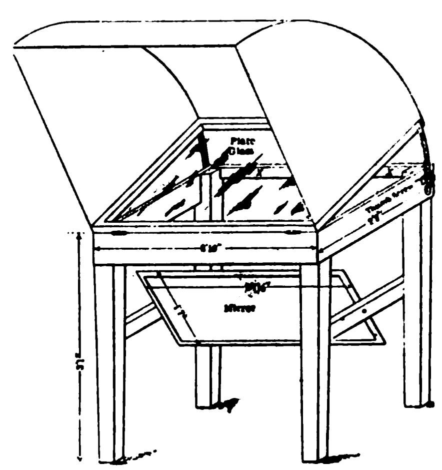
Passing beyond The first magnet, the belt goes beneath the second magnet which ranges in power from 9 to 12 amperes and attracts a heavy volume of particles that contain some zinc. A pin point of iron attached to a piece of zinc 50 times heavier than the iron, will respond to the magnetic force and jump upward to the magnetized zone. The ore that succeeds in getting beyond the second magnet and reaching the trough (14) at the end of the belt conveyer is therefore as free from iron particles as it is possible to get it. The cleaned ore passes to an elevator (14) and is lifted to the clean ore bin (15). It is in demand, as it is equal to the ores produced from the high-grade mines of the district.

To discard in the waste pile the particles that adhere to the powerful magnets (12) would cause a loss of zinc, therefore, the scrapings, instead of going to the tailing pile, fall into launders (20). The product is sized, (1) and (2), that passing through a mesh of 3-millimeter going to the jigs, while that passing through a 1-millimeter and a three-quarter millimeter mesh goes to the tables. The oversize goes to rolls (17), where it is reground and returned to the magnetic separators.

HANDY DRAFTING TABLE

By A. T. SCHWENNESEN.*

Every engineer has occasion to trace or copy a map plan, or other drawing on paper too thick for the ordinary way of using tracing-cloth or tracing-paper. When the figure is small and simple a copy may be made by holding the original against a window-pane, covering it



with the paper, and tracing direct by the aid of the strong sunlight from outside. The need of utilizing this principle on a larger scale and in a more convenient position led Dr. J. C. Branner to plan the table of which the following is a description:

This table was first made in the form of an adjustable glass-top table, with a mirror beneath, in 1887, while Dr. Branner was State Geologist of Arkansas. Later it was modified as experience suggested until the form as here described was evolved.

The device consists essentially of a drafting-table with a plate-glass top, upon which the original drawing and the paper are laid, and a mirror mounted underneath to reflect the light of the sky up through the drawing. The glass top is hinged and fitted with two arms and thumb-screws, so that it can be raised and fixed to any position, either inclined or horizontal. The mirror is pivoted and revolves about a horizontal axis, so that it may be tilted to any angle. The hood of cardboard or black cloth prevents the reflection of light from the tracing, and may or may not be attached to the table.

The apparatus is set up before a window through which part of the unobstructed sky is visible. The mirror is then adjusted like the reflector of a microscope, so that the sky light is reflected up through the drawing. If the mirror can be so located that the direct rays of the sun are reflected through the drawing, thicker paper can be used.

The map or drawing may be held in place by clips screwed to the top of the plate-glass frame or by lead weights placed on top of it.

The sketch gives dimensions and shows the general appearance of the table in use in the department of Geology and Mining at Stanford University. The dimensions may be varied to suit individual needs. An important point to be remembered in the construction is that the piece marked X should be made as narrow as possible, so as not to shut out more light than necessary. The frame of the glass top also should be made narrow at the top for the same reason.

This table can be used at night by employing an electric light, so placed as to be reflected or even to shine directly up through the plate-glass table-top.

It sometimes happens that the light from beneath is inconveniently strong, but this objection can be obviated by cutting a small opening in a piece of thick or dark paper, which is laid over the drawing. The tracing can then be done through the hole, and the sheet can be moved about at pleasure, which gives the advantage also of preventing the tracing from being soiled, and it often brings out more clearly the lines to be traced.

*Transactions of the American Institute of Mining Engineers.

The engraving division of the United States Geological Survey printed during the fiscal year ending June 30, 1911, 7,283,894 geologic, topographic, and other maps, many of them in several colors, each requiring a separate impression. Some of the geologic maps require as many as twenty printings. The total number of printings during the year's work was probably not less than 45,000,000 or 50,000,000.

A cubic foot of water contains 7.48 gals. and weighs 62.5 lbs.

ECONOMICAL METHOD OF SHAFT TIMBERING

By HUGH G. ELWES.*

The scarcity of timber in certain districts has led mine operators to try to use timber of less dimensions than those commonly employed in places where lumber is plentiful and consequently cheap.

The Nevada camps, especially Goldfield, are examples of places where the smallest timbers compatible with safety have been used. The light sticks used have been thought too weak by some, but practical experience has shown that all purposes have been well served and no failures of timbers have been recorded.

The writer ventures to suggest that in very many cases timbers much larger than those required are used. Beside the extra cost of big sticks, the lost space in the shaft is an objection, and in a large number of instances the timbering of the shaft is necessary only to support guides, ladders, pump lines, etc. A shaft in anything like good ground needs only light timbers such as those shown in the drawings, and if properly wedged, the latter, in combination with continuous lagging, will prevent rocks falling into the shaft as well as heavier sticks and at much less cost.

The drawings show the framing of timbers for a small two compartment shaft, each compartment measuring four feet by four feet in the clear, inside the timbers. All the sticks are six inches by six inches, except the special wall plates at the collar, and the special end plates of the bearer set which are six by tens.

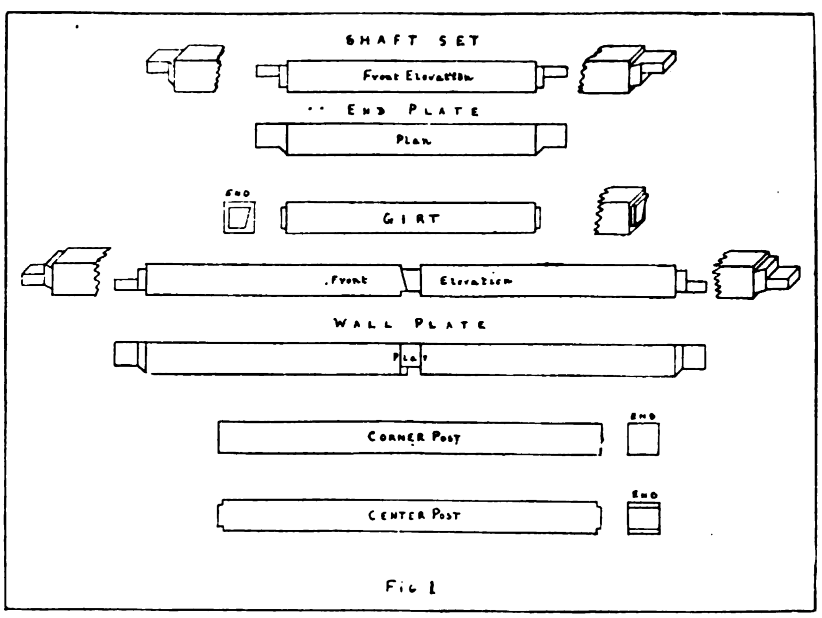


Fig 1

Referring to Fig. 1, it will be seen that the end plates fit above the wall plates, and that both have a beveled shoulder to afford additional resistance in resisting side pressure. Daps are cut, one inch deep to receive the ends of the corner posts. These corner posts have plain squared ends but the center posts have a one inch tenon fitting into the dap in the wall plates as shown.

The girts have a one inch tenon beveled on one side, which is always the right hand side in end elevation. The wall plate is framed as shown, so that all are the same, without any right and left hand plates, and any girt can be put in in either direction.

The dap in the center of the upper and lower sides of the wall plates is so framed that girts and center posts can be temporarily omitted to permit the lowering and swinging into position of the wall plates.

The small perspective drawings of the ends of the various sticks are given to make the framing more intelligible.

The distance between sets is six feet in the clear or six feet six inches centers.

In framing, all measurements should be governed by the upper side and the inner face of each stick, so that any irregularities in them will not affect the alignment of the shaft nor its inside dimensions.

Figs. 2 and 3 show respectively perspective views of the skip compartment and ladder way, since a drawing showing the whole shaft would be too large for convenient use.

To avoid confusion the hanger bolts are shown only in the drawing of the skip compartment. These hanger bolts are of one inch round iron, ordinary nuts being used with extra large washers. Holes are bored in the wall plates nine and eighteen inches from the edge of the end daps, and the hole nearest the end is useful in lowering the stick, since a short piece of round iron passed

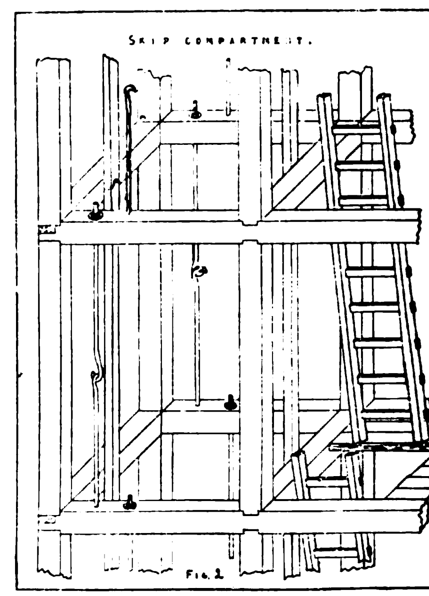


Fig. 2

through, having a thread at each end makes a convenient means of suspending the timber. The lagging of one inch boards is not shown so as to leave the drawing simple. Needless to say this lagging is placed outside the tim-

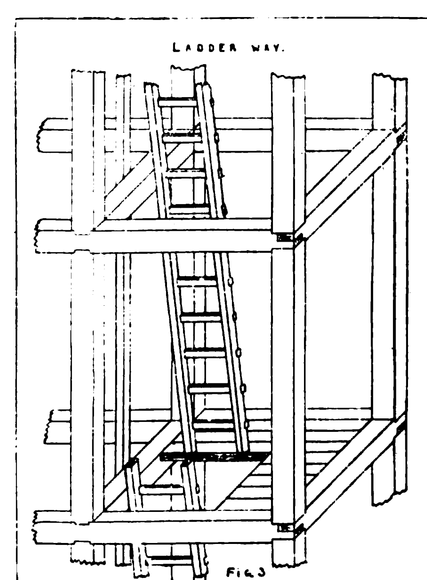


Fig. 3

bers, though the writer saw a shaft in New Mexico lagged on the inside, making a rectangular tube.

In Fig. 2 the guides are shown. These are made of two by four inch lumber and engaged dogs on the cage or cross-head.

*Mining Engineer, Papantla, Veracruz, in Mexican Mining Journal.

If the shaft sets are in proper alignment there is no need for any piece between the end plate and girt and the guides, but sometimes a small space block is used, so that the guide can be put true by varying the thickness of the block.

In Fig. 3 the ladder way contains a

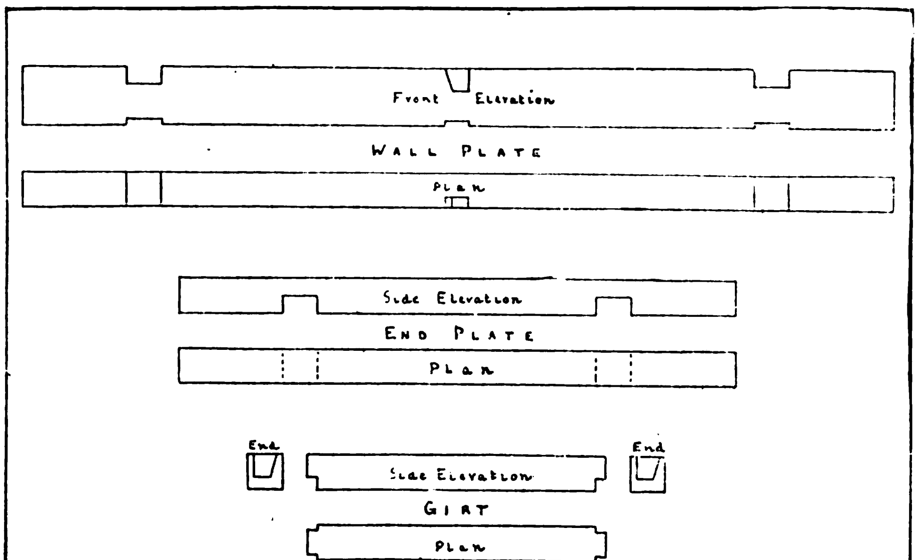


Fig. 4

series of ladders each reaching the height of two sets, and placed vertically over each other as shown. The manholes in the platforms at every other set are two feet six inches square. The tops of the ladders project above the platforms and hand holds are also placed above so as to facilitate stepping onto the flooring. The ladders are made of two by four lumber, the rungs being set apart at ten inches centers. The width of the ladders is eighteen inches over all. Each ladder is securely spiked in position and not left loose or half balanced. The steam pipe and water column for the pump and air line for the drills are carried in the ladder compartment, and the arrangement shown permits of any part of these pipes being easily reached.

Figs. 4 and 5, showing the collar of the shaft, are self explanatory, but it may be added that the writer uses concrete walls down to six feet from the surface, making the section of the shaft for that distance from the surface big enough to admit a thickness of eighteen inches behind the timbers. The timbers of the collar are bolted down into concrete piers forming extensions of these lining walls, but only three feet deep.

At every tenth set a bearer set is introduced. The bearer consists of an end plate made of six by ten lumber instead of six by six and there is a little difference in framing as shown in Fig. 6, on the following page.

To maintain the distance between sets the posts are cut four inches shorter immediately below the bearer.

The ends of the bearers are set into hitches cut in the walls of the shaft, and their use will increase the security of the whole job a great deal. Where the ground is at all soft or wedging difficult, the hanger bolts are replaced when removed by permanent bolts extending from one set to another.

By increasing the over-all dimensions of the sticks shafts of larger size can be timbered from the designs shown, and if another compartment is wanted, a

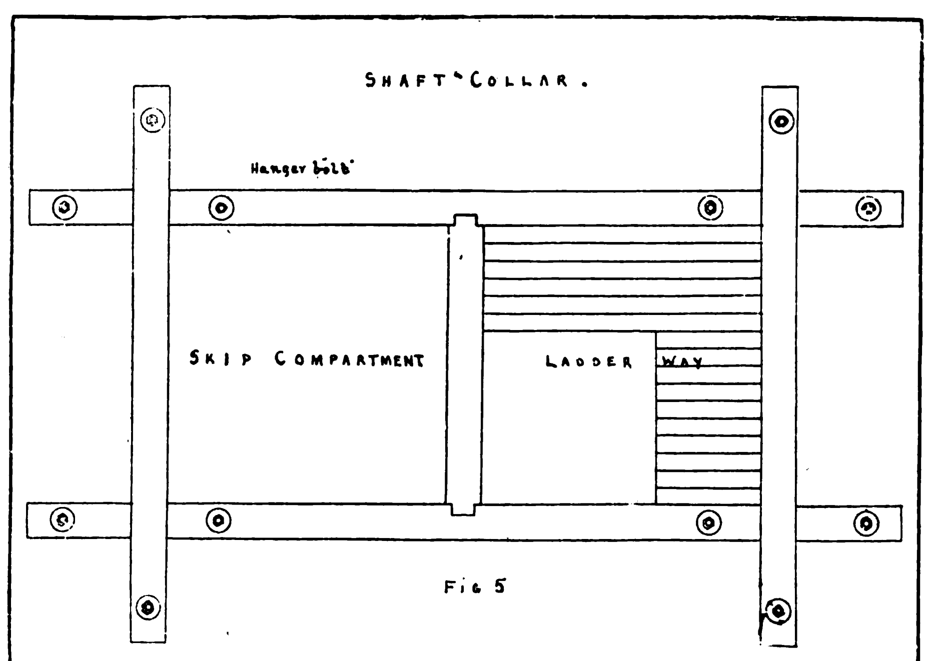


Fig 5

simple butt joint and a reduction in the length of the tenons on the end plates enable it to be added without trouble, but for three compartments each of four by four feet, the wall plates might well be designed in one piece, with extra girts to divide off the extra compartment.

Nothing very new or original is claimed for these few remarks, except that part relating to the exaggerated conception some miners have as to the safe size of timbers.

A shaft designed as shown can always be utilized for hoisting with a double drum hoist by merely removing the platforms in the ladder way. The appearance of a shaft timbered as shown is very neat, and no trouble from any cause has been experienced.

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Asbestos, according to J. S. Diller, plays a more important part in the national life than is generally credited to it. The well-made asbestos curtain assures safety of the audience from stage fires. In the home the asbestos covering of the furnace and heating pipes, or of the gas logs in the open fireplace, makes for economy and comfort. Wherever steam is used as a motive power in factories, on trains, or on ships, it is asbestos packing that holds the steam to its work; on the other hand, if electricity is employed the wires are probably insulated by asbestos tape and the adjacent parts are made of asbestos "lumber." Asbestos shingles and sheating make houses cooler in summer and warmer in winter and reduce the fire risk. From the ice-house, where asbestos protects the brine pipes from the heated air, to the foundry, where it shields the workman from molten metal, in the workshop, the home, or the place of amusement, asbestos contributes materially to human welfare.

UTAH MINE PRODUCTION FOR CALENDAR YEAR 1910

The total value of the mine output of gold, silver, copper, lead, and zinc in Utah in 1910, according to V. C. Heikes, of the United States Geological Survey, was $32,199,185, against $31,380,092 in 1909.

The total gold production in Utah in 1910 showed a decrease in value of $174-463, or 4.3 per cent. The largest producer of gold was Salt Lake County, which yielded $1,776,058, against $1,780,-573 in 1909. The West Mountain or Bingham district produced $1,767,992 of the gold credited to Salt Lake County and 43.8 per cent of the 1910 Utah gold output. Juab County produced $1,181,-366 in 1910, against $1,448,096 in 1909, and Utah County $193,234 in 1910, against $276,314 in 1909. The Tintic district, which is partly in Juab County and partly in Utah County, produced $1,370,-320 or 34 per cent of the gold production of Utah in 1910. Tooele County produced $721,361 (of which all except about $5,000 came from the Camp Floyd district) in 1910, against $820,486 in 1909.

The silver production of Utah in 1910 showed a decrease of 1,250,201 ounces, or 10.7 per cent. Juab County produced 3,835,062 ounces in 1910, against 3,544,918 ounces in 1909, and Utah County 1,500,625 ounces in 1910, against 2,995,658 in 1909. The Tintic district silver yield declined from 6,404,-847 ounces in 1909 to 5,222,742 ounces in 1910. Salt Lake County produced 2,006,-131 ounces in 1910, against 1,780,572 ounces in 1909. Of the Salt Lake County yield, the West Mountain or Bingham district contributed 1,800,410 ounces in 1910 and 1,615,394 ounces in 1909.

The silver output of the Park City mining region in 1910 was 2,571,771 ounces, a decrease of 253,614 ounces, or 10 per cent, from that of 1909.

Copper production increased in Utah 18,649,261 pounds in 1910, a larger increase than in any other of the copper-producing States. The Bingham district produced 113,725,280 pounds of copper in 1910 against 92,560,340 pounds in 1909, 71,155,740 pounds in 1908, and 45,431,964 pounds in 1907. The Tintic district yielded 8,993,036 pounds in 1910, against 5,915,669 pounds in 1909, an increase of 3,077,367 pounds. The Park City district, in Summit and Wasatch counties, produced 1,423,629 pounds in 1910, against 1,655,749 pounds in 1909.

The production of lead in Utah in 1910 was 123,324,635 pounds, valued at $5,-426,284, against 148,486,463 pounds, valued at $6,384,918 in 1909. Of the 1910 output, 30.9 per cent was derived from mines in the Park City district, which produced 38,129,761 pounds, against 46,350,390 pounds in 1909. The Bingham or West Mountain district produced 30,-271,016 pounds in 1910, about the same quantity as in 1909, and 24.5 per cent of the total Utah lead output. The Tintic district, which yielded 56,502,209 pounds of lead in 1909, produced only 37,553,455 pounds in 1910. This district yielded 38 per cent of the Utah lead in 1909, and only 30.4 per cent of that in 1910.

The zinc production of Utah was 16,-367,104 pounds, valued at $883,824, in 1910, against 9,860,778 pounds, valued at $532,482, in 1909. This shows an increase of 6,506,326 pounds or 66 per cent. The Park City mining district alone produced 9,437,992 pounds of zinc in 1910, against 6,737,237 pounds in 1909. This district yielded in 1910 over 57.7 per cent of the total zinc production of Utah. The Bingham district was also a large producer and increased its output from 649,542 pounds in 1909 to 3,572,347 pounds in 1910. Tooele County, which produced 2,843,032 pounds, and Beaver County, which produced 513,733 pounds, were the only other counties in Utah reporting a production of zinc in 1910. The zinc in concentrates, amounting to 12,959,422 pounds, all came from Salt Lake, Summit, and Wasatch counties.

There were 183 mines producing gold, silver, copper, lead, or zinc in 1910, against 179 in 1909. Of these, 8 were small placers. The number of producing mines in the Bingham district was 31; Tintic, 40; Big and Little Cottonwood, 17; Park City, 17. The total quantity of ore sold or treated in Utah in 1910 was 6,389,398 short tons, an increase of 1,266,809 tons. The average total recoverable value per ton was $5.02 in 1910, against $6.12 in 1909. The lower average value per ton was caused by the large increase in copper ores, of which 5,417,558 tons were sold or treated in 1910. This quantity was 84 per cent of the total ore treated and an increase of 1,201,332 tons over the 1909 production of copper ores.

Of the total tonnage of all classes of ore 263,041 tons, mostly from Tooele County, went to gold and silver mills, 5,182,057 tons, of which 4,937,285 tons were from Bingham district, went to concentrating mills, and 896,834 tons were sent to smelters.

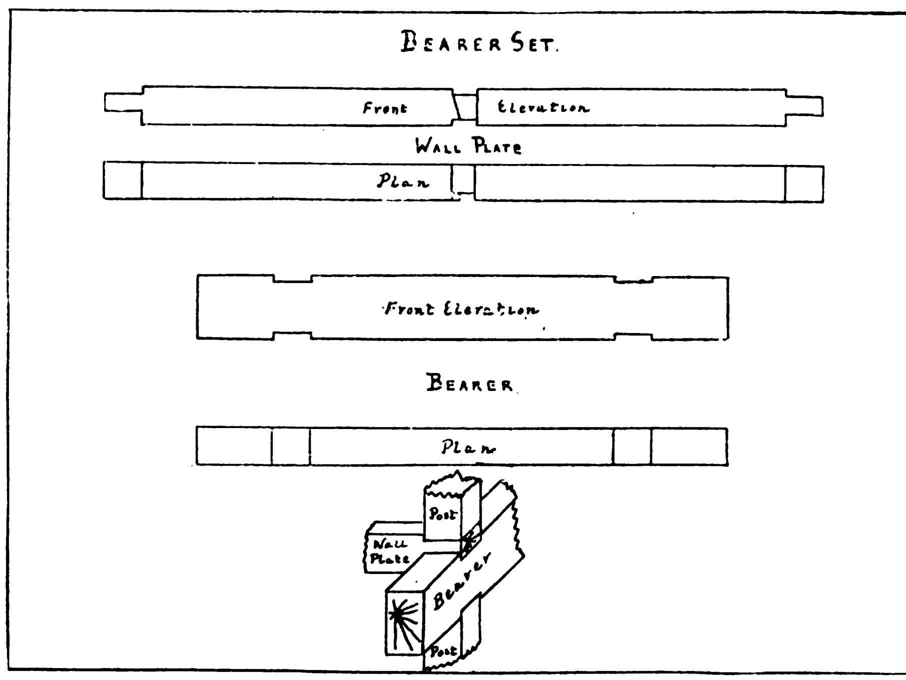

Figure 6 of Article on Preceeding Page

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Consul Frederick Simpich writes from Ensenada that a $200,000 California corporation has started quarrying onyx in the Sierra Blanco peninsula, Lower California, about 200 miles south of the international boundary. Thirty men are now employed in the company's quarries and monthly shipments will be made from the landing at San Jose. This Mexican onyx lies in flat ledges close to the surface.

Mines and Methods

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CONTENTS:

Mines and Methods appreciates the implied support that its efforts of the past two years have been given by the American Mining Congress at its recent annual session in Chicago, by the adoption of the following pertinent and timely resolutions:

Resolved, That in the opinion of the American Mining Congress, the mining industry has been greatly injured by designing and unscrupulous mine promoters; that the stand heretofore taken by the Congress against this illegitimate business has done much to prohibit it; that the Congress endorses the action of the Postmaster General in his efforts to prevent the use of the United States mails for fraudulent purposes, and that it urges the enactment of legislation in all states to prevent such frauds and to increase confidence in mining investments.

Resolved, That a copy of this resolution be forwarded to the Postmaster General.

UTAH COPPER REPORT AND PERTINENT COMMENT

We are pleased to note that the Utah Copper Company in its third quarterly report for the present year continues to maintain an appearance of candor in dealing with its shareholders. This being the third and charmed number of times in which the management of this corporation has made any pretense at giving in detail such information as invariably accompanies reports of this character put out by other corporations, it is to be hoped that the practice will, in future, become a regular—even if involuntary—habit.

It will be remembered that the first attempt to supply any information regarding the quantity of ore treated, the metal value thereof and the percentages of recovery and loss of the contents in the process of treatment, was contained in the sixth annual report of the company covering the year 1910, which was given to the stockholders in the latter days of April of this year, and then, only, after we had regularly for eighteen months supplied, in accurate detail, the facts which theretofore had been withheld and guarded with scrupulous care. Of course in publishing these facts—as was to be expected—we incurred the displeasure of the promoters and beneficiaries of the "Utah deal," but we are assured that the friends of fair dealing are now pleased to see the veil of secrecy—at least aparently, though reluctantly—lifted from the gigantic operations of this corporation.

It is also gratifying to us to note that our exposure and criticism of the stupid and imbecile methods employed by the management of the company in attempts at the treatment of its ores have at last resulted in the partial adoption of the more modern and sane practice which had been in successful operation in other mills throughout the mining regions for years before the spectacular advent of the novitiates who first attempted to stage an IMITATION OF PRACTICAL MINING AND METALLURGY under the seductive title role of Utah Copper Company.

In order that our new readers—among whom are many young engineers—may more fully appreciate the progress that has been made in the operations of the metallurgical department of the Utah company, we reproduce in another column of this issue, an article entitled, "Utopian Ore Dressing Methods," which first appeared in our July, 1910, issue, and in which is graphically related the struggles endured by two ambitious young men—WITHOUT PREVIOUS EXPERIENCE—in their efforts to equip a great mining property with metallurgical and mechanical devices which they hoped would AUTOMATICALLY extract the metal values from the ores thereof and thus enable each to continue to conceal from the other, and from their employers, the fact that neither had the slightest conception of what would happen to the ore when the wheels began to turn round. The story will be found to be entertaining and instructive, and of especial interest at this time in view of the fact that at least some improvement in methods and results has been accomplished during the seven years over which the operations have extended, notwithstanding the waste of millions of dollars in the effort.

Although the destructive Chili mills have not yet been wholly abandoned—as they must be soon or late—their harmful effect has been materially neutralized by the installation of additional rolls, whereby the principal crushing is now being done, so that the original thirty-six Chili mills which at first did the fine grinding of about sixty per cent of 5,000 to 7,000 tons of ore, now grind probably not more than 20 per cent of 16,000 tons per day. And what is of vastly more importance, the management has at last discovered that by using coarse screens on these mills, and allowing a large per cent of the ore treated by them to go to the tail pond, in sizes ranging up to 1½ millimeters, instead of grinding the whole to an impalpable slime, results in the recovery of a greatly increased proportion of the metal contents regardless of included mineral lost in the coarser particles rejected as tailings. But the most important advance has been recently found by adopting the universal practice of screening out the finished portions of the pulp after each crushing machine, so that now all material larger than 2 millimeters is screened out and returned to the rolls, the Chili mills only screening the undersize after preliminary concentration, whereby the freed mineral is extracted before the residue is sent to the Chili mills. The significance of these changes can only be appreciated after reading the story of the earlier practice, as related in the article above referred to, which will be found in another part of this issue.

As we have frequently observed in previous issues of this journal, it is only a question of the arrival of a time when these mills can be quietly dispensed with, without attracting attention, when their use will be entirely abandoned. For it must not be presumed that Manager Jackling is not NOW fully cognizant of the harmful results which has attended the use of these mills; but having been so industriously featured by the subsidized press as being second in importance only to the manager himself, one can readily see that if the fact should become known that these erstwhile—supposed—essential appendages should be abruptly consigned to the scrap heap, some doubt would naturally arise as to the integrity of the entire play, and thus not only further delay distribution of treasury shares, but even imperil the technical prestige of the entire metallurgical department.

Aside from the waste of several millions of dollars, due to the persistent use of these grinding mills after their destructive effect had become fully known to the management, a most unfortunate exigency arose, which required that the stamps which constituted the crushing plant of the original Boston Con.—now Arthur—mill be condemned, and that Chili mills be erected in their stead. This innovation was readily justified by "cooked-up" comparative tests which, of course—as designed—resulted in favor of the Chili mills; whereas, it was from the first well known that recovery of values by the Boston stamp mill at all times exceeded that of the Garfield (Magna) by more than fifteen per cent, and that the cost of operation of the Boston was lower than the Magna by an amount equal to more than one cent a pound upon the copper produced.

Manager Jackling himself is on record in a written statement in which he assumes to have made a practical test in the treatment of these identical ores—long before Utah came into existence—wherein THE CRUSHING WAS DONE WITH A STAMP MILL OF SIMILAR TYPE TO THE CONDEMNED BOSTON MILL, in which test he claimed to have made a recovery of 90 per cent of the copper contents of the ore, which exceds by more than 40 per cent, the recoveries of the Magna mill at any time prior to one year ago, and more than 30 per cent in excess of recoveries claimed for that plant at the present time.

In a letter dated March 20, 1901, and addressed to Major J. Edwards Leckie (then temporarily located at Republic, state of Washington, as manager of a property where Mr. Jackling was employed in operating a cyanide plant), referring to the porperty which composed the original Utah Copper Company's holdings, Mr. Jackling wrote as follows:

> During the summer of 1899, I undertook some metallurgical experiments on this ore, and concentrated several hundred tons taken from the tunnels and dumps at random. The mill which I used was an abandoned FIVE-STAMP MILL, without any particular adaptation to the ore, and without appliances for making a close saving. By crushing with LIGHT STAMPS to 25 to 30 mesh and concentrating roughly over a Wilfley table, without sizers of any kind, and without special endeavor to save values from the large amount of slimes produced, I made a saving of 71.7 per cent. Some experiments made in a rough way by collecting slimes and running them over a vanner, resulted in an additional saving of about 15 per cent, or a total of 90 per cent of the copper values.

In the light of this experience, it seems inconceivable that Manager Jackling would have adopted other devices of DOUBTFUL UTILITY for crushing Utah ores without a trial of their adaptability to that service, and especially that he should have been inveigled into purchasing from the Washoe plant of the Anaconda Mining Company his first installment of Chili mills, AFTER THEY HAD BEEN CONDEMNED AND DISCARDED by that company—even though he knew that Superintendent Janney held a United States patent upon essential parts of these mills. But so it happened, nevertheless.

Having discontinued the work of replacing the stamps of the Boston Consolidated mill after substituting other machinery for five only of the thirteen "units" or sections of that plant, one would naturally have thought they would have allowed the other eight sections to remain in condition for service in case future contingencies should demand additional increase in milling facilities; or, in any event, if it should be found desirable to remove the remaining stamps, at least the massive reinforced steel-concrete foundations would have been permitted to remain where they would have provided stanch support for rolls, or even Chili mills.

But it was not to be so. On the contrary, as if in fear that some future manager—possessed of some knowledge of ore concentration—might restore the hated stamps to their foundation and thus, by their operation, further discredit the use of the Chili mills, these costly structures were drilled and charged with dynamite, the explosion of which left only a mass of twisted steel bars and scattered fragments of concrete to mark the spot—and so it remains today.

Returning to the subject of our text, the Utah company's latest quarterly report. It appears that there was treated at the two mills for the period 1,273,373 tons of ore, the average copper contents of which was 1.4829%, being 29.66 pounds of copper per ton of ore. The gross yield of copper was 25,851,456 pounds, being equal to 20.3 pounds per ton of ore treated. The cost of the copper produced is stated to have been 7.56 cents per pound and that the net profit arising therefrom was $1,150,524.44, leaving a net surplus balance for the quarter after payment of the usual dividend of $361,699.80. No information is given as to the method pursued in determining these results. It may therefore be inferred that—in the opinion of the management—such matters do not concern the stockholders. But, however this view may be regarded, the result of operations for the quarter, if stated with even approximate accuracy, should meet with general satisfaction. And whatever may have been the means by which these results were arrived at, or the imperfections which still obtain in the milling practice, we are convinced that improvements have so far progressed upon right lines—so far as the treatment of the ore at the mills is concerned—as to render it possible now—even with the comparatively low grade of ore available—to earn a substantial profit upon each ton of such ore treated, provided that the ore can be brought to the mills burdened only with such costs as must necessarily attach to rational and economic methods of extraction—such, for instance, as obtain at the property of the Ohio Copper Company, which immediately adjoins the Utah on the southeast—or even such as prevailed in the underground workings of the property of the Boston Consolidated Company at and before the time when that property was taken over by the Utah company. But, if such a consummation be impossible, because of the temerarious character of the management, THEN NO APPRECIABLE, LEGITIMATE PROFIT CAN, OR EVER WILL RESULT from the vast tonnage of ores that may be rushed to the mills, however perfect the process of treatment thereat may become.

We are moved to reiterate an oft-repeated observation of this import at this time because of an item in the report not recited above, viz:

The increased rate of stripping, referred to in our last quarterly report was, for reasons then given, continued throughout the quarter under discussion with the result that we removed, during the period, 1,595,095 cubic yards of capping, as compared with 1,395,504 for the second quarter.

The annual report for the year 1910 shows that during that year 2,814,764 cubic yards of stripping were removed, at a total cost of $1,260,666.31, being 41 cents per cubic yard of earth removed. From this we determine that the cost of removing 1,595.095 yards for the quarter under discussion was $563,-988.95. The report also states that 24 per cent of the 1,273,373 tons of ore milled for the quarter was derived from underground mining. Therefore it follows that 967,764 tons were obtained by steam shovel operations. Assuming now that an amount of these stripping costs equal to 7½ cents a ton of ore obtained by steam shovels be charged to copper production—as was done for the latter half of last year—there will still remain $581,416.65 of the total stripping cost for the quarter, which sum is equal to 2.24 cents a pound upon the 25,857,456 pounds of copper produced for the quarter. If now for any reason it were desirable or necessary to include the entire cost of stripping in the cost of production, the actual cost of the copper produced would be 9.80 cents per pound —and there would still remain equipment and construction of stripping roads and many incidentals sufficient in cost to equal perhaps another one and one-half cents a pound, unprovided for.

Of course we are aware that there has been a general agreement among the members of the company's publicity bureau that the cost of removal of the surface capping is properly chargeable to capital account—as practiced by the management—and it is not our purpose at this time to repeat our previous charges of inconsistency in this method of disposing of mining costs, but rather to propound a friendly inquiry of adherents of this practice: Let us suppose that the Utah company had already divided all of its authorized capital stock among its existing shareholders, and was without corporate power to further increase its share capital. Would the management be justified in compelling the shareholders to abandon the property because of failure to realize from sale of the mine's products the cost of production by continuing the means and methods employed in the extraction of the ores when, by adopting methods in use in other mines, a substantial profit could be gained?

Let the outside shareholders, if there be any, answer.

OCTOBER OUTPUT OF UTAH

The Utah Copper Company reports the yield of copper for the month of October, 1911, at 8,660,729 pounds, which compares with a yield of 9,283,810 pounds for September month, a falling off of 624,642 pounds. No statement is made in the brief report received as to the number of tons of ore treated for the month, but we are able to state that the amount was largely in excess of any previous month, being approximately 514,000 tons, or an average of over 16,500 tons per day for each of the thirty-one days of the month. Deducting five per cent for moisture, which is probably high, the total number of dry tons treated was a little over 488,000, equal to a daily average of 15,750 tons. The yield of copper per ton of ore was approximately 17.72 pounds and compares with an average yield of 20.30 pounds per ton of ore treated for the third quarter of 1911—as recently reported—which shows a falling off in production of copper for October of 2.58 pounds per ton of ore treated, being equal to nearly 13 per cent. This shows that the average grade of ore treated was slightly less than 1.29% copper, and compares with 1.4829, the average for the third quarter of this year, as shown by the official report. This deficiency is equivalent to about 1.4 cents per pound in addition to the cost of copper reported for the last quarter, and indicates that the next quarterly dividend—if earned at all—will be saved by a very narrow margin. This serves to emphasize the fact frequently mentioned by us that as the rush of tonnage through the mills is increased, a corresponding dimunition of values in the grade of the ore follows.

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AN ECHO OF THE CHILI MILLS

An exhaustive series of tests is being made in the concentrator at McGill, to determine more precisely the saving made and and the amount of losses in tailings and what improvements can be made to increase the saving and profits. Four sections of the mill are being used to make the tests which will be thorough in every detail.

For some months the company has been experimenting with the slimes and now has eight tables on which nothing but slimes are treated and which are being operated successfully. With them the company is making a good profit and the management believes that all the slimes can be handled by the same or a similar process with the result of increased profits from the operations. At present the losses in slimes amounts to $100,000 a month, or about a million and a quarter a year.—Ely Expositor.

This company was the first of the porphyry group to be betrayed by the Utah Copper Company's subsidized press into the employment of Chili mills for reduction of their ores for concentration. Miami soon followed the trail of the "bell-wether," with Ray Con. a close third; and now Chino is being pushed into the line just in time to see Ray wobbling in the maverick class pending a rearrangement of her internal complexities.

The loss of a hundred thousand dollars worth of copper a month by the Utah company would not create a ripple in the financial affairs of that corporation, as the manager has frequently said in like contingencies: "Copper is the cheapest thing I've got." But with Nevada Con. the situation is different, as it only had about forty million tons of ore to begin with. It therefore behooves the management to endeavor to devise means for stopping the small leaks at least; but it is not probable that they will be permitted to look in the direction of the Chili mills for the cause of trouble for some time to come.

At the Miami we understand that Doctor Channing is proceeding to try out the Harding ball mill as a substitute for the Chilians, which are to be retired. By the way, we do not understand why Doctor Channing failed to avail himself of the advantages to be gained by use of steam shovels for stripping and mining Miami ores, as suggested by us several months ago, at which time we showed that by adopting the system of averages in use by the Utah company—as explained by the manager in his late annual report—the capping of the ore-bodies could be easily reduced to a mere film and thus render conditions ideal for steam shovel operations. Perhaps the professor may intend to adopt, instead, Manager Jackling's method of "breaking down the capping" by first removing the ore from directly beneath it and thus cause the capping to cave into the empty stopes and "break itself," which of course renders conditions for steam shovel removal of the capping quite ideal. But we think the system of REMOVAL OF THE CAPPING BY "AVERAGES" preferable under conditions which prevail at the Miami.

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WORDS OF APPRECIATION

Realizing the value of the work of Mines and Methods and appreciating the benefits that will sooner or later accrue from the campaign being waged by this journal against the deceptions practiced by some of the big corporations and their publicity agents, a prominent eastern engineering and investing firm pays us the following compliment:

"We have read with a great deal of pleasure your last issue of Mines and Methods, and we have come to the conclusion that regardless of how sore you may have made your enemies, that at any rate they cannot but admire your absolute fearlessness and the able manner in which you nailed them to the text and hold them up in full view, in broad daylight, and so persistently chase them out from the bushes and lumber piles and heaps of manipulated figures under which they seek to hide themselves."

ENCOURAGING COMPETITION

Much has been said and written since the United States Supreme Court decisions against the Standard Oil and Tobacco trusts, regarding the justice or injustice of the actions brought by the government against the United States Steel Corporation, or Steel Trust, as it is called. The weight of evidence thus promulgated has been and still seems to be that the Steel Trust is a "good trust" and should not be harrassed by the government. This was almost pathetically pleaded in a recent talk by Chairman Garey to the heads of the various subsidiary organizations and the idea was quickly promulgated by the corporation's publicity agents. The Engineering and Mining Journal of the 11th instant approvingly quotes the opinion of "a New York commercial house" on the subject. This "opinion" ends with the following declaration:

> "The United States Steel Corporation has always been tolerant of competition. It has encouraged competition. It has avowed and pursued a policy of live and let live in trade, and the remarkable result is that at the present time all of the big independent steel companies, instead of being against the big company, side with it."

It is not the purpose here to question the right of the Steel Corporation to continue to exist and do business in its usual way. The United States Steel Corporation is probably one of the best "trusts" that was ever formed, but there is no question that the "New York commercial house" is off wrong when it says that it has always been "tolerant" and that "it has encouraged competition" and also "pursued a policy of live and let live." Utah and Colorado are each so remote from the seat of all power behind the Steel Trust throne that business interests in these far western states would seem not to be in a position to know much about the manner in which the greatest corporation on earth accomplishes its ends; but they have both felt the grip of its mailed hand and both states will have reason to remember the acquaintanship for years to come.

The subject is too deep a one to touch in more than a superficial way and features that properly belong to the Colorado side may be left to Coloradoans to handle. But to show how keen the Steel Trust has been to encourage competition and display its spirit of tolerance and live-and-let-live disposition, it is only necessary to tell what happened here about eight years or so ago.

At that time a deal involving the sale of the iron deposits of southern Utah—or a large proportion of these vast resources—had been rounded into shape and the state was congratulating itself upon the outlook for the early establishment of great steel works, rolling mills, blast furnaces and the numerous other enterprises that would follow the opening and mining of the Utah iron deposits. There was no suspicion of fakery in the undertaking and it really looked as though the powerful Steel Corporation would soon find real competition on the far western slope of the continent. Options involving thousands of acres of iron had been secured at prices aggregating a total of more than $1,000,000 and a great deal of money had been used in developing the deposits, securing patents and otherwise getting things in shape for the final closing of the deal and preparation for the building of the plants that those behind the undertaking had already planned. The owners of the mines had received a first payment that amounted to nearly a quarter of a million dollars and a second payment, approximating $500,000, was just coming due when the whole business was dropped—dropped so suddenly and with such little concern on the part of the promoters that Utahns could hardly believe their senses.

This deal was being promoted by P. L. Kimberly and F. H. Buhl, of Chicago—the former now deceased. They were well known in iron and steel circles and both had cleaned up fortunes through turning in properties of their own when the Steel Corporation was formed, or following its formation. Mr. Kimberly had stated that both foreign and domestic capital was behind the move to begin the utilization of Utah's fine iron deposits and the impression was general at the time that some of this country's iron masters, associated with German talent, was the combination that would soon be taking care of the iron and steel business in the far western part of the United States and in the countries that might be dealth with through the harbors of the Pacific.

The time arrived for the second payment to the owners of the mines and word had been received that Mr. Kimberly would be here on time to make the payment—no one suspected a hitch of any kind. The night before payment was to be made Mr. Kimberly arrived and a representative of one of the Salt Lake papers sought him out and asked that he be permitted to announce in the morning—as a "scoop"—that the deal was to be carried through as previously planned and understood by everybody. What did Mr. Kimberly reply?

"I have no objection," he said, "to your pulling off a scoop on your competitors; but I am afraid the news will be altogether unwelcome. I am going to notify the owners of the mines in the morning that the deal is off; that the money already paid is theirs and that the papers in escrow may be taken back. That is all there is to it."

Questioned as to what the trouble was, Mr. Kimberly replied that all he could possibly say for publication was that he **"had agreed to be good;"** that he and his associates had been well repaid for all the time they had lost and expenditures they had made. That, in brief, explains what happened and that is about all that the public has ever learned about it.

Before Mr. Kimberly dismissed his interviewer, however, he confidentially explained that both he and Mr. Buhl had done lots of business with the Steel Corporation; that their business relations were most friendly; that every detail of the Utah deal, with the exception of the names of the men behind it, had become known to the trust officials; that they had declared that the Utah iron mines must not be developed for years to come; that he (Kimberly) must drop the deal and name his price for doing so. That he said, he had done, and that was what he meant by saying he had agreed to be good—and, incidentally, THAT ILLUSTRATES ONE POINT IN HOW THE STEEL TRUST "HAS ENCOURAGED COMPETITION."

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"WHAT THE MATTER IS"

Under the above caption Collier's National Weekly of the 18th instant says:

Most of the captains of industry (including Mr. Charles S. Mellen, president of the New Haven Railroad) thinks it is politics and a trouble-making administration. All the promoters and exploiters, and most bankers of the sort who are called financiers, say it is agitation, demagoguery, muckraking—all the same sort of thing. (There's a solid race of old-fashioned bankers, the backbone of Wall Street, who know better.) If one of those now under suspicion may be granted two minutes in court, we should like to venture the suggestion that the state of facts illustrated by the following figures has something to do with it. (We start with 1904 because that is the year Mr. Mellen came out of the West to become president of what was then one of the most conservatively capitalized and most stable Eastern railroads):

In 1904 the net income of the New Haven and Hartford Railroad was	$ 14,030,134
The capitalization (liabilities) that year was	136,436,893
In 1911 the net income was	28,255,160
The capitalization (liabilities) in 1911 was	492,118,175

To put this more briefly and roughly: in seven years the net income grew from $14,000,000 to $28,000,000; in the same seven years Mr. Mellen increased the debts and obligations from $136,000,000 to $492,000-000, or

1904 to 1911, **earnings** increased **100** per cent.

Same period, **debts and liabilities** increased **300** per cent.

Previous to 1904, for every one dollar of income there were ten dollars of liabilities; during the last seven years, every time the road earned a dollar extra Mr. Mellen piled on nearly twenty dollars of stock and bonds.

We think business will just have to pause and get its breath until the earnings catch up to something like the same relation to debths that they had ten years ago. We don't know anything in nature or political economy that will avoid this process or ameliorate it. And between Mr. Mellen and us, we want a fair umpire to say who caused the trouble.

N. B.—While we don't hesitate to put the example of the New Haven forward as typical of railroad and industrial corporations generally during the last ten or fifteen years, we don't want to say that it is universal; the Louisville and Nashville Railroad, for example, under President Milton H. Smith, has actually cut down its capitalization during the past ten years—upon which premise we venture the prediction that the Louisville and Nashville will have smoother sledding during the next few years than Mr. Mellen's New Haven.

Our friends who of late have been industriously rumaging the files of subsidized mining and financial journals in vain search of an intelligent and honest explanation of the cause of public indifference to the many "glittering opportunities" to amass great wealth by investment in the shares of mining corporations that are being offered—without takers—may find a solution of the loss of public interest in these ventures by a careful comparison of the "Mellen methods" with those of promoters of a number of the "porphyry" copper mines whose shares and bonds are being hawked in the market places of the world with such feverish persistence. Evidently these "matchless ones" have discovered that faked and "washed" sales upon the stock exchanges do not fool the same people all the time.

THE COPPER HANDBOOK

We acknowledge receipt of a communication from Mr. Horace J. Stevens, author of the Copper Handbook, in which he says:

"I am in receipt of your issue for October, 1911, referring editorially to the Copper Handbook, in which you make the following statement regarding the description of the Utah Copper Company, appearing in Vol. X of the Copper Handbook:

> As the story looks and reads, it is quite evident that "circa" all the data, as well as much, if not "circa" all the language in the recital, was supplied by the Utah Copper Company's own publicity bureau. But then—it costs money to issue works like the Copper Handbook.

"I beg to advise you that the foregoing statement that I have quoted from your October issue is absolutely and unqualifiedly false. It is not the case that 'circa' all the data, as well as much if not 'circa' all the language of the recital was supplied by the Utah Copper Company. The Utah company furnished me reports on my own blanks, of the sort that are sent by me to every live address of every live mining company that I can locate. The company also furnished me copies of its official annual reports and nothing further. ***."

Upon a careful comparison of the language quoted from Mines and Methods by Mr. Stevens—of which he so violently complains—with his own statement, as above quoted from his letter wherein he explains the manner in which he procured the information referred to regarding the Utah Copper Company's operations, we confess that the only perceptible difference which we are able to discover lies wholly in the fact that, in respect to the data supplied by the Utah company, (other than that contained in its several official reports), it was made UPON BLANKS FURNISHED BY MR. STEVENS FOR THAT PURPOSE. Not being aware, at the time, of the fact that Mr. Stevens had furnished the paper upon which the Utah Copper officials transmitted such statements as they desired to have published in the Handbook, we of course failed to give him the full measure of credit to which he now appears to have been entitled. For this unintentional omission we beg to tender a most earnest apology. At the same time we are strongly inclined to the belief that our playful use of Mr. Stevens' pet term, "circa," is the real cause of his displeasure, and for which indiscretion we tender our sincere regrets, with assurance that in future we shall respect his exclusive privilege in the use of that ONLY TERM which appears to indicate "any old thing" except the REAL THING.

BELLINGER TRIUMPHS

The October issue of the London Mining Magazine, in its "Review of Mining," has the following comment on the Great Cobar of Western Australia, the mines and works of which are under the general management of H. C. Bellinger, who quit the engineering staff of F. A. Heinze about four or five years ago to accept the offer of the Great Cobar corporation. The item, it will be noted by our Butte readers, shows that popular "Nick" Treloar, of Butte, is now mine superintendent and working in complete harmony with Mr. Bellinger who, according to periodical reports from Australia, has had quite a time in whipping Great Cobar affairs into first-class shape. The friends of Mr. Bellinger will be glad to know that he has triumphed:

> Conditions at the Great Cobar are improving. The weak point was underground, the workings not having been opened up so as to yield the proper mixture of ore required for economic smelting. This weakness was accentuated by the purchase of the Cobar gold mine, which gives a highly silicious output. The Chesney mine, which also belongs to the Great Cobar company, is developing satisfactorily, and the old concentration plant is being re-arranged with a view to eliminating the excess of silicious material in the form of slate. Mr. Nicholas Treloar, formerly at Butte, is now mine superintendent and worthily supplements the skilful metallurgical work of Mr. H. C. Bellinger. Rumors of the latter's resignation have now ceased.

EDITORIAL NOTES

It is several years since the price of silver was as good as it is at the present time. Conditions in India and the hording of silver as a result of the revolution in China, makes it look as though a prosperous period was ahead for the silver-lead miners.

This is a wonderful country of ours. Just as we begin to growl at Germany for placing restrictions on exports of potash the news is flashed out to the world that great deposits of this valuable fertilizing substance have been discovered at home. Nevada promises to make up for anything lost to us through the action of Germany, if the government conservationists will keep hands off for a short time.

Better and better reports are continually coming from the comparatively new gold camp of Jarbidge, in the northeast corner of Nevada, and it now seems reasonably certain that, within another year or two, it will be a large and important producer of the yellow metal. Unlike most of the camps discovered during the past eight or ten years, Jarbidge is not parading or relying upon tales of "fabulously rich" ores and "sensational" strikes to back its claims to recognition. The best news that is brought out by engineers is to the effect that many ledges are being developed that will produce good tonnages of $10 to $35 rock. The physical construction of the country, it is claimed, is such that most of the mining can be done through tunnels. There is an abundance of water for milling and all other purposes, while the hills and canyons are prolific sources of timber, with mahogany and other hard woods in abundance for fuel supplies. A late arrival from the district says the camp will boast of a number of good milling plants within another year, when operating protfis will be substantial and continuous for many years to come.

Once again the local newspapers are telling of the railroad that is going to be built from Salt Lake into the Deep Creek mining region. Times almost without numebr has this much-needed road been constructed upon paper, but that is as far as it has gone. When the Western Pacific road was built everybody felt sanguine that it would cut farther to the south and go into Nevada through the Deep Creek pass rather than fifty or sixty miles to the north, where there was practically no tributary business. Later it was promised that the Western Pacific would build a branch line south from Wendover—and it may possibly do so yet. One thing is certain, and that is that the

Deep Creek region is too well laden with mineral to go long without transportation facilities. If the Western Pacific does not provide it, someone else will. Maybe it will be the Salt Lake, Los Angeles & San Pedro, which could execute a splendid business coup by cutting west from Ironton through Dugway, to Gold Hill, Ibapah and on to Ely, Nevada, and probably through to Goldfield. If that is done, the Western Pacific will operate about 300 miles of practically tributeless road. Looked at in this light, it seems most likely that Deep Creek will get a road before long.

The "high line" of the Salt Lake, Los Angeles & San Pedro Railroad Company through the Meadow Valley Wash has been finished and turned over by the contractors to the operating department of the railroad company. This high line, which stretches along the precipitous, craggy mountainside well above the water grade in the bottom of Meadow Valley canyon, is conceded to be a magnificent piece of engineering and will permanently relieve the company from danger of floods and wash-outs in the future. In presenting the news concerning the completion of the task, the account of the Salt Lake Evening Telegram opens with the following data concerning the achievement:

Length, seventy-six miles.
Cost, $5,000,000.
Time of building, thirteen months.
Ten tunnels, aggregate length 5072 feet.
Twenty-four bridges, solid steel in concrete abutments and piers sunk to bed-rock.
Roadbed further protected by concrete retaining walls and riprapping of huge granite blocks extending for miles.

This cost of $5,000,000 for SEVENTY-SIX MILES of road in a hot, dry, barren region 300 miles from nowhere, in any direction, is not a bad record as compared with the widely heralded TWENTY-MILE LINE, costing over $5,000,000, of the Utah Copper Company. Just think about it a little. One cost a little more than $65,000 a mile—the other, $250,000 a mile.

COPPERETTES

A mine manager may be thoroughly honest and of good general ability; but, his judgment may not be good, and he may be lacking in the training and experience necessary for him to "make good" in the position he holds. A trial of a few months should demonstrate his executive ability, his fitness for the position; and, if it is found that he is lacking in these qualifications, he should be fired, no matter if he is in charge of a big mining enterprise.—Salt Lake Mining Review.

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Now, see here! If we thought for a moment that the writer of the above had in mind any one of OUR friends we should feel inclined to scold him and send him to bed without his supper.

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No feeling of friendship, nor fear of offending relatives and friends, should stand in the way of making a change in mine management when it is clearly evident that a change should be made. To hesitate in this matter often means the absolute failure of the enterprise.—Salt Lake Mining Review.

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A Paris cable says that negotiations are in progress for the listing on the Parquet department of the Bourse a number of American industrial stocks, notably those of the Ray Consolidated Copper Company and the Chino Company.—New York Curb.

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Ray Consolidated and Chino are being touted as the two next biggest things in the copper world to Utah Copper—which is certainly a star of the first magnitude when viewed in the scintillating, dazzling light of extravagant application of borrowed money—so it is only natural that the big backers and promoters of Ray and Chino should try and get the French to participate with them in these "good things," also. All three of these stocks have advanced so sharply in price during the past few weeks of acute distress in other market offerings that a sober, wondering world has gasped in contemplation of the spectacle.

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A man named Spencer a year ago conceived the idea of building a ten-story office building in connection with the late D. H. Moffatt. It was to be named the First National Bank building. Moffat was president of the bank of same name. Bank takes a lease for a million years or less at rental to pay big interest. Also bank takes $200,000 bonds. Building to cost a million dollars. Bank takes its bonds. Dear Public takes balance of $1,100,000. Promoter gets the $100,000 cash extra besides commission. Moffatt also controlled the International Trust Company. Turns his $200,000 bonds over to them. All promptly unloaded on public, while Spencer sells his million by mail, erects the building. Meantime Moffat dies. Building erected. Interest period on bonds comes due. Very few tenants. No interest money. Dear bondholders try to collect. Threaten foreclosure. Nothing doing. THEY ARE NOT BONDS, declare the Trust Company, through its V. P., Theodore Smith, a promoter formerly of Boston. They are merely preferred CUMULATIVE shares—profit sharing. Now the post office inspectors are trying to fathom the mystery, and matter is hushed up through Senator Guggenheim.—Denver correspondent in New York Curb of Nov. 4th.

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That suspicion of scandal should be attached to the First National bank of Denver so soon after the purchase of control by what is termed the "Utah Copper crowd" is indeed unfortunate and Mines and Methods, while standing in trembling suspense, hopes that nothing further will develop to put the big Den- institution or its newest sponsors in a bad light.

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Several hundred men on the Utah Copper construction gang have been laid off. The work at the Arthur mill will be discontinued for the present, and the officials are conferring with Manager Jackling as to plans for curtailing expenses for a few months. The meeting is being held in Denver. The two mills of the company have a greater capacity than is being supplied by the Bingham mines at present, and until the metal and general business conditions are improved a curtailment in operations will be observed. —Item from Salt Lake in the Mining and Engineering World of Sept. 23.

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Notwithstanding the action mentioned above the Utah Copper Company, we are reliably informed, opened a new "construction" account in its books October 1. So far as known nothing has happened in the line of new work or the resumption of rebuilding the remaining seven "wrecked" and unproductive units of the company's Arthur mill, so the opening of this "construction" account must be with a view of accomplishing some other purpose. We have it from an inside source that the average copper contents of the ore treated is now crowding 1% so closely and costs are so persistently climbing in consequence, that something must be done to provide a reasonable excuse for the showing and to provide a further excuse for seeking more "new money" through another sale of treasury shares. That lots of "new money" is soon going to be needed is a cinch.

LEACHING APPLIED TO COPPER ORE*

TWELFTH ARTICLE REVIEWING RESULTS ACCOMPLISHED, WITH SPECIAL REFERENCE TO TREATMENT OF COPPER SILICATES

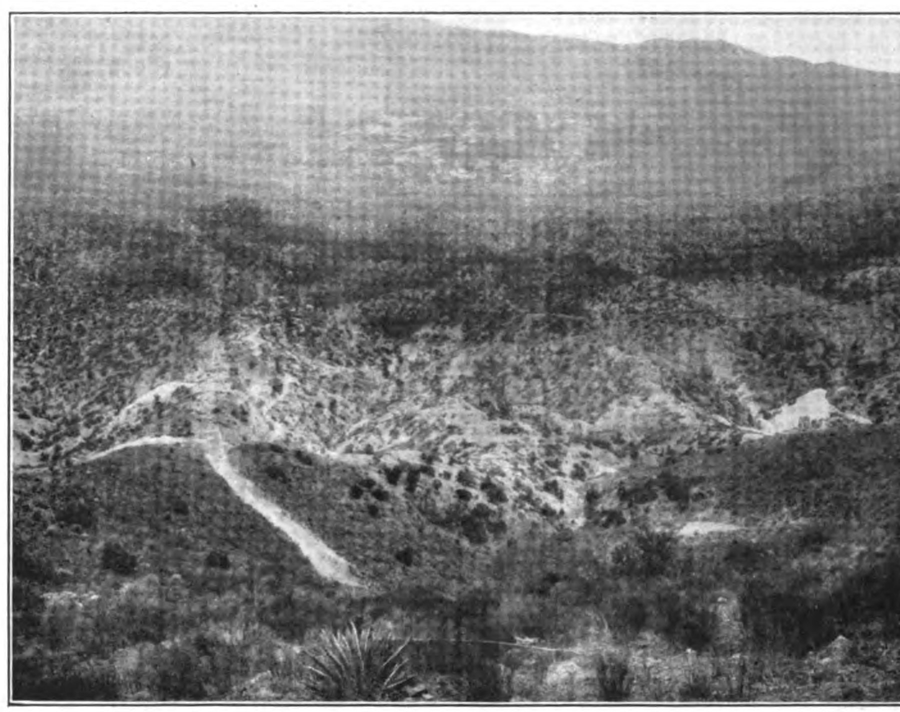
By W. L. AUSTIN.†

Through th courtesy of Mr. Paul O. Wels* the following description of a leaching experiment has been made available. The operations to be described were carried out at the Keystone mine in the Miami district, Globe, Arizona, in 1905, and the details are thought to present points of interest to those engaged in developing this branch of industry. However, as Mr. Wels remarks, this seems to be another case of experimental work insufficiently exploited to produce results of a definite character.

The leaching tests conducted at the Keystone mine were under the direction of Mr. John Herman**, who has kindly placed his notes at the disposal of the writer. Mr. Herman expresses the opinion that success might have crowned the effort made to introduce the process, had it not been that continual stoppages were caused by the inefficiency of the apparatus employed. There were troubles brought about through leaky vats, and through the means first adopted to produce circulation of the anode liquors. As originally constructed the plant could be operated only for an hour or two at a time, and some dozen attempts were made to get it into satisfactory operation during the month that the tests were in progress. Alterations were being introduced to overcome the mechanical difficulties encountered, when operations were suspended for reasons which are said to have had nothing to do with the merits of the leaching process. From a chemical standpoint the tests were considered wholly satisfactory, the results upon a working scale substantiating original laboratory experiments.

It would seem superfluous to criticise the policy of abandoning experiments when obstacles were encountered in the initial stages, were it not for the fact that instances of the kind are common, and that much money is wasted through loss of courage in the beginnings of undertakings of this nature. It is not to be expected that a small, perhaps inadequately equipped plant, will achieve success from the moment of its installation, especially when an ore is being subjected to treatment which has not previously been tested by the process employed. There must inevitably arise defects in apparatus which only make themselves apparent when the appliances are tried upon a working scale, and this is particularly the case when the process involves changes in aqueous solutions under operating conditions. Unforeseen developments may arise producing complications a remedy for which calls for considerable mechanical and chemical ability on the part of the engineer in charge. Provision should be made for such initial difficulties in order that investors who put their money into such enterprises may be properly protected.

When it has been demonstrated that the fundamental principles involved are sound, it is only through intelligent persistence that success can be attained in the application of any metallurgical process under novel conditions. It will be remembered that in the early days of Leadville, Colorado, when such docile ore as the heavy lead-carbonates were being smelted, the metallurgists of that day found considerable difficulty in keeping their furnaces in blast for twenty-four consecutive hours, and only the high treatment charges prevented a number of financial wrecks. One of the smeltermen (who afterwards made the greatest financial success of the district) "froze" his furnace up daily, and spent his nights in "barring out." Innumerable small metallurgical works of all descriptions have been from time to time erected in the United States with only sufficient capital to get them started, and when difficulties were encountered, were abandoned without a real effort being made to accomplish the purpose for which they were built. The Keystone plant was evidently an example of this kind, but often it is possible to derive considerable information from descriptions of incompleted undertakings.



Miami District, Arizona. Keystone Mine in Middle Distance

The Keystone ore-deposit presented on the surface the appearance of a white porphyry traversed by veinlets of chrysocolla (copper silicate), accompanied by malachite in small quantities and some chalcocite in the lower workings. One of these veins averaged a foot or more in thickness and was for some years the object of exploitation,

† Mining Engineer and Metallurgist, Riverside, California.

* Paul O. Wels, Mining Engineer, 1007 Central Building, Los Angeles, Calif.

** John Herman, B. Sc., Assayer and Chemist, Los Angeles, Calif.

the selected ore being sent to Canyon City, El Paso, and elsewhere. The ore shipped assayed as high as twenty odd per cent. The porphyry gangue was almost free from iron and lime, but contained considerable alkali silicates. The metallurgical problem as presented amounted to leaching chrysocolla.

The experimental leaching plant was designed to have a capacity of 1500 lb. copper in 24 hours, when using a modification of the Hoepfner* process. This method was considered to possess the most promise under prevailing local conditions.

Previous to deciding upon the adoption of the Hoepfner process, laboratory experiments were made to test the qualifications of various leachings methods, among these lixiviation with sulphuric acid. It was found that the copper could be readily dissolved out of the ore when dilute sulphuric acid was used, and that only a small excess of acid was consumed by the other bases present, if the pulp was not left too long in contact with the acid solution. Using a solution containing ten per cent sulphuric acid, 97 per cent of the copper could be removed from finely crushed calcined ore, and 95 per cent from coarsely crushed similar material. When copper silicate was calcined at a dull-red heat in an oxidizing atmosphere, it became black and friable, and the copper went readily into solution in sulphuric acid. Although a good extraction could be made in this way, the method was considered impractical because of the high cost of acid, and of the iron** necessary to precipitate the metal from the solution. An additional objection was the high refining charge attached to the treatment of the cement-copper. Furthermore, as the decomposition of the pulp was fairly complete, accompanied with gelatilization, it was thought that this feature might lead to complications in the subsequent separation of lixivium from tailings.

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* For description of the Hoepfner process see Mines & Methods for May, 1911, pages 212-214; and for June, 1911, pages 243-244.

Hoepfner's process was repeatedly tried out in Europe, and particularly at Weidenau and Papenburg. The principal difficulties encountered in attempts to introduce the process, (as also with Siemens & Halske's method), are said to have been in the extraction department. The ore had to be ground very fine, and treated with hot lixiviant under agitation, and nevertheless, even with these precautions, when tested on a commercial scale the extraction was insufficient. Iron went into solution and caused trouble; it was difficult to find suitable material for the construction of the extraction-barrels; washing out the slimes and their disposition, was not an easy problem; proper roasting of the ore was hard to accomplish; and the materials used for anodes and diaphragms were very unsatisfactory. Every change in the composition of an ore necessitated modification in the method of treatment. After many trials, attempts to introduce the process were abandoned, in spite of the attractive features it presented. However, what has been said applies to sulphide ore and not to copper silicates.

** A number of years ago experiments were made at Pittsburgh looking to the production of iron by the so-called direct process in competition with puddled metal. The iron ore was ground and mixed with powdered charcoal, and placed in sheet-iron cases. The cases were put into an ordinary puddling furnace and fired in the usual way. After a sufficient lapse of time the glowing lumps were removed from the furnace and treated the same as puddled iron. The resulting bars had the same appearance as regulation puddled metal, but the method did not prove economical. The process suggests, however, a means of obtaining iron for precipitating purposes under conditions favorable for its application.

Other lixiviation methods were also experimented with, the ammonia process being one of them. An ammoniacal solution (ammonia water and ammonium sulphate) showed very slight action on copper silicate: better results were obtained when the liquors were heated and agitated. Ammonium sulphate extracted more copper than ammonia alone. A mixture of ammonia, ammonium chloride, and sodium carbonate dissolved only ten per cent of the contained copper in three days. Ammonia was found to attack finely divided metallic copper readily, but solution was incomplete.

The Hunt & Douglas process (ferrous chloride) was also tried. A ferrous chloride solution had no appreciable effect upon the uncalcined ore, but with material which had been through the kiln the extraction was fairly complete. When both iron and copper were present in solution it was found that ferrous chloride was changed to ferric by the cupric chloride, with corresponding reduction of the latter compound to cuprous chloride. From calcined ore containing cupric oxide ferrous chloride solution extracted 47 per cent of the contained copper in two hours in the cold: when heated, 67 per cent was taken out in the same time.

Leaching with any acid per se of course involves the use of fresh lixiviant with each ore-charge treated: once salts are formed, there is no regeneration of the acid economically practical by chemical means alone. In most cases when it has been attempted to purchase commercial acid for lixiviation purposes, without regeneration of the lixiviant, the cost of the acid has proven to be an insuperable obstacle to leaching low-grade ore, and the management of the Keystone undertaking wisely determined to employ a method which would permit of regenerating the solvent liquors, and at the same time yield marketable copper.

In the Hoepfner process cupric chloride is the active factor, and in the tests made on Keystone ore previous to deciding upon the best method for use, it was found that this reagent had no appreciable action on raw copper-silicate ore. It was, therefore, determined to subject the ore to a preliminary treatment to ascertain if the metal could not be brought into a form in which it could be dissolved by the proposed lixiviant. To accomplish this purpose the ore was crushed to about three-quarter inch, and charged into a kiln arranged so that reducing gases could be introduced through openings in the side, the intention being to reduce the copper silicate to metal before subjecting the material to the action of solvent liquors.

The kiln employed was constructed with a sheet-iron casing, lined with fire-brick. The casing was necessary to prevent the leakage of gases through the bricks. The structure was fourteen feet high, eighteen inches by thirty-six at the tuyere openings (four in number) and widened towards the top. Reducing gases were obtained from a small producer placed contiguous to the kiln. Coke was burned in the producer, and towards the end of the experiments oil was introduced into the top of the producer, and volatilized for the purpose of economizing on coke, oil being the cheaper material. Air was supplied to the producer by a small pressure blower.

The ore column reached about six feet above the tuyere openings which were seven feet from the top, and after treatment the charge was removed through a gate in the bottom of the kiln. A careful regulation of the temperature was necessary to prevent clinkering.

The reactions which took place in the kiln were: (1) decomposition of the copper silicate, copper oxide and silica being produced while the color of the ore changed from blue to black. (2) By further action of the carbonic oxide gas upon the cupric oxide the latter was reduced to spongy metallic copper. The reduction was fairly complete, almost all the copper finally appearing in the metallic state.* When the operation is carried out at a low temperature the copper produced is powdery and difficult to concentrate: at high temperature it is "tougher" and may be concentrated by fine grinding and panning.

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* Heating calcareous copper ore with carbonaceous substances to reduce the copper to metal, and then separating the lime by an air-blast, was tried about the middle of the last century (Bischoff, Oesterreichische Zeitscrrift fuer Berg-und Huettenwesen, 1860, N° 5; Porth, Berg-und Huettenmaennische Zeitung, 1860, page 419). Oxide ore was also broken into pieces about the size of a walnut, heated either in a shaft-furnace or a reverberatory to produce metallic copper and lime, and then the latter was removed by treatment with water.

John Herman, in a paper treating upon mine fires, (Mining Reporter of March 19th, 1903,) states that the means employed by him to extinguish a fire in the United Verdi mine was as follows:

"A receiver five feet in diameter and eight feet in height was constructed and filled with roasted ore from the heap. This ore consisted of oxidized ore-lumps the size of a man's fist or larger. The hot gases of the burning fuel (coke) were passed through this receiver from top to bottom. The carbon monoxide present reduced the ferric and cupric oxides to ferrous and cuprous oxides being itself oxidized to carbon dioxide:

$Fe_2O_3+CO=2FeO+CO_2$

$2CuO+CO=Cu_2O+CO_2$.

The reaction was carried further under the influence of heat and much carbon monoxide:

$FeO+CO=CO_2+Fe$

$Cu_2O+CO=2Cu+CO_2$

It was found that all the copper present could easily be reduced to metallic globules of some size, while the iron parted with its oxygen with difficulty, leaving porous metallic iron. In practice very little metallic iron was formed. The copper could easily be concentrated."

Referring to a patent isued to N. S. Keith for a process of separating metal from its gangue, which consists in grinding the ore with carbon, heating the ground mixture in an atmosphere of reducing gases to the fusion point of the particles of metal, and then submitting the mixture to mechanical treatment, John Herman remarks (Engineering & Mining Journal, July 4th, 1903,) that with all such processes there is a difficulty in preventing the oxidation of the copper. He therefore suggests that a furnace be divided into two compartments, one for fuel and the other for ore, and that steam be injected into the burning fuel to form a reducing atmosphere. The hot gases could then be passed through the ore into the other compartment, thus attaining the full value of the combustible both from a reducing and calorific standpoint. Mr Herman states further that he has found no difficulty in reducing copper on a large scale in this way.

N. S. Keith, according to a paper published by him in the Journal of the Franklin Institute, "devised and put into successful operation" the process briefly outlined below. Mr. Keith states that when copper carbonates are exposed to a red heat they are decomposed—the oxides of carbon being freed as gases and cupric oxide is being produced. If the atmosphere in which this decomposition takes place be a reducing one, then the copper is reduced to metallic condition. If the temperature be high enough to melt copper, small metallic globules will result. Chalcocitic ore after roasting may be treated in the same way.

To carry out the process Keith proposed a shaft furnace about twenty feet in height, constructed of red brick with a fire-brick lining. Powdered rock, powdered coal, and producer gas were introduced at the top of the furnace through many holes provided for the purpose. At the bottom of the furnace was an incline extending into a dust-collecting chamber, which chamber connected in turn with another shaft. This latter shaft was filled with pieces of coke, or small stones, and was used as a collector. It was provided with a sprinkler to assist in retaining the dust and fumes. An exhaust fan drew the gases down the first shaft and up the second.

The operation consisted in feeding a comminuted mixture of pulverized rock and coal (three per cent coal) continuously into the top of the first shaft, which resulted in the reduction of the copper and precious metals to metallic globules. These collected in the loose gangue at the bottom of the shaft. This material, together with the condensed fume from the second shaft, were then treated on concentrators to separate the heavy metals.

The fuel used in the preliminary treatment amounted to four per cent of the weight of the ore.

An effort was made to utilize the unconsumed carbonic oxide in preheating the ore, and for this purpose a second set of tuyere-openings was introduced between the lower set and the top of the kiln. Air was blown into these openings from the same apparatus that furnished the supply for the producer. This intended economy did not work satisfactorily**, probably because the temperature was too low, or the gases too dilute, to permit combustion under the conditions specified.

The Keystone raw-ore treated in the tests to be described, contained between three and five per cent copper. It was crushed in rolls before being brought into contact with the lixiviant. The time required for leaching was found to be proportional to the degree of comminution to which the ore had been subjected. With thirty-mesh material the copper could be extracted in about two hours, leaving only 0.1 per cent of the metal in the tailings.

As an illustration of the effect of degree of comminution upon the amount of copper extracted from calcined copper silicate ore (20% copper), the following is of interest. The ore used in these tests was screen-sized after calcining, without being crushed.

Period Leached.	Mesh.	Extraction. Per Cent.	Mesh.	Extraction. Per Cent.
One hour	20 to 40	75	....	....
Two hours	....	....	20 to 40	91
One hour (crushed)	20 to 40	82	....	..
One hour	40 to 60	92	....	..
Two hours	....	....	40 to 60	97.5
One hour (crushed)	40 to 60	95	....	....
One hour	60 to 80	98.2	....	....
One hour	80 to 100	99.5	....	....

The above results were obtained using a two per cent cupric chloride solution, which was estimated to contain the theoretical amount of reagent necessary to effect solution. As shown in the table, there was an improvement in the percentage of extraction when the material had been crushed after calcination, over that obtained when uncrushed ore was treated.

The strength of solution above theoretical requirements used for lixiviating, it is said, did not effect either the amount of copper extracted nor the time. The cupric chloride lixiviant acted on the calcined ore when only 0.1 per cent of copper was present in the cupric form.

** The introduction of gases into shaft-furnaces with a view to their combustion, is impractical, because a certain amount of open space is necessary for commingling with air, and this space is not available under conditions existing in the apparatus indicated. In other words, to burn gases effectively an adequate combustion chamber must be provided.

The lixivant used in the Keystone tests contained about five per cent copper in the form of cupric chloride, and the presence of twenty per cent sodium chloride* was found necessary to hold in solution the cuprous chloride produced. A solution containing 200 grams per litre of sodium chloride was found to hold dissolved four per cent copper in the form of cuprus chloride: 250 grams per litre held 6.1 per cent. When employing hydrochloric acid for the same purpose, a 2.5 per cent acid solution held one per cent copper dissolved. A solution containing 250 grams sodium chloride per litre, and four per cent hydrochloric acid in addition, when cold held eleven per cent copper dissolved as cuprous chloride: when hot, 12.5 per cent. The working solution was heated to about 90° C. by passing exhaust steam from the engine into the sump tank, from which it was pumped to the leaching barrel.

* Compare Mines & Methods, Vol. II, page 212.

Heating the lixiviant had a beneficial effect, the action of cupric chloride on the calcined ore being much increased thereby. Calcined ore (12-mesh) when treated with hot cupric chloride gave an 83 per cent extraction in two hours: sixty mesh material gave 99 per cent in the same time. Without agitation, ninety per cent of the copper was extracted with a warm solution in two hours.

Only a small excess of cupric chloride over the theoretical amount required to dissolve the copper was necessary in the lixiviant. If after treating the pulp an excess of reagent remained in the lixivium, it was removed by means of cement copper, as described further down; or sulphur dioxide was passed into the solution, which reacted with the cupric chloride producing the cuprous salt, together with sulphuric and hydrochloric acids. The sulphuric acid thus formed reacted in turn upon the sodium chloride, forming hydrochloric acid, thereby compensating for the small amount of reagent lost in the wash-water. The sodium sulphate produced in these reactions did not interfere with the working of the process, either as to percentage of extraction, or as to time required to effect solution. The lixiviant used in treating a five per cent ore contained eleven per cent sodium sulphate. The maximum quantity of this salt which could be dissolved would be sixteen per cent in the cold, or thirteen per cent when hot, so that the lixiviant actually contained close to the maximum amount of sodium sulphate which could be held in solution.

The equipment for electrolyzing the lixivium comprised ten electrolytic vats, 7.5 feet long, forty inches wide, and eighteen inches deep—all inside measurements. These vats were constructed of pine wood, and put together without employing metal. They held water satisfactorily but warped badly when filled with lixiviant. Redwood was afterwards used to replace the pine, and it is thought that the change would have overcome the difficulty had the work continued. Incidentally it might be remarked that redwood vats employed for leaching at another place quickly deteriorated under the action of acid chloride solutions.

Of the ten vats available only eight were used in the tests. These were placed in two rows of five vats each, with long sides parallel. Each pair (they had a slight inclination towards each other) was placed about six inches lower than the preceding pair, so that the electrolyte (entering at the outside ends of the first pair) flowed by gravity to the inside ends, and thence to the succeeding pair on the lower horizon. In this manner two currents of electrolyte were produced, each flowing through eight vats in succession.

The anodes and cathodes were arranged in the vats in sets of four pairs, there being five sets (twenty anodes with the corresponding cathodes) in each vat. These sets were placed in series electricly: in the eight vats there were forty sets. In the sets themselves the anodes and cathodes were connected up in parallel. The reason for this arrangement was that a forty-volt dynamo, driven by a 15 horse-power engine, had to be used, and it was desired to have a drop in potential of one volt to the set.

The anodes were electric-light carbons (fourteen inches by five-eighths) hung vertically from wooden frames. Electrical connection was made between the carbons by lead poured on the top piece of the frame in such a manner as to firmly join them all. The anode frames were suspended in canvas bags attached to the frames, which served as diaphragms. It was estimated that the cost of the bags would amount to about one-eighth cent per pound of copper produced: they lasted about three weeks. These canvas diaphragms were attacked at the surface of the electrolyte, and it was thought that covering them with asphaltum where they dipped into the solution might add to their longevity.

This species of diaphragm was found to have a high efficiency as regards diffusion in a cupro-cupric chloride solution. Only 0.75 per cent of the copper salts passed through such a diaphragm in 24 hours, showing an efficiency of about 99 per cent: with copper sulphate solution the diffusion amounted to one per cent in 24 hours.

The cathode sheets were also hung from wooden frames in the vats. There were two strips on the top of the frames which rested on the sides of the vats and through these the sheets could be slipped in and out. The sheets were made in the usual manner common in electrolytic refineries, and were about thirty-six inches wide. They were immersed from twelve inches to thirteen in the solution. The distance between anode and cathode was about 1.5 inches.

The current density employed varied from ten to twelve amperes per square foot. The deposited copper adhered to the cathodes and did not drop off. Nodules were disposed to form on them, however, and they were not coated heavily—about one-quarter inch. It was found practicable to precipitate the copper nearly completely in the cathode compartments—to about 0.2 per cent.

The solution in the anode bags was siphoned from one bag to the next, for, as already stated, the vats were placed on an incline, both as to their respective ends, and with relation to each other. This method of bringing about circulation of the anode liquors was defective, for as chlorine was given off at the anodes the siphons became filled with gas, stopping circulation completely. Changes were in progress to obviate this difficulty when operations were suspended. About one ton of copper was produced in all.

The final washings of the tailings from the leaching barrel were not subjected to electrolysis, but were passed over scrap-iron to precipitate the copper remaining in them. The cement copper thus produced was used to take up excess of cupric chloride in the lixivium coming from the leaching barrel.

It is to be regretted that these experiments were not carried to a point where commercial results were attained, conclusively showing the cost of producing electrolytic copper from non-ferrous copper silicate. It would appear that Mr. Herman had worked out a method of treating such material which contained elements of much promise; but experience has shown that no definite decision can be reached with regard to any new metallurgical process from laboratory experiments or operations on a small scale. Its value can only be determined when it is placed in commercial competition with established methods of ore-reduction.

PAST, PRESENT AND FUTURE OF COPPER

By HORACE J. STEVENS.*

The great copper industry of the present day is a thing of small beginnings. One century ago, in the year 1811, the world's production of copper was a trifle under 10,000 long tons, an amount smaller than was secured last year by any one of more than twenty different mines. During the present year the great Anaconda mine, of Butte, has produced, during nearly every month, as much copper as was supplied by all the mines of the world, in the entire year of 1811.

Fifty years ago, in 1861, the world's output of copper was but a trifle more than 100,000,000 pounds, a production that was exceeded, in 1910, by the Anaconda, American Smelters Securities Co., and Phelps, Dodge & Co. The production of the year 1900, the last of the Nineteenth Century, was just fifty times as great as that of the year 1800. Should the same ratio of increase be maintained during the twentieth century, the output of the year A. D. 2000 would be 24,318,150 long tons of copper, twenty-five times as much as the present production, and even a fifty-fold increase for the twentieth century would allow an average increase of less than four per cent, while the average annual increase, for the decade beginning 1900 and ending 1910, was almost exactly seven per cent, compounded yearly. Those who foresee a complete collapse in the copper industry would do well to give consideration to the actual figures of increase during the past. The copper industry does not move forward at even an approximately steady rate, from year to year, but is given to advancing by great leaps, almost inevitably followed by periods of quiescence, or even of actual retrogression. High prices for the metal stimulate production, while curtailing consumption, and as a direct consequence, output is increased, which decreases prices, which in turn brings about decreased production, due to the inability of small and weak producers to stand the strain of low prices. Decreased production again brings about high prices, and the cycle is begun anew. Much the same conditions existed in the American iron and steel industry for 50 years, until the formation of the United States Steel Corporation, which, while unable to prevent periods of depression, as its sponsors fondly hoped, has proven a wonderfully steadying factor in the iron and steel market, serving the purpose of a gigantic balance-wheel.

* An address delivered before the American Mining Congress, Chicago, October 25, 1911.

GROWTH OF COPPER INDUSTRY.

The growth of the copper industry

is best shown by the following figures of the world's production, by decades, in long tons: 91,000 tons in the decade ending 1810; 96,000 tons in 1820; 135,-000 tons in 1830; 218,000 tons in 1840; 291,000 tons in 1850; 507,000 tons in 1860; 900,000 tons in 1870; 1,189,000 tons in 1880; 2,373,000 tons in 1890; 3,708,000 tons in 1900; 7,390,000 tons in 1910. The influence of the electrical industry upon the consumption of copper is plainly shown by the figures since 1880. The production of the seventh decade of the Nineteenth Century was only 900,000 long tons, or a trifle less than ten times the output of the first decade of the century, while the production of the last decade of the century, ending 1900, was more than forty times the output of the first decade, and was more than four times as great as that of the decade ending in 1870, only thirty years before. The output of the decade ending 1910 was more than six times as great as the output of the decade ending 1880, and was almost exactly double the production of the previous decade in 1900. The production of copper by the world, amounting to approximately 7,390,000 long tons, for the decade ending 1910, amounted to more than three-fourths of the total world's production of copper for the entire preceding century.

Figures of production and consumption of any given commodity in universal use may differ from year to year, according to whether a surplus is accumulated, or a preceding surplus is drawn upon, but over long-term periods, production and consumption necessarily are the same, and, figured by decades, it is safe to say that the figures of production are practically the figures of consumption. At present there is a copper surplus, of which much is heard, but to show how comparatively unimportant the present surplus is, when compared with the figures of output for the preceding decade, it may be stated that the world's surplus of copper, at the present time, is slightly less than 300,000,000 pounds of finished metal, or a trifle under 135,000 long tons, an amount less than 5½ per cent. of the total production of the decade, and equivalent to only about eight weeks supply of copper at the present time, measuring the supply either by productive capacity or by consumptive demand.

Very exact figures are available regarding production, dividends, costs and metal prices of the mines of the Lake Superior district since the first production was secured, in the year 1845, the total output for that year having been only 24,880 pounds of finished copper. The total production of fine copper, by Lake Superior mines, from 1845 to 1910, inclusive, a period of sixty-six years, or two-thirds of a century, was 5,122,478,402 pounds, having a gross value of $726,849,840, from which were paid dividends of $182,824,770, the ratio of dividends to gross values, for this entire period, amounting to 25.1 per cent., and dividends, divided by copper production, show average dividend payments of 3.56 cents per pound. The average price received for all Lake Superior copper, for this period of sixty-six years, was 14.19 cents per pound, which, after deduction of dividends, leaves an estimated cost of 10.63 cents per pound, for all years. By adding the figures of expenditures on unproductive mines, amounting to about $60,000,000, the cost of Lake Superior copper would be made almost 11½ cents per pound, and by adding a further $15,000,000 for assessments on mines that have since repaid in dividends the original assessments, the cost of copper would be made about 11.85 cents per pound, leaving a net margin of profit, for the entire production, of almost exactly two cents per pound, plus the present aggregate value of the various active mines.

Omitting the production of mines that have not proven profitable, the average cost of Lake Superior copper, yielded by dividend-paying mines, has averaged about 9.5 cents per pound, for all years, and the present cost of making copper, by all of the producing Lake Superior mines, probably is slightly above nine cents per pound. The actual average cost of making copper, in the leading producing fields, probably is between nine and ten cents per pound, at the present time. Some of the newer fields, which are skimming their cream, show lower costs, but it is difficult to see where the world will be able to produce its copper, in years to come, at an average cost materially under ten cents per pound, this figure excluding the limited production of badly planned and badly managed mines, which yield only a small fraction of the total copper output, but secure their metal at an average cost very much higher than the average cost of all mines.

For the immediate future, the supply of copper in sight is fully adequate, and no unduly high prices need be anticipated, but the figures clearly foreshadow another boom period, within the next two to four years, at which time the alarmists will be as badly scared, for fear that the copper supply is petering out, as they now are for fear that the production is so much greater than consumption that nothing but permanent disaster is in sight. Allowing an average increase of consumption of 7 per cent yearly, the figure that has ruled during the first nine years of the present century, the world's requirements of copper will amount to approximately 1,-650,000 long tons in 1920; 2,975,000 long tons in 1930, and 5,350,000 long tons in 1940—the latter named year, now only 29 years ahead, calling for a copper output almost six times that of the present rate. Twenty-nine years ago, or in the year 1882, the worlds production of copper was 181,622 tons, or about one-fifth of the present output. Allowing for even a five-fold expansion during the next three decades, to correspond with the five-fold expansion in the three decades past, the world's copper requirements in 1940 will be more than 4,500,000 long tons. Should the ratio of increased production and consumption remain at an average of seven per cent for the balance of this century, the world would yield and consume, in the year A. D. 2000, about 175,000,000 long tons of copper, a quantity of the red metal more than double the tonnage of the world's present production of iron and steel.

FIRST DECADE OF TWENTIETH CENTURY.

A survey of the progress made by the copper industry during the first decade of the twentieth century, now lacking only a few weeks of completion, shows no revolutionary changes, but does show steady and in some cases phenomenal progress, in nearly every division of the industry. In the matter of mines, the old districts of Butte and Lake Superior remain the largest producers, but Arizona, with a half dozen important copper fields, passed Montana in output in 1908, though again taking second place in 1909. In copper mining, the most important development of the decade has been the making of the so-called porphyry mines, in which disseminated copper sulphides are mined from schistose or porphyritic country rocks. The development of such important new producers as the Utah Copper, Nevada Consolidated, Miami and others of this class, has alarmed many people, who jump to the conclusion that the so-called porphyry mines must close down the older mines, developed on veins in Butte and other camps, and on the stratified trap beds of Lake Superior. There is no real occasion for this alarm, as the porphyry mines, while highly important, are not apt to be developed in large numbers. In fact, the entire western part of the United States has been scoured, by the keenest and strongest aggregation of capital in the copper business, for promising country-rock deposits, with a net result, to date, rather insignificant in the number of properties developed, though highly important in output secured already, and even more important in promise of future production. When the Mesaba iron range was opened, eighteen years ago, a similar wave of pessimism swept over the mine-owners of the older iron ranges in Michigan and Wisconsin, but time has proven that the high grade ores of the Mesaba, capable of being mined by steam-shovel, at wonderfully low costs, are absolutely necessary in furnishing an adequate supply of ore to the iron and steel works of this country, and similarly it will be found, as time passes, that the production of the porphyry mines is absolutely essential in supplying the copper needed by the world at anything like a fair figure to the consumer. Processes of actual ore extraction have been modified and imroved, in many fields, with a resultant increase in safety to miners, and decrease in cost of ore extraction. The steam-shovel has come to stay, in copper mining.

Strange to say, the copper mines which are vitally interested in extending the use of copper, were somewhat slow in adopting electric power but rapid progress has been made in this direction during the past decade and all of the mines of Butte are now electrified while there has been a great increase in the use of electricity in the Lake Superior district. The constantly increasing use of hydro-electric power is now restrained, and further restraints are threatened, by the conservationists. The newly adopted system at the Anaconda mine, in Butte, which combines the utilization of hydraulic, electric and pneumatic power, offers great possibilities of pliancy and economy, and the lead of the Anaconda is likely to be followed by many other important mines.

In ore reduction, material progress has been made in concentration, the very general adoption of Wilfley tables and similar devices permitting the saving of fines previously wasted. Hydraulic classifiers, settling tanks and a variety of ingenious devices for the saving of the uttermost mineral values, have aided in this work, and are now found in most important mills. Slimes, previously wasted, are now carefully collected in slum-ponds, and reworked; with an aggregate yearly extraction of many millions of pounds of copper formerly wasted.

Perhaps the most striking progress made during the past decade, in any division of the copper industry, has been in smelting. No new principles have been adopted in either reverberatory or blast-furnace work, but reverberatories of a gigantic size hitherto unknown have been adopted at many plants, while even more striking progress has been made in the capacity of blast-furnaces. Ten years ago, a 300-ton blast-furnace was considered exceptionally large, and near the possible maximum of size, but the Washoe works of the Anaconda Copper Mining Company, again blazing the way, now have two furnaces, each 56 inches by 51 feet in size, with a maximum daily smelting capacity of 1,800 tons each, and a third furnace that is 56 inches wide and 87 feet long at the tuyeres, this mammoth furnace actually having smelted 3,100 tons within 24 hours. It has been my privilege to see this great blast-furnace with smelting in progress at the western end, while the eastern end was frozen, and repairs in progress within the bosh.

The past decade has seen a further extension of the electrolytic process of refining, and the great bulk of the world's copper now is refined by electrolysis. In fact, very little finished copper, other than electrolytic, reaches the market, except from the Lake Superior mines, the product of which commands a premium by reason of its extra toughness and superior adaptability to drawing and stamping. With depth, many of the Lake Superior mines have shown a marked increase in arsenic, and for this reason a considerable part of the Lake Superior copper now is refined electrolytically, and sold as electrolytic and not as Lake copper.

COMBINES AND MERGERS.

At various times in the past efforts have been made at copper corners, but these have proven uniformly unsuccessful. The first copper corner was by the Associated Smelters, of Swansea, and might be termed the original copper trust. The Associated Smelters, which flourished from 1840 to 1860, were most arbitrary in their operations, buying cheaply, selling dearly, and zealously guarding their smelting processes. As a result of the very shortsighted policy of screwing prices of ore and matte to the lowest possible figures, while selling the finished product at the highest possible prices, with the ore producers aggravated by arbitrary charges for draftage and moisture, and the further grievance of unfair assay methods, the mine-owners were led to build independent smelters at and near the mines, in most of the principal copper producing districts, these effectually destroying the power of the Associated Smelters of Swansea as the arbiter of the copper industry.

The second attempt at a coper corner was made by the Societe des Metaux, of Paris, under the leadership of M. Secretan, the Societe des Metaux becoming in February, 1887, one of the sixteen underwriters that organized the Syndicat Secretan, with a nominal capitalization of $13,587,000. This syndicate contracted with the leading copper producers for their output, and speedily advanced the price of the metal to 17¾ cents, effecting an increase of more than 50 per cent in price within one month. Consumption immediately declined to a low figure, and the Secretan Syndicate borrowed enormous sums, to carry its rapidly accumulating copper, from French, German and English banking houses, the Comptoir d'Escompte of Paris alone lending the enormous sum of $33,368,000 to the Syndicat Secretan. This corner broke early in 1889, after about eighteen mnths' existence, and in a single day, in the spring of 1889, the price of cipper dropped from £70 down to £35 per long ton. About four years were required to clean up the wreckage remaining from this ill-advised corner, and put the copper industry soundly on its feet again.

The third attempt at a copper corner was made in February, 1889, by the organization of the Amalgamated Copper Co., which corporation maintained the price of copper, arbitrarily, at 17 cents per pound, until October, 1901, when an accumulation of 200,000,000 pounds of metal compelled a break that took the price of copper down to about 12 cents per pound, and about three years were required by the industry to recover from the effects of this corner.

The price of 26½ cents per pound, which was reached in March, 1907, by Lake copper, was not the result of any corner, but came about through an ill-advised scramble by consumers, who feared that they could not secure the metal. As a result of the high price, consumption was curtailed sharply, in all directions, as happens inevitably under such unsatisfactory price conditions, and the copper industry of the world still suffers from the existence of a surplus of slightly under 300,000,000 pounds of metal, remaining from a surplus that, including both visible and invisible supplies, reached about 450,000,000 pounds at the end of 1909, since which time there has been a small but steady decrease in surplus, from month to month.

The tendency in copper mining, as in all other branches of industry, is toward combination in ever-larger units. This tendency is based upon and governed by purely economic laws, and the laws of political economy are so much stronger than any law ever devised by a parliament, or any ukase ever promulgated by a despot, that it requires no spirit of prophecy to forecast the ultimate outcome of the present clash between the laws of political economy and the laws of congress.

In the copper industry the great bulk of production now is furnished by about a dozen dieffrent interests. The Amalgamated Copper Co. has a productive capacity of about 300,000,000 pounds yearly, with an actual output, last year, of 223,808,546 pounds. The American Smelting & Refining Co., or Guggenheim interests, have a productive capacity only slightly inferior to the Amalgamated, with an actual output of 174,150,000 pounds in 1910, which figure will be exceeded materially this year. The production of Phelps, Dodge & Co. was 116,880,070 pounds in 1910, while smelter production, including custom ores treated, was 138,805,562 pounds, and the sales agency of this firm handled 194,138,696 pounds of copper last year. The Calumet & Hecla, with its subsidiaries, has a productive capacity of nearly or quite 150,000,000 pounds yearly.. The Rothschild interests, controlling the Rio Tinto of Spain, and the Boleo of Mexico, have a copper output of more than 100,000,000 pounds yearly.

The leading copper producers of the world are now operating under check, a 10 per cent reduction in output having been put into effect in August of last year. Under the Sherman Anti-Trust law, this checking of production would be considered criminal, if it could be proven, yet the reduction of output was absolutely necessary in order to save the copper industry from a prolonged period of utter demoralization, during which scores of millions of dollars would have been lost by investors, and a quarter million or more of working men would have suffered severely, many of them losing their jobs, and the remainder suffering severe cuts in wages. We have the authority of Eminent Statesmen, totally devoid of business experience, that the Sherman Act is a panacea for all ills of the body politic, yet no sensible business man would do otherwise, if he had the power, than to reduce production, at a time when a surplus product threatened not only the small remaining profits, but the very foundations of the copper industry. The issue thus is drawn very plainly between our present politico-criminal law, and all the laws of business and of political economy.

BUSINESS AND POLITICS.

I have no connection, direct or indirect, with any copper mining company or copper producer, except that, in a general way, I have small business dealings with a great majority of the actual copper producers of this and foreign countries, hence I speak without personal prejudice, and not as the mouthpiece of any individual copper interest.

The greatest present menace to the copper industry in the United States is a menace that is common to all branches of mining. The entire American industry of mining is threatened by men operating under the names of progress and reform, whose slogan is conservation, but who are political economists of the Stone Age, and first cousins, in mental capacity, to the Troglodytes. The conservation experts of the forest service are systematically hampering legitimate mining operations throughout the western states, and both law and justice are disregarded by these conservationists, while the federal departments affected are governed more by rulings than by law. Congress has made the very grave and dangerous mistake of endowing the executive departments of our government with the power to promulgate rulings that have the force of law, and in some of the departments rulings have been put into effect that not only are arbitrary and unjust, but that also are absolutely illegal, yet the poor miner, who has complied with all the requirements of the law, is liable to see his property, to which he is clearly entitled, both by law and justice, taken from him by the officials of the forestry service, under the slightest pretext, and is denied access to or recourse by the courts. The most odious forms of despotism can show nothing worse, in this particular, than the hideous imposition under which honest miners are suffering in the western states of our country.

ANACONDA AND GUGGENHEIMS.

The conservationists, many of whom might, with greater truth, be termed conversationists, would close the Washoe Works of Montana, the greatest reduction plant in the world, with a monthly output valued at millions of dollars, employing thousands of men, and indirectly giving employment to tens of thousands of men, under the childish plea that the smelter fumes are injuring timber on the federal forest reserves—timber that, in a pinch, might furnish fairly good lodgepoles for Indian tepees.

The Guggenheims are the bogey-men with which the conservationists most frequently alarm the public. We have had it dinned into our ears, by innumerable patriots seeking office, and repeatedly set before our eyes, in every yellow newspaper and muckraking magazine, that "the Guggenheims are stealing Alaska." As a matter of fact, the Guggenheims control a copper mine in the interior of Alaska, that is a wonder in its way, yet which cannot be rated at more than a third-class property. Th's mine, the Bonanza, is a sort of copper-plated gold-brick, in that an interior core of limestone is surrounded by phenomenally high grade bornite and copper glance. No competent mining man who has visited this property ever has estimated the amount of ore in sight, and safely to be inferred, as capable of yielding more than 100,000,000 pounds of finished copper, a total production equivalent to only one year's maximum output by any one of the six leading copper mines of the world.

In order to get this ore out of a wilderness, the Guggenheim interests have built the Copper River & Northwestern railway, a line of 195 miles length, variously estimated to have cost from $13,000,000 to $25,000,000. The gross value of all the copper contained in the Bonanza mine, taking the outside estimate of tonnage, is considerably less than the lowest estimate of cost of this railway, and the net profits derivable from the Bonanza mine, cannot, by the most liberal figuring, be estimated at more than $4,000,000 to $5,000,000. Instead of being commended for their enterprise and courage in building this railway through an arctic wilderness, the Guggenheims are held up to public scorn as thieves and robbers. This railway cuts through workable beds of coal, but is prohibited, by the federal authorities, from developing or using this coal, and is compelled to import inferior coal, from British Columbia, at a cost more than double that of domestic coal, if its mining were permitted. Not only does the railway suffer from this arbitrary action by the federal government, but the 50,000 unfortunate American citizens who live in Alaska are compelled to pay double or triple the price they should pay for fuel, through the efforts of the conservationists, backed by the federal government, to 'save" the coal for some future use, at an indefinite date. It scarcely seems strange, in the light of this situation, that mourning was donned in Alaska when the High Priest of conservation reached that land, which the conservationists seem to consider a sort of penal colony. The conservation of our mineral, timber and power resources should be effected along legal and business lines, and not under the guidance of spiritualistic visions.

The reformers, as these gentlemen term themselves, are advocating the government building and operation of railways in Alaska, and the government ownership and operation of coal mines, which is state socialism pure and simple, and any man seriously advocating such a policy is a socialist, no matter what he may choose to call himself. It is further advocated by the junior senator from Wisconsin, and his official and unofficial organs, that the government also should buy the Copper River & Northwestern railway from the Guggenheims. Doubtless the Guggenheims will be very glad indeed to sell their railway, which is threatened by tidal floods and glacial floods, with its principal bridge across the Copper River threatened by a glacier itself, but it is difficult to see where the long-suffering taxpayer will benefit by such a purchase.

GOVERNMENT POLICIES DENOUNCED.

The federal government already has withrdrawn immense tracts of oil, coal and phosphate lands, and the next step in this cleverly devised socialistic propaganda will be to withdraw from entry, or inhibit mineral entries upon iron, copper, lead, zinc, silver and gold lands.

The pretext for past withdrawals is that our mineral resources are being depleted so rapidly that there is danger of their extinction, in the near future, unless administered by an all-wise and all-powerful central government, which can make no mistake, and can do no wrong. The figures regarding our natural resources, put forth apparently in earnest, by some of the leading conservationists are so utterly ridiculous that it is impossible to regard them seriously. There is more iron ore existing in a single county, in my own state of Michigan, than any professional conservationist ever has estimated to exist in the entire world. This is made as a plain statement of fact, and those who think to the contrary are challenged to impeach the assertion.

The lawless actions of the forestry bureau, which is perhaps the most odious of our bureaucratic iniquities, have been of a sort to arouse the alarm of all thinking men who believe in self-government. Apparently it is the cunningly devised scheme of the leaders of the so-called conservation movement, to appropriate the public lands, now held by the federal government in trust for the benefit of any and all citizens who will develop them, and hold these public lands for the sole benefit of the bureaucrats, who will enjoy the usufruct, through a carefully planned system of leases, by which the water-power, forests, mines and arable lands will be leased to corporations that are amenable to the benevolent control of the doctrinairies, and to individuals who can be terrorized to conform to the exactions of the bureaucracy. The opportunities for graft that are contained in such a system are almost inconceivably great, and comparing their claims with their actions, the conclusion is irresistible that the conservation movement, as now managed, is not a genuine effort to improve the condition of the American people, but a cleverly devised scheme to deprive the people of their landed heritage, and fix upon their necks the iron collars of serfdom, to the end that a more gorgeous and richly endowed bureaucracy may flourish upon the soil of what once was a free country.

It is said, and apparently with reason, that the spy system of the United States is now the finest and most extensive in the world, excelling even those of Russia and Turkey, heretofore the most progressive nations, in the matter of thoroughly organized espionage. We also have the benevolent activities of an attorney-general who is now vigorously prosecuting the kindling-wood trust. It is obvious that the shaving-paper combine and the office-towel monopoly had better watch out, for their turn may come next. Why does not the attorney-general prosecute the labor unions, which are trusts in the meaning of the Interstate Commerce law, existing in open defiance of the beneficent provisons of the Sherman act. The answer seems obvious. The present activities of the United States Department of Justice, as it is termed, officially, afford a spectacle for gods and men.

Business throughout the United States is suffering from uncertainty—which has been accentuated, rather than decreased, by the recent decisons of the Supreem Court, which read into the Sherman act a provision that only "unreasonable" restraint of trade should be punishable, under the terms of this act. As Richard Olney justly remarked, this leaves the Sherman law about as clear as if congress were to pass a law stating that only a 'reasonable" tariff should be imposed, and leave the adjustment of all duties to the Supreme Court of the United States.

This nation has been made great and prosperous by the initiative and enterprize of the individual, yet the theorists bid us throw aside the habits and course of conduct of centuries, and depend solely upon the initiative—God save the mark—of the bureaucrats. Why not speak out boldly, what all sensible and patriotic citizens are thinking, throughout this country? We are suffering from a most odious form of bureaucracy, fortified by an extensive system of paid spies, an organized claque, a clever press bureau, and the systematic support of that section of the press noted mainly for its dubious motives and devious politics. Some citizens with defective hearing take the clamor of this portion of the press, desirous of cheaper wood pulp, for the real voice of the nation. It is time that the yellow newspapers, muckraking magazines and purely political conservationists were told to stand aside, and permit the federal government to be run, once more, in accordance with law and common-sense. Some of the gentlemen who are preaching progress and conservation, have combined moral platitudes with business turpitude, and label their product as reform. In the name of progress they bid us turn our faces to the rear; in the name of conservation of our natural resources, for generations yet unborn, they forbid us to utilize the mineral, power and timber resources required for the needs of the present generation. Their plan of state ownership of mines and water powers is state socialism, very thinly disguised. These men are enemies of the republic, who, under the specious cloak of declamatory patriotism, would rob us of our right to self-government.

Our worthy president takes the stand that because the Sherman act is law, it must be enforced rigidly, regardless of consequences. If this be the case, it necessarily follows that all federal laws must be rigidly enforced, regardless of consequences, and it would be interesting to learn why our federal government does not enforce, or even attemtp to enforce, the fifteenth amendment to the Constitution of the United States, which reads as follows: "The right of citizens of the United States to vote shall not be denied or abridged by the United States, or by any state, on account of race, color or previous condition of servitude." Is it possible that the Sherman Act takes precedence of the Constitution?

DRESSING A CEMENT FLOOR

Many power users who have installed engines on large concrete foundations leave the surface of the concrete just in its comparatively rough condition as a floor for the engine-room. This is a bad practice, as the sand in the concrete is apt to come away with constant walking on it, and a large percentage of it eventually finds its way into the engine bearings, with results far from beneficial for the engine.

Wash the floor thoroughly with clean water, scrubbing with a stiff broom or scrubbing brush to remove all dirt and loose particles. As soon as the surface is dry, apply a solution of one part of water glass or sodium silicate, and three to four parts of water, the quantity of water depending on the porosity of the concrete. The denser the concrete the weaker will be the solution required, as it is necessary to penetrate the pores of the concrete. Do not mix more than can be used in an hour, and apply it with a large whitewash brush. After the first coat is dry, mop the floor with clean water, allow it to dry, and apply a second coat. Mop and dry again, and apply a third coat, and if the surface is not too good a fourth coat also after the same procedure. After it has dried thoroughly and received another mopping the result will be an extremely hard, dustless surface.

UTOPIAN ORE DRESSING METHODS

ONE OF THE UTAH COPPER COMPANY'S MILLS GOING TO THE SCRAP-HEAP

[REPRODUCED FROM JULY, 1910, ISSUE.]

As promised in our last issue we undertake to review as briefly as possible the extraordinary and chequered experience of the managerial department of the Utah Copper Company in its futile and costly efforts to install a successful system of ore dressing, without having first learned at least something of the rudiments of established practice, or sought the advice and aid of those who were familiar therewith. We do not in the least disparage the ability of the manager, or his mill superintendent, Mr. Janney, when we say that at the commencement of their employment by the Utah Copper Company, neither possessed any knowledge of the principles involved in ore concentration, or had ever had the slightest practical experience in work connected therewith. It is true, however, that Mr. Janney had for a short time run an engine which drove the machinery of a small concentrating mill, but as before indicated, had never been engaged in practical work or ore crushing or concentration, whereas Manager Jackling's experience had never extended outside of the field of smelting or chemical treatment of ores, but each was regarded as capable and efficient in his respective field of occupation.

It had been the good fortune of Mr. Jackling, as indicated in our last issue, by reason of his employment by Captain J. R. DeLamar at the Golden Gate mill at Mercur, to become familiar with the result of exhaustive examinations and working tests made of the mines and upon the ores of the Utah Copper properties by Victor M. Clement, Duncan MacVichie and other engineers employed by DeLamar, pending an option which he held to purchase certain interests in the property, and being of a thrifty turn of mind, he was able when the opportunity arrived, to use this information to very great personal advantage, as we also showed in our last issue.

It also appears that he had made use of this knowledge, but without substantial results, upon a former occasion, as will be seen from an excerpt from a report or letter written by him and addressed to Major R. G. Edwards Leckie, then temporarily located at Republic, state of Washington, as manager of a property where Mr. Jackling was employed in operating a "cyanide" plant. After a somewhat detailed description of the property in which he stated that there was at that time, March 20, 1901, reasonably called developed ore exceeding in amount "twelve million tons," the report proceeds as follows:

"During the summer of 1889 I undertook some metallurgical experiments on this ore, and concentrated several hundred tons taken from the tunnels and dumps at random. The mill which I used was an abandoned 5-stamp mill, without any particular adaptation to the ore, and without appliances for making a close saving. By crushing with light stamps to 25 to 30 mesh and concentrating roughly over a Wilfley table without sizers of any kind, and without special endeavor to save values from the large amount of slimes produced, I made a saving of 71.7 per cent Some experiments made in a rough way by collecting slimes and running them over a vanner, resulted in an additional saving of about 15 per cent, or a total of 90 per cent of the copper values, but I have made my estimates on a basis of 75 per cent saving. The ore is an ideal one for concentration, the grains of chalcopyrite breaking perfectly clear and free from the porphyry gangue, and readily yielding a concentrate carrying 25 per cent copper."

In a letter transmitting a copy of the "report" referred to, and dated Republic, Wash., April 4th, 1901, Mr. Jackling said:

"I want to assist you in every means possible in this matter, both for the reason that I would like to make some money out of it, and that I would like to see the deal go through and people get hold of the property who can and will do something with it. I do not know of a property on earth I would be more pleased to equip metallurgically myself than this one, and if the thing can be swung, I have hopes in that direction. * * * In consequence of my work on the Bingham experiments, I am able to give pretty accurately almost any information desired about the metallurgical end of the business."

The milling tests here referred to by Mr. Jackling were, for the first few days, conducted by a Mr. Forrester, who was very expert and reliable in that class of work, but who was superceded by Mr. Henry M. Crowther, also a man of ability, Mr. Jackling of course not being present and having no part in the work except that of assisting in metallurgical determination of the values contained in the samples taken for assay, which were sent to Mercur and treated in the mill laboratory at that place under his supervision. It is evident that the result of the figures, 71.7 per cent, given as the proportion of the copper contents recovered in the operation of the Wilfley table and the additional 15 per cent said to have been recovered from the slimes on the vanner, were carelessly or hurriedly copied from the reports of Forrester and Crowther, because 71.7 per cent and 15 per cent do not make quite 90 per cent, the total recovery claimed to have been secured.

It is quite evident that President MacNeill and associates never for a moment doubted that the DeLamar tests were actually made by Mr. Jackling, which fact in part no doubt accounts for the many blunders into which the manager drifted in attempting to conceal the facts and his lack of knowledge of the business in hand.

The employment of a capable man to take charge of the ore dressing department would have resulted in the exposure of the total ignorance of the subject of both the manager and his assistant, Mr. Janney, and besides would have spoiled the "record" that each hoped to make. True, the manager thought Superintendent Janney knew how, and would not claim all of the credit, whilst the superintendent evidently thought he could pick up the necessary information as the work progressed to enable him to conceal his lack of primary knowledge from the manager.

Results prove that both were right for a time in respect to their estimation of each other, but, as time and events progressed, the failure of each fool scheme began to tread so closely upon the heels of the next, that a collapse often seemed inevitable. But luck was with them, for the exigencies of the share market at all times rendered a change of management extremely hazardous, and hence the hired press continued to subordinate the importance of the millions that were daily added in value of ores, to the matchless engineering skill of the manager and then, at the psychological moment, the wonderful properties of the "Garfield table" were discovered, which for the time being seemed to have averted the impending wreck of the entire Utopian fabric. Even the advent of this messenger would doubtless have failed to stem the exposures of Mines and Methods except for the timely change of the name of the "Garfield mill" to the less euphonious one of "Magna plant." At the same time, in order to prepare the Boston mill for intestinal regeneration, its dignified cognomen was discarded for the more aesthetic "Arthur plant." But the "Copperton plant," which had been the embryo of so many brilliant conceptions of misguided genius, seems to have been overlooked in the process of rechristening.

COPPERTON PLANT TO SCRAP HEAP.

This was a fatal oversight, and as a consequence orders have been received from the head office, commanding that it be closed down permanently, and offered for sale, either as a whole, or in units or segments, to suit any purchaser. This was to have been expected after the analysis of Manager Jackling's annual report published in Mines and Methods, which shows that the actual cost of all copper produced at that plant for the year 1909 was fourteen cents a pound, and for the year 1908, 10½ cents, and this exclusive of its share of the costs of stripping the ore treated, which would have added about 1½ cents additional to the cost per pound of copper produced.

Just what explanation will be offered to stockholders and the public for this action it would be difficult to conceive, because it has been persistently stated that the new Garfield plant is an exact duplicate of the Copperton. It is operated by power generated at the Garfield plant, so that it could not be a question of excessive cost in driving power. Its capacity was 1,000 tons a day, which should render its operation in all respects quite as economical as that of any two of the 500-ton units of the Garfield plant; besides, there is an advantage of 15 cents a ton in the freight charge on ore delivered at Copperton as compared to the rate paid on ore delivered at Garfield, the former rate being 12½ cents, and the latter 27½ cents per ton, the difference being equal to a little more than three-quarters of a cent per pound of copper produced.

Moreover, the burden of the cry of the management and its hired press had been for INCREASED MILLING CAPACITY, and we are told daily that most strenuous efforts are being put forth to increase the consuming power of both the Garfield-Magna and the Boston-Arthur plants to the extent that twenty thousand tons daily shall be drawn from the limitless cuprous fields of the Bingham monzonites. Why then should this Copperton mill, "the mother of inventions," at the very zenith of success, and after having so long and well performed the dual functions of matron and wet nurse to the brood of new-born ideas which we are told are destined to revolutionize the copper industry, be consigned to the merciless auctioneer, or the scrap heap?

To those who have followed the exposures of this journal, the answer is not difficult. The public have refused to be fooled by the false cry of cheap copper production and have refused to buy their shares, and as a result the pooled interests have become loaded to the breaking point, and now to escape further drain upon their weakened resources in pretense of doing their share in curtailing production, they have gladly decided to close this unprofitable plant. But, whatever has been the cost of production at the Copperton plant applies with even greater force to the Garfield, and were it not for the disaster that impends holders of the pooled stock, this plant would undoubtedly be closed also.

HOW, FAILURES COME.

Unfortunately it is a fact that although theoretical and to some extent practical ore dressing forms a part of the mining engineer's college course, only in very rare instances does the graduate pursue these initial lessons into the field of actual practice, and this solely for the reason that the operation of an ore concentrating mill does not comport with the professional dignity of the average mining engineer. Hence the operation of these important appendages is usually assigned to some dependent relative or friend who has a "pull" with the manager, and who in turn, if he be wise, selects his foreman and crew from those who have had practical experience in the different departments of the work, and so has the successful practice of today been handed down from the generations which sprung from the old Cornish and German ore-washers of the past, so that if you want information of real practical value as to the best method of treating a particular ore, you go to the man who is successfully treating a similar ore. If you want to know WHY a Wilfley table, or other device is most efficient in the recovery of the valuable mineral, ask Wilfley, or the inventor of the machine in question, but if you want to KNOW HOW TO OPERATE the machine in order to secure the best results, ask the man who OPERATES this most important unit in the plant.

These observations are simply designed to impress upon the engineer the importance of a liberal PRACTICAL APPLICATION of University theoretical studies, in order that there may be combined in one head sufficient actual knowledge of the subject to enable the possessor to design and manage the erection of a complete structure which shall combine all the elements employed in the successfully operated plants in use for treatment of ores of the kind to which it is to be applied, for no engineer is justified in squandering other people's money in attempts to reinstate obsolete and useless devices; nor is it in the least disparaging to the ability of the most intelligent engineer should he find it necessary to seek information and aid in his work from men occupying inferior positions, because, as before indicated, the actual practice of ore dressing is little understood by the average engineer or mine operator. On the contrary, his thoughts and ambitions run rather to the promotion of mining deals in which a liberal rake-off may be secured, as a premium or reward for his skill in manipulating his friends and the general public, without regard to merit of property, or the process by which ultimate values are to be recovered; and so it frequently happens that highly remunerative pecuniary results follow the flotation of wholly worthless properties, and likewise mining properties of great value are frequently destroyed by grasping or dishonest methods of incompetent, self-styled mining engineers.

Coming now to the subject of this article, the mines now controlled by the Utah Copper Company were at the date of their acquisition little known outside of the former owner and a select few, who, as before indicated, by reason of their employment had access to the reports of the engineers employed by Captain DeLamar in exploiting the property under an option to purchase an interest.

As before stated, it is quite evident hwever, from the unlimited responsibility placed in the hands of Manager Jackling by President MacNeill and associates, that they had accepted his second-hand reports as demonstrations of actual knowledge, or possibly, perpetual management of the property with its millions to spend was awarded to him as his share of profits in the deal whereby the Guggenheims secured the contract to smelt all the concentrates to be produced at double the current rate, and MacNeill and associates in return secured twenty dollars a share for a large portion of their original holdings, the first cost of which was only about fifteen cents a share, as was shown in the June issue of this magazine.

WHEN BLUNDERING BEGAN.

The Copperton mill was erected by a local corporation, called the Utah Copper Company, which preceeded the present company, and held the option to purchase a controlling interest in the mining property at a stated price in cash, and in addition required the erection of a first-class concentrating mill having the capacity to treat successfully 500 tons of ore per day, the cost of which it was understood would be at least $250,000, which was to be borne by the proposed purchasers. Mr. Jackling was made manager of the company and Mr. Frank G. Janney was employed as chief engineer of construction.

In learning that it was the purpose of the manager to employ in the fine crushing department an old grinding device called the "Chile" mill, the owner of the property entered a vigorous protest, urging the adoption of the method in universal use for similar work, which was rolls, to be followed, if necessary, by Huntington mills, also in general use. But it was urged that, owing to the extremely soft and friable character of the ore, complete results could be had with rolls alone. It was also pointed out that exhaustive competitive tests had been made at the Washoe plant at Anaconda, Montana, with Chile mills, rolls and other fine crushing devices and that as a result the Chile mills had been discarded as absolutely destructive to successful concentration.

Finding the manager unmovable in his purpose to adopt the Chile mill, the owner of the property, in order to avert the failure which he thought would result from their use, offered to waive the requirement of the option and accept instead an experimental plant of only twenty-five tons capacity a day, or to build a complete modern plant of 500 tons capacity and guarantee results equal to any mill in use treating ores of like character for $75,000, but both proposals were refused. The former, no doubt, because a market could not be made for shares upon the operation of a mill of such diminutive proportions, and the latter because the manager and his assistant could not make a "record" in the operation of a mill which they did not design, not to mention possible royalties on a patented feature

And so the mill was constructed upon their own design, but chiefly of second-hand machinery brought from Colorado. Three of the Chile mills, however, were the identical mills which had been discarded as the result of the test referred to at the Washoe plant. Another, and new mill, carried a supposed valuable improvement which was the subject of a patented invention devised and owned by Superintendent Janney, which it is said, is attached to all the Chile mills which subsequently were installed in the Garfield plant.

In due time the mill was completed and put in motion, but results from the start were most discouraging. It was found that whilst the grinding capacity of the Chile mill was very great, the valuable mineral contained in the resulting pulp had been ground into an impalpable flour which resisted every device designed for its recovery.

The fault was at first attributed to the hydraulic classifiers, which refused to classify, and so an assault was made upon those helpless things, but without beneficial results. The superintendent became quite tame and appealed to visitors for information as to the usual habit of this now interesting device, but for many days no one appeared who seemed able or willing to explain the cause of its rebelious conduct.

GOOD ADVICE IGNORED.

The manager seemed disinclined to encroach upon the prerogative of the superintendent and discretly offered no advice. Finally a visitor appeared who had seen something similar in appearance before, and soon discovered that instead of the usual spiggot used for discharge of the classified product being placed directly beneath the several compartments of the classifier, a two-inch nipple had been inserted, and a T with some 2½ feet of pipe attached with extended out horizontally, at the end of which the discharge of pulp was provided by means of a valve, the classifying water being introduced through the vertical portion of the T. Of course if the valve was closed sufficiently to admit only the desired amount of pulp the long horizontal stem of the T would fill up with mineral, and if opened sufficient to force the pulp through the valve, there was a rush of water, but no classification.

Simple instructions were offered how to cure the trouble, but the superintendent was not satisfied, and so he struggled on until he secured a copy of Richards' work on ore dressing, where he found satisfactory relief, but the losses due to overgrinding continued and still continue to the extent of 14 to 20 pounds of copper to each ton of ore treated. Another, and equally serious trouble appeared in provision which had been made in the trommel screens which were designed to separate finished product after it had passed through the rolls. It was found that after passing the coarse breaker and the rolls that 35 to 40 per cent of the pulp was crushed to the proper degree of fineness—about 30 mesh—and that this portion of the crush yielded excellent results upon the concentrators. In order to eliminate this portion before sending the oversize to the Chile mills, two revolving trommels were provided, one discharging into the other. The head trommel was covered with wire cloth of about 5 mesh, or 3½ milimeter openings, the other was covered with 30x30 brass wire cloth. The oversize of the head screen was returned to the rolls and that of the other screen went to the Chile mills. Of course the result of the excessive quantity of coarse material being passed over the fine screen, was the destruction of its delicate and costly fabric in about thirty-six hours.

The matter of excessive cost did not disturb the manager, but the loss of time and labor in making the necessary renewals was most exasperating. Results during the short life of the screen cloth were, of course, quite satisfactory, but the cost of renewal of screen cloth was not less than thirty dollars a day for each of five trommels, and so the work went merrily on for several months, until it was said the bill for screens for trommels alone aggregated some $75,000.

At the outset of the struggle the same person who had volunteered a remedy for the cure of the classifiers suggested that all that was required to insure satisfactory duration of life to this finer screen was the introduction of two other screens of intermediate mesh openings between the fine and coarse screens then in use, which would skim out the coarser material and allow only such sizes of material to enter the fine trommel as would approximate the size of the screen openings; that with such arrangement the fine screen would stand the wear of its proportion of the pulp as well, and would last as long as the coarser fabric, but as that part of the mill structure had been so designed as to accommodate only two trommels—end to end—it was suggested that a very common and effective practice in such cases was to lengthen the screen arms sufficient to admit of placing two more screens of proper intermediate size, opening on the coarse trommel outside of the original screen.

But this was not adopted, probably because the superintendent did not know how to first think of it himself, but in course of time he evolved a scheme of his own, and thus saved his "record." He had seen jigs used, and knew they were equipped with screens, and that by covering a coarse wire cloth in a jig with a quantity of mineral coarser than the cloth mesh, only the finely crushed portions of the pulp to be treated would pass through the screen and so trial was made first with two or three jigs of the Hartz plunger type, the screens being bedded with lead shot, and, sure enough, the greater portion of the coarser "fines," ore and sand passed through all right, whilst the finer particles of mineral and uncrushed rock passed over the tail and was returned to the Chile mill to be ground into flour, which was just what they seemed to want.

From this on the number and kind of jigs installed increased with commendable rapidity. Even the Hancock jig was tried, but proved unsatisfactory, then Woodberry seemed to take first place, with the result that the trommel scheme of screening out the finer material was abandoned. The hutch product was not perceptibly enriched by the process, but afforded, when classified, a good feed for the Wilfley table. The result of this brilliant scheme was heralded by the hired press as the most wonderful advance in ore dressing of the century. Its operation, as against the ordinary and simple method of screening, involved an excessive cost equal to more than a cent a pound upon all the copper produced during the years of its use both at the Copperton and Garfield mills, in addition to the increased waste due to the greater quantity of material that was sent to the Chile mills, the sum of which loss of otherwise recoverable mineral is equal to more than three cents per pound upon all copper produced at both mills.

We have shown in former issues of this paper that the average recovery of the mineral contents of the ore treated at these mills never exceeded 63%, and the average for an entire quarter has been less than 48%. That 55% is a liberal allowance for the average recovery, as compared to about 72% recovered at the Nevada Consolidated and the Boston Consolidated mills, and that this great disparity is due solely to the destructive effect of crushing, or rather grinding, with the Chile mills. It is evident that our comments and criticism has brought about the desired reformation, as a few months ago a system of finer screening was quietly installed at the Garfield plant, whereby all material larger than about one milimeter and smaller than about four milimeters, which had previously been sent to the Chile mills, is nnw returned to the rolls, thus reducing the grinding heretofore done by the Chile mills by about 65 or 70 per cent.

Of course, improvement in recovery of values, and increased capacity of the concentrators, was startling, but strenuous efforts were put forth to conceal the real cause of the improvement. President MacNeill announced that it was brought about by screening and then "crushing dry" with rolls, which he sought to make the public believe was the result of an entirely new discovery in ore crushing, as if ores were ever crushed in any other way with rolls than dry where the conditions admit of such crushing—or that water is ever introduced except in crushing clayey ore.

And then this discovery was followed by the still more startling discovery of the Garfield table, which he says (in the Boston News Bureau) has superceded all of the hundred or more jigs. This is certainly an important advance, because jigs never had any excuse for their presence in the economy of ore dressing where 65% of all the material to be treated could pass double file through the openings of a 200x200-mesh screen.

WALL'S RIFFLE IDEA ADOPTED.

Now, as to this very remarkable table. It is simply in every effective principle a Wilfley table, and its use no doubt would be restrained except for the fact that the Wilfley riffle patent has probably expired. The riffle is patterned after a riffle which has been in use on a patented table in Wall's mill at Bingham for three years past. It is rectangular in form, about one inch thick at the head end and tapers about ¼ inch at the tail, and extends the entire length of the table, which, like the Wall table, is set so that the tail is higher than the head by the amount of bevel, longitudinally, in the the riffle. When in operation the surface of the riffle is level from head to tail. It has the capacity of probably four Wilfley tables. It is fed with material from the finest sizes to 1 or 1½ milimeters. The effect upon the pulp is to discharge over the side all of the coarser sands, together with much of the extreme fines—as in the Wilfley—which is returned to the Chile mill for further crushing—whilst the intermediate grade sands and mineral which adheres to the table is carried forward and discharged over the end, whence it is elevated to classifiers and dressed on Wilfley tables. The product is slightly enriched by the process, but no finished product or rejection of tails results from the operation, so that the mixed product must still be subjected to the same process and labor of rehandling as would the original pulp if delivered to the regular tables properly classified.

Whatever dimunition in quantity has resulted from the operation of the Garfield table, due to the elimination of the slimes and oversized material is balanced by the transfer of the same material to another department of the mill for treatment after it has been passed through the Chile mills and thereby rendered more refractory than ever. If only a small portion of the worthless sands were rejected in the operation it might be made to appear that something had been gained, but to slough off and send to the grinding mills sands which are already crushed sufficiently to liberate any recoverable mineral and thus increase the difficult task of dressing other portions unavoidably slimed, is too absurd for serious consideration. And when the fact is taken into consideration that all this floundering is the result of efforts to cover up the inexcusable blunder of refusing to adopt a sensible method of screening out the finished product at the outset, this latest novelty becomes a silly joke.

If now the screening system be extended one more short step, and all oversize material be returned to FINISHING ROLLS, the entire system will be as complete as the ill-arranged plan of the plant will permit. This would put the Chile mills in the scrap heap, of course, but the stockholders would enjoy the luxury of an honestly earned dividend which, up to this time, they have never received, and they will then know that the difference in the value of what might have been and what has been recovered amounts to not less than four millions of dollars, the equivalent of which now slumbers in the tailings pond.

We shall now shortly be advised by the hired press that the Utah Copper Company has performed its share of duty to the metal interests by temporarily closing the Copperton plant, but it can hardly be expected that stockholders will be informed that Superintendent Janney has already conducted prospective purchasers of junk through the plant and informed them officially that it is for sale as a whole or in parts. Such admissions would hardly be consistent with President MacNeill's recent statement that the plants were all new and still growing, and therefore it was not yet time to charge off anything on depreciation account.

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According to advises from Guatemala, the government of that country has recently granted to an American company the exclusive right to exploit all mines discovered on the public lands of Guatemala in return for a tax of ten per cent of the net profits of the company, which is to be organized in the United States with a minimum capital of $10,000,000 American currency. It is understood that Senator W. A. Clark and former Governor A. E. Spriggs are backing this new organization. French capital is also said to be interested in the deal. If consumated, the new company will begin active operations at once and with this large amount of capital at the company's disposal for exploration and exploitation purposes a great development of the mineral resources of Guatemala is to be expected.

MERITS OF SO-CALLED SCREENLESS SIZING

The exploitation of the merits of the recently patented "McKesson Screenless Sizer," which has been described in several mining and metallurgical journals during the past few months, is bearing fruit in the way of criticism and comment that is sure to prove educational and instructive to all interested in the best methods of extracting values from ores of various kinds. Carl F. Dietz and Dyke V. Keedy, consulting and metallurgical engineers of Boston, who, through their intimate identification with a process of their own for the classifying of complex ores, are qualified to speak, are credited with the following lively discussion—on the merits of the newest machine—in Metallurgical and Chemical Engineering for this month:

SIZING WITH OR WITHOUT SCREENS

The greater interest taken in recent years in the possibilities of the dry concentration of ores has brought out, aside from marked improvements in magnetic and electrostatic processes, several new and ingenious forms of dry concentrators, or rather tables, which have successfully overcome the difficulties of the early attempts at dry concentration. The prejudices against dry concentration in general, which in some instances may be justified by the many failures of the past, are most generally the result of ignorance or a disregard of the fundamental principles involved.

It is not the purpose of this paper to discuss the relative merits of dry vs. wet concentration. It may, however, be mentioned that each has its own field. Only a careful study of the mixture to be separated, together with local conditions, can determine which system is the more desirable. Such decision should, of course, in every case be verified by the treatment of a representative quantity of the material. While it is evident that close and accurate sizing as a requisite to successful dry separation, especially in the case of a complex mixture showing close specific gravity differences, is gradually becoming better understood, it remained for the advent of the Keedy ore sizer to make the application of a system of accurate and close sizing of practical importance. Reference may be had to Engineering and Mining Journal, Feb. 5, 1910, "The Keedy Sizer for Classifying Complex Ores."

This machine is based on diametric sizing, that is, the grades are actually measured by the aperture of the screens, limiting each grade, and therefore the ratio in volumes between the largest and smallest particles in any one grade is as the cube of the apertures of the limiting screens. This law, while it is applicable to all minerals breaking into massive particles, is directly affected by the coefficient of fracture. The latter is variable, and as yet extensive investigations have not resulted in determining a suitable factor for each of the usual minerals. Hopes, however, are entertained that something of value in this connection may soon be developed and published. It has been found in practice that the law of cubes gives very satisfactory results and can be relied upon with the exception of certain minerals, such as mica and specular hematite, which break into flat scaly particles, presenting a large area as compared to their volume.

Exception was taken to the cost of sizing an ore into, say, 12 or 15 grades because of the complexity of the apparatus and flow sheet, wear and tear and cost of screen renewals. When considering the old methods of using shaking or bumping screens or reels, the objections are well founded, but are no longer tenable with the more modern form of apparatus. The system is compact, noiseless, dustless and requires but small power. Attention required is at a minimum and screen renewal cost, while varying with the class of material treated, is well within the limits of expense which any given ore can stand if it is worth treating at all.

The objections to the cost of grading in this manner, even though actual operations in a number of instances prove them to be unfounded, still continue and have caused the minds of metallurgists and inventors to seek other means.

NEW SCREENLESS DEVICE.

Recently there have been given to the mining and metallurgical world some details of a new and ingenious device designed to size ore into any number of grades from 10 to 30 without the use of screens.

This new "screenless sizer," in the operation of which the laws of gravity are reported as having but a very slight influence, is capable of some rather remarkable perfrmances, and the published results of an official test will bear some close mathematical analysis. It is barely possible that this machine performs a function as yet apparently not recognized by the inventors or their associates, and if such is true, the apparatus should have a wider range of usefulness than would be accorded to a machine intended to be used as only a sizer.

The measurement of efficiency of any sizing operation is determined by test screening any particular grade through screens which supposedly mark the limits of that particular grade.

In preparing a complex ore for dry table separation it is necessary to make as many sizes as may be demanded by difference in specific gravity between the minerals which vary the least, so that the most perfect stratification may result and that clean zones of minerals, with a minimum of accidental middlings, may arrange themselves on the tables; these conditions can result only when the ratio of volumes between the largest and smallest particles, in any one grade, equals or is less than the ratio between the specific gravity of the two closest minerals.

As an example, in the case of iron pyrite and zinc blende, in which the respective specific gravities are 5 and 4, let Vp be the volume of the pyrite particle, while Vb is the volume of the blende particle. Then

$$\frac{V_p}{V_b}=\frac{5}{4}=1.25$$

As pointed out, grades in which such ratios exist can be produced by considering the apertures of the screens, and if S_1 is the aperture of the coarse screen while S_2 is the aperture of the fine screen, we have

$$1.25=\frac{S_1^3}{S_2^3}$$

Of course, a series of screens from say, 20 mesh to 200 mesh, which throughout would have its aperture cubes bear a relation to each other as 1.25 to 1, leads too far for one sizer and necessitates two machines, as some 22 sizes would be required.

It may be mentioned that in the case of a very complex Mexican ore such a series was employed with the most gratifying results, showing sharp lines of demarcation between the fields occupied by galena, pyrite and blende, so that it was not necessary to cut a zinc-iron middlings.

This, of course, is an ideal condition, but it was found that the system could be much simplified by making only 13 sizes and collecting the accidental pyrite-zinc and zinc-gangue middlings, which, by resizing together over a machine dressed differentially, that is, making between-sizes, prepared them for successful treatment for the reason that the particles were rearranged, and therefore they could not all again report themselves as middlings.

THE McKESSON SIZER.

The McKesson screenless sizer is designed to make as many as 30 grades in one operation, which, if the ratios of volumes between the largest and smallest particles in any one grade should prove to be as above shown, would be admirably suited as feed for a dry concentrator.

The aperture dimensions of the screens used to test the various grades must be known, but for illustration we may arbitrarily use the following in discussing the results of the official test on the McKesson sizer.

Mesh.	Aperture inches.
24	.0342
28	.0282
30	.0268
34	.0229
40	.0185
44	.0172
50	.0145
66	.0102
82	.0079
97	.0058
116	.0047
139	.0033
172	.0028

The results show that, except in the two coarse grades, efficiency is based on the material reporting in the two heaviest screen products, which, when taken together, show a large volume-ratio between the largest and smallest particles lying between the limiting screens used in determining measure of efficiency.

The results of a test on the McKesson machine making fifteen products are reported to be as follows:

Product No.	Screen.	Per Cent.	Efficiency.
1.	— 24	....	
	+ 30	15.60	
	+ 40	81.20	81.20
	— 40	....	
2.	— 28	....	
	+ 40	93.75	93.75
	— 40	6.25	
3.	— 30	....	
	+ 34	10.92	
	+ 40	50.00	
	+ 44	32.83	82.83
	— 44	6.25	
4.	— 34	....	
	+ 40	28.13	
	+ 44	37.50	
	+ 50	25.00	62.50
	— 50	9.37	
5.	— 40	....	
	+ 44	7.28	
	+ 50	25.00	
	+ 66	64.06	89.06
	— 66	3.12	
6.	— 44	....	
	+ 50	6.25	
	+ 66	68.75	
	+ 82	21.87	90.52
	— 82	3.12	
7.	— 50	....	
	+ 66	37.50	
	+ 82	53.13	90.63
	— 82	9.37	
8.	— 50	....	
	+ 66	9.37	
	+ 82	62.50	
	+ 97	25.00	87.50
	— 97	3.13	
9.	— 50	....	
	+ 66	6.25	
	+ 82	50.00	
	+ 97	37.50	87.50
	— 97	6.25	
10.	— 66	....	
	+ 82	37.50	
	+ 97	46.87	84 37
	— 97	15.63	
11.	— 66	....	
	+ 82	25.00	
	+ 97	50.00	75.00
	+116	21.87	
	—116	3.13	
12.	— 66	....	
	+ 82	15.63	
	+ 97	43.75	
	+116	34.37	78.12
	—116	6.25	
13.	— 66	....	
	+ 82	6.25	
	+ 97	37.50	
	+116	43.75	81 25
	—116	12.50	
14.	— 82	....	
	+ 97	25.00	
	+116	43.75	
	+129	28.12	71.87
	—139	3.13	
15.	— 82	....	
	+ 97	6.25	
	+116	18.75	
	+139	43.75	
	+172	25.00	68.75
	—172	6.25	
		Average........	81.32

The efficiency, determined even in this most favorable manner, cannot be said to be high, and when considering the vitiating effect of the relatively large amount of "through" product recorded, and its detrimental effect on table work, the results cannot even remotely be compared to those obtainable by diametric sizing, when making even a lesser number of products and covering a wider range.

To quote from Metallurgical and Chemical Engineering: "It will be noticed that the grading efficiency in some of the products is lower than in others, but it is claimed that this can be remedied by adjusting the cutters to throw the oversize and undersize into the preceding and succeeding grades respectively, and thereby increase the efficiency of the sizing in all grades."

In the above statement the absence of such positive action as exists when sizing diametrically is clearly admitted.

That the efficiency shown in one grade may be improved by throwing the over and undersizes into the preceding and succeeding grades respectively is obvious, but on the basis of the published screen analyses of the products, instead of thus increasing the efficiency of all the grades, those into which the oversize and undersize are cut would be more likely to suffer, with the result that, while one grade would be improved at the expense of its tonnage, the two grades affected by the improvement of the one would probably show not only a lower efficiency, but would represent a correspondingly larger proportion of the whole. If the action of the machine were positive the explanation of the possibility of improving the grades would have some force which, in view of the results, is lacking.

Taking the basis of the efficiency calculation as given, and applying the laws of cubes, we can calculate the ratios existing between the largest and smallest particle in any one product, giving the machine the advantage of using the screens specified, which limit the efficiency calculation. We have then:

Product No.	Limiting Screens.	Per Cent. Efficiency.	Vol. Ratio of Largest to Smallest Particle.
1.	— 30 + 40	81.20	3.04:1
2.	— 28 + 40	93.75	3.50:1
3.	— 34 + 44	82.83	2.30:1
4.	— 40 + 50	62.50	2.70:1
5.	— 44 + 66	89.06	4.80:1
6.	— 50 + 82	90.52	6.20:1
7.	— 50 + 82	90.63	6.20:1
8.	— 66 + 97	87.50	5.40:1
9.	— 66 + 97	87.50	5.40:1
10.	— 66 + 97	84.37	5.40:1
11.	— 66 + 97	75.00	5.40:1
12.	— 82 +116	78.12	4.70:1
13.	— 82 +116	81.25	4.70:1
14.	— 97 +139	71.87	5.40:1
15.	—116 +172	68.75	4.80:1
	Average ratio............		4.66:1

In the practical application of close and accurate screening we have adopted, as a standard, a series of 13 screens between 0 and 200 mesh conforming to a harmonic series, thus producing 14 products, including oversize and fines. The average volumetric ratio is 2 to 1, while the efficiency, when measured by the screen area usually exposed, varies be-grade, averages better than 90 per cent, the only drop under 90 per cent being in the —150 + 200 grade, which, with the screen area csually exposed, varies between 80 and 85 per cent.

The percentage of oversize is practically nil and the particles passing through the fine limiting screen, in testing the grade, are usually of such size as to just pass through the aperture, but much too course to go through the next screen of the series. If the efficiencies in testing the products from the Keedy sizer were figured in the same manner as those for the McKesson sizer products, the former would show an average efficiency of from 95 to 98 per cent, as against 81 per cent for the latter.

The series as developed and used by us as a standard is the following, in which screen cloths have been selected of apertures conforming with the law of cubes:

Mesh.	Appertures, Inches.	Ratio of Vol. of Largest to Smallest Particle.
20	.0410	1.722 to 1
24	.0342	1.722 to 1
28	.0282	1.783 to 1
34	.0229	1.867 to 1
42	.0183	1.959 to 1
50	.0145	2.012 to 1
62	.0116	1.953 to 1
74	.0089	2.214 to 1
86	.0068	2.242 to 1
109	.0054	1.996 to 1
125	.0041	2.284 to 1
150	.0032	2.103 to 1
200	.0026	1.865 to 1
Average.............		2.000 to 1

A comparison between these ratios and those of the screenless sizer work, entirely aside from the considerably better efficiency of diametric sizing, clearly indicates which products may be expected to yield the better table results.

The results of the McKesson test show that in a general way the efficiency varies inversely as the ratio of maximum to minimum particles in the grades, excepting in the extreme coarse and fines, but the most important characteristic revealed is the gradual graduation by size almost identical in its character with, but somewhat more emphasized than, that resulting from feeding an unsized pulp over a dry table of the Sutton, Steele & Steele type.

It may be especially pointed out that in every instance in the screen analyses the coarse limiting screen used is of larger aperture dimension than the fine limiting screen of the preceding grade. The efficiency of products 8, 9, 10 and 11 is measured by exactly the same screens, the only difference in the grades being that they grow finer by reason of the fact that the oversize is gradually reduced while the undersize increases. The latter is also true of products 12 and 13.

This fact proves that the products very considerably overlap, and thus the sharp line of demarcation existing between diametrically sized grades is wholly lacking in the new method of sizing. The overlap of the products is graphically shown on Plate I, and it is to be clearly noted that no sharp line exists between any two or even three of the grades, while the overlap, in specific cases, is sufficiently great to completely destroy the effect of sizing. For example, products No. 7 and No. 15 are so poorly sized that —82x97 mesh material is contained in each.

With an average recorded efficiency of but 81 per cent, and that, too, on an average particle ratio of 4 66 to 1, the actual average particle ratio on whole product exceeds 6 to 1, which is far too much to permit of anything like desirable work.

The above discussion is, of course, all predicated on the statement that specific gravity plays an unimportant part in the operation of the McKesson apparatus.

That a machine of this general type will operate as a sizer has been pointed out, but the sizing is of an extremely in-

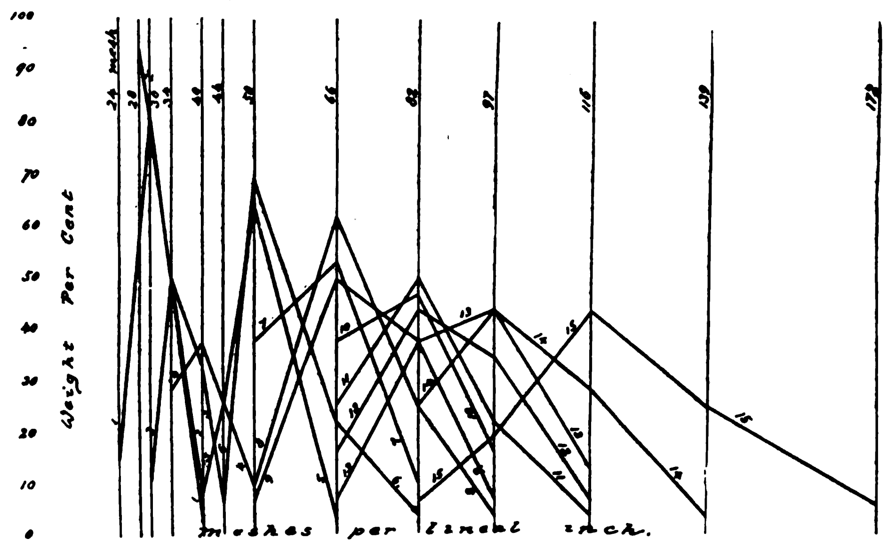


Fig. 1.—Graphical Presentation of Screen Analyses of Product from a McKesson Screenless Sizer

different quality, and specific gravity actually does play a part well worthy of notice. In one instance, an unclassified ore was treated on a Sutton, Steele & Steele table, primarily for the purpose of noting the sizing effect. The tendency was marked but the gradations along the periphery of the table were so gradual as to be characterized as only an abortive attempt at sizing. The feed to the table and the four products caught at the periphery gave the screen analyses on top of next column which are graphically represented in Plate II.

These results were obtained on a magnetic iron ore, and the products "b," "c," "d" and "e" clearly showed that the finer heavy magnetite particles had a distinct tendency to associate themselves with coarser gangue particles—the result of the ever-operating law of gravity. If 15 products had been cut, the result would have been quite as perfect as that of the McKesson machine.

		Products			
Mesh.	Feed.	B	C	D	E
— 50					
+ 58	1.50	4.1	.10	.25	0
+ 68	.50	2.3	.45	.25	0
+ 90	9.50	16.0	10.00	7.25	2.50
+100	12.00	28.7	13.00	13.75	3.50
+140	14.25	18 0	19.25	14.75	5.00
+163	21.50	10.1	16.25	11.25	6.00
+200	18.00	14.1	24.00	26.75	32.25
—200	20.50	6.5	16.00	24.00	49.00

Another notable instance—in the treatment of a mixture of galena, pyrite, zinc and fluorspar, it was invariably found that the finer galena traveled under the pyrite, the finer pyrite under the zinc, and the finer zinc under the fluorspar. In air, a particle of zinc need be only 25 per cent greater in volume than a particle of pyrite to weigh the same, while a particle of fluorite need be only 25 per cent greater in volume than a particle of pyrite to weigh the same, while a particle of fluorite need be only 30 per cent greater in volume than a zinc particle to weigh the same.

Now these particles of equal weight are acted upon equally, and necessarily produce a middlings which when screened over a cloth of proper aperture results in a concentrated product either on or through, or both, the heavier mineral reporting in the finer product.

MACHINE NOT A CLASSIFIER.

The published screen analyses of the products from the McKesson sizer do not indicate that specific gravity always plays

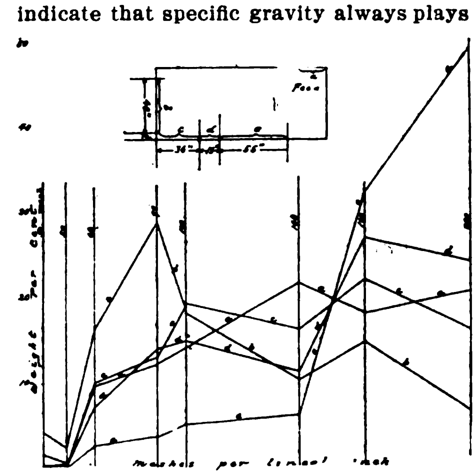


Fig. 2.—Graphic Presentation of Screenless Analyses of Products from a Sutton, Steele & Steele Table, when fed with unsized ore. Small diagram at the top represents the deck of Sutton, Steele & Steele table, showing peripheral discharge of products—b, c, d, e.

no part in the operation, and the question obviously arises whether this machine does not perform a function of greater importance than the one which its inventors desire to perform. Certain it is, on the basis of the recorded efficiencies and the evident gradual classification of the products, that the name screenless sizer is a misnomer. As far as the usual understanding of sizing is concerned, this machine is not a sizer, as its products overlap far too much. It would be more appropriate to call the apparatus a dry classifier, which in effect it is.

Mr. Charles J. Downey, in Mining Science, Sept. 14, 1911, states: "Concerning the theory of the McKesson method, I have no disposition to enter into a discussion of it, beyond what has already been said. An outline of the laws governing the selective action, in which differences of specific gravity play but a very small part (and then only in the case of widely different minerals, according to the engineers) will be the result of systematic and prolonged experiment. That the sizing is effected to a high degree of efficiency is apparent to an observer, while the operation of the machine has all the aspects of simplicity."

Now going back to the thought expressed above that this machine is essentially a dry classifier, all speculations vanish as to a new principle having been stumbled upon, and viewing the action as one of classification is the more tenable, when considering the analogy between the operation of the McKesson machine and the Sutton, Steele & Steele dry table.

It is difficult to conceive of one making separations between minerals of equal size, on the basis of their specific gravity differences, while the other collects together the various minerals according to their size, regardless of their relative specific gravities. These two thoughts are distinctly contradictory.

If the McKesson sizer acts in the nature of a classifier, which is exactly what a table does (only the new machine by means of the deflectors and discharge arrangement takes advantage of and emphasizes the action, it must be shown by the character of the screen products of each grade.

A hydraulic classifier when making fifteen products appears to deliver a fine string of perfect sizes, however a screen analysis and assays of the screen products reveal the true action, which is classification both by size and specific gravity.

In each grade it will be found that lightest mineral reports, to the greatest extent, in the coarsest grade; while the heaviest mineral will be found, to the greatest extent, among the finer particles of the particular product under consideration.

This same action is to be expected in a machine of the McKesson type.

It can readily be verified by testing a mixed sulphide ore and screen—analyzing the products, just as was done in the reported official efficiency test.

The investigations should, however, be carried further, and each of the screen products should be assayed for the principal metals contained in the mixture, thus readily establishing the actual facts of the operation.

We anticipate that results of such an investigation will show each product to be made up of coarse gangue, finer zinc, somewhat finer pyrite, and still finer galena. If this explanation of the operation of the new machine is found to be true, we will no longer be confronted with a new and paradoxical theory to worry the research metallurgist, but will realize the ease with which appearance may deceive and the danger of a too ready acceptance of an apparent overthrow of fundamental principles that have served us long and satisfactorily.

The development of a dry classifier should have a wider field of application than a sizer, if its capacity is sufficiently high, since, if the machine acts as herein discussed, its products should make an admirable feed for a wet table.

That the new machine is not in any sense a sizer of mixed minerals seems well established, and that it follows the laws of classification in which specific gravity plays an important part is strongly indicated by an analysis of the published results.

We may express a hope that the inventors will shortly supply the metallurgical world with further, more complete data, preferably along the lines suggested, including a screen analysis of the feed to the machine for purposes of comparison, so that speedily a more definite understanding of the principle involved in the performance of this ingenious new contrivance may be had.

MILLING SUCCESSES WITH INEXPENSIVE CANVAS PLANT.

By AL H. MARTIN.

Simplicity breeds success. And the adoption of simple ore-treating methods by mine managers has often swerved the point from failure to achievement. The paramount problem confronting the manager of a new property is to make its operation profitable. And too often this aim is defeated by the expenditures for complicated, costly equipment when more simple means may be made to answer with equal satisfaction.

The canvas plant idea is almost as old as mining, and has played a stellar role in the advancement of the industry. Its great merits lies in its efficient recovery of values from mill tailings, the low costs attending its construction, and the economical advantages attending its operation. Employed largely in the California gold districts, where it has attained its greatest development, the canvas table has pioneered the way for a majority of the modern gold-saving concentrators now in use.

Approximately 150 years ago the Cornish tin miner employed blanket troughs in concentration work, and this idea has been employed in many of the foremost gold districts of the world. In the early days of California gold mining, bullock hides and blanket sluices were employed to catch the gold after passing the plates. These devices consisted of an ordinary sluice covered with the hairy hide or blanket. Later heavy woollen blankets were manufactured for this express purpose. The blankets were exceedingly rough and results proved satisfactory. Then an ambitious millman, named Morris, devised incline tables, covering the same with heavy canvas. From this idea dates the canvas table as it is now known in the free-milling gold districts of the west.

In modern California milling, the tailings from the plates first pass to Frue vanners before commanding the canvas tables. This results in a higher and more satisfactory concentration. There are several types and modifications of these tables in use, varying from the most simple design to the Darrow & Hambric patented type. Usually the tables are of two distinct types, the long, narrow design, and the broad tables of comparatively short length. Both types have their advocates, but for general use the short broad table appears preferable, owing to the greater ease with which it is handled by the operator. However, the design is largely a matter of personal choice.

In designing the canvas plant, it is desirable to select a site with a natural slope, giving the tables an inclination of one to one and a half inches per foot. Of course when the natural conditions are unfavorable in this respect, the builder must construct the plant to provide the required slope. The supporting posts should be sunk to bedrock, to insure solid foundation, as it is absolutely necessary that the original inclination and perfect condition of the floor be maintained. In case it is too far to bedrock, other provisions should be made to insure stability of foundations. The posts are usually treated with creosote or other preserving material to guard against rapid decay. The stringers are usually two by eight inches, or larger, and the flooring consists of pine or redwood planks. Dry lumber is desirable, as otherwise care must be taken in laying planks. It has been found best to lay the dry planks about a half-inch apart, allowing for the swelling of the wood when water is turned on. The surface of planks must be as equal as possible, any deviation from the natural incline militating against best results. The canvas covering is laid over the planks, and lengths of hose provided at frequent intervals to assist in washing down the tables. Generally the tables are equipped with movable strips of wood which serve to deflect the concentrates into the launder running alongside.

Among the most successful canvas plants operated in California was the noted installation at the Empire mine, in the Grass Valley district, and the one operated by the Kennedy Mining company, in the Jackson district. The following is a description of the Empire canvas tables, and illustrates the general style of installation and operation. While this plant has been replaced by the cyanide process, it is representative of most of the successful types in operation in several California fields.

The pulp from the mill, crushed through a No. 7 slotted screen, was received by eight copper amalgamating plates. From these the product passed to two Frue vanners. From the vanners the tailings passed into a settling box, and thence to a battery of 26 canvas tables. The tables were arranged in two lines with an inclination of about 1¾ inches. Each table was 12 feet wide by 8 feet long, composed of a wooden flume covered with No. 8 canvas. At the lower end of each table was placed a 6-inch board, designed to turn the concentrates into the launder built along the discharge end of the table. The board was raised and lowered by means of a long rod extending to the upper end of the table, and conveniently within reach of the operator. At convenient points short pieces of hose were placed, facilitating the washing down of tables every half hour. The product from the tables was received by an agitator, commanding a 6x10-ft. Gates vanner. From this machine the material passed to a second vanner of identical size and type. The second vanner passed the tailings to another blanket concentrator, consisting of two canvas tables 15 ft. square. The tailings from this battery united with the tailings from the first set of 26 tables and the spigot discharge from the settling box; the whole commanding a 22x60-ft. canvas concentrator. The tables handled 80 tons of pulp per 24 hours, and were operated with the waste water from the mill.

At the Kennedy the mill tailings are first received by forty 6-ft. Frue vanners and transmitted by these to the canvas plant. The tables are 12-ft. wide by 13 ft. in length, arranged in a double row. Mode of operation is about the same as pursued at the Empire. After passing the vanners at this plant, the pulp passes into a Gates classifier before delivery to the tables. The classifier divides the valueless coarse sands from the fine product, thus reducing the amount of material to be handled by the tables. It is stated that the coarse sands assay around 60 cents per ton in gold, but the Kennedy management deemed an attempt to recover this as economically impracticable, as fine grinding would be required to release the values. The Kennedy canvas plant is operated steadily and has given excellent satisfaction. As the Kennedy company is the largest producer in California, and one of the most progressive concerns on the mother lode, its satisfactory experience with the canvas plant is a decided testimonial in favor of the economical efficiency of the method.

With few exceptions the canvas table is used throughout the great mother lode, the principal quartz gold producing region of California, and adjoining districts. As a high extractor of slimed sulphides and similar material it has attained particular success. The Darrow-Hambric table, an improved type of the canvas concentrator, is employed at the Zeila, Bunker Hill, Fremont Consolidated and Argonaut, four of the largest of mother lode producers. The system consists of a circular frame, approximating 28 ft. diameter, with six to eight decks or tiers of tables. From 21 to 24 tables are allotted to a deck, each table having an area of 12 square feet. Formerly canvas was employed exclusively, but in the later machines the tables are covered with asphaltic felt, or the plain wooden surface merely painted with asphalt paint and then treated wtih a coat of fine sand. The inventors state that both of these methods of covering the tables have proven highly satisfactorily, exceeding the canvas as a collective agency. The circular frame is mounted upon an upright axis at the center, the machine being operated by means of an encircling rope receiving power from a pulley, driven by water power. The waste water from the power wheel is employed in cleaning the tables and in other work about the plant. The concentrates are subsequently treated by agitation and cyanide treatment in Pachuca tanks. It is stated that a high recovery is effected at all these plants.

The effectiveness of a canvas plant depends principally upon the maintenance of an even flow of pulp over the surface. The volume of feed must be uniform, otherwise the heavier flow will naturally dislodge and bear away the concentrates previously settling upon the canvas. Consequently care must be taken to maintain a steady and unvarying flow of pulp. The experience of the operator and the character of material treated determines the proper period of time for the pulp to flow over the table.

Cost of plants varies considerably. Some have been constructed for $1,000, while others have cost as high as $7,000. From $2,000 to $4,000 appears a good average. The size of the plant, and the amount of ore to be treated naturally regulates the initial cost; the installation of a plant at a small property being attended with low expense. The location of the property also influences the first cost of construction, the absence of nearby timber augmenting expenditures. A fair quantity of water is required for successful work, the size of plant and amount of material washed regulating the water consumption. But with natural conditions favorable, the canvas plant has proven remarkably efficient.

HANDLING OLD TAILINGS

By J. B. HARPER.*

To those concerned in the treatment of tailing dumps by the cyanide process the accompanying drawing may be of interest, as it illustrates a cheap and rather novel method of filling leaching vats. It is applicable only where scrapers are used to move the material, which should be fairly dry.

The device consists of a bridge with a span slightly longer than the diameter of the vats in use, fitted with wheels or rollers so as to be easily movable along a track from one vat to another, and strong enough to support four horses and scraper filled with sand. The floor-

* Mining Engineer, Denver, Colo., in Mining Science.

ing made with plank set vertically 2 in. apart acts as a grizzly. Aprons at each end give the horses an easy approach, serving also in keeping the track clear of sand and the bridge solidly in place. Eight-pound T rails are used to hold them in position, and when moving the bridge with pinch bars they are taken off like the gang plank on a boat.

The contrivance was used on a 100-ton tailing plant operated by Messrs. Oastler and Southworth at Dun Glen, Nev. The idea was originally theirs, though I assisted them in working out the details of construction. The drawing shows some slight alteration from the original, which I believe is an improvement.

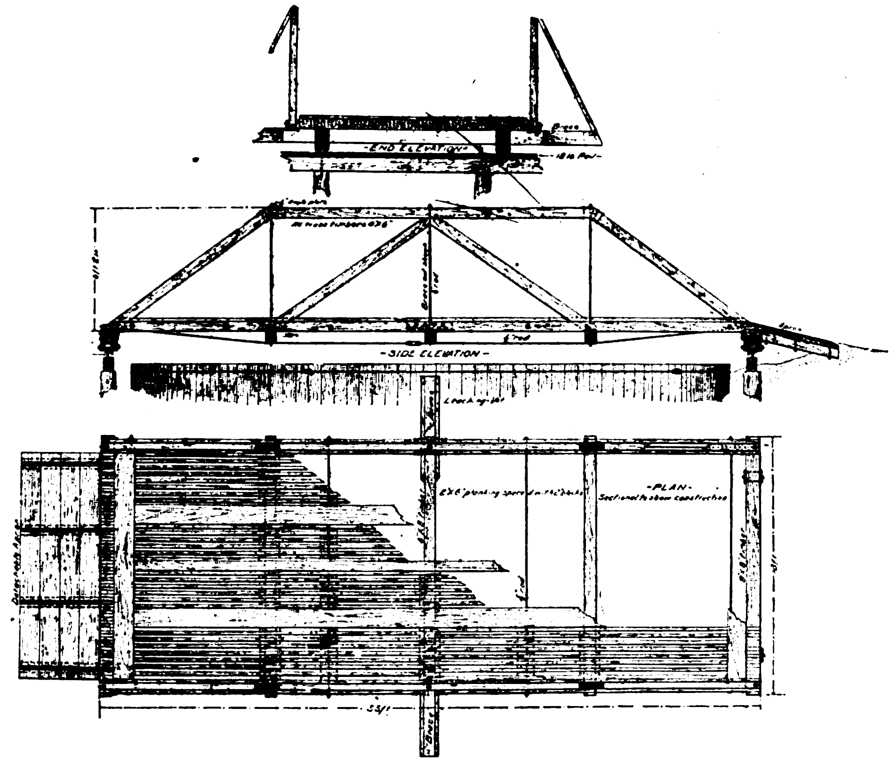
The leaching vats in use at Dun Glen were 30 ft. in diameter with 5-ft. staves and held about 110 tons of dry sand. They were set up on sills and sleepers placed upon the ground. The pipe lines carrying the off-coming solution from each of the four vats were laid in a shallow ditch leading under their centers direct to the zinc boxes. It required about eight hours to fill each vat, using two 5-ft. Fresno scrapers with four horses abreast and a man to trim the sand below the bridge as the scrapers were dumped. The length of haul varied from 100 to 300 ft. Unloading took about the same time as that required to fill the vats, the former being done at night and the latter during the day. Two 2-horse scrapers or "slips" were used for this work, and it is surprising how little shoveling was necessary. Before the first vat was filled dirt or tailing was scraped on the outside nearly to the top of the staves, so as to make an approach for the bridge at both ends; and, because of this, there was no difficulty in driving the teams into the vats, even when unloading the first charge. Only one man was needed to help the drivers. By means of a small suction pump connected to the leaching line moisture in the sand was sufficiently reduced to prevent the horses from miring when unloading was going on.

There is nothing very difficult about the construction of the bridge, and any good carpenter or millwright should be able to build it from the plans and data given.

I should recommend the use of first-class lumber, preferably Oregon pine, particularly for the truss timbers, though as originally built we had to make use of whatever material was at hand, some of which was very poor. The planks spiked on top of the bridge grating shown in the plan are spaced so as to engage the scraper runners. They take up most of the wear, and when worn out can be easily replaced. Strap iron cannot be used on account of the difficulty in dumping the scraper on it.

It was thought that there would be trouble in getting horses and mules to cross the spaced planking, but after the first day there was not the slightest difficulty in that respect.

So far as I know the plant mentioned is the only one where this method has been put into practice.



Drawing Illustrating Construction of Bridge

In testing the quality of iron, if the fracture is found to give long silky fibers of leaden gray hue, cohering and twisting together before breaking, it may be considered a tough, soft iron. A medium, even grain, mixed with fibres, is considered a good sign, while a short, blackish fibre indicates a badly refined iron. A very fine grain denotes a hard, steady iron, apt to be cold and short and hard to work with a file. A coarse grain, with a brilliant crystallized fracture and yellow or brown spots, shows brittleness working easily when heated and easily welded. Cracks on the edge of bar are a sign of hot short iron. Good iron is readily heated, is soft under the hammer and throws out few sparks

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The copper ore of Keweenaw Point, Michigan, was known to the Chippewa Indians, was reported by La Garde in 1636, by the Jesuit missionaries 1632-1672, by Baron Le Houtan in 1689, by P. de Charlevoix in 1721, and by Jonathan Carver in 1765. Captain Carver's report led to the formation of a company which mined copper ore in 1761 and 1762, but failed. Alexander Henry, an Englishman, mined copper in 1771, but quit in 1774. H. L. Schoolcraft reported on the deposits in 1819, and Major Long in 1823, for the United States government. From 1830 to 1841, Douglas Houghton, for the first Michigan Geological Survey, systematically explored the deposits, his reports leading to the modern development of the region dating continuously from 1844. In that year a few tons of oxide, not native copper, were taken from a fissure vein near Copper Harbor, Keweenaw county, by the Pittsburgh & Lake Superior Mining Company, which later developed the Cliff, mine, 20 miles to the southwest.

———o———

Monel metal is a "natural" alloy of copper and nickel of the following approximate compositions: Nickel, 68 to 72 per cent; copper, 26.5 to 30.5 per cent; iron, 1.5 per cent. It is made directly from the nickel-copper matte of Sudbury, Ontario, and is regarded as a successful substitute for steel and bronze in certain important uses. It has recently been cast in pieces weighing as much as 25,000 lbs., most of these having been for propellers that are furnished to the United States government. The demand for wheels of this material is said to be increasing. A prominent naval vessel which has recently been equipped with monel metal propellers is the battleship Rivadavia, launched for the Argentine republic.—Mining Science.

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Grade resistance is usually figured at 20 pounds per short ton for each per cent of grade.

Mines and Methods

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Guggenheims "Goldbricked"

How the Famous Family's Ship of Fortune Recently Has Been Recklessly Steered and Severely Buffeted by the Winds of Adversity

Horace J. Stevens, copper statistician and author of the Copper Handbook, in an elaborate address delivered before American Mining Congress at its recent session held in Chicago, and printed in full in the last issue of Mines and Methods, vigorously assailed the Government's "conservation" regime in Alaska and incidentally—though perhaps inadvertently—dealt a killing blow to the copper mining feature of the Guggenheim Copper River railroad enterprise.

For years the copper-producing world has been kept in a sort of "cold sweat" by the fabulous tales that have from time to time been told regarding the magnitude and richness of the mountains of almost pure copper which it was claimed existed in the Copper River region of Alaska, all owned or controlled by the Guggenheims, and to become available on completion of this, the most difficult, daring and expensive railroad enterprise of any age or people. But, as indicated several months ago by this journal, there never was any real cause for apprehension that any possible production of this forbidding region would ever seriously embarrass or disturb the actual metal industry excepting through such fictitious fluctuations as might arise from manipulations of the stock market. And now, all hope of the harvest of other people's coin—which seemed almost within the grasp of realization from the flotation of "convertible bonds" and shares which were soon to have been offered to the impatient public investor—has been knocked into "smithereens" by an innocent slip of the historian's unguarded tongue.

After an exhaustive and masterful review of the copper metal producion industry, from its inception in this country some fifty years ago, in which he displayed remarkable familiarity with his subject, Mr. Stevens trained his batteries upon the Government's "conservation policies" as applied to the great Alaskan coal fields, and in pathetic language recounted some of the trials and tribulations endured by the Guggenheims in their patriotic efforts to develop the resources of that far off region. On this subject, Mr. Stevens said:

A "COPPER PLATED GOLD BRICK."

"The Guggenheims are the bogey-men with which the conservationists most frequently alarm the public. We have had it dinned into our ears, by innumerable patriots seeking office, and repeatedly set before our eyes, in every yellow newspaper and muckraking magazine, that 'the Guggenheims are stealing Alaska.' As a matter of fact, the Guggenheims control a copper mine in the interior of Alaska, that is a wonder in its way, YET WHICH CANNOT BE RATED AT MORE THAN A THIRD-CLASS PROPERTY. This mine, the Bonanza, is a sort of copper-plated gold-brick, in that an interior core of limestone is surrounded by phenomenally high grade bornite and copper glance. No competent mining man who has visited this property ever has estimated the amount of ore in sight, and safely to be inferred, as capable of yielding more than 100,000,000 pounds of finished copper, a total production equivalent to only one year's maximum output by any one of the six leading copper mines of the world.

"In order to get this ore out of a wilderness, the Guggenheim interests have built the Copper River & Northwestern railway, a line of 195 miles length, variously estimated to have cost from $13,000,000 to $25,000,000. The gross value of all the copper contained in the Bonanza mine, taking the outside estimate of tonnage, is considerably less than the lowest estimate of cost of this railway, and the net profits derivable from the Bonanza mine, cannot, by the most liberal figuring, be estimated at more than $4,000,000 to $5,000,000. Instead of being commended for their enterprise and courage in building this railway through an arctic wilderness, the Guggenheims are held up to public scorn as thieves and robbers. This railway cuts through workable beds of coal, but is prohibited, by the federal authorities, from developing or using this coal, and is compelled to import inferior coal, from British Columbia, at a cost more than double that of domestic coal, if its mining were permitted. Not only does the railway suffer from this arbitrary action by the federal government, but the 50,000 unfortunate American citizens who live in Alaska are compelled to pay double or triple the price they should pay for fuel, through the efforts of the conservationists, backed by the federal government, to 'save' the coal for some future use, at an indefinite date. * * *.

"The reformers, as these gentlemen term themselves, are advocating the government building and operation of railways in Alaska, and the government ownership and operation of coal mines, which is state socialism pure and simple, and any man seriously advocating such a policy is a socialist, no matter what he may choose to call himself. It is further advocated by the junior senator from Wisconsin, and his official and unofficial organs, that the government also should buy the Copper River & Northwestern railway from the Guggenheims. Doubtless the Guggenheims will be very glad indeed to sell their railway, which is threatened by tidal floods and glacial floods, with its principal bridge across the Copper River threatened by a glacier itself, but it is difficult to see where the long-suffering taxpayer will benefit by such a purchase."

SIDE-LIGHTS ON SITUATION.

It should not be inferred that in exposing the certainty of an early collapse of this unfortunate venture, Mr. Stevens had any thought of "knocking" or blocking probable future attempts of the Guggenheims to recoup their loss by the usual method of bond and share flotations. On the contrary, it was clearly his design to clinch his denunciation of the Government's acts in intercepting the Guggenheim "coal land grab" and thereby enlist the sympathy of the public in behalf of those gentlemen because of the great loss they had sustained by reason of failure to get away with these valuable coal fields, in addition to being "buncoed" in their copper mines and railroad investments; though in the latter case they were following the advice of the "greatest mining engineers in the world."

Of course the good people of Alaska are much disgruntled at the failure of the Guggenheim-Cunningham-Ballinger Pierce land piracy—regardless of the future monopoly they were fostering—because, for a time at least, it meant the expenditure of large sums of money in that immediate locality, and greatly increased industrial and speculative activity throughout the entire region, thus affording resident citizens innumerable opportunities for thrift. But, like the people who inhabited the region traversed by the Union and Central Pacific railroads, they were willing and would have been glad to see the most valuable possessions of that entire region given away if thereby an opportunity for immediate temporary gain were afforded.

And so, in the case of construction of the Union Pacific, no one thought of the empire of choice lands that were donated to the projectors of that great enterprise, in addition to sufficient money to have built a double-track line for the entire distance covered. But, in later years, when they came to realize that every person, article of produce or merchandise that was transported over these lines was taxed to the very limit of endurance, (all local traffic being charged full through-rates to the west coast and back to destination), many have been heard to curse the day that those roads were conceived.

PLANS THAT WENT AWRY.

Recurring to the Copper River railroad and mining enterprise: From their well known methods of financing their undertakings, frequent expressions of surprise have been heard that the Guggenheim Brothers have not long since sought to draw from the public the necessary funds with which to handle the business by means of the issue and distribution of convertible bonds and shares. But the reason for not doing so is plain.

At first they thought they possessed the greatest copper mine in the world, and naturally wanted to keep it all in the family. In truth, they made no effort to conceal the fact that they expected thereby to actually control the copper metal markets of the world—for had not the greatest engineers in the world told them so? And, besides, upon such assurance they had enlisted the house of J. P. Morgan in the enterprise, and therefore no further financial help or division of profits was desired. It is well understood, however, that the rounding out of the enterprise contemplated the inclusion of the coal mines in the railroad-copper mines combine, whereupon the flotation of a $100,000,000 convertible bond issue would have seemed extremely modest and in fact would have been much more conservative than many other of their offerings.

With Brother Simon in the United States Senate, and chairman of the public lands committee; with Ballinger and Frank Pierce at the head of the Department of the Interior, and Cunningham in charge of the small army of hired entrymen in the field, the situation for a time seemed most promising. But luck was against them, likewise the blatherskite Pinchot, and finally the President took a hand, with the result that the scheme was "cooked to a frazzle." And now comes the copper historian, Stevens, and declares that the ultimate net profit derivable from those great Copper River copper mines "CANNOT, BY THE MOST LIBERAL FIGURING, be estimated at more than four million or five millions of dollars," whereas the actual cost of the railroad to date is estimated at from thirteen million to twenty-five millions of dollars.

SIMON'S PATRIOTISM WANES.

Having failed in the purpose for which he is said to have bought a seat in the United States Senate, Mr. Simon Guggenheim has announced that his business interests make it imperative that he shall vacate that seat and resume more pressing duties, wherefore some people may wonder what he meant when he said, upon entering upon his candidacy for the Senate, that he had "disposed of all of his business interests and if elected would devote his entire energies and time to the interests of his constituents and the public." But this is unimportant. Now Simon knows that both he and the country have had enough, and he will retire wiser, though poorer and sadder.

As to the rest of the "retiring bunch," Frank Pierce at least appears to have improved both in worldly possessions and native cunning, so that the firm of which he is star member has found it expedient to extend the field of its operations to the oil regions of California, where Mr. Pierce should find profitable employment in a congenial atmosphere. And as to those "Great Engineers" who steered the hapless Guggenheims against the Copper River "GOLD BRICK," one at least—Mr. A. Chester Beatty—now counts his dollars with seven figures and, as we are informed, has since opened an office in Bankers' Row, London, where he will doubtless find a new crop of "suckers," in the meantime awaiting the result of an action now pending before Justice Gerard, of the Supreme Court, New York, wherein Mr. Beatty is seeking to collect from his former employers the sum of about $700,000 as the price of options conveying a portion of these Yukon properties.

YUKON "GOLD BRICK."

But the mistake and misfortunes into which the Guggenheims were lured by these great engineers are not limited to the Copper River "Gold Brick." The "Yukon Gold" promises to be equally unprofitable. In this case, like the Copper River venture, the promise of profit for a time seemed to be too good to admit of any portion being offered to the public (not even Morgan was allowed participation) until some fifteen millions of hard-earned dollars had been dumped into and filtered through the stupendous engineering schemes that had been planned in the New York offices of these great engineers and which they promised would yield more real gold than Solomon ever dreamed of. But in course of time —as in case of the Copper River "gold brick"—the cold fact began to dawn upon the Guggenheim Brothers that, although there was much "glitter," very little gold had come into view. And the panic of 1907 was still on in full force. The capital stock of the company at that time consisted of three million shares, par value $5, or fifteen million dollars, all issued and fully paid, being 500,000 shares for each of the six brothers participating, one (Benjamin) having—as we are informed—withdrawn from mining investments. The "Nipissing deal" also had just put an ugly crimp in their exchequer, so that there was urgent need for other people's money—in fact, the "boys" were "all in."

Then it was that an additional issue of 500,000 Yukon shares was determined upon and Tom Lawson was called in to dispose of the block at $4.50 per share net to the corporation. As nobody else had any shares, Lawson found it easy—by his methods—to "wash" quotations up to $8 and better, and it was reported that about 140,000 shares were disposed of at prices ranging from $5.50 to $8; but this stock practically all came back within a few days, so that, after a campaign of a few weeks, Mr. Lawson found himself again in possession of the entire issue and minus considerable cash because, in order to support the "boom" he had started, it became necessary to take all offerings at advancing prices, the final result being that the six brothers were compelled to supply the cash and keep the entire issue of 3,500,000 shares in the family, bringing their total investment up to $17,500,000.

The property has paid in dividends to September of this year $3,150,000, a return of a total of 18% of the original investment, and it is not believed that this sum will be duplicated during the entire future productive life of the property. But the eminent engineers who "turned the trick" are still in affluent circumstances.

THE BRADEN FLOTATION.

In addition to th foregoing our friends, the Guggenheim Brothers, have some other enterprises to their credit which give promise of similar results, all promoted by the same corps of eminent engineers, prominent among which is Braden Copper, located in the province of O'Higgins, Chile. The ores are of the same general character as those of the so-called porphyry deposits of Utah, Nevada and Arizona, and the ground—operated by natives—had for many years been productive of considerable quantities of high-grade ores which occurred in small, irregular seams which had been pursued in depth as far as any profit could be realized therefrom. But the property for years had been practically deserted until it was picked up by the Guggenheims at a comparatively nominal cost and incorporated with a nominal share capital of $6,000,000, divided into 1,200,000 shares of the par value of $5 each.

Strenuous efforts were made to distribute sufficient of these shares to return the purchase price and provide a development fund, and also to equip the property with reduction works of moderate capacity; but owing to the unsavory character of the "Nipissing deal," which was pulled off at about that time, the public refused to follow the Guggenheims and their engineers into that far-off and uninviting region. So that, to make the scheme more attractive, the usual method of convertible bond issues was resorted to, with the hope of securing from the public the necessary funds. A portion of these issues were listed on the London Stock Exchange and also on the New York Curb, but with indifferent success in all cases. As a result, the burden of carrying the entire flotation fell chiefly upon the Guggenheim Brothers themselves. There has been four installments of these convertible bond issues—of $2,000,000 each—making in all, to date, $8,000,000. The first three issues bear 6% interest, though this rate was increased to 7% in case of the last issue. But the increased rate seemed to render the bonds even less attractive than those bearing the lower rate.

An explanation of the lack of confidence on the part of the public in this "flotation" will be found by reading "between the lines" the latest report of Pope Yeatman, which was recently given to the public through the usual publicity channels. Possibly in the course of a year a considerable portion of the outlay may be returned, but at present and in the meantime the Guggenheims, in following the advice of their ex-engineers, have added probably nine or ten more millions of dollars to their Alaskan burdens, which must swell the total amount of these unproductive and unrecoverable millions well above the FORTY mark, without having scored a single winner.

Naturally the investment of this vast sum in unproductive fields must produce severe stringency in other channels, which no doubt in part will account for the announcement contained in late New York dispatches to the effect that "Daniel Guggenheim, Murray Guggenheim and Edward Brush have retired from the National Lead Co.," otherwise known as the "lead trust." This corporation was formed some fifteen or more years ago by the Guggenheim Brothers, and through it they have maintained a complete monopoly of the lead manufacturing industry ever since. They have drawn down in dividends from its operations over $24,000,000; but the time having come when they needed quick money they have no doubt disposed of their holdings, and hence retired from the directorate. And now that the Senator has resigned an unprofitable and uncongenial position, the brothers will doubtless get together again and endeavor to recoup their scattered fortunes—and in the future it is likely that they will not require so many nor such high-priced engineers.

It might be thought that, instead of parting with National Lead, the Guggenheim Brothers would have disposed of Utah Copper shares, of which they have very large holdings; but that would have been impossible for the reason that all of their shares in that issue, together with those of the other "inside" holders, have been securely locked up in a "selling pool" for the past four years—as previously shown by this journal—and it has been impossible in the meantime to work up a public demand for these shares. Of course liquidation of the pooled interest has been impossible. Besides, in order to preserve the entire proceeds derived from the sale of the mine's product for distribution as dividends, the burden of providing funds to meet the "stripping" costs, as well as the construction of the Bingham & Garfield railroad has fallen upon the "pooled interest," so that as a result, and as previously stated in this magazine, A BOND AND FLOATING DEBT OF ABOUT $11,000,000 NOW BEING CARRIED BY THE POOLED INTEREST, stands between the individual members thereof and any possible profit that may hereafter be derived from the "distribution" of pooled shares.

AN ECHO OF YUKON GOLD

Before Supreme Court Justice Gerard, Thomas W. Lawson of Boston testified that in order to raise $3,000,000 the Guggenheim Exploration Company capitalized the Yukon properties in Alaska at from $17,500,000 to $25,000. He was engaged to float the stock by advertisement.

Lawson testified for the plaintiff, Alfred Chester Beatty, mining engineer, who sued to recover about $700,000 as his reward for having passed his options over to the company. Delays in settlement caused the suit.

When the Guggenheim company obtained the property Lawson talked with Daniel and Sol Guggenheim about letting the public in on the stock. He testified that the large outstanding interest bothered him, as he feared he might be fed with the stock of insiders if he made a good market. The Guggenheims promised to keep their stock out and also that of Engineers Treadgold and Perry, but it was thought best not to take Beatty into the pool and Lawson was unable to learn how much stock Beatty held or was entitled to hold.—New York dispatch in Boston Financial News, Dec. 20, 1911.

The memory of Mr. Thomas Lawson is at fault wherein he indicates that the nominal cash capital valuation of the "Yukon Gold" was raised from $17,500,000 to $25,000,000. The exact facts in this regard are as stated by us in the article preceding the above item of court news from New York.

EXPLORING DREDGING GROUND

By AL H. MARTIN.

Most of the failures attending dredging in late years are directly traceable to careless or incompetent examination of deposits. To be economically successful the territory must be sufficiently extensive for the type of boat designed, and must necessarily contain sufficient gold values to justify the large expense attending preliminary arrangements. As in many other branches of the mining industry, the tendency has frequently been to undertake the construction of a costly dredge before resources were comprehensively demonstrated. As modern dredges cost all the way from $50,000 to $250,000, it is readily aparent that resources must be ample to justify initial expenditures.

In prospecting dredging ground many elements enter into consideration. A deposit may contain comparatively high gold values and yet prove unprofitable because of hard rough bedrock; presence of huge boulders; abundance of clay, etc. The principal factors, however, consists of sufficient ground, good gold content and fairly favorable economic conditions. Exmination of dredge holdings should be under the supervision of an engineer skilled in this branch of the mining industry, as one of little knowledge of the difficulties attendant upon the dredging practices would be apt to find unexpected problems suddenly developing.

In California dredging has been brought to a particularly high standard, and the modes of prospecting prevalent in California districts are favorably regarded by operators of other fields. The general practice is to sink a number of small prospect shafts, or conduct explorations with Keystone drills. Testing deposits by prospect shafts is considered the most satisfactory method, but this mode is restricted to favorable localities. A great percentage of California dredgable ground has been proven by the Keystone drills ,and this methodd is applicable to all districts, even with most adverse conditions regnant.

Round shafts are usually employed, with a uniform diameter from surface to bedrock. For shafts of approximate depths of 30 feet the diameter is usually three feet. For shafts of 50-foot length or deeper the diameter is increased to 40 inches. When shafts are sent down in wet ground round iron caissons are generally employed in place of lagging. These caissons are usually installed in four-foot sections. However, when the ground is so loose or wet that considerable timbering is required, shaft sinking soon becomes too expensive and is replaced by drill holes. Under favorable conditions the cost of shaft-sinking runs from 50 cents to $2 per foot, but when timbering is required costs run high. California operators generally employ the shaft-testing method only when conditions are favorable, as timbering of loose ground proves too costly. At times the entire amount of material taken from the shaft is washed and sampled, while in most instances a small portion of the material is taken sectionally from surface to shaft-bottom. The great advantage claimed for the shaft method of testing gravel deposits is less liability to error if extracted material is carefully handled. In drilling, a careless runner by failing to keep the pipe well ahead of the bit allows the pumping out of an excessive quantity of materials when the drillings are extracted. This, of course, results in indication of higher values than the deposit contains. If the pipe is driven too far ahead of the drill, particularly in loose ground, the drill pipe is liable to become clogged and not sufficient material is removed to indicate the real value of deposit. Elements like these naturally compel the exercise of constant care and require the employment of skilled runners and engineers.

The Keystone No. 3 traction drill is employed by most California operators. This machine is usually equipped with an 8 or 10-hp. boiler, and drives the drill by means of a walking beam. Of late years the boiler is being replaced by a motor, as the main dredging fields are well supplied with electric power. When the boiler is used, wood, fuel oil and coal are burned, the class of fuel depending upon the locality. Six-inch casing is usually employed, divided into five to seven-foot sections. The sections are added as additional pipe is required. Occasionally drilling has been accomplished in hard ground with the employment of casing, but the practice is extremely dangerous, as the core can not be considered as truly accurate. And when the ground is sufficiently hard to drill in this manner it may also prove too difficult to be successfully dredged. This is a feature commanding the attention of the examining engineer as a too difficult ground means complete failure, no matter how high the gold values may be. This fact must be determined before the construction of a dredge is recommended, not afterwards.

Drillers recommend the employment of a slender bit when testing sand or gravel, with quick long strokes favored. This prevents a settlement of material between strokes, with the re-cutting of material, loss of time, and possible loss of gold. In this mode of drilling the machine delivers 55 to 60 strokes per minute, with each stroke over 36 inches long. When the bedrock or large boulders are drilled a heavy rock bit, with a wider cutting edge is used. In all instances it is advisable to keep the drill sharp to prevent a possible flouring of the gold.

A vacuum pump, composed of a steel cylinder equipped with a piston rod surmounted by a valve is employed to extract material from the casing. When working above water level, or in dry ground, some water is constantly kept in the casing to assist pumping and facilitate drilling. Pumping is usually done after drilling a foot, although some operators send the drill down several feet before resorting to the pump. Pumpings are repeated until all material in pipe to within a few inches of end of hole is withdrawn. Usually two or three pumpings suffice for each foot put down, but this varies with the character of material. The extracted mterial is discharged into a pan placed in the sample box, washed and the gold values recorded. The tailings and material escaping from pan into the sample box are placed in a tub and treated by rocking. The fine colors from pan and rockers are kept in a small dish and amalgamated at conclusion of work. The amalgam is usually kept in a vial and the quicksilver later parted from the gold by nitric acid, after which the gold is washed, dried and weighed. Other operators avoid the use of quicksilver by separating gold from the black sands by magnets and close panning. Every endeavor is made to carry on sampling, amalgamating, etc., under identical conditions as prevail on dredges in actual practice. By this means over-valuation of the material is avoided, and the results obtained are accurate.

Costs of drilling varies in accordance with existing conditions, the more difficult ground naturally resulting in heavier costs. Under favorable conditions drilling costs generally range from $1.50 to $2.50 per foot, but this may be increased by accidents or the encountering of particularly refractory deposits. It is imperative that a large number of holes be sent down in order to gain an accurate record of the value of deposits. In every instance the greatest care is required to prevent over-valuation. In considering the value of a deposit many engineers base their calculations on 75 to 80 per cent of the total value shown by the prospect drills or shafts, considering this a safe figure. However ,experiments prove that actual results vary considerably from tests, although careful work largely eliminates the element of risk.

The life of a dredging enterprise is restricted to proscribed confines. The experienced engineer knows how much ground will be handled and the approximate value of the total recovery. Unlike a quartz mine, there is no possibility of profitable existence beyond the developed resources. Consequently, in considering a dredging proposition the profits in sight must be sufficient to return the entire amount of capital invested, with a good rate of interest added. California operators generally consider 10 per cent as the minimum rate. An acre of ground 33 feet deep contains 53,240 cubic yards, which allowing for loss in operation, would mean the handling of 50,000 cubic yards by the dredge. One hundred acres would embrace about 5,000,000 cubic yards of material, or sufficient to keep a medium-capacity boat in commission for about four years. The more extensive the area the greater becomes the ultimate profits, provided values are fairly uniform throughout. And the more material handled the lower is the cost per cubic yard.

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Selenium is a rare and little known element described by the United States Geological Survey as having its greatest use in the manufacture of certain glasses to which it gives a red color and in coloring enamel ware red. It is used to overcome the natural green color of ordinary glass and also in making glass of a distinct red color such as that used on railroads for signal lights. Selenium has the peculiar property of being a very poor conductor of electricity in the dark and a fairly good conductor in the light, and a number of electrical inventions depend on this peculiarity. It has been used in experiments in telephoning along a ray of light, and for transmitting sounds and photographs from one place to another by means of a telephone or telegraph wire.

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As the strength of concrete depends largely upon the thoroughness of the mixing, great care should be exercised in this respect.

Mines and Methods

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CONTENTS:

Seventy-seven United States Circuit Courts will go out of existence on Jan. 1. This is only one of the reforms provided for in the new judiciary code enacted by Congress last March. Since the Circuit Courts of Appeal were organized in 1891 the existence of the old Circuit Courts has been regarded as superfluous and expensive. Twenty-nine circuit judges will lose their benches but they will continue to sit in the Circuit Courts of Appeals and help out in the District Court. All the clerks of the Circuit Court will see their position abolished. The new code makes the salary of the chief justice of the United States Supreme Court $15,000 a year and each associate justice $14,500. Jurors for federal courts hereafter will receive their summons by registered mail instead of being personally served by marshals. The new code contains a provision to prevent members of Congress from practicing before the Court of Claims here.

UTAH COPPER IN PARIS

In its review of the copper share market the Paris Globe of November 30 comments on Utah Copper. Translated the item reads:

"It was certain that the introducers (promoters) of this property would try to profit by the awakening—durable or passing—of the coppers to resume the sale and consequently place their titles (shares). It is for that reason that the Utah Copper stock, the sale of which had fallen into oblivion, has briskly awakened and advanced to 275f ($55.10). It would be useless to point out the dangers of these intermissions (ups and downs) or the particular conditions under which the Utah Copper shares find themselves again admitted to our market, for the buyer is bound hand and foot to the good pleasure of the introducers. They will sell their titles (shares) and buy them in again, when it pleases them, at their own prices."

This is the first mention the Globe has made of Utah Copper shares in a long while. The item is evidently intended as a warning to the French investors that if they "monkey" with Utah Copper again, they may count on getting their fingers burned, as they did following the first listing of the 300,000 shares of individual stock at an expense to the company of $250,000—according to newspaper reports at the time—about two and one-half years ago. The Globe's statement that the shares have "again been admitted to our market," would indicate that after the sale of the something over 2500 shares to about 2100 French patrons of the market at and around $56 a share—and the succeeding slump—the "introducers" and their wares had been bundled out into the street. Mines and Methods told how all these shares had found their way back into the hands of the "introducers" at the cheap prices and now the Globe warns the French people that, with the opportunity afforded in the better price of copper metal, these "introducers" have again secured recognition on the Bouse with the evident purpose of repeating the original performance. The Globe is evidently awake to the fact that it is within the power of the "introducers" to make and break the price of this stock at will—to fictitiously advance the market price for selling purposes and likewise put it down when they want to buy—thus making it possible to reap a harvest from the Frenchmen going and coming.

The would-be French investor should not overlook the fact that when the 300,000 shares were listed in Paris two and one-half years ago, all of the capital stock had been distributed. Since that time the number of shares have been increased from 750,000 to 2,500,000. Of the extra shares authorized about 900,000 are still unissued and available to supply any demand that the management may be able to create. In addition to this reserve stock the company also had, when the recent upward turn in the market was effected, about 85,000 shares of the 160,000 shares set aside for money-raising purposes to be sold at $50 a share and of which 75,000 was converted into cash about two years ago. It is believed that a considerable amount of this remaining 85,000 shares of stock has been shoved on to the market since the rise in order that a better financial showing might be made when the forthcoming annual report is made up, and to relieve the heavy strain of the burden now being supported by the "pooled interests"—as shown in a previous issue of Mines and Methods—resulting from advances made to carry these costs against a time when the price of shares might be advanced and the load shifted to the public.

IS IT WORTH WHILE?

Since the adjournment of the American Mining Congress and the promulgation of the various resolutions adopted by that body aiming at the betterment of conditions under which mining is carried on, technical and class journals are beginning to discuss the propositions set forth by the Congress. The resolution memoralizing Congress to establish, under direction of the Bureau of Mines, metallurgical experiment or ore-testing stations for "the purpose of devising methods for the extraction of metals from low-grade ores" appears to have created some friends and some adverse criticism.

Mines and Methods does not wish to say a word that might be construed as being in any sense inimical to the best interests of the industry or those engaged in the business of mining, milling smelting or any of the professions which depend upon mining for existence; and yet, the impression will not down that in the matter referred to the Mining Congress is asking for something which, if obtained, would work more harm than good.

It may be granted that there are plenty of people in the world—including wealthy corporations perfectly able to bear the cost of making their own experiments—who would grasp the chance to have the government supply the talent and do the work for them; but we submit that such a plan would soon destroy the incentive and determination to do which today exists in the ranks of the mining, metallurgical and mechanical engineering professions.

Into the government laboratories and testing plants would most likely go mainly such degrees of skilled artisans as the "political pulls" or business importance of the particular locality effected would command and, once installed, only changes in the political complexion of the communities would work to dislodge them. A great show of "learning" might be made in the beginning, but it could not last—and while it did the engineer or metallurgist with a method or process worthy of testing would more than likely discover that his education, training and labor of years had all gone for nothing; that effort and research in his particular field, without having the sanction of the "political" engineers in the "public" works, could not secure recognition. And it might be added that no engineer of ability, with a problem personally solved, would care to turn it over to a government concern for the benefit of everybody without commensurate compensation, even if the "works" were inclined to give it a trial.

It seems to us that anybody—either individual or corporation—with complex problems in ore treatment or mining methods to solve can find a way to final solution without the aid of the government. The brightest minds in the metallurgical and allied engineering professions today are encouraged in their work through the knowledge that individual merit is sooner or later recognized; to abridge the field and close the gates of recognition and opportunity against them, would be to pursue a policy that would, in a few years, work incalculable injury to the mining industry. Metal mining is a peculiar business and calls for the widest range of technical skill. Its diversified and extremely intricate metallurgical and engineering problems can never be successfully relegated to solution by public testing works. Banish the thought.

BROKERAGE PUBLICITY

The exaggerated mining news items published by Chas. A. Stoneham & Co. have bred much mischief, says the December issue of the Canadian Mining Journal. One mining company has adopted the expedient of advertising in the daily papers the fact that it cannot be held responsible for any statements made by Chas. A. Stoneham & Co. It would be a very wholesome thing if every mining company whose shares are listed on Canadian exchanges were to make a similar protest. Unclean parasites, and this describes the firm of Chas. A. Stoneham & Co., could thus be promptly choked to death.

EDITORIAL NOTES

The appointment of Waldemar Lindgren as chief geologist in the United States Geological Survey is one that will be enthuiastically approved by every mining man and engineer in this western country.

The dividends paid by mining companies operating in the state of Utah during the past twelve months aggregate over $9,000,000, or approximately $1,000,000 more than in 1910.

It is seven long years since the Salt Lake Stock & Mining exchange has been compelled to record as small a volume of business as during 1911. In 1909 over $17,250,000 worth of transactions were registered. For 1911 the total will not be over $4,000,000. However, with two dull years shoved out of the way, the outlook for a lively twelve months ahead is much more encouraging.

The better prices that have ruled in the lead and silver markets during the past several months has had a splendidly stimulating effect on operations in the lead-silver camps of the West and the coming year should witness a genuine revival of interest all along the line. Alta should show up well and Park City should make a better showing than for several years past. Bingham, Tintic, Beaver county, Pioche and many other camps and districts tributary to Salt Lake valley smelters are counted upon to greatly increase outputs and shipments of ore.

Last January, when Mines and Methods published the highly instructive and entertaining article on "Unsolved Problems in Geology," by Hiram W. Hixon, a number of vexing errors crept in and an omission of several hundred words, through loss of manuscript, destroyed at least one of the vital points in Mr. Hixon's discussion. Recently Mr. Hixon passed through Salt Lake on his way home from Los Angeles and at that time he was prevailed upon to make the necessary corrections in the article so that it might be reproduced in this issue. So much interest has been shown in the theories advanced b Mr. Hixon in that article, by geologists and scientists in different parts of the world, that we feel certain our readers will be glad of the opportunity given by the article's republication of again going over the subject.

On the 15th of the present month the Iron Blossom Mining Company, operating in the Tintic district and controlled by the Jesse Knight interests, issued its annual report. To the officers of that company Mines and Methods wishes to offer congratulations and commend the honesty and candor, lucidity and detail of that report. It is a model of excellence in which there is not a suspicion of the juggling of figures. No one, after reading it, has to guess what the profits of operation have been. Every dollar received has been intelligbly accounted for; the costs of mining and development are separately shown and properly apportioned and charged against the separate tons of ore mined with such splendid, clear-cut detail, that "he who runs may read" and understand. Mine conditions are just as clearly explained and discussed. When some of the big companies begin producing such reports they will be entitled to more consideration at the hands of the investing public, because then the purchaser of their shares will have some idea of what he is getting for his money without having to laboriously pry out the "cull'd gem'man" from the woodpile.

GOOSE TELLS OF GOLDEN EGG

Telling of boundless wealth, illness, privation and hope abandoned in the h art of the Alaskan wilds, a message signed "Frank Wilson" was found tied to the leg of wild goose killed recently by a Granite City, Ill., sportsman, says the Engineering and Mining Journal. The message read:

"July 16, 1910—250 miles due north of White Horse rapids, on Pine creek. Ill since June 15. Feel certain I am going to die. Right arm broken above elbow in falling from side of mountain. Can hardly walk. Flour in cabin, no way of cooking it because of my condition. Two hundred yards up the gulch is a body of almost solid gold—not nuggets, but a solid sheet or vein. It will never do me any good. Winter is near. I will freeze to death. There is no hope for me. I can hardly move in my bed. I came from Memphis, Tenn. My last move before I die will be to call to my side a young goose of wild breed, which I have raised from a gosling. I will tie this message around its neck. When I am dead it will become wild again and fly away."

This story is indeed touching, and were it not one of our hardiest perennials, might start a new rush to Alaska. Those who don't go immediately, however, will be on hand for staking in the goldfield annually presaged by the finding of nuggets in the gizzards of chickens.

The ultimate strength for ordinary iron castings may be taken at from 15,000 to 18,000 pounds to the square inch.

SURVEYING A MINE WITHOUT INSTRUMENTS

By J. B. HARPER*

An experienced engineer and the best of instruments is the only safe combination to be intrusted with the mapping of a mine, but it sometimes happens in the case of a remotely situated prospect that neither surveyor nor transit is at hand and an approximate map of the workings is badly needed. The method which I shall try to explain will be recognized by any surveyor as merely a crude adaptation of the plane-table. For those without technical training it may be of interest.

We will assume that the man who wants the plat knows nothing of trigonometry and does not even own a compass. All that will be required is a tape line, a 2-ft. square, some stout twine, a few pins and a sheet of paper with a flat surface on which to fasten it—the bottom of a powder box, for example.

Suppose that a raise has been started

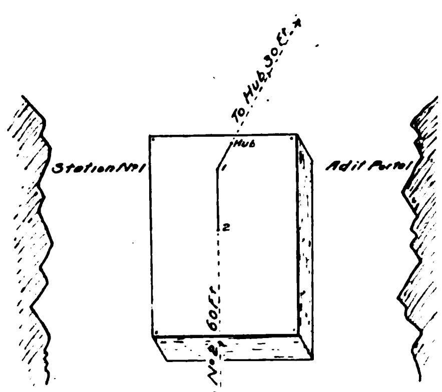


Fig. 1

in a rather crooked adit about 200 ft. from the portal, and it is essential to know about where that raise will come out on surface and how high it will have to be carried above its present point.

Select a place on the dump where there is an unobstructed view of the hillside cut by the adit, and there drive in a drill. After tacking a sheet of paper securely on the bottom of a powder box place the latter bottom side up at the portal of the adit as nearly level as possible and stick a pin in the paper not far from the edge closest to the dump. (See Fig. 1.) From this pin sight along the surface of the paper to the drill on the dump, and in the line of sight close to the edge of the paper stick another pin. Tape the distance from portal to drill, which we will suppose is 30 ft. Adopt a certain scale for the plat, say 1-16 of an inch to the foot, then that distance on the plat will be 30-16, or 1⅞ in. Draw a line from the first pin to the second and 1⅞ in. from pin No. 1 make a dot on the line and mark it "Hub," being very careful not to move the box.

At the first turn in the adit, as far as

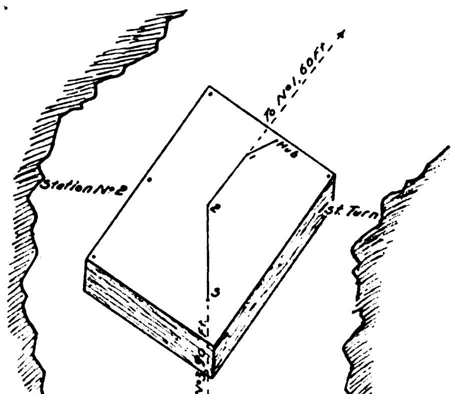


Fig. 2

it is possible to get an unobstructed view of the box, drive a nail into a tie or make some other distinctive mark, and there place a candle. Make sure that the first line drawn still points directly to the drill on the dump, then sight from pin No. 1 to the candle; stick a pin on the line of sight, tape the distance and scale it on the paper as previously; mark that point No. 2. Pick up the box and drive a drill into the ground as nearly as possible under that point on the paper marked No. 1. Move the candle to the next turn and set up the box in the place just occupied by the candle, so that the line drawn from No. 2 to No. 1 will be exactly in the line of sight between those two points (Fig. 2). Then proceed as above at each turn in the adit.

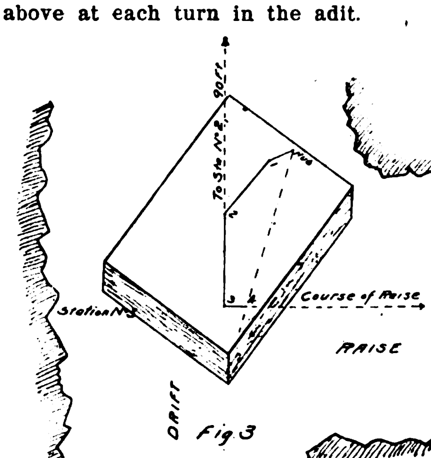


Fig. 3

When the raise is reached its course may be plotted on the box just as the various turns in the adit have been; but it is also necessary to get its horizontal and vertical projections, that is, its length on the horizontal plane (as it would appear on the plat) and its height on a vertical plane. To do this, stretch a string near the hanging wall, giving it as nearly as possible the same angle as the raise from top to bottom. (See Fig. 4.) Suspend a plumb line from the hanging wall and hold a square so that one blade will lie along it and both will project beyond the string. Move it up or down along the plumb line so that the 1-ft. mark on one of the blades will intersect the string along the hanging wall. As shown in the illustration, the lower blade from string to plumb line (C-B) measures 1 ft. and the upper (A-B) 18 in., or 1½ ft. The distance along the string (A-C) is found to measure approximately 21½ in. In measuring this distance it is convenient to stick pins through the string at points of intersections (A and B). From the above it will be seen that in 21½ in. of the raise the vertical projection is 18 in. and the horizontal projection 1 ft. If the raise is 50 ft. long, or 27.9×A-C, its horizontal projection will be 27.9×C-B, or 27.9 ft. Reducing this scale, it will be about 28-16 or 1¾ in. Measure this distance on

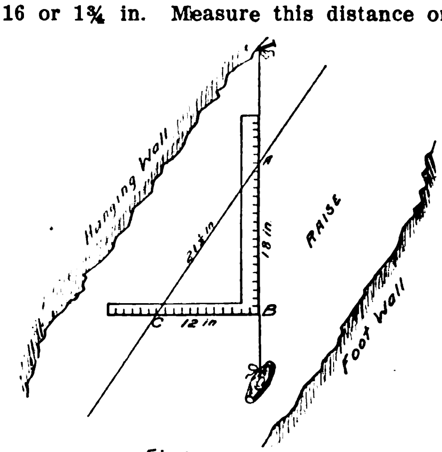


Fig. 4

the plat and call it station No. 4. (See Fig. 3.) The vertical projection is obtained in the same way and the result will be 41.85 ft. If the work has been carefully done the plat will now show approximately the position of the top of the raise in relation to the rest of the plan. Draw a line from "Hub" to point No. 4. Take the box out to the "Hub" and set it so that the line drawn on the plat from "Hub" to Point No. 1 will conform to the same line marked upon the ground by the drills previously set at "Hub" and portal. The dotted line from "Hub" to No. 4 now gives the direction to the top of the raise, and by measuring it the horizontal distance is obtained also. Get the slope of the hillside in the same way that the angle of the raise was measured, but for convenience substitute a straight-edge instead of the string. Calculate the horizontal and vertical distrance as before. To find where the raise will "hole through" on surface, if continued at the same vertical angle, make

*Mining Engineer, Denver, Colo., in Mining Science.

an elevation sketch (see Fig. 5) to scale on a large piece of paper. The illustration (Fig. 5) needs no explanation; H-G at surface, measured on the course of the raise, will give the desired point.

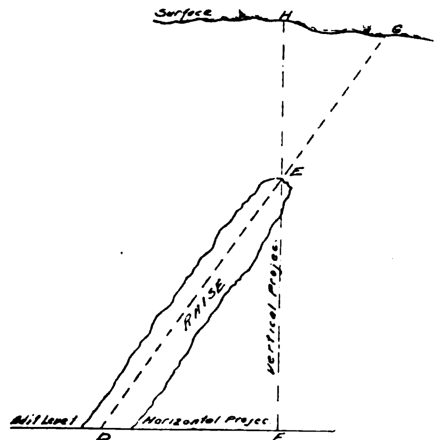


Fig. 5.

For brevity in explaining the above I have purposely taken a simple example. The larger the scale and fewer the angles the more accurate will be the result, which at best can be only roughly approximate.

WET ASSAYING FOR GOLD

By G. M. AUSTIN.*

From time to time details have been published of various methods used for the wet assay of gold ores which enable the prospector to carry a portable outfit to a remote district without the necessity for taking a field furnace, crucibles, cupels, fluxes, etc.

With a view to determining the degree of accuracy obtainable with both free milling and refractory ores, the author has conducted a series of tests, using a wet method described by R. De Luce and which is carried out as follows:

About 50 cc. of a solution consisting of 100 parts of water, 2 parts of iodine, and 4 parts of potassium iodide, are added to one assay ton of finely-ground ore in a porcelain mortar. The mixture is ground well for 10 minutes and allowed to stand for 1 hour to ensure the solution of all the gold in the ore. Should the solution become colorless in the meantime, there is an excess of reducing agent in the material and a further quantity of iodine solutions must be added until the brown color remains permanently. The iodine solution is next filtered and the residue is washed, the solution and washings transferred to a stoppered bottle, 3 grm. of pure mercury added and the whole shaken vigorously until the solution becomes colorless. The gold is thus precipitated and forms an amalgam with the mercury, which is transferred to a porcelain evaporating dish and washed with water.

Ten cc. of nitric acid are added and the dish warmed gently until vigorous action commences. The mercury collects as a single globule and dissolves, leaving the gold in a compact bead. The mercury nitrate solutions is next poured off, the gold bead is washed with distilled water if available, otherwise with waters lightly acidified with nitric acid. The gold bead obtained is dried and weighed. Instead of weighing, beads may be compared with standard beads mounted on a card, or after melting, may be measured.

De Luce states that the method is adapted to all ores that can be successfully treated by amalgamation, or by the cyanide or chlorination processes. With certain modifications it may be adapted to almost any ore, and for ores rich in copper he suggests a preliminary treatment with nitric acid to remove that metal.

A method very similar to the above has been described by Dr. F. Jerome Davis, who recommends an iodine solution of exactly the same strength as that mentioned above, and uses 40 to 50 cc. for each assay ton of ore. This mixture is ground in a mortar at intervals for two hours and filtered, 40 to 60 grm. of zinc amalgam being added to the filtrate and the whole agitated freely. The gold is recovered from the zinc amalgam as in De Luce's method.

Dr. Davis states that, in the case of silver ores, ½ assay ton may be taken, the silver being precipitated from the nitric acid solution with hydrochloric acid and weighed as silver chloride.

The following results were obtained by the author from free-milling and refractory ores, containing from a trace to several ounces of gold to the ton.

In each case assays were carried out by the iodine assay, as detailed first in this paper. With a large variety of ores, results may be obtained which are sufficiently accurate for ordinary field work.

Many oxidized ores, containing only a trace of gold, showed this trace quite distinctly. Low results were obtained in every case with basic ores containing manganese. Pyritic ores containing iron pyrites gave somewhat low results, while the simple treatment of pyritic ores containing copper pyrites gave no gold on a 34 dwt. ore; in this case, even after roasting, no gold was obtained, and after nitric acid treatment only 44 per cent was recovered. The telluride ore gave very good results, although it was found that as much as 150 cc. of the iodine solution might be required in order to obtain a permanent iodine color in the solution, whereas 50 cc. was sufficient for most of the other ores. In the case of the ores containing zinc blende and mispickel, it was found to be impossible to get more than 75 per cent of the gold by wet assay.

A series of experiments proved it to be necessary to shake the filtrates with mercury until the whole of the iodine color had been dispersed.

Where many assays are being made and only one mortar is available, the preliminary grinding may be made in the mortar, and the pulp run into a bottle in which it is shaken occasionally, the iodine solution being added until the deep color is permanent.

The filtration of the pulp may be expedited by the use of glass wool as a filter. If the filtrate be somewhat cloudy, a second filtration through paper is an easy matter.

The mercury used should be examined for gold by solution in nitric acid and its amount determined if present. Commercial mercury usually contains small quantities of gold.

In case nitric acid should not be available for dissolving the mercury, this may be volatilized, either in a glass tube or on charcoal by means of the blow-pipe and the remaining gold weighed.

If the beads are to be measured on an ivory scale, it must be remembered that it will be necessary to melt them down before the blow-pipe after they are obtained by solution of the mercury in acid.

The chemicals necessary for carrying out 100 assays for gold by this method consist of 4 oz. iodine, 8 oz. potassium iodide, 10 oz. mercury, and 1 litre nitric acid, while the apparatus necessary will include iron mortar, pestle and sieve for preparing samples, ore balance, Wedgewood mortar and pestle, bottles, funnel, glass wool and filter papers, spirit lamp, wax lam or candle, porcelain crucible, blow-pipe, small delicate balance or ivory scale.

In calculating the size and strength of a hoisting engine for a shaft, it is important to remember that the dead load which has to be overcome at the beginning of the wind, requires more power to move it than is necessary subsequently to keep it in motion. In order to leave sufficient margin, it is best to consider the load as equal to the combined weights of the coal or ore hoisted, the rope, the cage, and the cars.

Solution, according to Van L. Hoff, is a homogeneous mixture, the composition of which can undergo continuous variatin within the limit of its stable existence. Similarly, a solid solution is a solid homogeneous complex of several substances, whose proportions may vary without loss of homogeneity.

* Paper read at meeting of Institute of Mining and Metallurgy.

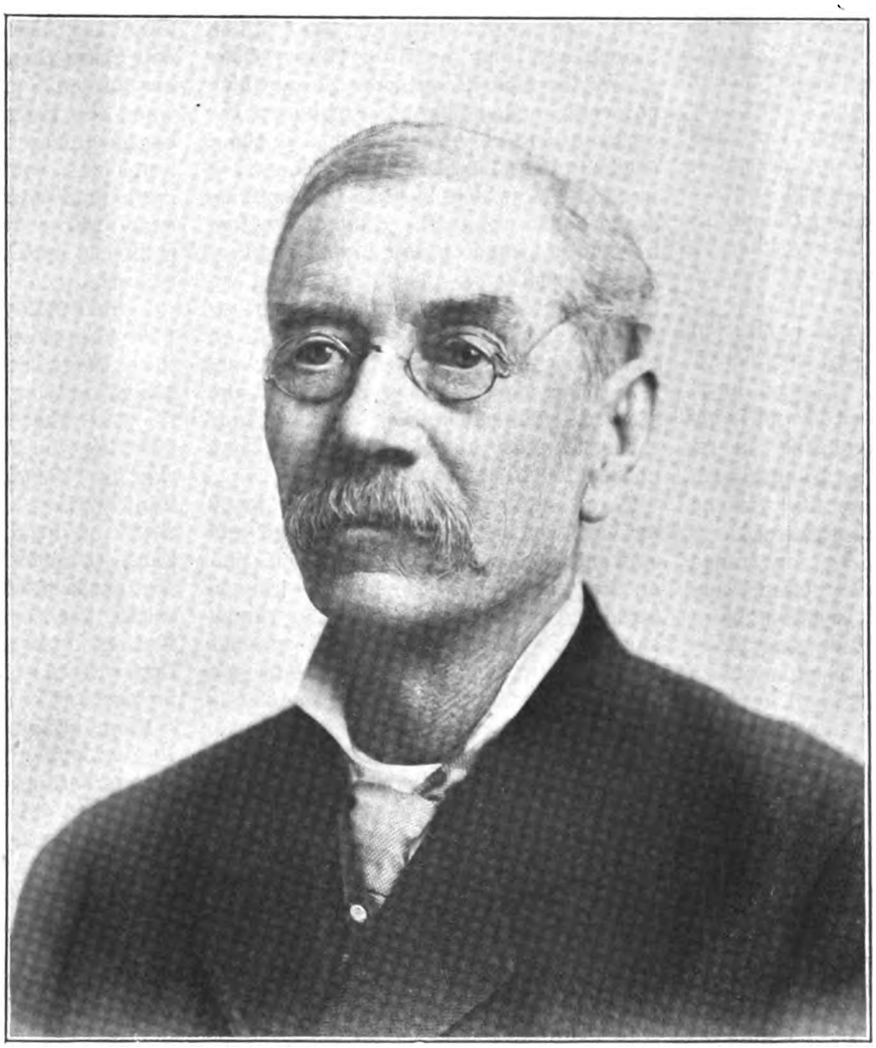
View of Col. Wall's Bingham Mines, showing branches of the Bingham and Garfie'

d railroad, constructed for the purpose of disposing of the waste of the Utah Copper properties, which occupy

WALL *vs.* UTAH COPPER

The name of Col. Wall, whose photograph appears on this page, has become a sort of nightmare to the management and pensioners of the Utah Copper Company, in so much that it is seldom mentioned except subjunctively qualified as "the man who for years has been fighting the Utah Copper Company." In fact, so industriously have evil impressions of Col. Wall's pugnaceous propensities been circulated by the victims of his alleged persecutions that his friends have at times been almost led to doubt his sincerity.

Whatever may be said or thought, in this regard, it cannot be denied that, for some time past the courts have been considerably occupied with litigation involving conflicts of interest between Wall and the Utah Copper Company. And, as these conflicts have tended materially to retard the market purposes of the management of one of our "greatest industrial enterprises," it is but natural that the press and the general public should feel and express more or less concern as to the prevalence and final outcome of this litigation in such degree at least as financial interests, or individual sympathies might be affected thereby; and this, without regard to the legal or moral equities involved in such litigation.



COL. E. A. WALL.

But, apart from all this, there is involved in this litigation certain novel abstract legal questions touching the relationship or subordination of mining rights to statutory law of eminent domain which are of vital importance to all investors in mining properties and which we assume may be here discussed without prejudice, or favor to either of the parties to any pending litigation.

MINING A "PUBLIC USE."

By decision of the United States Supreme Court in an action brought by the Highland Boy Mining Company vs. Strickley, "MINING" is declared to be a "public use," in behalf of which the law of eminent domain may be invoked for the purpose of securing right of way for railroads, tramways, etc. The Statues of Utah enumerate a great variety of uses, covering every conceivable necessity which might arise in the operation of a mining property including "dumping ground," for which the lands of another may be taken on formal allegation of necessity, without regard to the requirements of the original owner of the lands. And, although the owner of each individual mining claim in a district may have the right under the Statute to condemn necessary easements through, over, or across the lands of his neighber, as well as the "inalienable right" to develop, mine and extract the ores from within the borders of his own claim, it appears that all these rights may, nevertheless, AT WILL, BY A SINGLE JUDGE OF A DISTRICT COURT, be subordinated or set entirely at naught in favor of the owner of another mining property whose convenience or cupidity might prompt him to devastate or confiscate the property of another. Of course the mining of ores having been declared a "public use" of the land the courts, of necessity, should be empowered to compel, when practical, mutual concessions of easements over and through adjacent lands where existing physical conditions render such easements necessary to the successful mining of the ores. But it would be difficult to conceive of the existance of conditions physical, legal or otherwise — in contemplation of the law of eminent domain — wherein a court would be justified in confiscating or impairing the possession of one miner in order to promote the convenience or enhance the value of the property of another.

Of course, public use, (mining) as herein alluded to— no matter how profitable to the individual so engaged — may properly be required to give way to SUPERIOR public use, but such superiority could only exist in cases wherein A COMMUNITY of individuals, having diverse interests to be served are concerned and demand such use.

A TRAVESTY OF JUSTICE.

To say that a body of men owning a mining property, either as individuals or corporate body, and as such possessing only limited rights of eminent domain may, by the formation of a railroad company every share of the capital stock of which is taken over by the individual owners of the mining property, and in the name of such railroad company and under pretense of serving the public where there is no public, nor even individuals, REQUIRING or desiring such service, thereby secure the confiscation of the mining rights of another, is a travesty of justice and common sense. But such seems to be the intent and meaning of the Statutes of this State as construed by the Supreme Court.

If this result could only ensue after a full trial of each case the proceedings would be less repugnant but, on the contrary the peculiarly accommodating statute PERMITS the judge of a district, at his pleasure, upon application of such a railroad company for a right of way over private lands, to GRANT or REFUSE immediate possession of the premises, with the right to construct and operate the desired railroad, pending the determination of an action at law, whereby such right of way is sought to be condemned.

Before any order granting possession of the lands sought to be condemned, will be issued, however, a formal hearing in open court is ordered by the judge thereof at which the applicant is required to SAY—by witnesses under oath—that there "is public necessity" for the construction of the proposed railroad and that the lands sought to be condemned are essential to its construction and maintenance; whereupon, upon filing of a bond of indemnity in such amount as the court may determine to be sufficient to compensate for resulting damage to the land owner, an order granting exclusive possession of the premises will be issued. In such hearings the defendant is cited to be present and may submit proofs as to the measure of damage that he may suffer by reason of the road, but MAY NOT QUESTION THE ALLEGATIONS OF NECESSITY for its construction, or the lack of public or any desire for its construction, or even the existence of any community or individuals whom it would be possible to serve.

UTAH COPPER'S ACTION.

Proceedings of this character were instituted by the Utah Copper Company about fifteen months ago through its nominal representative, the Bingham & Garfield Railroad Company, by which it has succeeded in securing absolute and exclusive possession of over eighty-nine acres of a tract of ninety acres of mining ground owned by Col. Wall, the surface of the remaining fraction of an acre being shared jointly for "dumping" purposes—by the Tintic (Yampa) Development & Mining Company.

The large photographic insert herewith gives an excellent view of the greater portion of the ground involved showing an interlacing and overlapping net-work of railroad tracks built and in course of construction. The three lower lines to the left have heretofore been owned by the Rio Grande Western Railroad Company but, as indicated by the sworn testimony of Mr. Goodrich—chief engineer of the Bingham & Garfield Railroad Company—these lines have been transferred to the Bingham & Garfield Railroad Company. The "switchbacks" rising up the mountain side to the left lead up from the main line of the Bingham & Garfield Railroad and connect with the various stripping lines which branch out from the Utah Copper Company's three main stripping lines, which enter the main Bingham canyon on the opposite side of the mountain and about fifteen hundred feet distant. The track marked I-K, which is seen to terminate a short distance to the right of the tunnel-mouth shown in the center right of the picture, it is alleged, is to be extended across the property and on westerly to the Bingham and New Haven company's mines, situated on the mountain side opposite that shown in the picture. The distance is about four thousand feet, and the vertical rise about twelve hundred feet.

Three different attempts were made by Wall, by injunction, to intercept and prevent the continuation of this line on the ground that—as planned—its construction would close up the tunnel shown in the picture, and all avenues of approach to the most valuable portion of his property, and completely consume all remaining dumping ground. It was also shown that the Utah company had two other lines completed and in operation—removing waste from its property—and which were situated several hundred feet higher up the mountain, and which extended far out in the direction of the Bingham & New Haven mines and that, therefore, the construction of an additional line for the purpose claimed was wholly unnecessary. Besides, the Bingham & New Haven Company already had long since completed and in operation a tramway which afforded all desired facilities for transportation of its ore. And further, it was alleged that the B. & G. R. R. Co. had no real intention of building the road beyond the boundary of Wall's grounds, and that the sole purpose of its construction was to dam up the gulches and afford storage for the "waste-overburden" of the Utah Company's orebodies.

In respect to this view of the situation, it may be here observed that practically no cuts are made in the construction of any of the lines. In crossing the gulches temporary tracks are first laid from the highest points on the ridges along the contour of the surface out to the center of the gulches. When the overburden from the Utah ground is hauled with dump cars to the end of the track and dumped into the gulches, the tracks are shifted out toward a straight line until the gulches are filled up on a level with the tops of the ridges. These fills in several instances are more than 100 feet in depth beneath the finished grade, and from 400 to 700 feet long, thus forming level fills above the tracks of 200 to 400 feet in width; and in this manner storage room has been found already for probably more than six million tons of Utah overburden, and it is estimated that when the entire "system" of roads and back-switches that are planned shall have been completed, AS PLANNED, more than thirty-five millions of tons of Utah Copper overburden will have found lodgment upon the surface of Col. Wall's property.

POINTS IN HEARINGS.

At the conclusion of a recent case, the Court, in summing up the evidence, replying to the charge of counsel for Wall that the sole purpose in constructing the lines, as was being done, was to dispose of Utah overburden, said: "Now, while the court may join with you in the suspicion that it (the road) is outlined in the way it is for the purpose of being able to use the waste, yet the court is unable to say that it is not necessary to outline it that way in order to have a proper road up there."

From all of the testimony elicited at the various hearings, it was clearly manifest that, when the ground shall have been filled with all of the Utah Copper overburden it will hold, there will be no further use for any of the lines above the lower branch of the lines shown in the picture above the tunnel.

The Court, in order to prepare himself to do full justice, before the hearing in one of the several cases, visited the ground and personally examined the method of construction of the several lines. And it was doubtless this examination that gave him the "suspicion" that the lines were being constructed in such manner as to provide storage for waste; but Engineer Goodrich, and Assistant Manager Gemmel had said the purpose was to use the SMALLEST POSSIBLE AMOUNT of waste in order to damage Wall's property as little as possible. In fact, it appears that these gentlemen had been lying awake o'nights in order to devise the most gentle method whereby the excessive overburden of the Utah mines could be transferred to Col. Wall's property and at the same time not cause him any damage or discomfort. In their struggles, at least one very, very brilliant, and really humane scheme had been incubated, but the Court promptly declined to hear about it on grounds of "irrelevancy and immateriality;" but in justice to the benign intentions of these gentlemen, we think it should be given publicity:

LETTING WALL DOWN EASY.

In order to let Col. Wall down easy, it was decided to prove by expert testimony that Wall's property contained no ore of commercial value, and therefore he could not be damaged by covering the surface and closing his tunnels with waste. In fact, it would be a real kindness to Col. Wall if in this way they could cause him to abandon the property and thereby involuntarily conserve his strength and means. To this end, after a thorough examination and sampling of the underground workings (consisting of some 5000 feet of drifts and tunnels) by a crew of Utah mine engineers, which was quietly done between the hours of one and five o'clock in the morning—when Wall's men were not at work—Professors W. A. Wilson and Lafayette Burton were engaged to carefully and thoroughly examine, sample, and DETERMINE THE LACK of metallic value of all that part of the surface which had not theretofore been covered with waste. There is little doubt that these experts, had they been permitted to testify, would have established the fact that the ground not only contained no ore, but that Wall would be greatly benefitted by being forcibly prohibited from spending his money in any further search therefor in or upon the ground. But as before stated, the Court refused to hear the testimony, evidently much to the disappointment of Burton and Wilson, who appeared impatient to perform their part of the engagement. Mr. Shulder, of counsel for the Utah Company, took occasion, however, to declare "that the development of vast bodies of valuable ore by the Utah company upon adjoining ground had vastly more than compensated Wall for any inconvenience or damage which could result from dumping of any quantity of waste upon his ground," the inference being that Col. Wall ought to be required to pay the Utah company liberally for the benefits he would derive from knowledge of the existence of those vast bodies of valuable ore upon adjacent grounds, and that he should, in addition, cheerfully acquiesce in the Utah's method of disposing of its waste. After the explanation of Mr. Shulder, the Court rendered an opinion entirely in accord therewith. But, whether Col. Wall will accept the good intentions of his adversaries, as indicated by their engineers and counsel, in full satisfaction of his supposed grievances, we are at present unadvised.

WALL GROUND VALUABLE.

In respect to the ore-bearing character of the ground, Col. Wall testified at one of the hearings that the tunnel shown in the picture extends into the mountain about 300 feet; that the last ninety feet of its length is in ore of excellent commercial grade; that drifts extend longitudinally in similar ore eighty feet in each direction, and that an upraise has been made eighty-five feet and to within twenty feet of the surface, all in equally good ore. In fact, we are reliably informed that much of this contains from 3 to 7% copper, and that these facts are well known to the Utah company whose engineers have made frequent examinations and sampling tests of the ore during the absence of Wall's workmen. These developments lie parallel to and within about 150 feet of the Utah line, and it is believed that Utah underground mining has long since been extended over the line, into Wall's ground, and to within less than fifty feet from the face of the tunnel. This belief finds confirmation in the fact that a section of the surface about 150x100 feet, within a few feet from the face of the tunnel, and immediately above, was found to have become crushed and sunken several feet below the surrounding surface, precisely as the surface of the adjoining ground had sunken from underground "piracy" before it was bought by the Utah company from Barnsdall. It will be remembered that—as stated in this journal at the time—a little over a year ago that property (the Pay Roll group) was bought by Mr. Hastings for the Utah company for about $75,000 in cash, and that later, on our exposure of the pilfering of this ground by the Utah company to the extent of nearly $500,000 in value, Mr. Barnsdall secured restitution to the extent of 6,666 shares of Utah Copper stock.

It now seems quite certain that those same underground workings have been extended into Col. Wall's ground, which adjoins the Pay Roll ground on the north, the boundary line being shown in the picture near the top. The cave-in of the ground was first discovered by Frank Anderson, a mining and civil engineer, whilst engaged in locating the tracks and grades of the Bingham & Garfield Railroad Company, with relation to the boundaries of Col. Wall's ground. But, not thinking it expedient to expose the fact at the time, Col. Wall suggested to Mr. Anderson that possibly the cave might have been caused by means other than encroachments of the Utah company's underground workings and advised that no mention be made of the matter. Suspicion of the invasion of Wall's ground by the Utah underground miners was intensified by the feverish haste with which Chief Engineer Goodrich had sought to close the approach to the tunnel and thus prevent further progress of development in the direction of this caved section.

TO STOP WALL'S WORK.

It appears that about two months ago, when the railroad track shown in the picture as crossing the ground just above the tunnel entrance had been laid to the middle of the gulch and about 200 feet to the right of the tunnel, Mr. Goodrich notified Col. Wall that he had received instructions to fill in the gulch below the tunnel with waste overburden from Utah Copper ground, and that in doing so would necessarily cover the entrance to the tunnel, whereupon Col. Wall procured from the court a temporary injunction restraining the Bingham & Garfield Railroad Company from carrying into effect its avowed purpose. Whilst the injunction order was in full force Engineer Goodrich caused a train of cars loaded with Utah waste to be brought on the track and halted opposite the entrance to the tunnel so as to dump every car of the train directly over the entrance to the tunnel and in this manner effectually closed the approach thereto. But at the hearing of the case the fact appeared upon the testimony of Mr. Goodrich that the track—which had been previously laid, and which was on solid ground—was only temporary and that his ultimate design involved the complete filling in of all the low ground, which was being used for tunnel dump, down to the next railroad track below, and that when complete the track would be down to a straight line, so that in its extension to the right it would strike only the high point on the next ridge. This explanation was accepted by the Court as entirely satisfactory, and the restraining order was thereupon vacated.

Having secured the sanction of the Court to the closing up of Wall's tunnel, and thus shut off the possibility of its further extension in that direction, and exposure of the "caved section," all further work of extending "the much needed road" to the New Haven mine ceased, the object of the fill having been accomplished.

INJUNCTION VIOLATED.

Now it appears that this particular railroad track, with its two branches to the left, was laid upon ground not covered by the Court's original grant of possession, and therefore, a week or two later, another action was commenced by

Wall whereby he sought to prevent its further extension, as well as the use of that portion theretofore constructed. And thereupon an injunction was granted accordingly. By reason of certain contractural rights covering that portion of the property upon which these tracks had been laid, it seemed inevitable that this injunction must become permanent, and that the plan of the Utah company, by means of these "temporary" lines to dam up the gulches and thus provide storage room for waste, would thereby be defeated. It was therefore determined that, at all hazzards, the job of effectually rendering it impossible for Wall to reopen his tunnel or to run a new one in the region of the "cave-in"—for want of dump room—should be made complete.

To this end, in open and flagrant disregard of the Court's injunction, train service on that line was pressed to the limit, and with all possible speed waste from the Utah stripping benches was rushed over the road and dumped into the gulch shown in the picture below and adjacent to the tunnel, until every available foot of space between the line of the track shown above and the first track shown below the tunnel was filled, the upper track being shifted out on a level as the fill proceeded, so that on completion of the fill, that track occupied—and still occupies—a position from eighty to a hundred and sixty feet nearer the next track below than the position shown in the picture, the deepest portion of fill being probably seventy feet, and the breadth at the surface about 200 feet, and covers the tracks at the entrance to Wall's tunnel to the depth of about fifteen feet. There was consumed in completing the fill approximately 85,000 cubic yards of overburden, resulting in a saving to the Utah Copper Company, as compared to the actual cost of transporting the same to its nearest other available dumping ground, of at least eighteen cents per cubic yard, or a total of about $15,000, besides effectually shutting Colonel Wall out from any approach to that portion of his mines, or any means of espionage upon any encroachment of his more enterprising neighbors upon his orebodies, as was so successfully accomplished in the case of the Barnsdall-Pay Roll claims.

Upon a preliminary hearing in this latter case, the Court—as had been confidently anticipated—rendered a decision in which he ordered that a permanent injunction be issued. A few days later, however, he signed an order which practically, though doubtless unintentionally, vacated his previous order. By this action it is made to appear that the Court shares in the general sentiment which has been fostered by the management of the Utah company, viz., "that Col. Wall's fights against the progressive methods of that company are prompted solely by spite." Whatever may be the future outcome of these controversies—from a glance at the photograph—it is quite evident that Col. Wall will now be compelled to quit unless another branch of this tentacular railroad should be projected across that remaining three-quarters of an acre of his mining property which, as before stated, is shared by the Yampa people; in which event, good faith would seem to require that he should at least interpose a perfunctory defense in respect of the rights of his co-tenants.

COPPERETTES

"I would buy Chino stock. It certainly is entitled to sell up to $35 or $40 a share.—GEORGE L. WALKER." In Walker's Weekly Copper Letter, (Copyright by Dukelow & Walker), etc.

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Goodwin's Weekly: Through the dumping of waste the Utah Copper, of necessity, extends its railroad tracks. Every gully, gulch and draw in Carr fork and main Bingham canyon is being filled in with the overburden from the property. Consequently, the tracks are being extended to the shafts and tunnels of nearly every property in Bingham and within a few years the ore hauling situation in the camp will be controlled by the new railroad.

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Pain, Weber & Co.'s market letter of the 21st says: "The buying of the coppers was RATHER impressive and in that connection our London friends say they are of the opinion that the copper metal will sell higher." It will be noted that "our London friends" are being treated with a great deal of deference these days. Somebody is preparing to "put one over on them," sure.

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Referring to the deal through which it is claimed there will be a merger of the Miami, Live Oak and Inspiration properties in Arizona, the Salt Lake Tribune of December 7 says: "It looks to the disinterested western eye that there is to be a closer relation hereafter between the big copper producers, and that all possible cut-throat rivalry will be eliminated from the industry. It is now a case of everyone pulling together for the mutual good of all interested in the copper producing industry."

Let's see; if we remember correctly it is less than three years ago that the American Smelting-Utah Copper-Guggenheim interests were doing no small amount of boasting about "the survival of the fittest." It looks different now. As Jonah failed to swallow the whale, maybe the whale is figuring that it is time for him to get busy and show Jonah a trick or two.

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Last month it was stated in this department that Utah Copper had reopened a "construction" account on October 1. Two weeks ago we were advised that the company had begun the rigging up of two more units of its Arthur mill. With this heavy (?) and costly (?) piece of work under way, real justification for the sale of say 50,000 more shares of treasury stock at $50 ($2,500,0000) ought easily to be shown in the next annual report. Now that the price of copper has been advanced so materially the share market has broadened and the company ought to have seized the opportunity thus afforded to "get the money." Wonder if the forthcoming annual report will show that it did? If so, it will not much matter for some time to come what the real cost of stripping and mining has been; net earnings and surplus can be made to loom up bigger than ever.

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Salt Lake Tribune, Dec. 22: "Do you know that the Arthur mill of the Utah Copper company is doing by 10 per cent the finest work of any concentrating plant in the entire world?" asked an engineer who recently had the opportunity to convince himself of the kind of work being done there. He stated further that the Arthur plant is making copper for 7 cents a pound, and that six sections have been remodeled, the seventh is being worked on now, and all thirteen sections are to receive the same treatment shortly. It will not be long until the Magna mill is brought up to a like point of efficiency, although the Magna is making a magnificent record as it is now constituted.

It is certainly refreshing to learn that the Arthur plant "is making copper for 7 cents a pound" and that "it will not be long till the Magna plant is brought up to a like point of efficiency," because we have always been under the impression that copper was not made in either of these plants. The declaration that the Arthur mill "is doing by 10 per cent the finest work of any concentrating plant in the entire world" would sound better if some figures were given to illustrate the claim. The declaration also would have had more intrinsic value had the engineer's name been given.

UNSOLVED PROBLEMS OF GEOLOGY

SECOND PRESENTATION OF ORIGINAL AND INSTRUCTIVE DISCUSSION OF COMPLEX SUBJECT

By HIRAM W. HIXON.*

All the standard works on geology leave no doubt in the reader's mind that there have been no satisfactory explanations offered for many of the most common of geological phenomena. The following is a list of the most common of these effects for which a competent and satisfactory cause has long been sought:

(1) The normal fault, in which the opposite sides of the fracture have been spread apart and usually one side raised above its original position. This effect cannot be due to contraction or a settling down of crust blocks as that would produce an overthrust, or what is commonly called a reverse or thrust fault, because of the arching of the earth's crust.

(2) Earthquakes—Earth tremors or quakes are most common in regions of elevation, which is incompatible with their being produced by fracture and subsidence, in the manner generally ascribed. Further, the faults which are made at the time of great earthquakes are normal faults, which cannot be produced in an arching crust by subsidence.

(3) Volcanic action—This cannot be explained unless we can account for the local accumulation of heat beneath the volcanic vent accompanied by a large amount of steam saturating fused lava.

(4) Any explanation of volcanic action that does not include fissure eruptions will be incomplete.

(5) The observed order in which the lavas have been erupted, beginning with the acid lavas and ending with the basaltic lavas must also be accounted for.

(6) The formation of fissures of large and small extent wherein the crust is torn apart and the walls do not go back into contact, leaving long openings which are subsequently filled with mineral matter deposited from solution or by fused matter injected as a dike at the time the fissure was formed.

(7) The ascensive or elevating force which injects the dike matter into the fissure.

(8) The source of the heat and the water of hot springs and geysers. Such springs and geysers contain so much mineral matter in solution in their waters that they build up cones of deposition at the surface, from which it is apparent that the same solutions deposit mineral matter along the path of ascent and isolate by cementation their paths from all connection with surface waters. Water has about five times the specific heat of rock, so that five times the weight of rock would be required to furnish the heat units in the discharged water, if the rock were cooled through the same range of temperature as the water is heated. Applying this rule to the discharged water from Old Faithful or any other hot spring brings out the fact that the waters could not come into contact with or extract the heat by conduction from the adjacent rock for any great length of time. The cementation of the walls of the pipe would prevent circulation.

(9) Metamorphism, regional and local, in which the rise of temperature and the influx of highly heated waters have resulted in changing the bottom members of the sedimentary series from shales to mica schist, from sandstone to quartzite, gneiss and granite, and from limestone to marble.

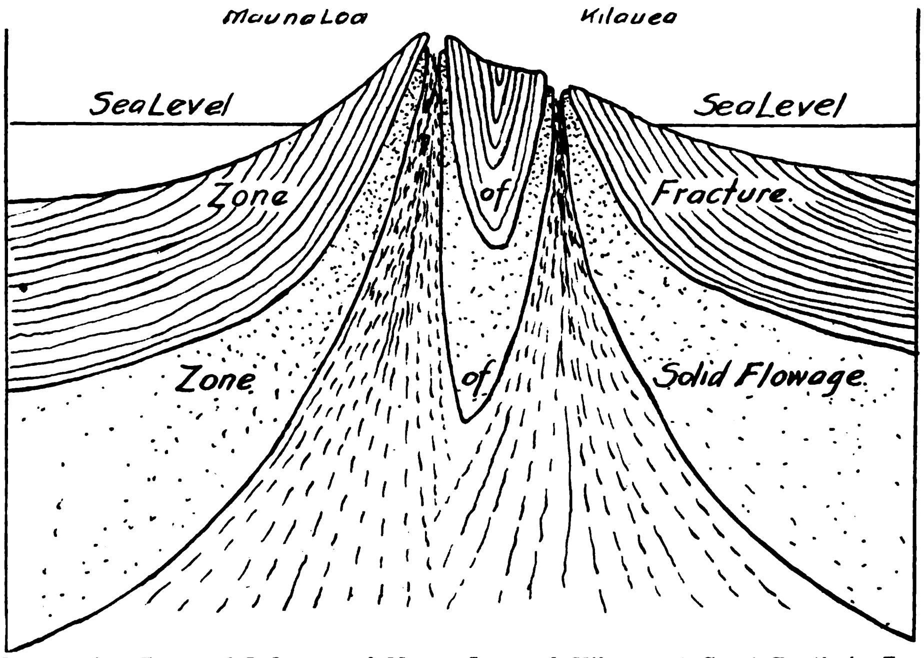
(10) The accumulation of natural gas and oil beneath impervious coverings such as shale; salt water usually being found below the oil and all occupying the arches of anticlines.

(11) The cause of elevation and subsidence, both continental and local.

PHYSICS OF THE EARTH'S CRUST.

The earth's crust, considered as a dome of 4000 miles radius, is incapable of supporting one five-hundredth part of its weight, even if thirty miles thick and composed of the material of the strength of granite.* This makes the crust a floating shell supported by the material beneath it and differences in elevation between continents and ocean bottoms are due to differences or density in the sub-crust material.

It is well known that wherever the crust is being loaded by sedimentation, as at the mouths of rivers or on coasts where sand is being deposited by the ocean currents, as is occurring along the eastern coast of the United States, that subsidence is general. It is also generally true that a region of erosion is a region of elevation, but if this part of the crust continued forever to be a region of elevation, then it would follow that continental areas would lose all their sedimentary rocks and would present to view only igneous rocks. It would also follow that if a region of deposition was forever a region of subsidence and that a region of erosion was always one of elevation, the earth would



Intersecting Zones of Influence of Mauna Loa and Kilauea at Great Depth in Zone of Solid Flowage.

*Metallurgical and Mining Engineer, Philadelphia, Pa.

*Le Conte, Chamberlin and Salisbury.

turn itself inside out. It is, therefore, apparent that the forces which govern these movements are subject to reversal after reaching a maximum in either direction. If the differences in elevation are due to differences in density of the sub-crust material as above stated, then how can these densities be reversed?

The answer to this problem includes the answer to all the others before enumerated, and in fact the operating cause can be shown according to the following theory of the earth's physics to be common to all the effects produced, and to include, in addition to those already mentioned, ore deposits, mountain folding and elevation, the deposition of graphite in gneiss and in mineral veins, and the formation of diamonds in volcanic necks.

Since the introduction of the electric furnace into metallurgical operations, it has been found that all known elements can be volatilized at a temperature estimated to be below 3700° C. (6692° F.) Carbon, the most refractory of all substances by itself in a pure state, is easily attacked by hydrogen and converted into one of the most volatile of gases (CH_4) at comparatively low temperatures, as shown in the formation of water gas and the decomposition of steam by red-hot coke.

In like manner the volatilizing temperature, the critical temperature and the fusing point of all the mixed materials that go to make up the interior mass of the earth is probably influenced by the presence of steam.

The first requisite condition is to prove the presence of steam and other light gases throughout the interior mass. The method of doing this is by the application of the law of critical temperature and the law of the diffusion of gases to a gaseous planet.

Farraday and others discovered that for each gas there is a critical temperature above which it cannot be liquified by any pressure, however great. SINCE ALL SUBSTANCES CAN BE GASIFIED IN THE ELECTRIC FURNACE, IT FOLLOWS THAT AT SOME HIGHER TEMPERATURE THEY WILL BE PERMANENT GASES REGARDLESS OF ANY PRESSURE THAT THEY MAY BE SUBJECT TO.

Astronomers are generally agreed that all the matter in the sun is permanently gaseous, regardless of pressure, for the reason that it is above its critical temperature. There is every reason for believing that the earth has passed through the same critical tempeature stage as the sun is now in, regardless of the condition or mode of accumulation of the material that entered into its composition. It is not necessary to postulate a temperature higher than physicists are willing to admit in order to have matter in the zone of critical temperature in a gaseous state; neither is it necessary to insist on any particular temperature gradient from the surface downward in order to arrive at a critical temperature at some depth. It is immaterial if that zone of critical temperature be reached at 100 miles of depth or 1000 miles. When it is reached all the matter in that zone will be gaseous AND NECESSARILY DENSER THAN THE SOLID forms of matter above it because of the pressure. IF IT WERE LIGHTER THAN THE SOLID FORMS OF MATTER IT WOULD NOT REMAIN AT THE BOTTOM, BUT WOULD GET ON TOP. We have thus a means of knowing that gaseous matter above its critical temperature can be compressed to a greater density than a solid.*

Whether we start with a gaseous planet above its critical temperature and go forward to the present condition of a cold crust lying on top of a solid viscuous zone of material of increasing temperature until it finally becomes gaseous, or start with the present zone of critical temperature and go back to the gaseous planet, the result is the same. We arrive at a gaseous condition of matter where, owing to the law of diffusion of gases, each gas of which the planet is or was composed diffused throughout the whole body of gas. The essential point is to prove that in the mixed body of gaseous matter in the zone of critical temperature there is every kind of gas that entered itno the composition of the gaseous planet. THIS WOULD FOLLOW AS A RESULT OF THE LAW OF DIFFUSION OF GASES WHICH IS TO THE EFFECT THAT IN A MIXED BODY OF GASES EACH GAS DIFFUSES THROUGHOUT THE ENTIRE MASS REGARDLESS OF DENSITY.

Starting with this zone of critical temperature of gaseous matter denser than the solid forms and containing some of each of the gases that existed in the original gaseous planet, it is possible to outline some of the effects that will follow upon secular cooling.

EFFECTS FOLLOWING SECULAR COOLING.

Knowing as we do that the gaseous matter in the zone of critical temperature must be denser than the solid in order for it to remain below the solid, we can see that as it loses heat a portion of the gases of high critical temperature will pass from the gaseous to the next lighter condition of matter, WHICH WILL BE THE SOLID IN PREFERENCE TO THE LIQUID, BECAUSE IT WOULD HAVE TO EXPAND LESS AGAINST THE HIGH PRESSURE IN ORDER TO DO SO.

The passing of a gas denser than a solid into a solid condition of matter without becoming liquid is in line with the observed facts that an increase of pressure increases the melting temperature of all matter that expands on fusing. SUFFICIENT PRESSURE MAY INCREASE THE MELTING TEMPERATURE TO SUCH AN EXTENT THAT THE MELTING POINT AND THE CRITICAL TEMPERATURE ARE THE SAME. Liquid or melted matter is only supposed to exist in the peaks and ridges in the top of the zone of solid flowage where it is supersaturated to the highest degree by steam.

The gases of low critical temperature, which have been associated with this material while it is gaseous, can no longer remain with it under the same conditions since it has become a solid, and they therefore supersaturate the zone of critical temperature and the solid matter above it, which we have called the zone of solid flowage, and diffuses upward until it reaches the bottom of the zone of fracture. AS LONG AS THESE GASES OF LOW CRITICAL TEMPERATURE ARE IN THE ZONE OF CRITICAL TEMPERATURE THEY ARE HELD THERE BY THE SAME POWER OF DIFFUSION WHICH PUT THEM THERE ORIGINALLY. But when by the loss of heat the gases of high critical temperature are changed into solids, there comes into action a force which for want of a descriptive name, I have called "DIFFERENTIAL PRESSURE," THE DIFFERENCE BETWEEN THE WEIGHT OF A COLUMN OF THE HEAVY MATERIAL FROM THE SURFACE OF THE EARTH DOWN TO ANY PARTICULAR DEPTH, AND THE WEIGHT OF A COLUMN OF THE GASES OF LOW CRITICAL TEMPERATURE UNDER THE SAME PRESSURE AND TEMPERATURE TO THE SAME DEPTH.

I have estimated this at 27 tons per square inch for a depth of ten miles, or 270 tons per square inch at 100 miles of depth, and increasing rapidly with depth.

This is the force which drives the gases of low critical temperature up through the zone of solid flowage in which fractures are impossible and causes it to collect below the zone of fracture under constantly increasing temperature and pressure, like water collecting above a dam. The gases of low critical temperature supersaturate the whole mass of the zone of solid flowage and a bubble of gas above the point of

*The term "gas" does not refer to density, but to a definite amount of latent energy, just as does the liquid condition of matter.

saturation cannot disappear at one point without appearing at a higher level, so that the bubbles, although disconnected, are forced upward by the unbalanced force the difference between the weight of a column of the zone of solid flowage and a column of the gases under the same temperature and pressure to the depth where the particular bubble is located.

In this manner the gases of low critical temperature cannot escape from the zone of critical temperature faster than they are liberated by secular cooling, and this governs their passage through the zone of solid flowage and their accumulation below the zone of fracture. The passage of these gases through the zone of fracture is much slower than through the viscuous solid material of high temperature in the zone of solid flowage and the result is that THE UPPER PORTION OF THE ZONE OF SOLID FLOWAGE IS MORE HIGHLY SUPERSATURATED THAN ANY OTHER PORTION. The accumulation of these gases of low critical temperature (which are principally steam) results in elevating the temperature beneath the cold crust or zone of fracture and brings about the regional metamorphism of the bottom beds of the sedimentary series and produce conditions FAVORABLE FOR INFILTRATION OF SILICA AND THE FORMATION OF FELDSPAR AND MICA WHICH CANNOT BE FORMED BY DRY FUSION.

The increase of temperature with depth varies between wide limits depending upon the volcanic activity in the place where the observation is taken. If the bore hole or shaft happens to cross an inclined fault plane which acts as a vent for heated waters, the temperature may even decrease after passing below the intersection, which would give rise to the belief that has been advanced that the earth gets colder with depth instead of hotter, but the evidence of high internal temperature is unmistakable and the local variations are of small consequence in the final consideration.

THE ACCUMULATION OF GASES BELOW THE ZONE OF FRACTURE IS ACCOMPANIED BY A REDUCTION OF DENSITY DUE TO THE EXPANSION OF THE GASES UNDER DECREASED PRESSURE AND THE GREATER VESICULARITY OF THE ROCKS RESULTS IN SUPERFICIAL ELEVATION. LE CONTE QUOTES SORBY AS STATING THAT GRANITE CONTAINS AS MANY AS ONE THOUSAND MILLION VESICLES PER CUBIC INCH.

EARTHQUAKE PHENOMENA.

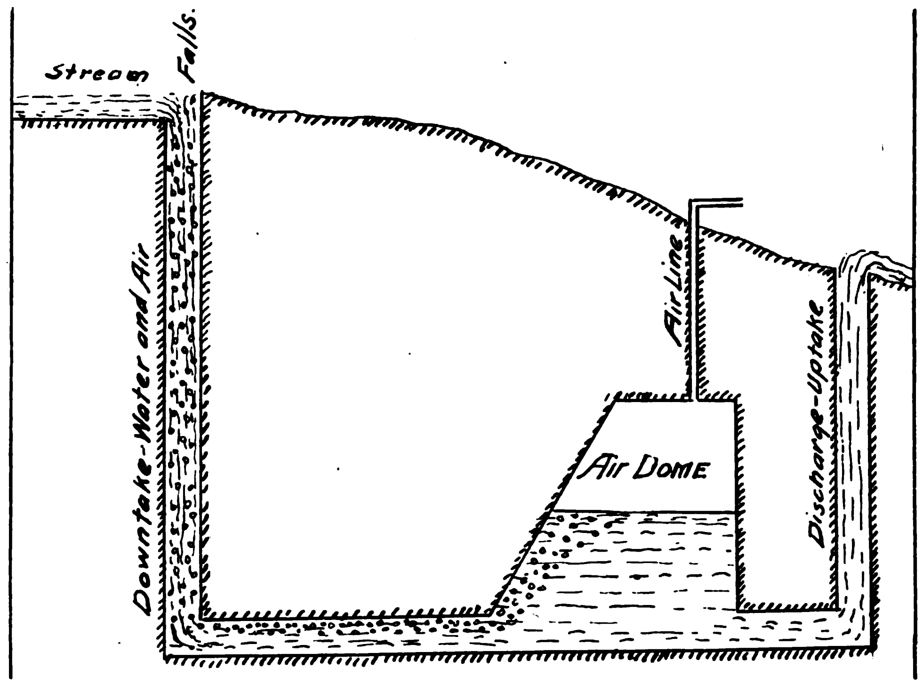
The tendency is for the elevation to become more pronounced locally along the axis of the region and when the elastic pressure of the supersaturating steam in the top of the zone of solid flowage is sufficient to rip the zone of fracture, a fissure is formed, into which the steam rushes under the differential pressure which has been accumulating for geological ages and in an instant an earthquake follows. The walls of the fissure are cold enough to condense the steam and they close by reflex action resulting in a sudden blow to the region immediately above and around the fracture plane. The steam continues to open the fracture and be condensed with the accompanying noise and shocks until its elastic pressure is so diminished as to be unequal to the task when another period of accumulation must follow before a sufficient elastic pressure will be available for reopening the fissure.

The strength of an earthquake as measured by the area of surface over which it is felt is proportionate to the depth at which the focus is located. Great earthquakes occur at depths of from 7 to 15 miles and at such depths rock matter is capable of movement under pressure without fracture so that fractures cannot be the cause of earthquakes occuring at that depth.

Steam above its critical temperature of 365° C. (689 F.) cannot condense to water so that shocks cannot be produced at depths where the temperature is 365° C. or above. Assuming 30° C. the surface and an increase of 1° C. per 100 ft. or 53° C. per mile, earthquakes due to condensation of steam as suggested should occur at about 7 miles of depth.

The main displacement in connection with the San Francisco earthquake was horizontal, but there was vertical displacement on both sides of the fault at different points. *"From the rift at times in the past, masses of molten rock have flowed out. Of such origin is the cliff of basaltic columns near San Francisquito creek on the Stanford university campus. Much more recent flows of black lava occur to the southwest of Stanford University and numerous dikes of lava occur for the whole length of Santa Clara valley; these have not flowed from volcanoes, but in times long past have escaped from rifts in the rocks—producing earthquakes. Some of the rifts have been cemented and closed by their own lava flows."

Steam probably escapes from the fault and condenses in the ocean as indicated by the following extract: "The steamer Argo crossing the fault line the moment of the earthquake, of Mendocino, ninety miles to the northward of Point Arena, bears witness to the fact. The captain thought that he had struck a raft of logs, so fierce and hard were the shocks of the waves in the water. The movements were short and violent not forming a tidal wave, but a strong choppy sea. At this point numerous earthquakes have been reported by passing vessels."



Sketch Illustrating Hydraulic Air Compression, in which the Principle of Differential Pressure is Used, as Described in This Article.

The following are probably due to the rapid opening and closing of the fault by intrusion and condensation of steam: "During the shock men, cows and horses found it impossible to stand and fell to the ground; and some persons were thrown from their beds. In a general way all these evidences of violence diminish gradually with distance from the fault on either side. The springs and streams on both sides of the Santa Cruz

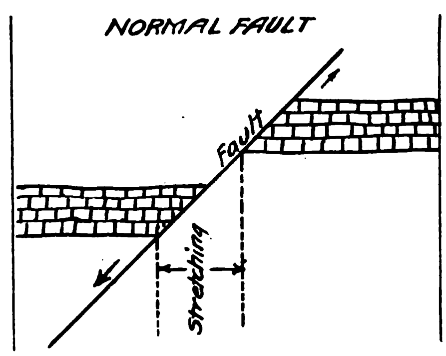
* California Earthquake, 1906; edited by David Starr Jordan.

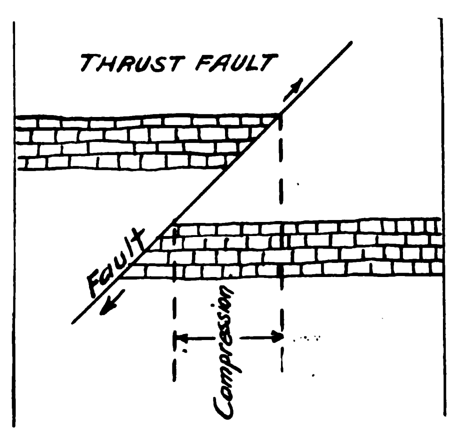
range south of San Francisco, increased in volume after the earthquake and some creeks on the west side were nearly doubled. All the streams were muddy for several days after the earthquake. A market effect was produced on the ARTESION BELT near the head of San Francisco bay. Wells that had previously been dry began flowing, and wells that flowed before the shock greatly increased in volume and pressure. A well near Alviso, at the head of the bay, formerly required a wind mill to pump the water. At the time of the earthquake the casing was driven 2 feet out of the ground, wrecking the pump, and since that time the well has been flowing under a heavy pressure." These flows of water appear to have been due to condensed steam as the temperature was raised, and the horizontal displacement due to the relief of earth strain while the walls of the fault were thrown apart by the steam.

When in the process of time and repetition the dike is advanced to the surface, the material blows out as lapeli, pumice or scorea and is usually highly silicious as it has been derived from a silicious magma long in process of making by the infiltration of silica into the rocks through which it has finally melted and fractured its way to the surface. Subsequent eruptions will be less and less silicious if derived from the same fissure until by the process of displacement and rise from great depth under the impelling force of the supersaturated steam, basaltic material is brought up to complete the cycle of eruptions which gradually come to a close because of the liberation of a great local accumulation of steam which has required much greater length of geological time for accumulation than for its escape. The fissure eruption differs from the crater eruption in quantity of material discharged and also in the lavas always being basaltic in character with a much greater fluidity and lower fusing point. They are supersaturated with steam in the same manner, which reduces their density to less than that of the overlying rocks and when a fissure is opened by tearing of the crust by the tension of the steam under the accumulated differential pressure, the lava continues to well up and discharge from the fissure until by the escape of the steam the density of the mass which has been left behind and in the fissure is equal to that above, and the eruption stops and another period of accumulation follows when the eruption is repeated from the same fissure or a new one formed.

FAULTS AND FISSURES.

The normal fault which as its name indicates is the most numerous type of faults, can be explained on the theory that after the rupture of the crust by the tensional pressure of the supersaturating steam in the peaks or ridges in the top of the zone of solid flowage, one of the regions on either side of the fault has had the density reduced more than the other and after the rupture that side of the fault remains permanently higher than the other. In the case of the Sonora earthquake of 1886, there was a vertical displacement of several feet on each side of a range of mountains, the mountains being elevated en block, which would indicate that the density beneath the region elvated was reduced more than that which was not





elevated and the strain on the crust caused it to snap or tear at the fault planes.

Fault planes are places where the inelastic crust adjusts itself to changed conditions in the zone of solid flowage which have been a long time in developing. They are also lines of least resistance for the passage of the excess of elastic matter to the surface and are therfore occupied by dikes or by matter deposited from solution, by replacement of the walls if they happen to be of a soluble nature, or by mineral matter deposited from solution by reduction of temperature and pressure. The elevating force is the same elastic pressure of the gases of low critical temperature which have accumulated under the differential pressure corresponding to a much greater depth than where they may have caused the rupture.

This differential pressure has now a practical application in compressing air at waterfalls, two of which are in operation, one on the Montreal river near Cobalt, Ont., and the other in Northern Michigan or Minnesota.

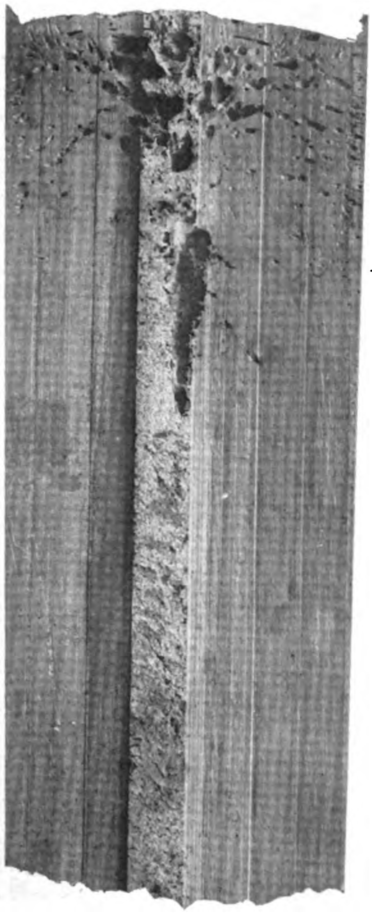
Shafts are sunk above and below the falls to a depth corresponding to the air pressure desired. Those shafts are then connected with a horizontal tunnel at their bottoms and a dome chamber is cut out in the roof of the tunnel from which a pipe (with the end opening into the top of the dome) leads to the surface to take off the air that separates from the water in the dome. If air at 130 lb. per square inch is required then the shaft above the falls must be about 350 feet deep if the falls are 20 ft. high, which will make the shaft below the falls 330 ft. deep. The water will rise into the dome probably 10 ft., which will make the air under a differential pressure of 320 ft. and deducting 20 ft. for loss of head due to friction, etc., the air will be delivered at the surface under a pressure of 300 ft. of water which at 0.44 lb. per foot will give 132 lb. per square inch.

Air is admitted with the falling water into the shaft above the falls and carried down by it to the dome in the tunnel, where it separates and comes up the air pipe while the water rises up the discharge shaft into the river below the falls. The air pressure depends entirely upon the depth of the shafts and not upon the height of the water falls.

The pressure of the air is governed by the depth of the point of separation between the air and the water in the dome in the tunnel connecting the bottoms of the shafts and is the difference between the weight of a column of water from the surface of the discharge down to the surface of the water in the air dome, and the weight of the air through the same depth. The water is supersaturated with air and only the air above the point of saturation in the dome is available for discharge as compressed air, the air dissolved in the water escapes with it into the river. The principle involved is exactly the same as in the case of the gases of low critical temperature supersaturating the material in the zone of solid flowage.

The fact that the material in the zone of solid flowage is solid and not liquid, makes no difference because at the temperature and pressure in that zone the solid matter behaves like a thick viscous liquid or like ice in a glacier, which is solid but still able to move and readjust itself to changes of pressure or distorting influences, allowing contraction to take place throughout the interior and only locally in the crust as it does in mountain ranges. The zone of greatest supersaturation is probably the line of slip between the zone of fracture and the zone of solid flowage.

If the gasses of low critical temperature accumulate beneath the cold crust or zone of fracture more rapidly than they escape through it to the surface, then the density of the highest point in that zone will be reduced most rapidly and result in regional and local elevation, JUST AS THE SURFACE OF A LOAF OF BREAD RISES FROM THE ACCUMULATION AND EXPANSION OF GASES IN THE DOUGH. At the same time the differential pressure of the gas will increase to correspond to greater depths of separation and may



Section of Steel Ingot (Unhammered) With Little Bubbles of Gas Traveling Upward and Expanding Beneath The Crust.

acquire a pressure of several hundred tons per square inch if not relieved by the opening of a fissure or a volcanic explosion or by the passage to the surface through the capillary pores of the igneous rocks when not covered by impervious sediments.

If, on the other hand, fissures are opened giving rise to earthquakes, hot springs and volcanic explosions, or if erosion carries away the impervious covering of sedimentary rocks so that the gases escape to the surface faster than they accumulate beneath the zone of fracture then the regional density will increase and the surface will subside.

MOUNTAINOUS FORMATIONS.

It follows from the above reasoning that where there are no volcanoes and the accumulation of gas below the zone of fracture is slowest in making its escape to the surface that the greatest elevations will be found. The Himalaya mountains and plateau of Tibet seem to corroborate this theory. The effect of a small difference in density is much greater on a thick zone of solid flowage than on a thin one and as a result the difference of elevation may be growing larger as the zone grows thicker.

Another phenomena which these great fluctuations of elevation may account for is the glacial periods which have occurred in past geoligcal ages. Certainly elevation brings about refrigeration of climate and places near the equator may have been given such a climate by elevation.

The generally accepted theory of mountain formation is that the beds are compressed and thickened by lateral thrust which results in local elevation and folding along the axis of the folds. If this were the cause of elevation it would be contrary to the generally observed fact that loading the crust produces subsidence.

THICKENING THE FOLDS LOCALLY BY COMPRESSION WOULD INCREASE THE LOAD LOCALLY AND AS BEFORE STATED, THE CRUST IS INCAPABLE OF SUPPORTING THE 1-500 PART OF ITS OWN WEIGHT, SO THAT, WHATEVER THE CAUSE OF ELEVATION, IT IS A FORCE ACTING IN THE SUBCRUST MATERIAL, AND AS THAT IS CAPABLE OF MOVEMENT UNDER A DISTORTING PRESSURE, THE CAUSE OF ELEVATION MUST BE A REDUCTION OF DENSITY. The effect of an accumulation of a large amount of steam and other gasses locally would be to SOFTEN THE SUBCRUST MATERIAL, ELEVATE THE ISOGEOTHERMS, REDUCE THE DENSITY AND PROMOTE FOLDING FROM THE EFFECT OF THE LATERAL DRAG ON THE BOTTOM OF THE COLD CRUST BY SHOVING IN OF MATERIAL OF REDUCED DENSITY BENEATH THE ELEVATED REGION.

The effect of this bottom drag on the zone of fracture WOULD BE TO STRETCH REGIONS ON BOTH SIDES OF MOUNTAIN RANGES AND CRUMPLE OR FOLD THE ZONE OF FRACTURE WHERE THE OPPOSING SHEETS OF THAT ZONE MEET. Normal faults would be produced in all places of stretch and thrust faults in regions of fold. The incompetence of simple contraction, as shown by Osmond Fisher to account for the reduction of the circumference of the earth to the extent shown in mountain folding indicates that the folding and elevation must be due to some other cause which produces folds in some parts and extensions in others. It seems probable that volcanic action may follow along the rifts produced by extension as well as by folding.

The planitesimal hypothesis proposed by Prof. T. C. Chamberlin, appears to be open to three serious objections.

First. If the earth was built up slowly of cold planetesimals and the heat at the surface was never sufficient to fuse or gasify the material after it reached the earth—then it would follow that the water on the surface would stratify that planetesimal material into a

Hammered Steel Ingot, Showing How the Gas Bubbles Cause Little Volcanoes to Erupt Liquid Steel Until the Crust is Solidified.

series of rocks which should everywhere show as the archean stratified beds and be easily identified. The planetesimals which fall at present are probably representative of what fell in the past, and these are largely composed of nickel-iron which resists oxidation and should be found among the material composing the archean sediments. The fact that no such beds are known indicates that they never existed.

Second. The moon with only 1-81 the mass of the earth shows unmistakable evidence of volcanic action, if we regard the craters as such, or of heat sufficient to fuse at the surface if we regard the craters as due to impact, and it seems highly improbable that the earth with so much greater mass should be cold at the surface as postulated by the planetesimal hypothesis.

Third. Heat is not produced by pressure acting on a cold incompressable aggregation of matter such as the planetesimal hypothesis indicates that the earth was built up of. In order to produce heat weight must act through distance which would make it necessary that the cold material be compressable.

Fourth. If the heat has been developed in recent geological times by pressure, then expansion of the earth should have taken place instead of contraction and folding of which there is so much in evidence in mountain ranges.

The computed temperatures according to the planetesimal hypothesis as given on page 564 of Vol. 1, Chamberlin and Salisbury Geology, are higher than seems necessary to pass the critical temperature of all matter, at a depth of one-quarter of the earth's radius, or approximately 1,000 miles. This would mean that the interior is in a gaseous condition regardless of density.

All objections to a gaseous interior based on lack of rigidity disregard the fact THAT ALL MATERIAL KNOWN LOSES RIGIDITY AT SUCH HIGH TEMPERATURES AS CHAMBERLIN INDICATES AND IN FACT AT VERY MUCH LOWER TEMPERATURES RIGIDITY IS ENTIRELY LOST. PRESSURE MUST THEREFORE BE THE MAIN CAUSE OF RIGIDITY OF THE EARTH'S INTERIOR.

As corroborative evidence that elevation depends on density not only in mountain ranges but in continental areas, I will call attention to the work that the Indian government has had done on a series of tests with the second pendulum at various altitudes in the Himalaya region, by which it was found that the density of the earth at different points varies with the altitude*.

A similar transcontinental survey of the United States is mentioned by Le Conte, page 177, as giving similar results.

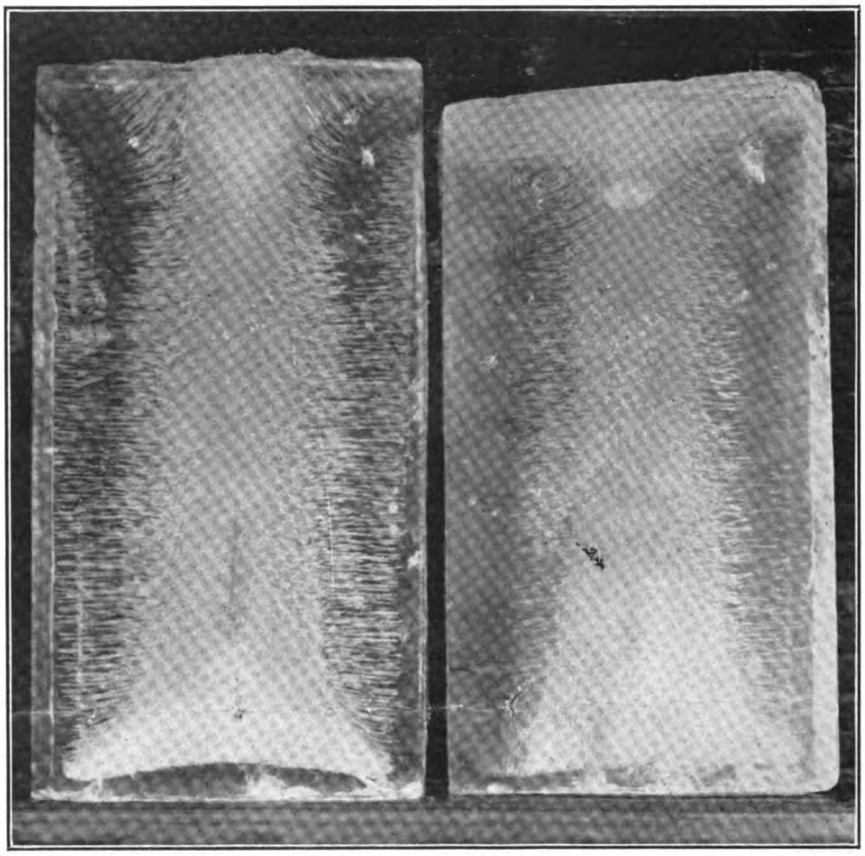
Followed to its logical conclusion, this theory of the cause of elevation and subsidence leads to the same result as stated in recent publications of the investigation of the Coast and Geodetic Survey, viz., that the isostic layer of the earth's crust, if divided into equal areas bounded by vertical planes to a depth of 70 miles below sea level will contain equal amounts of matter, whether the area is above or below sea level.

From the money grubbing individual without imagination such theories bring forth the comment that there is no money to be made out of that, therefore what's the use? But here is the ultimate result which includes the non-imaginative individual and his money; if it were not for the existence of this force which renders some parts of the earth's crust less dense than others and causes them to stand higher, then the whole solid surface would stand at about the same level and the ocean would cool it all and render life, as we see and know it, impossible. It is certainly worth while to know of a cause so universal in its action.

Take the Grand Canyon of Arizona as an example. There is a geological record in its walls of subsidence followed by deposition of beds of Algon age—elevation and erosion followed by subsidence and deposition of several thousand feet thickness of sediments, and again elevation and erosion of probably 10,000 feet of beds only remnants of which can now be detected on the plateau through which the river has cut the canyon. Erosion is given as the cause of the canyon, but I submit that erosion is caused by elevation and as elevation is shown to be caused by reduction of density by expanding steam traveling towards the surface, then the ultimate cause of the Grand Canyon is due to some general cause, as elevation. As evidence that this is true: at a point known as Vulcan's Throne on the Toroweapa opposite Cataract Canyon, a crater has erupted lava which Powell reports as having filled the canyon nearly to the rim, remnants of the lava flood still adhering to the canyon walls on both sides and a rapid known as "lava falls" in the river shows that the canyon was deeper than now, at the time of the eruption.

The numerous subsidences of islands and land areas following volcanic eruptions and earthquakes point to an increase of density after liberation of or condensation of steam. The temple of Serapis near Naples as described by Le Conte, page 141, furnishes a classical example of repeated elevation during accumulation of steam, and subsidence following the volcanic explosion of Monte Nuova.

These rapid changes of elevation due to fluctuations in density are exceptional and the great continental changes take place by a much slower process wherein erosion of the impervious covering of sedimentary rocks is the means of providing the more rapid escape than accumulation. The slow increase of density results in a slow rate of subsidence unless the crust be rapidly loaded by sedimentation, as is the case in river deltas



Artificial Ice, Showing how Dissolved Gases are Crowded Toward Center of the Cakes as Freezing Takes Place from the Outside. This illustrates how the Zone of Fracture, Which is Solid Because it is Cold, Does Not Allow the Steam to Pass Through Like the Zone of Solid Flowage, Which is Solid from Pressure.

*Osmond Fisher, Physics of the Earth's Crust.

which are known to subside more rapidly than other parts. SUBSIDENCE AFTER VOLCANIC ACTION HAS CEASED IS INDICATED BY DESECTED CONES SHOWING THE STRATIFIED BEDS DIPPING TOWARD THE CENTER OF ACTIVITY, WHILE IN ACTIVE CONES JUST THE REVERSE IS TRUE. This indicates that after the escape of the elastic medium, steam, which is the motive force of volcanic action, that the density has increased and the surface has subsided.

SURFACES NOT PERMANENT.

It follows from a consideration of the above-mentioned conditions that the continents are not permanent and neither are the ocean basins. The logical conclusion therefore is that every part of the earth's surface whether covered by land or ocean has been above sea level at some time and at another time below.

This disposes of one of the greatest difficulties geologists have had to contend with, NAMELY, FROM WHENCE CAME THE MATERIALS TO MAKE THE THOUSANDS OF FEET IN THICKNESS OF THE SEDIMENTARY SERIES WHICH AT PRESENT COVER OUR CONTINENTAL AREAS?

"The hills are shadows and they flow
"From form to form, and nothing stands—
"They melt like mists. The solid lands
"Like clouds they shape themselves and go."

Suppose two adjoining regions to have a difference in density of say 2%.

Apply that difference through a thickness of 200 miles of crust and it will admit of a difference of elevation of four miles and still the two regions be in equilibrium without taking into account that the ocean water will cover the lower portions and admit of a still greater difference in elevation. There are doubtless much greater differences of density than 2%, but they are local and give rise to local elevations. When these densities get reversed by the more rapid discharge than accumulation of the leavening gases beneath the continents and the more rapid accumulation than discharge in the case of the sediment covered ocean bottom, then the ocean bottom will be elevated above and the continent depressed below sea level.

The thicker the covering of sedimentary rocks the more impervious will be the covering and the more certain is the region to be elevated in time. This explains why it is that the sedimentary series exposed in mountain ranges is thicker than in the level plains on either side and shows how it may not be due to compression.

The discharge of hot water through geysers or hot springs or volcanoes where the discharge is not rapid enough to be called an eruption is easily understood if both the water and the heat are derived from the interior zone of critical tempreature. They may deposit mineral matter in the fissures through which they ascend until they choke themselves, and it will result in the pressure accumulating until the walls of the fissure are spread apart again, A FACT THAT IS OBSERVED TO HAVE OCCURRED FREQUENTLY, AS SHOWN IN THE MINING OF ORES IN FISSURE VEINS.

The great accumulations of oil and natural gas can be explained on the basis of the gaseous interior containing hydrocarbon gases along with the steam and other gases or by the action of the ascending steam on metallic carbides contained in the zone of solid flowage.

The latter explanation is the more probable and is similar to the theory of Mendelljeff except as to the origin of the water. By this theory the great pressure of the oil and gas are residual from the differential pressure and the salt water below the oil is due to the condensation of the steam and the leaching of salt from igneous rocks.

The reservoirs are found below thick beds of shales which act as elastic coverings for non-elastic beds which are faulted by the pressure of the ascending gases, while the shale will stretch and not fault and acts as an impervious blanket for a non-elastic series below.

The deposition of graphite would follow upon the decomposition of some of the heavy hydrocarbon series in the same manner as coke is left behind in the cracking or distillation of oil and diamonds be deposited in volcanic necks in the presence of superheated water, carbonic acid and hydrocarbons.

Gardner Williams' description of the diamond mines of Kimberley (Smithsonian Institute, 1905) shows that the region within which the volcanic pipes are located has no exterior drainage, and has evidently subsided by increase of density since the volcanic action ceased. The material erupted was probably volcanic mud, easily eroded, which accounts for the ejected material being swept away. As conditions favorable for the formation of diamonds required high pressure, the portion swept away would not contain them and erosion would have to remove the upper portion of the pipe before they would be brought to the surface.

The objection has been offered that H_2S, CO_2 and the hydrocarbon series as represented by $CN\ H_2N+_2$ are unstable at high temperatures and could not come from a region of critical temperature. This is easily explained if we suppose the unstable gas to be the result of chemical reactions taking place near the surface, where the temperature is below their decomposing temperature. For example: $3CO+H_2O+SO_2=H_2S+3CO_2$ by which two unstable gases are made out of three that are stable at high temperature.

Metallic carbides would be formed by the action of carbon on the metals as soon as they condensed to solids and must form a considerable portion of the zone of solid flowage. Steam rising through these will produce acetylene, CH_2, which united in various proportions with CH_4, which make the whole paraffine series CnH_2n+_2.

From the fact that a short distance below the surface of the earth ores are generally sulphides, and from the presence of hydrogen in volcanic gas and the evidence offered by petroleum and natural gas, we can see that there is a deficit of oxygen below the surface and further that the oxygen in the atmosphere is the result of the decomposition of CO_2 by the vegetation which is now buried in the coal measures.

The formation of laccolites may be explained in much the same manner as the intrusion of dikes, with this difference that a laccolite requires an elastic covering above an inelastic base in the same manner as suggested for the accumulation of oil and natural gas.

The inelastic base is faulted by stretching and the dike matter intruded below the elastic shale which stretches and rises in a dome as the fluid mass collects beneath it. Laccolites are in most cases of silicious character because they represent the first efforts toward volcanic eruptions and are hydrous fusions of granite and other silicious rocks. Laccolites are much more favorable to the formation of ore bodies than lava flows because of the slower separation of the steam from the fused matter and the opportunity for local enrichment from magmatic solutions.

The standard objection to the theory of a gaseous interior is lack of rigidity to resis tidal action. This may be answered by the statement that rigidity is a property of matter acquired by reduction of the amplitude of vibration of its molecules with relation to each other.

For example heat a bar of iron and the amplitude of vibration of its molecule is increased and it loses rigidity; cool the bar of iron and the amplitude of vibration is reduced until it acquires rigidity.

The gaseous matter in the zone of critical temperature must be denser than the solid matter above it in order to retain its position; having greater density than the solid matter the amplitude of vibration of its molecules with relation to each other must be less, and it should therefore have greater rigidity.

LEACHING APPLIED TO COPPER ORE*

Thirteenth Article Reviewing Results Accomplished, With Special Reference to the Laszczynski Process and Its Adaptability to Small Leaching Operations.

By W. L. AUSTIN.†

On April 19th, 1904, there was issued to Stanislaw Laszczynski of Kielce, Russia, U. S. Patent No. 757,817, covering a "process of electrolytically extracting copper and zinc from ores." The essential feature of this patent is the use of insoluble anodes, tightly wrapped in thick cotton or other texture (flannel), in electrolyzing a sulphate lixivium. This texture constitutes a permeable envelope, the thickness of which must be in inverse proportion to the applied density of current, (as will be explained further down), and serves to prevent anodic oxidation of the cathions. It is stated on good authority that this process permits the economic removal of copper from solutions containing that metal, with the production of a superior quality of electrolytic copper, leaving the liquor in condition to be used for leaching a fresh batch of ore.

According to published statements, the method is in operation at two points in Russia, and it is claimed for it that it can be employed advantageously in small units, and that it does not require expensive supervision. One of the plants, that at Miedzianka in Russian Poland, has been described in "Oesterreichische Zeitschrift fuer Berg und Huettenwesen,' 1906, page 387, and quite recently a serial article, reviewing the general aspects of the process, together with an account of its application at Kakaralinsk in Siberia, has appeared in "Revista Minera, Metalurgica y de Ingenieria," written by Walter Stoeger. The sequence in this latter article has been followed in the description of the process given below, amplified by notes derived from other sources.

The development of the process has been ascribed to the efforts of Dr. St. v. Laszczynski, who also is given credit for constructing the first plant, and directing its operation until the initial difficulties had been satisfactorily overcome.

APPLICATION OF PROCESS.

In carrying out the Laszczynski process the ore is first crushed by rolls, and if it happens to be a sulphide, it is then mixed with five per cent of damp loam (brick-earth), molded into blocks, dried, and roasted, with a view to getting a product containing copper-oxide and sulphate. The roasted ore is then again crushed fine before lixiviating with dilute sulphuric acid, whereby, (provided the roasting has been properly conducted), all the copper is said to go into solution in the form of sulphate. The lixivium is then subjected to electrolysis, using insoluble lead anodes and copper cathodes, and current is applied until no more than traces of copper remain in the electrolyte. While copper is being deposited at the cathode, a corresponding quantity of sulphuric anhydride is formed at the anode, and the spent liquor from the electrolytic vats, containing the regenerated acid, is used over again in the treatment of further batches of ore. The process forms therefore a cycle.

The operations, (roasting and lixiviation of the ore, accompanied by electrolytic deposition of the copper from a sulphate solution), are so simple, and so well known in all particulars, that it would seem as though the extraction of copper by electrolysis in the manner indicated should have been worked out long ago. But with the roasting methods heretofore employed for the purpose of oxidation, sufficiently pure solutions of copper sulphate could not be obtained for electrolysis under working conditions and this fact has constituted one of the greatest impediments to the introduction of humid methods of copper extraction. In carrying out the process, other soluble metallic salts were taken up from the ore by the solution, among these being ferruginous compounds which introduce complications into the operation. For instance, when an electric current is passed through a solution containing sulphuric acid and ferrous sulphate, the latter is oxidized to ferric sulphate, and this salt vigorously attacks the copper deposited upon the cathode, rapidly dissolving it. As a matter of fact, when a solution of ferruginous copper sulphate is electrolyzed using insoluble anodes, not only is the quantity of copper deposited much less than that which theoretically should be expected, but in addition the metal obtained is fragile and of subordinate value commercially speaking.

CARE IN ROASTING.

In order that the least possible quantity of iron should pass into solution, and at the same time to diminish losses when treating sulphide ore, roasting should be conducted in such a manner that only ferric oxide is produced, which of course is insoluble in weak acids. However, even when exercising every precaution, roasting cannot be carried to theoretical perfection, and a certain quantity of iron invariably passes into solution.

Even when the first solution off the ore contains a quantity of iron so small as not to materially interfere with the operation, nevertheless the proportion grows as the process is repeated, until finally the accumulated ferric sulphate dissolves as much copper from the cathode as the current deposits—that is to say, deposition of the copper ceases. Under usual conditions the high cost of acid prevents the employment of fresh lixiviant with each new batch of ore, and discarding the spent liquors is therefore impractical. As a remedy for this evil it has been proposed to purify the solutions before submitting them to electrolysis by precipitating the iron with calcium carbonate. But the ferric hydrate thus formed carries down with it notable quantities of copper, which fact renders this method also unavailable.

The employment of diaphragms in the electrolytic vats overcomes to some extent the baneful influence of iron salts, provided the space surrounding the anode can be kept filled with dilute sulphuric acid. The acid then prevents contact between the anode and the ferruginous salts, impeding oxidation. Nevertheless the use of diaphragms has its disadvantages also: it complicates the apparatus, necessitating two separate currents of electrolyte, with corresponding systems of pipes for the anode and cathode baths. It also frequently happens that diaphragms break during the operation, or while charging the vats, and the deposited copper, or the electrolyte, becomes contaminated. Furthermore, the construction of vats fitted with diaphragms is expensive and complicated, and frequent repairs cause much work and expense. For these reasons, electrolytic methods employing diaphragms are not to be recommended for practical work—at least, experience up to the present time has indicated that such contrivances should be avoided where possible.

† Mining Engineer and Metallurgist, Riverside, California.

OVERCOMING DIFFICULTIES.

The Laszczynski process is said to have overcome the difficulties enumerated in the following simple manner. In the first place, the anodes employed consist of refined lead-plates enveloped in a coarse cotton texture (fustian) in close contact with the surface of the plate. The effect of this simple disposition is said to be surprising. Although the solution may contain large quantities of ferruginous salts, the deposited copper has a beautiful appearance and the electrolyte is said to yield practically all of the copper originally in solution. The amount of copper deposited is almost that which would be theoretically expected from the indicated quantity of current employed. The texture used has proved to be very durable, (provided it is left in the liquor), requiring renewal once a year at the most. If it is removed often from the bath, it is speedily destroyed.

The satisfactory action of the envelope surrounding the anode may be explained as follows: The lixivium which permeates the texture is at first identical with the rest of the electrolyte. If, however, the bath is agitated, (which is essential in obtaining a good deposit of copper), that portion of the lixivium which is enmeshed in the texture remains practically undisturbed. Furthermore, electrolytic treatment of the lixivium produces liquors of varying densities, and those of high specific gravity enter the pores of the texture very slowly. It follows that as the texture is very tightly wound around the anode, the latter remains surrounded with a solution practically in repose, even though the rest of the electrolyte be in a state of violent agitation.

When the electric circuit is first closed, everything proceeds as though there were no envelope. However, as the ferric and ferrous ions are cathions, that is, as they move from proximity of the anode in the direction of the cathode, it transpires that within a short time after the current has been passing through the electrolyte the ferruginous salts have for the greater part left the vicinity of the anode. Then, as there are no salts of iron near the anode, such compounds are not subjected to the action of the SO_4 ions liberated at that electrode, as there are none of these salts present to be oxidized. The result is that there are no ferric salts formed which might act upon the copper deposited upon the cathode. The only way that iron-ions can reach the anode is by diffusion through the envelope, and it follows that the time required for such diffusion depends upon the thickness of the texture. If therefore a current strength is applied which causes a movement of the iron-ions towards the cathode approximately equal to the speed of diffusion, then few, if any, of the iron-ions will reach the anode, and the troubles due to anodic oxidation of the ferrous sulphate are overcome. That such a state of equilibrium can be brought about is said to have been confirmed by actual working results.

It is evident that the thickness of the envelope must be in inverse proportion to the strength of current; because, the thicker the texture, the greater will be the distance through which diffusion must take place to reach the anode, and the longer the time required. Increasing the strength of current charges more ions and starts them off towards the cathode, therefore the movement of the cathions is increased relative to diffusion, and less thickness of envelope is required.

It is only when the envelope is placed tight against the anode that the desired results are attained. If it hangs loose, or if it is placed on a frame at some distance from the electrode, then diffusion is assisted by vertical currents set up in the liquor through difference in specific gravity of the solutions, and in this manner iron-ions may reach the anode. When properly adjusted, the envelopes do not interfere with escape of oxygen liberated at the anode, and it is said that a lixivium containing twice as much iron as copper can be electrolyzed with close to theoretical current-efficiency. It is interesting to note in this connection that in the Farnham electrolytic cell (U. S. Patent No. 1,006,836) the anodes are made hollow and are pierced with a multitude of holes. The diaphragms (asbestos, burlaps or canvas) are secured to the outside of the anode, which gives them a rigid backing.

ORIGINAL PLANT IN POLAND.

The first plant operated under the Laszczynski system was put up at the Miedzianka copper-mine near Kielce-Checiny in Russian Poland, not far from the German and Austrian frontiers. The ore exploited contained azurite, chalcopyrite, malachite and grey-copper. The richest grade carried as high as forty per cent copper; the poorest, approximately fifteen per cent.

In the beginning the works were designed for an approximate output of 100 kilograms (220.46 lb.) copper in 24 hours, but provision was made for increasing the production should it seem advisable to do so. As water-power was available, a 50-horsepower Francis turbine was installed, but to date not over approximately fifteen horsepower have been used.

As sulphides predominate in the ore it has to be roasted, thereby producing a mixture of sulphates and copper-oxides. The copper oxide formed is changed over into sulphate in the course of operations by means of sulphuric acid derived from electrolysis of the lixivium, while the sulphuric acid contained in the sulphate formed in the roasting compensates in part for that lost in the tailings.

The degree of concentration of the electrolyte may vary greatly without seriously affecting electrolytic treatment. The relative proportion of copper sulphate and copper oxide in the roasted product therefore does not necessarily have to be constant. It is sufficient that the average ratio existing between these compounds should remain approximately the same over an extended period.

The roasting must be carried to a point where no undecomposed sulphides remain in the roasted material, because sulphides do not go into solution in dilute sulphuric acid and therefore any of these compounds present would constitute a direct loss. The percentage of extraction manifestly affects economic results, and too low an extraction caused by inadequate oxidation of the raw sulphides reflects upon the applicability of the process. The majority of roasting furnaces are not well adapted to the complete oxidation of copper sulphides, which can be ascribed to the fact that in smelting copper-ore it is not necessary, nor even desirable, to attain a perfect roast, and it is for this latter method of reduction that most roasting furnaces are designed. Because of the inefficiency of such apparatus, in the introduction of the Laszczynski process much experimentation was necessary to discover a method of roasting appropriate to the purpose in hand. After many ineffectual attempts, the following means of reaching the desired end was devised, and very satisfactory results are said to have been attained.

The mineral was first pulverized in two cylindrical grinders, so as to pass through a 1 mm sieve and then mixed with five per cent of clay and moistened so as to form a plastic mass suitable for molding in a press. The briquettes thus obtained were then dried on top of the furnace before being roasted. The roasting furnace consisted of a shaft of rough masonry, with firing-door half-way up the side. The briquettes were charged at the top through an opening which could be closed by an iron plate, and passed down through the furnace, being cooled by the air drawn into the shaft after they had passed the firing door. At the bottom of the structure was a discharge opening, provided with a contrivance for regulating the draft. In this manner the air entering the furnace was preheated as the briquettes were cooled. The kiln described is strikingly like the one used for a somewhat similar purpose in Arizona, (described in Mines and Methods, November, 1911, page 356), a fact which is interesting in that it shows how, when occasion arises, practically the same problem may be attacked simultaneously at two widely separated localities, and solved in the same manner.

The briquettes are said to be sufficiently porous to permit a thorough roasting of the mass, the burning of the sulphides increasing the draught and facilitating the oxidation. The operation of this furnace is said to be satisfactory, all of the copper being transformed either into oxide or sulphate so that no insoluble copper-sulphide remains in the roasted ore.

LEACHING AND ELECTROLYSIS.

The roasted ore, coming from the furnace in condition to be readily crushed, after comminution is placed in leaching-vats and subjected to successive lixiviations, using as lixiviate the liquor from the electrolytic vats which contains approximately seven per cent free sulphuric acid, and from one to one and a half per cent copper. This operation is conducted in such a manner that the partially saturated lixiviate is brought into contact with fresh roasted ore, while the acid solution from the electrolytic vats is used on partially lixiviated material. This is, of course, the application of the principle of contrary streams. As electrolysis is always accompanied by more or less evaporation of the liquid, and furthermore, as a certain portion of the liquor always adheres to the tailings, such losses are made up by additions from wash-water used in washing the residues from the leaching vats.

The solution of sulphate of copper (lixivium) from the leaching vats contains approximately five per cent copper and one per cent free acid. It is turbid and must be passed through a filter-press before being sent to the storage tanks placed below the leaching vats from which the clear solution, now ready for electrolysis, is drawn as required.

Electrolysis is carried out in vats made of wood which are lined with lead, similarly to those used in copper-refining establishments. Each vat is equipped with nine anodes, composed of plates of lead about one-eighth inch thick, covered with cotton texture, and eight cathodes, consisting of thin copper leaves—so-called, mother plates. Between each anode and cathode is placed a wooden agitator which serves to maintain the electrolyte in continual agitation. Copper rods, placed longitudinally over the electrolytic vats, serve as current-conductors to the anodes and cathodes respectively: all anodes in each bath being connected to one of these rods, and all cathodes to the other. A difference between the Laszczynski vat and those used in copper refineries, consists in the use of insoluble anodes in the former, as well as in keeping the liquor in movement with agitators in place of injecting air.

When the electrolyzing vats have been filled with lixivium, the current is turned on. Each vat contains about 35 cubic feet of liquor, and is supplied with 900 amperes of current which shows a drop of from 2.25 to 2.50 volts in potential per vat.

As already explained, the current effects deposition of copper upon the cathode, and produces free sulphuric acid and oxygen at the anode: the oxygen is allowed to escape into the atmosphere. The amount of copper deposited per ampere-hour is said to be as high as 1.1 gram, which is approximately equivalent (92.9%) to the quantity (1.184 gram) theoretically attainable. If one ampere of current will deposit 1.1 gram copper in one hour (irrespective of voltage), to deposit a kilogram of the metal will require $\frac{1000}{1.1} = 909.1$ ampere-hours. As stated above the mean voltage employed was $\frac{2.25+2.5}{2} = 2.375$ volts. A kilowatt-hour (the conventional unit upon which electric power is sold) equals 1000 ampere hours at one volt pressure, or one ampere-hour at 1000 volts, or 421.05 ampere-hours at 2.375 volts, therefore the kilowatt-hours expended in depositing one kilogram of electrolytic copper under conditions as stated, amounts to $\frac{909.1}{421.05} = 2.16$, measured at the vat, or from 3.2 to 3.5 steam horsepower hours, according to size and efficiency of the dynamo and length of electric circuit. Hence, for the production of a ton (1000 kg=2204.6 lb.) of copper daily, there will be necessary approximately $\frac{3.2 \times 1000}{24} = 134$ steam horsepower, when losses in dynamo and conductors are taken into account.

It is evident from the foregoing figures that on a basis of steam power costing $60.00 per annum (365 days @ 24 hours), the expense for current used in depositing electrolytic copper in the manner described would be one-half ($0.01 per lb.) that of precipitating with iron at one cent per pound for that reagent, using two pounds iron to precipitate one pound copper in the form of cement-copper. However, electrolytic precipitation has the advantage of producing a finished product, (instead of the undesirable mixture of copper with impurities known as cement-copper), and the bath-liquors are at the same time regenerated and made available as lixiviant for treating a further batch of ore—two very important considerations.

Because of the limited production of the Miedzianka mine, only four electrolytic vats were put into use, and these furnished approximately 100 kilograms of copper daily. The current was supplied by a dynamo with capacity of 900 amperes per hour at ten volts pressure.

The lixivium was subjected to the action of the current until its contents had been reduced to approximately 1 to 1.5 per cent copper, while the proportion of free acid rose to about seven per cent. the gradual discoloration of the liquor indicates the advance of the treatment. About 35 hours were necessary for the deposition of all the copper contained in the liquor held by a vat of 35 cubic feet capacity.

After the removal of the copper the liquor is returned to the leaching vats where it takes up more copper, and this operation is repeated until the cathodes reach a thickness of from three-quarters to one and three-eights inch, which requires approximately one month. Then the plates are taken out and replaced by new ones.

The copper deposited on the cathodes possesses a uniform bright-rose color. It is said to be nearly chemically pure: purer than copper produced by electrolytic refineries generally. It gives out a metallic sound when struck and can be put on the market without further treatment.

In preparing the cathode plates, sheet-copper is coated with graphite and suspended in an electrolytic bath. When there has been deposited on each face approximately 1-32 inch of copper, the sheets are taken out and the deposited metal is stripped off: these strips then serve in turn as cathodes.

The process is, therefore, obviously simple, and should call for very little expert supervision: in fact, it is said that practically any intelligent workman can be sufficiently instructed so as to be able to take charge of such a plant. At the Miedzianka mine it was found possible to place operations in the hands of an old miller who happened to be living in the neighborhood.

Should it be desirable to recover the oxygen separated at the anode and thus realize profit from a by-product, this can be done; but then the construction of the electrolytic vats becomes more complicated, and the simplicity of the apparatus is affected, which simplicity constitutes one of the advantages of the system.

SECOND PLANT IN SIBERIA.

A second establishment employing the Laszczynski process has been in operation since 1908 at Kakaralinsk in Siberia. The reasons given for deciding on the adoption of the process in this particular case were: (1) the simplicity of installation and certainty of action; and (2) the fact that the nearest railroad station was 700 kilometers distant from the mine, which effectually precluded shipping-in bulky supplies. This plant was designed for a daily production of 1.1 metric tons of copper, but at present only about half a ton is turned out. On the surface of the deposit oxidized ore is found which does not require roasting; at greater depth it is naturally expected that sulphides will be encountered.

The installation is similar to that at Miedzianka, but there are more electrolyzing vats, and these are of larger capacity. The leaching is carried out in the manner already described. As water power was not available, recourse was had to steam. There being no coal nearby, wood is used as fuel. The consumption of wood is said to be large, for it not only serves as a source of power, but also is used to heat the works and living houses of the employees—by no means an inconsiderable item in that inhospitable climate.

Many difficulties were encountered during construction, and while putting the plant into operation, as would be anticipated in a region almost totally devoid of means of communication, and extremely barren. For instance, when it was found that a certain rock-breaker did not respond to the work required of it, eighteen months passed before another could be obtained from Europe to replace it. In the beginning of operations the only food available was mares' milk. Scarcity of water also created complications. In summer water is very scarce and contains considerable chlorides, which corrode the lead and diminish the effectiveness of the electric current in the electrolytic vats. A remedy for this evil was found in purification of the water.

The liquor remaining in the residues after lixiviation carries with it very little copper: by washing, the amount is brought down to a small fraction of the total originally in the ore, so that the loss from this source is unimportant—in the electrolytic vats there is, of course, no loss of metal whatever, because that remaining in the lixivium goes back to the leaching vats.

It is thought by Stoeger that a plant designed to produce one metric ton of copper daily, provided with the necessary solutions, should cost (in Spain) approximately 45,000 marks ($11,250), including electrolytic vats, dynamo, storage tanks, pumps and accessories. Where steam power is not unduly expensive, the cost of electrolytic treatment, including amortization, should be about the same as precipitation by means of iron. However, there is in favor of the Laszczynski process the fact that electrolytic copper is produced, which can be sold for commercial use, whereas cement-copper resulting from precipitation by iron must be smelted and refined before it becomes a marketable product. The difference between these two products, viewed from the standpoint of selling price, is of course in favor of the electrolytic copper, and this fact in itself is thought to justify the adoption of the last named method when conditions permit.

ADVANTAGES OF PROCESS.

In recent times the electrolytic manufacture of weldless copper-tubing, as well as plates and wire, has assumed considerable proportions. All such methods of manufacture make use of soluble copper anodes and call for refined metal of great purity. By adopting the Laszczynski process the required quality of metal is obtained direct from the ore, and the manufacture of commercial forms of copper, it is said, may be carried on without difficulty.

It is self evident that a plant employing a process based upon the application of electric energy should be located as close as possible to a source of cheap power. It is apparent, therefore, that such methods of reducing copper ore are particularly adapted to localities where water-power can be developed but where fuel is expensive.

In favor of electrolytic methods of treatment, as with leaching processes in general, is the fact that the percentage recovered is high, and therefore the maximum amount of copper may be extracted from an ore. This may become a feature of much importance in the treatment of low-grade ore where wet-concentration methods leave from 25 per cent upwards of copper in the tailings. Furthermore, some ore cannot be smelted at all per se, or the expense for fluxes and fuel may consume a large portion of the profits, so that such methods of reduction affect the value of a given property. In such cases some leaching process is the rational recourse, and with the number to choose from, some one of them ought to meet the conditions in most instances. At Kakaralinsk, owing to absence of suitable means of communication, bringing in iron for cementation could not be thought of, consequently there remained nothing to do but to apply an electrolytic treatment, which was done.

In the Laszczynski process it is said that the presence of iron, zinc, lead, arsenic, and antimony in an oxidized ore exert no prejudicial influence. Lime, or other compound soluble in sulphuric acid, are naturally injurious, because such substances bring about wasteful consumption of acid.

Heretofore it has been found necessary to put up sulphuric acid chambers, or to purchase acid, where this reagent was employed for leaching purposes; but introducing sulphur-dioxide into the bath, as described in preceding articles, has been found an economical method of making up loss of acid occasioned by the operations.

Briquetting sulphide ore is not a suitable method in all cases where roasting is necessary. It happens that cupriferous pyrites, in very fine state of division, must often be treated in mechanical roasting furnaces to render the copper content soluble. In such cases not only is it essential that all the sulphur should be oxidized, but also that the temperature should not go above a certain point, because then insoluble compounds composed of oxides of copper and iron are formed. This is the reason why pyrites roasted in the usual manner often cannot be satisfactorily lixiviated with dilute sulphuric acid even after repeated roastings. In carrying out the first roast, proper precautions as to temperature may not have been taken, which results in the difficulties described.

The Laszczynski process is said to be applicable in all cases where the extraction of copper by humid methods appears advisable; for example, in the treatment of low-grade ore, or of pyrites when the leached material is to be smelted for iron after the copper has been removed. As it has been shown in the two Russian plants referred to above that works of small capacity may be economically operated, it can be expected that other mines similarly situated, from which ore cannot at present be economically shipped, might be handled along the same lines. The process might also be economically adopted in chemical factories where pyrite is burned to make acid, even when the copper content of the ore is not large. With a process which turns out copper in as pure a form as the one under consideration, the necessity of disposing of cupriferous by-products to refineries might be avoided.

In electrolytic refining establishments it is necessary to change the electrolyte when the amount of impurities assumes excessive proportions. As a usual thing such impure solutions are treated so as to convert the contained metal into cement-copper, or into sulphate of copper. As in such works baths and current are already at hand, it is possible with some simple additions to arrange for extracting copper from the residual liquors without making by-products: all that is necessary is to add some lead anodes wrapped in cotton texture. By applying proper current-density, it is said that all the copper can be removed from such residual liquors.

To recapitulate, the advantages claimed for the Laszczynski process are: (1) simplicity of installation; (2) positive action and small cost of operation; (3) high priced supervision not required; (4) in case of strikes it is easy to substitute other workmen, which is not the case in smelting works; (5) small loss of copper in tailings—therefore, availability for low-grade ore; (6) avoidance of melting operations of all kinds; (7) possibility of producing metal in commercial forms direct from ore; (8) applicability to small works located in proximity to small mines; (9) possibility of extracting copper profitably from impure solutions; (10) utilization of water-power for metallurgical purposes where fuel for power, and iron, are not available.

What is very much needed at the present time is some such process as the one described, which is not very expensive to put in, and which turns out copper in a commercial form. Such a process might render profitable many small mines which are now idle from one cause or another. From published accounts the Laszczynski process appears to have met the required conditions at two properties—in any event its merits in a given case are easy to establish.

MODERN MINE BUILDER

From an Arizona prospect to a transcontinental railway would seem a far cry, but that is what is eventuating at this very moment, says the Southwestern Mining Record.

Not more than a score of years ago, Dr. James Douglas, now head of the Phelps-Dodge interests, sat mooning and ruminating in a canyon at the place now known as Bisbee, Arizona. The ore had given out in the then prospective Copper Queen mine. The doctor's eastern associates had manifested a bad case of "cold feet."

Notwithstanding these vitally discouraging circumstances, the doctor's faith never faltered nor did his courage swerve. But the coincidence of the ore being lost and the unwillingness of his eastern associates to further furnish money for the development of the mine were of such seriousness that the doctor felt depressed. And that was why he sat down, one night, lonesome, dejected and absorbed in thought, in a canyon which is now one of the main thoroughfares of Bisbee.

"The formation is perfect," soliloquized he. "The amount of ore in the original discovery was too great to have been anything else but the detached portion of a great body."

"Faith moves mountains," flashed through the doctor's mind; and right then and there did he determine that faith should reveal the secret of a mountain. Arising from his discouraging reflections, he was amazed at the change which had come over him. He was really lighthearted and buoyant, and turning to wend his way to his makeshift office and sleeping quarters he was impelled to give one glance backward at the mountain, and, surveying it from the base to apex with a look that was almost menacing in its intensity, he mentally said: "Thy secret thou shalt unfold unto me."

The die was cast with the doctor. The very next day saw him astride his faithful horse on the long and weary jog to the nearest rails, at Fairbank, Arizona. Pitilessly did the sun beat down upon him, painfully did his mount amble through the sands of the desert and the steep, rocky passes of the mountains; but the doctor was oblivious to it all, for he was dreaming dreams—dreams of the kind which when realized, make for the betterment and happiness of mankind.

So absorbed and obsessed was he with the idea of wresting the secret from that mountain that the journey from Fairbank to New York seemed scarcely a day. Arriving in the metropolis, he found, as had many before him, that although faith may move mountains, it has oft failed to move financiers.

Through weeks of varying fortunes he passed, one day hopeful, the next despairing, until finally through his sublime faith, courage and persistence, he secured one hundred and fifty thousand dollars with which to conquer the mountain.

Every mining man knows that one must be especially favored of Providence if he develop a copper mine with one hundred and fifty thousand dollars. Many have tried, but few have succeeded. But the doctor seemed to be one of the elect, for he found the main body of the Copper Queen mine. And even then, for a few years, things went in a way to try a man's soul. Copper was low, lower than now, and the bullion had to be transported by team to Benson, a matter of seventy miles or more.

Nothing daunted, the doctor persisted, and ere long was figuring on a railroad connecting the mines with the Southern Pacific and Santa Fe systems. The railroad project rather staggered the easterners, who were required to finance the venture; but finally the railroad was built—and paid for itself the first year.

The railroad venture was an eye-opener to the easterners, who had fatuitously thought railroads, reasonably capitalized, paid only five and six per cent, as do the shamelessly overcapitalized roads of today.

The lesson was not lost upon the astute doctor, however, and he suddenly began to realize that he had not only wrested a secret from a mountain, but from a railroad as well.

The mines now paying profits, it was thought advisable to build a line to El Paso. This was speedily done. Then the original copper company known as the Copper Queen bought a coal mine in New Mexico and a railroad connecting it with El Paso. The doctor seemed to have been invested with a magic wand, for this moribund coal mine and railroad immediately developed into big money-makers.

Then a mine at Nacozari was acquired, and another at Morenci; and all, under the guidance and management of Doctor Douglas, proved to be good payers. The result of all these paying concerns was that a stream of wealth began to flow into the coffers of the eastern associates of the doctor until they were threatened with engulfment by the very plethora of money.

This money sought investment. Mines cannot be bought every day, and certain it is that they cannot often be found even at the behest of money. Therefore the surplus had to be invested in something ready at hand.

Then the doctor bethought himself of railroads—railroads that when reasonably capitalized make profits exceeding even those of mines, and increase in value with time; whereas mines inevitably tend toward exhaustion. Surveying the railroad field, it was determined that a transcontinental line—one from sea to sea—would be of the kind best calculated to insure profit and permanency. But as even transcontinental railways cannot be bought every day, some circumspection, judgment and diplomacy were requisite to the acquisition of one.

But the man whose faith had wrested the secret from a mountain was equal to the problem now confrontinkg him; and ere long, without any fuss or feathers, stock was beginning to be secured in the Rock Island Railway, a moribund, mismanaged road, running from Chicago to a place where it seemed to peter out altogether in Kansas. The magic wand was applied to it, and the derelict responded most gratifyingly to its revivifying influence. Soon there were Golden State Limiteds running over the line. Eighty-five pound rails replaced the streak of rust. Double tracking soon became necessary. Traffic increased to an incredible degree. The road now had its terminus at El Paso, where it necessarily had to disgorge its huge business into the maw of the Southern Pacific.

This evidently was too unreasonable to last; so now we see the extension to Tucson. Soon, it seems, we shall see a further extension—perhaps to Phoenix. And then, look out, for it will be a "dash for the coast," an irresistible, all-conquering dash that will land the road in whatsoever port it elects to make its western terminus.

And thus we think we "have made clear a thing that already seemed clear so clearly that it seems perplexed"—the development of an Arizona prospect into a transcontinental railroad.

Mail this number to a friend.

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CONTENTS:

Last month we had a few words touching upon the subject of how the Guggenheim's had been gold-bricked in various ways. We have since been asked if the notorious family did not get another "copper-plated gold brick" when it went into Utah Copper. To that question we may answer: "Not exactly; the Guggenheims went into Utah Copper for the particular purpose of securing a contract to smelt that company's mill or mine products at a price that would insure them against loss in the purchase of shares at $20 or so, even though they dropped to nothing before they would get a chance to unload." That is all that it is necessary to say at the present time on that subject.

UTAH COPPER

Recent Issue Of New Shares.
Production Estimates Shrink.
Working Both Ends on Labor.
Some "Utah Copperettes"

The Boston News Bureau of recent date has the following:

"Several holders of Bingham & Garfield R. R. Co. 6 per cent bonds have signified a desire to exchange their holdings for stock of the Utah Copper Co., which guarantees the issue.

"When the bonds, totaling $2,500,000 were issued in 1910, it was stated that they were to be exchangeable afted July 1, 1911, for the ensuing three years at the option of the holder into stock of the Utah Copper Co. at $50 a share.

"In order to care for such conversion the Utah Co. has made application to list 55,651 shares of additional stock to be issued from time to time."

To the uninitiated the disparity between the face value of the total bond issue and the gross amount of the nominal value of the authorized issue of shares thus made available for exchange, requires some elucidation. Besides, "in order to care for such conversion"—or exchange—the average reader will doubtless fail to conceive of any necessity for "listing" the 55,651 shares as a condition precedent to such exchange. At the present rate of dividend disbursements, Utah Copper shares at $50 return the same rate of interest per annum as that paid—or promised—to the holders of the bonds, except that quarterly disbursements are made to the shares, whereas interest on the bonds are promised only semi-annually; and in this respect the shares appear most attractive, especially in view of the higher market quotations that are daily recorded in their favor. But the bonds are secured, principal and interest, by mortgage upon all of the property of the Utah company, which—if regarded as safe and sound—should give these bonds a ready market value on a basis of four per cent interest, or $75 for the exchange rate of each share of Utah stock. But this is immaterial, and is mentioned only to indicate the degree of respect in which this class of securities is held as compared to other industrials.

It will be observed that the exchange value placed upon the shares totals $2,782,550, being $282,500 in excess of the total par, or exchangeable value of the bonds, and an excess of 5,651 shares of Utah stock over and above the number issuable in exchange for the entire bond issue. The probable explanation of this disparity will be found in the fact that no interest has ever been paid upon the bonds and, as the defaulted interest would attach to the mortgage lien, it could easily be made to appear that the issue of sufficient additional shares to cover accrued interest was justified. It will be remembered that these bonds were underwritten by Hayden, Stone & Co., and as the public did not participate to an appreciable extent in their purchase, the burden—as usual—fell upon the inside, or "pooled interest," so that an adjustment of interest or commission could be easily arranged.

Evidently the sole purpose of conversion of the bonds at this time was to "work off" the shares upon the public and thereby relieve the "pooled interest" of a portion of its burden. And in this connection it will be of interest to note what measure will be adopted to recoup the additional $2,500,000 or more which was likewise advanced by the pool to enable the management of the Utah company to complete its B. & G. railroad.

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UTAH COPPER PRODUCTION

Referring to the visit of Manager Jackling and associates to the Butte district a few months ago, a Boston paper published the following telegraphic special from Butte:

D. C. Jackling, Charles M. McNeill and George Bradley of the Utah Copper Co., are in Butte making an examination of the Butte & Superior mines and the new concentrating process. They declare this process is a decided success. Mr. Jackling says:

"At no time since I have been in the copper business have I known stocks to be so low as at present. When industrial conditions improve this will have its bearing.

"Utah will produce about 150,000,000 pounds of copper this year against 20,000,000 pounds seven years ago. The low price of copper has its effect upon the state's production, but the POTENTIAL condition is good and will improve as the market improves."

On the 10th of the present month,

Thompson, Towle & Co., in their weekly news letter—an official organ of the Utah Company—published the following:

"A preliminary estimate of Utah Copper's operations for the year 1911 places the gross production of copper at 98,000,000 pounds, and the net production, after allowing for smelter deductions, etc., at 93,000,000 pounds. This latter figure compares with 1910 net production of 85,644,511 pounds, or an increase for the year of approximately 7,350,000 pounds."

It will be observed that the actual yield of copper by the Utah company, as officially estimated at the close of the year, fell short of the estimate of Manager Jackling—made a few months previous—by fifty-seven millions of pounds, or THIRTY-EIGHT PER CENT. The only remarkable feature of this fact, however, is the striking relation which it bears to the shrinkage in grade of the "sixty-two millions of tons of TWO PER CENT ore," so frequently mentioned in the manager's earlier "Reports," which later shrank to about one and one-quarter per cent copper, being almost exactly THIRTY-EIGHT PER CENT, and what is still more remarkable, the volume of ACTUAL ORE was found to depreciate in even greater ratio; but the deficiency was partially made good in the masterful acquirement of the Barnsdall-Pay Roll claims, as related in this journal for December, 1910. It may be observed, however, that whilst Manager Jackling's estimate of the quantity and quality of the ore and—as a consequence—the yield of metal has been slightly at fault, it is believed that the "potential condition" of the several elements named has remained fairly constant.

WORKING BOTH ENDS

Under the caption, "Workmen are Prey of Labor Agents; County Attorney Investigating Charge, Asks Mining Companies to Take Action," the Bingham-Press-Bulletin of recent date publishes the following:

Complaints have been made to the county attorney that Greeks and other foreign laborers employed by the Utah Copper Company and the Bingham & Garfield Railroad Company have been compelled to purchase their jobs and pay tribute to labor agents to hold them, County Attorney I. E. Willey yesterday directed letters to the two companies, calling their attention to the fact that such practice constitutes practical slavery, and is in violation of the constitution and statutes of the state of Utah on peonage.

The letters cite the law which makes such a system of tribute from laborers a felony, and calls upon the proper officials to take immediate steps to put an end to the system.

The action of the county attorney was brought about through a letter received from John H. Stampolas, secretary of the Independent Grocery company of Bingham, and upon information which has been laid before him by residents of Bingham.

The letter from Stampolas charges that a well-known labor agent of Salt Lake, who furnishes foreign laborers for mining and railroad companies in Utah and adjoining states, requires Greeks who secure jobs from the Utah Copper company to pay him $20 to get the job and $1 a month for each month they work.

It is alleged that if the laborers fail to keep up their monthly tribute payments they are discharged.

The same conditions are said to exist with reference to the Bingham & Garfield Railway Company.

Mr. Willey believes that the companies when their attention is called to the violation of law, will have the proper officials take hold of the matter and see that this system is stopped.

The method of supplying corporations and contractors with foreign labor related in the foregoing, is not new or unusual in Utah and other Western States. In fact, the custom has come to be regarded by those who employ large numbers of laborers of that class as essential, because of the fact that these people, aside from being enrolled as regular members of "labor unions," are also under a system of peonage absolutely controlled by a padrone upon whom they depend solely in all matters of securing employment and to whom, in addition to a fee, paid on entering employment, they pay weekly or monthly contributions, according to conditions involving the positions secured for them. But this is the first instance of which we have ever heard wherein failure to pay "monthly dues" subjected the victim to peremtory discharge by the employer. Such condition could only be enforced by the connivance and participation of the manager or superintendent of the business or corporation employing such labor.

It would be interesting to know what manner of reply Manager Jackling or his assistant, Mr. Gemmel, of the Utah Copper Company, or Mr. Chief Engineer Goodrich, of the Bingham & Garfield Railroad Company, will make to the letters of inquiry said to have been addressed to the officers of these companies by County Attorney Willey. But it is safe to assume that this will never be made known to the public and that there will be no prosecutions or other unpleasantries to disturb the very cordial relations which exist between the management of the Utah Copper Company and all important State and local officers.

It will probably surprise some of our citizens to know that while very few of these foreign laborers can speak or understand a word of the English language, and are only known or designated by their employers by a number on the "tags" which they wear or carry when at work, yet many of them are full-fledged American citizens. In this connection a ludicrous if not amusing incident occurred—shortly prior to the last general election—during the progress of the trial of an important case in which the Utah Copper Company was a party. It appears that on two occasions during the trial squads of these foreigners—in the employ of the Utah Copper Company—were brought into court and put through the form of naturalization, the trial of the case being suspended by the court pending the more important process of equipping some thirty illiterates with the right to vote at an important election at which the court judges were to be selected.

No, there will be no prosecutions on account of "graft" imposed upon the Greek laborers, and the process will be continued just the same; but the Bingham newspaper—for its indiscretion—will probably find its subscription and advertising patronage greatly diminished.

COPPER STOCKS AND METAL

Every day, almost, witnesses a new batch of "publicity" being ground out by the market-boosting machines which are such an important part of the Utah Copper-Ray Con.-Chino companies' "visible supply" of assets, or equipment. This stuff is becoming almost as nauseating and equally as copious as the mass of stuff that used to be worked off on the public during the Nevada gold boom days as news. It is being compiled and distributed in cunning fashion, because governmental investigations are more in evidence than they were a few years ago, but the public are still refusing to take the bait. Stock that will earn "$8.50 a share for thirty-seven years" is not wanted at $56, or $50, or even $38 or $75, because the public has learned and is wise enough to realize that the present owners of such stock would not part with it at any price if the representations made were true.

There also is considerable doubt as to the correctness of the statements being put out concerning the market absorption of copper metal, as indicated in the following abstract from the Mining and Scientific Press' New York correspondence, which appeared on the 13th of the present month:

"In copper there seems to be a good deal of underlying skepticism concerning the recent upward trend in prices. Some of the large consumers are questioning the soundness of the situation and the movement in the shares hardly justifies the fears expressed by some of the producers of a runaway market. While it is not known as an absolute certainty that a pool of big producers was formed during the latter months of last year, it is so asserted in some quarters, the story being that the group included some of the more important foreign agencies, and that a large amount of copper has been accumulated in an endeavor to stampede the American manufacturer into the market. Discussion of the topic with manufacturers reveals the fact that many of them were, and are, uneasy over the prospect of higher prices and no metal on hand, but, while the report of the Producers' association for December, 1911, was expected to make a strong showing, there was a tendency to await developments. If it be true that a group of copper producers working with the larger selling agencies has purchased and is now carrying any large part of the copper which is supposed to have gone into consumption, if the decrease in the world's visible supply proves eventually to be accounted for in this way, it is safe to say that in the end the copper market will suffer more than it will gain."

UTAH COPPERETTES

W. E. Hazen, representing the Boston News Bureau and the Wall Street Journal, was in Salt Lake for a day or two about the middle of the month. He rode out to Bingham over the $5,000,000 Bingham and Garfield railroad, it is reported, "just to see if the steam shovels are still at work removing the capping from the Utah Copper Company's side of the 'mountain of copper ore' on to the opposite side, owned by Colonel Wall, and to satisfy myself that the Utah Copper Company really and truly has enough ore to pay $8.50 a share per annum, on a 15c. copper market, for thirty-seven years." From Salt Lake Mr. Hazen expected to go to Ely, from there to Mason Valley, and then down for a visit to the Ray Consolidated, Inspiration, Chino and other properties.

* * * *

"At the (Utah Copper) mine between twenty and twenty-five big steam shovels are in operation. It is said that every time one of the scoops digs its great iron teeth into the porphyry mountain it lifts at least $10 worth of copper and dumps it into a car. Averaging the copper content at 1.5 per cent that is thirty pounds of copper per ton. Each scoopful holds several tons. Five tons would contain 150 pounds of copper which, at 14c. a pound, is worth $21."—Salt Lake Herald-Republican, Jan. 12, 1912.

And to continue the method of calculating, (a la George L. Walker)), 100 tons would contain 300 pounds, worth $420, and 1,000 tons would contain 3,000 pounds, worth $4,200, while one scoop of ore containing 3 per cent copper at 28c. per pound, or one trainload of ore carrying 15 per cent copper, with the market at 38c. per pound, which it might be by 1915 or 1930, would make the figures read like real business was being done. When you undertake to figure on the future value of Utah Copper don't be timid or weak-kneed. Go right after 'em.

* * * *

A mysterious new concentrating device is now being tried out at the Magna plant of the Utah Copper company. The expert gang of farmers, cowpunchers and "relatives" which now constitutes the subordinate directing force at the great mill—or that portion which is still unafraid of its voice—appears to be at a loss just how to describe the newfangled machine. One, better versed in the names of concentrating machinery than most of the others, says the thing is generally known at the works as "the big drum," which is "a cross between a Cornish buddle and a Callow tank, set wrong end up." It is said to be automatic and absolutely costless in operation and when the intermittent, steady, heaving, pulsating and other features of the rotary and horizontal movements of the "big drum" have been sufficiently brought under subjection it is expected that almost limitless numbers of snare drums can be washed over the rim and saved. These snare drums will be carefully dried and tuned and then shipped and distributed to the various stock market centers of the world, where they will be utilized in making a big "noise" in support of the advancing prices that will be given to Utah Copper shares when the real "unloading" game is being worked on the suckers of London, Paris, New York, Boston and Salt Lake.

KANSAS SMITES THE FAKERS

The Boston News Bureau of recent date, under the caption of "Putting the Vultures to Flight," in caustic language approvingly comments upon the so called "blue sky law," recently enacted by the legislature of the "long-suffering" State of Kansas, as follows:

Massachusetts, at suggestion of its bank commissioner, is thinking of following where Kansas has led.

"Bleeding Kansas" has now become doubly historical, in the past tense. Its pocketbook is no longer freely bled by vendors of fake "securities." These vampires have been banished from the sunflower state.

The ban is the unique "blue sky law," passed last March, which seeks to protect the people's investments by safeguards akin to the supervision and guaranty that the state extends to banks. The law was fathered by its present administrator, Bank Commissioner Dolley, who previously had been unofficially advising Kansans against piratical promoters who would sell even the "blue sky" to the increasingly opulent farmers.

This curious and drastic act provides that any concern offering securities other than government or Kansas state or city bonds, or mortgages, shall file detailed statement of plan of operation, organization, contracts with investors, financial condition, property, and any other information the commissioner may ask. If he finds it solvent, and its proposals are "fair, just and equitable" and "promise a fair return," he shall permit it to do business—bold type declaring this not a recommendation—otherwise shall exclude it. Condition must be reported semi-annually, beside monthly trial balances available to investors, and investment agents be registered yearly. The commissioner has the same power of examination as over state banks, may compel a physical valuation, and may urge receivership if assets fall below liabilities. False statements are punishable by fine of $200 to $10,000, or imprisonment of one to ten years; attempt to do business contrary to the act by fine of $100 to $5000, or not over ninety days in jail.

Only fifty out of 500 applicants have passed muster. The flagrant fakes simply, and silently, crossed the state line, one of them, which had reaped $400,000 in Kansas, going as far as Winnipeg. One brazen mining promoter is now behind the bars. A drain of over $6,000,000 cash a year has been stopped. Better 6,000 automobiles than reams of worthless engravings.

The postoffice, which is soon to report more concretely on the matter, has conservatively estimated that in the past decade credulous dupes nave been swindled out of a billion—thousands of shabby tragedies of shame, tears and blood. Bequests, insurance benefits, and lifetime savings have bnen scented and looted by the mining, oil, rubber, land, building and irrigation pirates. "Sucker" lists, running from 10,000 to 250,000 names, have been peddled at one to 25 cents a name, according to quality.

It is true that exposure has rubbed the bloom off this game. Over sixty such frauds have been stamped out by Uncle Sam. Access to the mails and to advertising columns is now less easy and more dangerous. The public itself is less ignorantly gullible.

But the postal raid can come only after much of the damage is done. The ounce of prevention must be furnished by the states that in the past have let their sovereign chartering powers to be so abused. Theft or misuse of the people's money by banks, insurance companies, etc., is guarded against; so should it be with these other, generically less dependable, creatures of the state. The stable door should be locked in time.

It is from this viewpoint that the newly convened legislature of Massachusetts has been officially asked to consider such a statute remedy where none exists. No definite statistics are now available as to past plunderings in the frugal Bay State; but legislative inquiry supplemented by promised federal data, may fairly disclose the need of action that is believed by local investment authorites to exist.

At the recent convention of state bank commissioners in New Orleans the Kansas experiment aroused deep interest. As yet, the vultures need merely fly across state lines; were joint and uniform state policy adopted, broadly following the Kansas example, they could land nowhere. The sole criticism might be of the establishment of forty-eight dictators as to what "promised a fair return," should the full measure of Kansas stringency be accepted.

Were the states, however, to check, by publicity and supervision, the snatchings of these financial harpies, more than the salvage of an immense sum would follow. It would hasten the extinction of the credulous "get-rich-quick" belief in impossible income returns; and it would largely recruit the twin armies of savings depositors and of small stockholders in legitimate corporations.

It is a notorious fact that for years every city, town and hamlet in every state of the Union, has been infested with promoters and vendors of the shares of fake mining schemes and other fraudulent devices whereby vast sums of money have been drawn from unsuspecting and unsophisticated individuals of all classes, trades and professions, whose avarice or cupidity ever renders them an easy prey to the wiles of unscrupulous tricksters and "promotion thieves."

Boston, for many years having enjoyed the distinction of possessing the greatest market in the world for copper-mine shares, it is but natural that the speculative fever which had led to the enrichment of so many or her prominent citizens, should permeate and finally infect the industrial and moral fabrics of the entire country. Their earlier investments, which were chiefly confined to the great copper mines of the Lake Superior region, proved to be immensely profitable; but it soon came to pass that there were not enough REAL MINES to provide investment opportunity for the numerous small hoards of her thrifty and progressive citizens, who began to look upon the meagre increment derivable from the factory or farm as entirely too tardy to meet the requirements of a constantly expanding ambition.

At first, their appetites were appeased with small and carefully selected packages of beautifully gilded and embossed paper, labeled certificates of shares in the "Great Eureka,'" "Last Chance" or "Bunker Hill" copper, gold and silver mines.

Of course, all mining shares looked alike to a people who were willing and eager to be made rich at the expense of the accommodating fakir, who seemed ever anxious to share his bounty at ridiculously low prices, so that there was always impatient haste to load up with the precious documents lest the supply should become exhausted before the constantly increasing demands could be satisfied. But to the bewildering astonishment of all, the sporadic adventure of the pioneer solicitor proved to be the advance courier of an army of "refined swindlers," each bearing bundles or bales of title deeds to a share in the "latest discovery," which always exceeded in richness and value all that preceded it. Finally, when all of the wants of the people had been supplied with these gilded evidences of wealth, in exchange for their surplus hoards, and they had sat down to await the coming of promised "dividends," NO DIVIDENDS came. Then it was that the "cost of living" arose to insuperable heights. But this was unimportant, because there were but few who could supply the price, had it remained ever so low. Then they cursed the "rich" and the frugal and thought "the thoughts of socialism and anarchy"—and thus you find them today. However, it now seems apparent, in the light of the News Bureau's comment, as quoted above, that in their sane moments, the people of Boston and of Massachusetts have determined to forstall a recurrence of the swindles that absorbed their substance and paralyzed the vital energies and industry of the state, by adopting the "Blue Sky law" of Kansas. Let us hope that the good resolution may not be forsaken and that every other state in the Union will "go and do likewise."

Such a law, had it been in force in this State ten years ago, would have saved the people of Utah MORE THAN TEN MILLIONS OF DOLLARS. And above all—and of infinitely more value than preserved wealth—it would have prevented the deplorable degeneration of moral, mental and industrial energy which now glares from the sunken eyes of the thousands of victims of the ravages of accursed greed, fit and forced companions of socialism and anarchy.

Remembering the "Newhouse Mines" and the hundreds of other swindles of less magnitude but equal perfidy, perhaps our own Utah Legislature, when it shall again meet, will follow in the footsteps of our sister, Kansas, and preserve our people from the plundering schemes of these rapacious rogues.

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"BAD LUCK" GUGGENHEIMS

At the risk of receiving another peremptory "stop" order from some of the Guggenheim offices, Mines and Methods goes back to the files of the Salt Lake Tribune of October 10, 1908, for the following recital of Guggenheim bad luck. It will be noted that it serves to emphasize all that Mines and Methods said on the subject in last month's issue.

Some unfortunate investments of the Guggenheim interests in the mining line are just coming to light and explain in a measure why there has been such a housecleaning in the field forces, for the purchase of these properties was largely upon the recommendation of the highest paid mining engineering talent in the country, says the Boston News Bureau.

The Guggenheim Exploration company which is the principal mine owner of the Guggenheim outfit, has expended a total of $27,000,000 in acquiring properties within a comparatively few years.

One of the leading mining assets of the company was the property at Valerdena, Mexico. This was a silver-lead group, and was operated privately for years by Barton Sewell and associates, known as the old American Smelting and Refining crowd. The property produced between $8.000.000 and $10,000.000 from the old silver-lead ground from carbonate ores. Then no zinc had appeared in the ores and smelting costs were exceedingly low, and it was possible at that time to derive excessively large profits in treatment of custom ores. The Sewell interests sold the properties to the Guggenheims for $6,000,000, and they expended $1.000.-000 in a new furnace plant and $400.000 on a new power plant. At the same time they purchased a copper property sixteen miles distant, and built a railroad to connect it with the Valerdena plant, so that the total investment at this point amounted to not far from $10,000,000.

Soon after the Guggenheim control, however, arsenic came in the ores, and operating conditions changed so that it is now said there has not been a dollar of profit derived to date on this investment. At the copper mine they went down 600 feet and found that the ore is practically exhausted, running at the lower levels but 1¾ per cent copper. Here is a $10.-000,000 investment which could probably not be resold for over one-tenth of the cost. Valerdena is now a fighting word in the Guggenheim offices.

A second pronounced Guggenheim failure was a silver-lead property near Silverton, Colo., for which $2.500.000 was paid for the mine and an additional $750.-000 expended in a new mill and equipment only to discover when the mill was ready that the mine was practically out of ore.

The Guggenheims likewise have a $7.-000.000 investment in the Yukon, but the public was given an opportunity to help shoulder this burden. The selling of the shares was given to Lawson, who was given an option upon 700,000 shares at $5 per share. The Yukon flotation—some people call it by a harsher name—resulted in 400.000 shares of the company being distributed to the public at from $6 to $8 a share. The distributor got his stock for $5 per share net, but as he had previous to the public affering distributed 200,000 shares among a favored few at 5½, he was obliged to take this stock back in the open market from $6 to $8, so that the net Lawson profit was ⅝ of a point on the 400,000 shares, or $270,000. The Guggenheims paid the advertising bills of about $80,000, and received an acknowledgement in the shape of an immense bunch of Lawson pinks sent to the Mauretania when Daniel Guggenheim sailed for Europe, shortly after the Yukon flotation.

Another chapter could be written of the Guggenheim investment for the American Smelting Securities company of between $8,000,000 and $10,000,000 in the three smelting plants on the Pacific coast. These included the Tacoma plant, for which $4,000,000 was paid, or many times the price at which the same plant had been offered to other interests six months previous to the time the Guggenheims purchased it. The Selby plant on San Francisco bay cost almost as much as the Tacoma plant. It is not now productive of earnings, because it it shut down tight, the agricultural interests having secured a permanent injunction against its operations because of the smelter fumes.

A third was the San Bruno plant, which was to have been built on San Francisco bay at a cost of $7,000,000, but was abandoned after the expenditure of $1,500,000 because of court injunctions from the agricultural interests.

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Elsewhere in this issue will be found an article dealing with the financial methods of the Guggenheims which is reproduced from the January 6 issue of Collier's Weekly. It describes how the family of "smeltermen" worked the public in Federal Mining and Smelting and gives an intimation of what is likely to happen if things work out right in the Braden Copper scheme. The article is a good companion story to that published in the December issue of Mines and Methods, wherein it was shown how the famous family was beginning to feel the effects of drifting on to the shoals of greed and avarice where they had been steered by sublime faith in their own infallibility and advice of their engineers. They had used the public's millions to make millions for themselves and they hoped to gather a much greater harvest without letting the public in. When their predicament finally dawned upon them, it was too late to again secure a public following. The article from Collier's gives one of the reasons why. Mines and Methods expects to offer others in the near future.

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The cut in the dividend of the Yukon Gold Company's dividend—from 2 per cent to 1½ per cent—is explained away by Mr. S. R. Guggenheim, who attributes the reduction to "the extraordinarily dull season prevailing in different parts of the world," and to the fact that two new dredges were not finished in time to be of much use. Glittering generalities don't go far towards soothing disappointed shareholders.—Canadian Mining Journal.

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Crib coffer-dams can sometimes be made by building a crib and sinking it. For shallow water the crib is sometimes made of uprights framed into caps and sills and covered on the outside with tongued and grooved planks.

As Others See Guggenheims

An Article From Collier's Weekly of January 6, by Garet Garrett, that Shows Up Federal Mining and Smelting Deal, and Which is Offered As a Companion Piece to Our Last Month's Story on "How the Guggenheims Were Goldbricked"

Collier's article, which is here reproduced in full, appears under the title and introductory heading of "Finance—the Division of Wealth. First of all people wish to be prosperous. After that they wish to reform each other. That is why an era of reform follows an era of great prosperity. Finance waits until the stomach has overcome the passion for reform and then begins all over again. Guggenheim Finance."

Though advertising space in Collier's be increasingly valuable, a little of it, free and unasked, may be spared to give wider circulation to the following paid notice inserted in the financial pages of New York newspapers:

> **To the Public:**
>
> Statements have been made in the public press to the effect that the Guggenheim interests have from time to time and recently sold or traded in the stock of the Federal Mining & Smelting Co.; the statement further being made that the recent decline in this stock was doubtless due to selling on the part of the Guggenheim interests. Such statements are without any foundation whatever, and are false. The undersigned desire their friends and the public in general to know that none of the Guggenheim brothers and no company in which they are interested has at any time bought or sold or owned or traded in any of the preferred or common stock of the Federal Mining & Smelting Co., except that a number of years ago the American Smelters Securities Co. purchased at private sale a portion of the common stock. This interest is approximately only one-sixth of the entire capital stock of the Federal. The Securities Company still owns every share of this stock, which they so purchased.
>
> The above statement indicates the only interest, either direct or indirect, which the Guggenheim brothers have had in either the preferred or common stock of the Federal Mining & Smelting Co.
>
> M. GUGGENHEIM'S SONS.

It is doubtless consoling to the holders of Federal Mining and Smelting Company stock to know that M. Guggenheim's Sons did not sell it to them. Federal Mining and Smelting in 1905 became known to Wall Street as a Guggenheim proposition on the announcement that the Guggenheims' American Smelting Securities Company, which is owned by the Guggenheims' American Smelting and Refining Company, had bought control of it. That the Guggenheims controlled the Federal Mining and Smelting Company was never denied until M. Guggenheim's Sons printed the notice above, saying that the American Smelters Securities Company's interest in it amounted to only one-sixth of the capital stock. Consider, therefore, the untrustworthy nature of such works of fiction as "The Manual of Statistics," "The Investor's Supplement of the Financial Chronicle," "Moody's Manual," and other books of reference, all of which have been saying until now that in 1905 control of the Federal Mining and Smelting Company was acquired by

Senator Simon Guggenheim, of Colorado, whose early retirement has been announced.

the American Smelters Securities Company.

DID THE STOCKS SELL THEMSELVES?

However, Federal Mining and Smelting shares had a speculative vogue in Wall Street on the belief that the company was Guggenheimedly controlled, and they somehow got widely sold at high prices. In 1906 the common stock paid 14½ per cent and sold as high as 199. It has been declining ever since. In 1908 it paid no dividend; in 1909, 1½ per cent, and none since; it was quoted nominally at 10 bid and 17 asked on the day the Guggenheim's Sons' notice was printed. The preferred stock has paid its 7 per cent until now, but is not earning it; in two of the last three years it has not earned it. The preferred shares sold at 112⅞ in 1906; they were quoted around 40 on the day M. Guggenheim's Sons denied selling them.

The riddle is: How did Federal Mining and Smelting shares get sold to the persons who now hold them at a heart breaking loss? The shares must have sold themselves, of course. They sold themselves to credulous people not only in this country but, strangely enough, abroad, especially on the Continent, where the seven Messrs. Guggenheim are great travelers. If M. Guggenheim's Sons did not know in 1906 that Federal Mining and Smelting shares were either selling themselves or being sold on the Guggenheim name, they were the only seven men in the world of finance ignorant of it; and if they did not know that they were either selling themselves or being sold at a fantastic price value, then there is no accounting for the fact that M. Guggenheim's Sons have got rich in mining and smelting shares. So much for that point of view.

A PROBLEM IN THE MAKING.

There is a particular brand of finance, hardly any more popular in Wall Street than elsewhere, which may be called Guggenheim finance. A Guggenheim prospectus, apealing to private capitalists in the first instance, is a marvel of typographical beauty. It is done on heavy, calendered paper, expensive to the touch and suggestive to the imagination. For instance, one was recently issued on the Braden Copper Company, which has undertaken to develop the mineral resources of Chile, especially in copper. It is a perfect document, treating of history, climate, geology, sociology, costs, capitalization, profits, etc. Under the head of "Labor" one reads:

"The Chilean laborer is proud, independent, and improvident, but proves himself on the whole an excellent workman."

Mark the "but." In spite of being proud, indepenednt, and improvident, the Chilean on the whole proves himself worthy of hire. Continuing, one reads:

"Drink is his curse, and every effort is made to keep liquor out of the Braden Company's mines. . . . Labor is pretty thoroughly organized in the cities of the republic, but not miners and common labor."

Obviously, the Chilean laborer, though better sober than drunk, is at his best unorganized. These are matters all very interesting to capital, invited to embark itself in a strange land. Directly one reads: "The Government of Chile is a republic, stable and reliable, and no fear is felt regarding the safety of investments made by foreigners." That is most reassuring. All of these remarks tend to the following culmination:

"The monetary system is such as to favor the foreign investor, for the reason that he pays for his labor in depreciated currency, and sells his product on the gold standard. A law has been passed putting Chile on the gold basis, and this was to be operative on January 1, 1911, but it has been considered to the advantage of the large landowners to avoid the change, and hence it has been again postponed—probably to be continued. The proposed change would bring the Chilean peso to 18d sterling in value, whereas now its value is below 11d."

Seldom does one see a problem of division in the making.

There it is.

Guggenheim finance undertakes to exploit the mineral resources of Chile, not for Chile, but for finance. It will make the Chilean laborer sober (though he be proud and independent), not for his own sake, but for finance; it will keep him unorganized if possible. Lastly, it will strike hands with the large landowners of Chile to postpone the gold standard, in order that finance and the large landowners together may buy labor for a peso worth twenty-two cents and sell its fruits in a peso worth thirty-six cents.

The reason finance can exact always the larger division is that it is heartlessly intelligent. The Chilean laborer is proud and independent, but too unintelligent to know what is happening to him.

One can imagine that after the Chilean laborer has been kept sober in spite of himself, for the sake of finance, he will, after many years, begin to think. He will have the effrontery to demand a larger division. He may protest against receiving his wage in a depreciated currency, while the product of his labor is sold on the gold standard. Then finance, with its large investments in copper mines, railroads, and prerogatives, ably supported by the landowners, will call the Chilean laborer a Socialist and lecture him sternly on the sacred rights of property. He will hesitate and perhaps forbear, but not for long. He will be dissatisfied with the slight concessions received, and demand yet more whereupon finance and the large landowners will warn him solemnly and with sorrow, and purely for his own good, that if he persists in the way he is going all progress will stop, all property will perish, and Chile will become a wilderness. Perkinses, Garys, and Littletons will rise up to tell him that they love him and are for him, only he is unreasonable. Above all else, he must be reasonable and patient. They will pension him, they will make him more comfortable, they will raise his wages, and they will allow him to buy shares in their business and thereby share in the profits of capital, but he must be fair and desist from his Socialistic attacks upon capital.

It will then be 2012, perhaps, and finance, both foreign and Chilean, will have had time to incorporate companies and sell the shares thereof to the people of Chile, so that when the Chilean laborer has become intelligent enough really to know what is happening to him, he will perceive that the resources of Chile have been bought back from finance at a very high valuation by the investors of Chile. They would be greatly damaged by radical and progressive legislation and are all against it. After that it will be a compromise of Things As They Might Be with Things As They Are, and then the average Chilean will learn how to lose money in things like Federal Mining and Smelting common stock.

OTHERS ALSO HAVE BEEN TAUGHT.

The people of Chile have much experience to digest before they will be as intelligent as some of the casual-minded people who bought Federal Mining and Smelting shares in 1905 and 1906 under the delusion that they were getting into a fine Guggenheim speculation, and who, now that those shares have only a nominal uncertain value, have the consolation of learning from whom they did not buy them.

The Chilean laborer does not know what is happening to him in Braden Copper. Neither does the holder of Federal Mining and Smelting know exactly what has happened to him.

The Braden Copper Company is owned by the Braden Copper Mines Company, which is a holding concern controlled by the Guggenheim interests, according to "Stevens' Copper Handbook." But if anything untoward should happen to Braden Copper it might develop that the "Stevens' Copper Handbook" was as much of a word of fiction as the other works of statistical reference which have called Federal Mining and Smelting a Guggenheim proposition. The holding company is a wonderful devise!

NORTHWEST MINING MEETING

There is to be an important gathering of mining men at Spokane next month, the purpose of which is to discuss many subjects of grave importance to the mining industry. Unlike a session of the American Mining Congress, in which everything but the real things which affect mining is annually accorded so much valuable time of the delegates, this Spokane meeting promises to consider and discuss phases of the present situation that are calculated to encourage the industry and its development along lines that will safeguard investment and secure a greater co-operation among those actually engaged in the business.

This meeting is to be held under the auspices of the Mining Men's Club of Spokane, at the Spokane hotel, on the 15th, 16th and 17th of next month (February), and promoters of the gathering are making preparations to take care of not less than 1,000 people from the western mining states and British Columbia. Some of the subjects that will receive particular consideration are: The mining laws; leasing vs. freehold; mining in forests; mining investments; water power development; metallurgical economies; wastes and losses; the prospector; the miner; the promoter; the mine manager; the investor; safeguards of mining investments; mining development, and other subjects which the spirit of the gathering are sure to suggest and force to the front.

Elaborate plans of entertainment are being arranged by the club and everybody engaged in the business of mining and kindred pursuits—and particularly through the Pacific Northwest—who may attend, are promised a profitable and enjoyable time. Railroad rates of one and one third for the round trip are being arranged for, the Club's announcement on this subject reading. "Pay full fare going, demanding certificate from agent, to be presented to the convention secretary." Utah ought to be well represented.

"What is this new commission form of government that has been inaugurated here since I left the state?" inquired a mining engineer who has just returned from a two years' trip to South America. His old Salt Lake friend disgustedly replied: "O, that's something that the cat dragged in."

EVOLUTION OF THE CALIFORNIA DREDGE

By AL H. MARTIN.

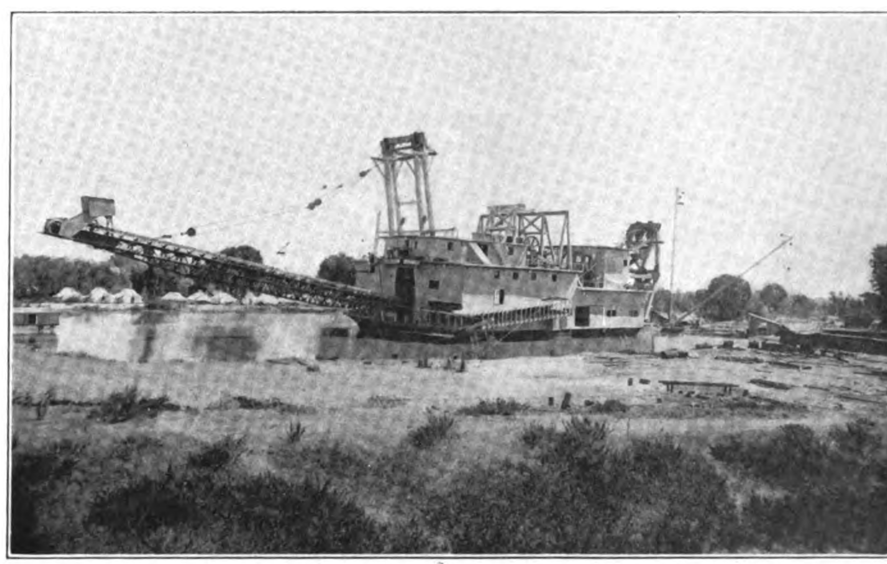
The first successful dredger in California went into commission March 1, 1898. The hull was eighty feet long, thirty feet wide, with a draft of seven feet. The rated steam horsepower was sixty-three. The latest designed gold-ships are 150 feet long by fifty-eight feet wide, with a depth of twelve feet. The rated electrical horsepower averages over 1070. The pioneer was equipped with 3½ cubic-foot buckets; the newcomers have fifteen cubic-foot buckets. The oldtime dredges were considered good workers if 1500 cubic cubic yards were handled daily; the latest design easily take care of 500 to 600 cubic yards per hour. And this remarkable advancement in efficiency has been scored in the brief space of thirteen years. As a result the California type of dredge is universally acknowledged the most efficient ever designed, and is employed alike in the tropics and in polar climes.

From the earliest days of gold mining in California, projects to recover auriferous gravel from the beds and bars of streams attracted attention. A rude contrivance was shipped to California in 1849, about a year after Marshall's discovery near Sutter's Fort, to excavate the golden wealth from the placers. Shipped from New York it successfully survived the long sea voyage and was placed on the Sacramento river. According to oldtime records it was unsuccessful from the start, and soon lay at the bottom of the kingly Sacramento. Following years recorded other attempts, but always failure rode the pilot. In New Zealand dredging made fair headway, and Montana was the first of American States to record the operation of a successful gold boat. In 1897 a dredge was constructed by the Risdon Iron Works of San Francisco and floated on the Yuba river. But this stream proved too turbulent for the newcomer and it was wrecked soon after going into commission.

SUCCESS OF RECENT BIRTH.

Thus far dredging history in California has been a record of unmilitated failures. Accordingly when W. P. Hammon, Thomas Couch, W. H. Christie and others arranged for the installation of a dredge at Oroville in 1899, many believed another folly had been launched. In the construction of the new gold-boat advantage was taken of the lessons gained in New Zealand and Montana practice, while not a few points of inestimable value were gathered from the ordinary gravel handling machines employed in canal building in the Eastern states. The pioneer, known as Couch No. 1, was of the single lift open-link bucket-elevator type, and after several modifications worked successfully.

The next great advance was recorded in 1901, when Indiana No. 1 went into action July 4th. This dredge was fashioned along entirely new lines and was the first of the celebrated California type. The hull was eighty-six feet long by thirty-five feet wide, with a draught of four and one-half feet. The buckets were close connected, in place of the usual open-connected type previously employed, and excavated gravel to a depth of thirty-five feet below the water line. There were seventy-nine buckets, each having a capacity of three and one-half cubic yards. The plate-girder digging ladder had a length of seventy-eight feet between centers. The washing screens were of the flat shaking-screen type. The drive was excentric, a twenty horsepower motor delivering energy. The gold tables were constructed of wood, with riffles and quicksilver trays. They were of the side-table type and had a total riffle area of 528 square feet. A forty horsepower motor delivered energy to the eight-inch centrifugal pump, which supplied water to the screens and tables. A sand-pump was also provided, receiving power from a thirty-horsepower motor.



Yuba No. 13, a Fifteen Cubic-foot Dredge—One of the Largest and Latest of California Gold-Boats.

The design of this dredge embraced so many improvements and departures from accepted lines, that the owners, Cameron, Griffin & Perry, experienced the greatest difficulty in persuading a firm to manufacture the machinery. It must be remembered that dredging in California was then in its infancy, and the ideas of men considered to possess little experience were not hailed with particular delight by manufacturers of dredge machinery. But the Bucyrus company of South Milwaukee, Wis., was not lacking in the spirit of enterprise, and undertook the production of desired equipment. The new dredge proved remarkably successful, and all the later types of California gold boats have been modelled along the lines of Indiana No. 1.

IMPROVEMENT RAPIDLY DEVELOPS.

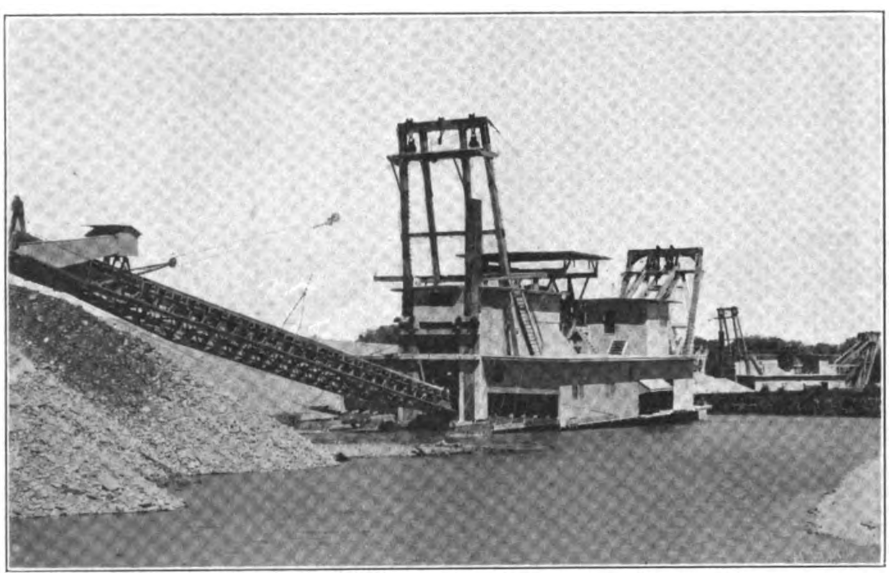
The next important step was introduced on Folsom No. 4 dredge, when double-bank tables were installed to treat a larger quantity of gravel, thereby largely increasing the profit-earning abilities of the dredge. This boat was of the thirteen cubic foot bucket type, and was one of the first of the new type of large dredges to be designed. The hull was naturally heavier, and the massive machinery required the installation of motors developing 415 horsepower. The double-bank gold-saving table arrangement was worked out by S. A. Martindale, superintendent of the dredge, and the general idea of construction originated by R. G. Hanford, general manager of the Folsom Development Co.

The success attending the operation of No. 4 led to the construction of Folsom No. 5. This was the first gold dredge to be equipped with hydraulic monitors. The dredge was designed to operate on the Rebel Hill deposit, near Folsom, where conditions were particularly unfavorable. The deposit ranges from fifty to seventy-five feet in depth. The upper six to eight feet is partly cemented, and the following twenty-five to thirty feet is very compact. The lower deposit is easily handled. The monitors were designed to break down the upper strata of cemented gravel by undermining the bank with streams of water. The deposit had been considered as too difficult to dredge, but the monitors proved successful, their use further establishing the permanent value of the California dredge. It soon became manifest that the washing facilities of the boat were inadequate to handle the immense amount of material available, consequently revolving screens replaced the shaking screens, and longitudinal sluices were installed on each side of the dredge. The two monitors were stationed in the bow, each provided with three-inch nozzles. The gold saving tables were constructed of steel, thus eliminating sand troubles, and dispensing with sand pumps.

FIRST DEEP DIGGER.

The first California dredges ever designed to excavate to a depth of sixty feet went into commission in the Yuba River field in 1904. The depth of the deposits in this district ranges from sixty to seventy feet, the great depth largely due to the deposition of immense quantities of debris on the native ground by hydraulic mining operations. The land is located in the Yuba River portion of the Sacramento valley, and for years the debris was washed down into the Yuba basin by the giants operating in the eastern foothills. The first boats installed had close-connected buckets of six cubic feet capacity, and required electrical machinery developing 230 horsepower. The construction of these dredges demonstrated the economical practicability of dredging to great depth; further augmenting the value of the gold boats.

Recent advances have been more along the increase of capacity, extending the life of the machinery and reducing operating costs per cubic yard. The latest dredges are equipped with fifteen cubic foot buckets, and easily handle from 350,000 to 450,000 cubic yards of gravel per month. The buckets number ninety, arranged in a close connected line. Each bucket is made in three sections, consisting of bottom, hood and lip. The first is constructed of high-carbon steel, with an insert plate of manganese steel fitted under the back eye. The hood consists of half-inch steel plate, while the lip is formed of manganese steel. It is thirteen inches wide, and two and one-fourth inches thick at cutting edge. Sections are securely riveted, the entire bucket weighing about 3,700 pounds. The gold-saving tables are of the double bank type, and with auxilliary trays, have a total area of approximately 7,600 square feet. These machines usually are digging gravel at a depth of fifty-five feet below water level. The dredge embodies all the best features of earlier designs, with numerous improvements suggested by long experience and skillful tests.



A Thirteen Cubic-foot Dredge in the Yuba River Field.

The latest departure is the construction of steel hulls, in place of the ordinary wooden ones. An all steel dredge is being constructed for the Natomas Consolidated of California, the largest dredging company in the world, and it is probable that future gold-boats will avoid the use of wood as much as possible. Not only does this result in a lighter hull and other advantages, but largely eliminates the danger of fire, a destroyer that has frequently visited the gold-boats.

ELECTRIC POWER IS UNIVERSAL.

The pioneer dredges of California were actuated by steam power. The first electrically operated boat was the Continental. This boat commenced operations in 1889, and was equipped with variable speed motors. This was also the first gold dredge to be equipped with close-connected buckets. This dredge was originally of the double-lift type, but was subsequently remodelled to conform to the ideas of the owners, Messrs. D. P. Cameron and F. W. Griffin. The excellent results obtained by the electrical equipment resulted in the gradual adoption of electric power by dredging companies throughout the State, and contributed largely to a more decided success in the industry.

At present electricity is furnished to the numerous dredging companies by several hydro-electric power companies. Power is generated in the high Sierras, where an abundance of water power is ever available, and transmitted to the dredges over high power transmission lines. In most instances the current is delivered at 2,000 volts to the dredges. In the newer type of dredges transformers are being eliminated, further safeguarding the gold-boats from danger of fire. Eliminating the transformer has been facilitated by the manufacture of motors to operate with 2,000 volts, several concerns producing machines as low as fifteen horsepower that may be thus directly operated. In numerous instances, when it has been necessary to employ transformers, these have been located on shore, rather than on the dredge. The power is usually brought aboard the dredge via insulated cables, of the submarine armored type.

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The sand used for filtering purposes should be clean quartz sand free from gravel and large particles and also free from excessive quantities of fine particles and dirt of every description. The presence of a small amount of fine material often aids the action of filter sand. For filtering river waters and any waters carrying carbonic acid, the filter sand should be free from lime, as otherwise the water will be hardened.

LEACHING APPLIED TO COPPER ORE*

Fourteenth Article Reviewings Results Accomplished, With Special Reference to Leaching Rock Without Mining

By W L. AUSTIN.†

It is immaterial whether or not a line be drawn between the extraction of copper from mine-waters which have been pumped, or allowed to flow from mines, in the ordinary course of events, and an operation comprising the artificial preparation of a copper deposit so as to facilitate oxidation and subsequent extraction of the metal. Both operations have been repeatedly carried out, and are practically identical in their nature, but the treatment of waters necessarily removed from mine-workings has been much the more common undertaking. The present article will deal primarily with the treatment of waters designedly passed through ore with a view to collecting the soluble copper salts therein contained, and the subsequent precipitation of the metal—in other words, with the artificial leaching of rock in place.

In a former article (Mines and Methods, Volume II, pages 153 and 187, there was described an experiment carried out upon a cupriferous deposit artificially prepared so that the ore had a chance to oxidize, water being let in afterwards to dissolve the soluble salts. It was explained in the said article how a deposit of porphyritic rock might be opened so as to expose a very large tonnage at comparatively small cost per ton of contained cupriferous material, and it is clear that once such a mine has been made ready for the water, the cost of producing copper will be confined to precipitation, with possibly the additional expense of pumping where it is necessary. Such a mine will yield copper for a long term of years from rock of a grade which it is not possible to mine under average conditions, and it will do this regardless of strikes, panics, or other disturbances of the usual kind.

When the experiment at Clifton was undertaken, it was not known to its projectors that there had been any previous work of a similar character; but since then a number of examples have been cited in the technical press, among which is one described by Philip Argall in Mining & Scientific Press of May 19th, 1906, pages 325-326.

Mr. Argall relates that at the Cronebane mines in Wicklow county, Ireland, the drainage was formerly run into a series of pits—each ten feet long, four feet wide, and eight feet deep. The sides of the pits were of masonry and the bottoms consisted of smooth flagstones. Rude wooden beams were laid across the pits upon which iron bars were placed to serve as precipitating metal. The iron bars were taken up frequently and the copper rubbed off them into the pits, so as to afford the waters better access to the iron. The bars were dissolved in about twelve months, when the iron was soft; but hard iron or steel were acted upon less rapidly.

When the iron in any particular pit had been sufficiently eaten away, the water was turned aside from that pit and the copper precipitate was shoveled out. One ton of iron (probably 2240 lb. was meant) is said to have produced 4424 lb. precipitate, and each ton of precipitate yielded 1792 lb. pure copper. On this basis one ton of iron was sufficient to produce 3539 lb. metallic copper, which is equivalent to a consumption of one pound of iron for each 1.6 lb. pure copper turned out. This copper brought in the market £10 more per ton than did copper resulting from ordinary ore-smelting operations. These figures, (presumably taken by Mr. Argall from the pages of the "Philsophical Transactions" whence the data was derived), do not agree with the usual statement that it reuqires from two to three pounds of iron to extract one pound of copper from mine waters. It is known, however, that with varying conditions the amount of iron consumed in the process of cementation differs widely, and as Mr. Argall had charge of the underground precipitation plant for a time, and therefore was familiar with the relative amounts of iron corroded and copper produced, it must be assumed that conditions at the Cronebane mine were out of the ordinary. The fact that pig-iron was used for precipitating purposes may have had something to do with the favorable result achieved, for the carbon present would form with both the iron and the copper galvanic couples, and it has been shown that such couples are very active in cementation. With proper apparatus, and the right adjustment of proportions of the elements composing the precipitant, it is not difficult to obtain results such as mentioned by Mr. Argall.

One of the improvements derived from experience at the Cronebane mine was settlement of the drainage in pits, only allowing the clear liquors to pass over the iron.

It was found in these precipitating operations that only a small quantity of the copper in solution was saved in the pits, and it is stated that these might be indefinitely extended without observing a sensible abatement in the copper content of the waters. The quantity of copper wasted at the property about the time referred to is thought to have been comparatively large, for in one stream alone the loss was estimated at 124,100 lb. per annum.

The handling of corrosive mine-waters has often been a problem with which those in charge of mines carrying sulphides in their ore have had to contend, the means employed at Wicklow to secure an efficient pumping apparatus are, therefore, of interest. Cornish pumps were used, the cast-iron water-columns of which were lined with quarter inch softwood staves. The flange-joints of the pipes were connected by gaskets of iron, one-and-a-half by quarter inch, around which was wrapped coarse flannel soaked in tar. The flannel and iron combined made a gasket about two inches thick, and in screwing up the pipe joints the tarred flannel was pressed out over the wood lining, securely sealing the iron pipe against contact with the acid waters, as well as making a tight joint between the pipes. Coarse tarred flannel, well painted with warm tar, was also wrapped around the pipes wherever these were exposed to dropping water. The suction pipes for these pumps consisted of logs of beach-wood, bored out to size, the bottoms being drilled with suitable holes to form strainers. The plungers and glands were made of bronze; the valves of copper and leather. These metals corroded, of course, and were about the only parts of the pumps which required frequent attention and occasional renewal.

By 1798 the copper content of the Cronebane mine drainage had fallen off materially, and low-grade pyritic ore was heap-roasted and subsequently

† Mining Engineer and Metallurgist, Riverside, California.

leached to increase the amount of copper salts in the drainage waters. Then came a period in which operations were suspended.

The workings were reopened in 1874, and the effluent waters were then found to carry merely a trace of copper, though the mine had been closed for twenty years. Ocher had accumulated in the drainage adits almost to the roof, and the stopes above water, and the vein exposures were almost completely sealed with ocherous deposits. Apparently the copper had gone, leaving the sulphides so coated with ferruginous matter that the waters and air did not have access to them, which would account for the lack of soluble copper salts. As soon as the stopes, drifts, and working faces had been cleaned, oxidation proceeded as before, and the effluent waters again became rich in copper.

On account of difficulties arising with an adjoining property, it was no longer feasible to treat the waters in an outside plant, so an underground system of precipitation was inaugurated. This, Mr. Argall states, was a great success, owing in part to the higher temperature of the water, in part to freedom from sediment and almost entire absence of ocher.

Immediately below the gossan of the Cronebane vein there was found a rather soft clay filling which carried an abundance of granular pyrite, and various other copper minerals including sulphate. These deposits were leached in place, by first driving numerous small drifts through them, and then turning water into the overlying loose gossan. This innovation soon formed an important part of the mining work. The copper-bearing solutions were allowed to flow into the different levels between the outcrop and the lower adit, and being forced to traverse some old stopes and fillings, were finally collected at the lower adit where the copper was precipitated from the liquors on pig-iron.

As experience was gained in the work the following leaching cycle was evolved: First, there was allowed a period for oxidation of the sulphides, followed by a second period permitting the salts formed to go into solution. A third period succeeded, in which the ferric oxide, (which had a tendency to seal up the sulphides and prevent further oxidation), was removed. The ground was divided into sections, some of which were oxidizing while others were leaching, constituting the first two periods of the cycle. The third period was occupied in running short drifts across the vein and allowing these to cave. At times stoping was resorted to, to afford room for the settling vein-matter. Sometimes the vein-matter was caved through to the gossan workings, and the caved material was employed to fill lower stopes where in due course it was again subjected to the leaching process. The methods used are said to have proven entirely satisfactory.

The Connorree mine which adjoined the Cronebane is said to have produced prior to 1872, $75,000 worth of copper annually. It was worked for a year or two almost entirely for the cement-copper obtained from drainage, and all the water was pumped from a depth of 540 feet, using expensive coal for power. This mine was closed in 1880, and in 1884 it is stated that the stagnant mine-water was found to contain forty grains of copper to the gallon. Taking the gallon at ten pounds, forty Troy grains would be equivalent to 1.14 lb. copper per ton of 2,000 lb. of water, which is close to the amount observed in other cases where mine-water has been permitted undisturbed to take up soluble copper salts. At one time the ore of this mine was kernel-roasted, and the oxidized envelopes of the sulphide kernels were leached in the mine water.

A precipitating plant was also erected at the Ballygahan mine which is on the same lode-series, and this plant is said to have been in profitable operation for five or six years. The pumping was done in this case with water-power. Some analyses made of the waters before and after precipitation gave following results:

In 100,000 Parts.

	Before Precipitation.	After Precipitation.
Ferrous oxide	81.81	94.75
Ferric oxide	4.30	6.70
Cupric oxide	9.32	1.91
Sulphuric acid	634.26	642.34
Manganese oxide	2.30	2.50
Zinc oxide	1.20	1.80

A content of 9.32 parts of CuO in 100,000 is equivalent to 0.00932 per cent, which corresponds to 0.00744 per cent Cu (0.1488 lb Cu per 2000 lb. solution), an amount of metal which approximates the average that mine water in motion appears disposed to take up under normal conditions.

It is stated that the water issuing from the Butte mines contains an average of 0.0025 per cent copper, and that 5,000,000 lb. of the metal are recovered from them annually (Engineering and Mining Journal, Vol. LXXXV, page 99); but the conditions there are somewhat unusual. The Butte mines are very extensively opened and were very hot, so that the waters traveled long distances through old workings (some of which are on fire) and had every opportunity to take up soluble copper salts. The drainage at the Anaconda mine is allowed to run from level to level through drill-holes until the pumps are reached. These drill-holes choke up with sediment and basic ferric salts and require re-drilling from time to time. An analysis of the water from one of the large Butte mines, made some time ago, gave the following results:

(Specific Gravity of Water=1.005.)

	Grams Per Liter.	Per Cent.
Copper	0.1226	0.0122
Iron in suspension...	0.1274	0.01267
Iron in solution	0.0672	0.0067
Arsenic	0.00264	0.00026
Antimony	0.00088	0.000088
Free acid	0.1400	0.0139
Prob. combination.		
Bluestone ($CuSO_4 5H_2O$)	0.4830	0.0481
Ferric oxide (Fe_2O_3)	0.1820	0.0181
Ferric sulphate [$Fe_2(SO_4)_3$]	0.2399	0.0239
Arsenic	Undetermined	
Antimony	Undetermined	
Sulphuric acid (H_2SO_4)	0.1400	0.0139

In September, 1906, the flow for the month from one of the largest groups of Butte mines averaged 0.02 per cent copper; in December of the same year the average for the month was 0.04 per cent on a flow of 470 gallons per minute. In January, 1907, the same waters carried 0.16 per cent—the highest record, due to fire in the mine—and in February of that year the average for the month was 0.07.

Another instance of leaching unoxidized copper-ore in place is mentioned by Mr. H. T. Durant in Engineering and Mining Journal, November 11th, 1911, page 928. The name of the mine is not given, but it is said to be situated "barely 300 miles from London," and it is stated that the operation is upon a working scale and has been carried on day in and day out for over sixty years. The deposit is referred to as being a vein, which in places exceeded one hundred feet in width but elsewhere was so narrow as to render working unprofitable.

The underground workings are said to resemble a rabbit-warren, and the fact that the mine is thoroughly honeycombed accounts to a large extent for the ease and rapidity with which much of the copper passes into sulphate form.

The property is drained by an adit the mouth of which is closed by a dam, the latter fitted with a sluice valve. The operations consist in pumping the mine full of water, practically to the collar of the old main shaft, and then opening the valve at the adit mouth and allowing the liquors to flow to the precipitating plant. The latter consists of a number of shallow, rough, stone-lined pits, arranged in parallel series for convenience in cleaning and distributing solutions. These pits are filled with scrap-iron.

After precipitation of the copper, the liquors containing the iron derived from the ore, together with that corroded in the precipitation pits, are passed through a number of pits similar to those already mentioned. These latter pits are also arranged in parallel series but are larger than the ones employed for cementation: in them the bulk of the iron is deposited through aeration and oxidation, and a good, marketable ocher is produced. This material brings in the market from twenty to thirty shillings per ton, according to quality.

After flowing through the ocher pits the water is more or less freed from iron and when required may be pumped back to the mine to repeat the same cycle of operations. The liquors flow by gravity from the adit mouth through the precipitating pits, and then through the ocher ponds, power being used only for pumping back to the mine.

The mine is filled with water from two tc four times per annum, varying with the seasons. Only one skilled man is employed on the work, assisted by two or three laborers, the number of the latter being increased when the copper precipitate and ocher are cleaned up. The application of the described method of leaching was facilitated by the contour of the country, and by the unsystematic methods of exploitation used by the old miners. The further fact that much of the ore was left in place, either on account of narrowness of vein, or grade, or both, and the existence of large blocks of complex sulphide-ore containing small quantities of copper, made it feasible to leach this copper-sulphide ore in place.

The net result from the operation since the inception of this method of treatment is said to be about two hundred tons of metallic copper annually, and during the same period from 1500 to 2000 tons of ocher are produced. The whole equipment is represented to be extremely crude, and the ingenuity displayed in securing such good working results with the means at hand commands admiration.

According to Mr. Morton Webber (Engineering and Mining Journal, (April 8th, 1911, page 700), at Rio Tinto, in Spain, water is led into the mines under certain conditions. The ore is mined in large galleries, and the honeycombed part of the "vein" produced by the removed chambers offers a large surface exposed to the action of the air and moisture, which in turn brings about oxidation of the copper in the ore to sulphate and other forms. The cupreous liquors naturally gravitate to the bottom of the mine from where they are pumped to the surface. They are then led into precipitating pits similar to those employed for treating cupreous solutions obtained more rapidly from ore which has been heap-roasted. The copper derived from mine drainage is such an important item at Rio Tinto, that the magnitude of the rains during the wet season is said to materially affect the years' profits.

Another case mentioned by Mr. Webber is that of the famous old Parys mine at Anglesey. For a long time water was pumped out of the mine and led into pits which were lined with brick and contained scrap-iron. The iron was raked over from time to time, and gradually the old pots, kettles, meat tins, shovels, etc., passed into solution while the copper was precipitating. The iron was not lost for the waste liquors from the precipitating pits were drawn off into large pools where the ferruginous salts gradually passed to a higher state of oxidation, depositing ocher. The ponds were run dry and cleared out periodically.

In a more recent communication Mr. Webber (Engineering and Mining Journal, July 29th, 1911, page 197) calls attention to an interesting example of the solubility of copper minerals under natural conditions as recently observed in the lower workings of a mine belonging to the Transvaal Copper Mining Company, at Cumpas, in the State of Sonora.

In September, 1910, after five years or more of submergence, the lower workings of the said mine were pumped out and resampled. The result of this sampling disclosed the fact that there was apparently no commercial ore left in this particular part of the mine. Previous samplings on different occasions by two independent engineers had indicated an average of over two per cent copper in this same ore. It being assumed that the different samplings were all carefully done, and that the findings were correct, then it would appear that the copper had been leached out in the interim between the earlier and later samplings, which view received confirmation from the interesting fact that the silver content of the ore in question was found to be the same after as before submergence.

In a criticism upon any novelty attaching to the idea of leaching ore without previously mining it, Mr. Channing in a contribution to Engineering and Mining Journal, March 25th, 1911, page 601, states that at the Eureka mine, in the Ducktown District of Tennessee, copper was extracted from rock in place as early as 1850.

Mr. Channing is rignt in contesting on a broad basis novelty in the practice of leaching rock "in place;" but there may be different methods of accomplishing a given purpose, one of which may be new. Besides, it is sometimes advisable to provide precautions against patents being issued to other parties who may be inclined to take advantage of a situation thereby created. Furthermore, circumstances may arise where those financing an enterprise demand that patent-protection be sought and obtained if possible. In any event, the systematic preparation of a large mass of low-grade cupriferous rock for leaching in-place is not such a common occurrence as to wholly exclude the projectors of the enterprise from claim to some originality of idea.

Mr. Channing states that at the time to which he refers, mining at Ducktown was confined entirely to the so-called black-copper ore, which was a product of secondary enrichment, lying just under the gossan and just over the unaltered sulphide. In most of the mines this black copper was from six to twelve feet thick and often carried as much as fifty per cent copper. At the Eureka mine, however, and also at the adjoining Isabella property, the zone of black copper ore was not much over a foot in tickness, and it was soon discovered that it would not pay to mine it.

The Eureka was provided with a shaft and several hundred feet of drifts along the black copper zone, and a method was finally evolved which consisted in permitting the mine to fill with water, then, after the water had been allowed to work on the ore for about a month, to pump it out again. By this means, it is stated, the black-copper was pretty thoroughly dissolved, and the metal could be precip-

(Grams per 100 cc. solution.)

Names of shafts	Free Sulphuric Acid	Ferrous iron	Ferric iron	Total iron	Copper	Chlorine	Iron precipitated in Bottle	Alkalinity Equival'nt in Sulphuric Acid	Percent copper	Lb. Cop. per ton Water	REMARKS
Diabase	0.261	0.0096	0.0031	0.0127	1.056	......	0.0048	......	0.1056	2.112	Strong green color to solution.
Old Ray	0.027	tr	.....	0.0021	......		......	......	.....	.....	......
Flux	0.1004	0.31	0.0990	0.4090	0.06	Pres.	......	......	0.006	0.12	Organic acid present.
Cittadini	0.126	0.392	0.03	0.422	0.152	......	......	......	0.152	0.304	Solution greenish.
Man Tiger	0.134	0.395	0.032	0.427	0.253	0.072	0.0313	......	0.0253	0.506	Solution clear.
Pearl Handle	0	0.1482	0.0072	0.1554	0.012	......	.....	0.0077	0.0012	0.024	Solution clear with brownish tinge.
Sharkey	0.019	0.5687	0.0397	0.6084	0.8378	......	......	......	0.08378	1.6756	Solution blue-green.
Collom	0.046	0.1682	0.0335	0.1917	0.476	......	0.01	......	0.0476	0.952	Solution with strong green color.
Rector	0	0.0254	0.0176	0.043	tr	......	.....	0.047	tr	tr	Solution dark with disagreeable odor.
Hecla	0	0.2249	0.0030	0.2279	0.0646	......	0.002	0.057	0.00646	0.1292	Solution colorless.
Mathias & Hall	0	0.0098	0.0155	0.0253	0.0474	......	.....	0.0067	0.00474	0.0948	Solution brownish.

itated from the solution by scrap-iron in the usual way.

When the mine was opened later it was found that the primary sulphides carried less than one per cent copper, which accounted for the thin deposit (one foot) of black ore referred to. The vein, or deposit, on the Eureka was wide, averaging at least 250 feet, and the gossan (aggregating approximately 500,000 tons) has all been mined, shipped, and smelted for iron.

The leaching power of ground-waters upon certain types of ore-deposits is illustrated by the analyses given in the table below. The analyses were made from waters taken from a number of old shafts on the Ray property in Arizona, and were furnished the writer by Mr. Philip Wiseman of Los Angeles.

The average copper content of these waters is 0.02689 per cent, which is ten times the average of the flow from the Butte mines as given in the Engineering and Mining Journal quoted from above.

At Bisbee, Arizona, 300 gallons of mine-water are pumped per minute from the Czar shaft, (Engineering and Mining Journal, October 31st, 1908, page 854), which is said to contain an average of ten grains of copper per gallon. The copper content of the water is, therefore, 0.0171 per cent. This water is passed over scrap-iron in a precipitating plant, the saving being in excess of ninety per cent. The precipitate shipped contains forty per cent moisture: the dried sample assays, copper 35%, silica 6%, iron 17%, aluminum 13% and sulphur 1.5%.

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UTAH'S GOLD-SILVER OUTPUT

Increased production was made in all metals except zinc in Utah in 1911 according to V. C. Heikes, of the United States Geological Survey. The gold output was greater owing to the larger quantity of silicious ores mined in the Tintic district. Also of importance were the increases made at Bingham in the mining of low-grade copper ores, which carry only a few cents per ton in gold, but the aggregate of which is large. The total output of gold from the producing gold mines of Utah—the Mercur, Sevier, Susannah and Jennie, was less than in 1910. No new developments in deep mines were made that would tend to increase the future gold output, except in the Newton district, Beaver county, where some high-grade ore was encountered in rhyolitic rock, and at a property in Wayne county, which was equipped with a stamp mill. The placers on Green River yielded an increased quantity of gold. A dredge of the suction type with amalgamators was erected on Pahreah River, in Kane county, and is said to be operating and producing gold.

Silver production increased owing to the large tonnage of argentiferous lead concentrates and ore shipped, especially from Park City, where the output was greater than in any one of the last four years. In the Tintic district the yield of silver decreased owing to the reduced tonnage of lead ores, but this decrease was met by the increase in the mining of other ores, so that the total silver yield was not much less than in former years. According to early figures Utah ranked first in output of silver in 1911.

Fortunately for Utah mine operators, the facilities for treating ore and concentrates were ideal in 1911, and the lead-mine owners especially were provided with the best competitive smelting market that they have had for years. On the other hand, complaints were made by the lead smelters as to the small ore tonnage shipped, as only 40 to 65 per cent of their maximum capacity was in operation. Silver production under these conditions, of course, increased as every available ton of lead ore was mined and shipped. A part of this ore awaits the completion of the lead furnaces at Tooele. Nearly 7,000,000 tons of ore was mined in 1911 in Utah. Of this record-breaking output, about 5,850,000 tons was credited to the mines of the Bingham district. The greater part of this tonnage was low-grade copper-bearing porphyry ore mined from the Utah Copper and Ohio properties, and lead and copper ore from the mines of the United States Co. The two last-named companies increased their shipments of ore to such an extent that the roasting capacity of the lead smelters was overtaxed and they refused ores of high sulphur content in excess of contract agreements.

Beaver county mines yielded about 258,000 tons of ore, of which about 30,000 tons was crude ore and concentrates shipped from the Frisco, Star, and Newton districts. The new equipment at the Cactus mill was successful. The mill of the Horn Silver mine was closed, as a favorable contract was offered by the smelters. The Sheep Rock and Rob Roy mines near Beaver City, and the Susannah mine and part of the old dump of the Century mine, in Box Elder county, yielded gold bullion. Mines in Juab county produced approximately 246,000 tons of ore, of which the Centennial-Eureka mine, a gold-silver-copper producer, yielded about 117,000 tons, and the Iron Blossom about 60,000 tons of siliceous and lead ores. Other properties in Juab county from which shipments were increased are the Black Jack, Bullion Beck, Gemini, Golden Chain, Grand Central, May Day, Mammoth, Opohongo, Uncle Sam and Yankee. In the Fish Springs district the Utah mine produced rich silver-lead ore. The Park City mines were productive of about 300,000 tons of ore, against 215,339 tons in 1910. Part of this ore was concentrated, making about 65,000 tons of lead concentrates and 12,000 tons of zinc concentrates, both averaging well in silver. The crude ore shipped to smelters in 1911 contained silver and lead, and aggregated over 42,0000 tons, against 30,140 tons in 1910. From the Ophir, Rush Valley, and North Tintic districts, in Tooele county, 30,738 tons of lead ores were shipped from the Hidden Treasure, Cliff, and Honorine mines, and lead, zinc, and zinc-lead ores from the Scranton mines. In the Camp Floyd district, at Mercur, 250,000 tons of low-grade gold ore was treated by the cyanide process, yielding about $551,000 in gold.

According to preliminary figures compiled by the Director of the Mint, Utah produced in 1911, $4,709,747 in gold and 12,679,633 fine ounces of silver, valued at $6,973,798, against $4,312,700 in gold and 10,445,900 ounces of silver valued at $5,640,800, in 1910.

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EVERYBODY'S EXPERT

O. R. Henney, who is a guest at the Linden hotel, this city, and booked to make this his headquarters for some time to come, is making a business of gathering reliable data concerning mines and prospects in this particular region. "My special mission," said Mr. Henney a few days ago, "is to secure information for small investors who have neither the time or means to get a correct idea of the value of their investments or speculations. I have had eleven years' experience in Colorado, New Mexico, Arizona, Southern Nevada and California, in addition to some time spent in Mexico and Honduras. Now I am gathering information and data for clients interested in the surrounding territory." If you want Henney's services, write to him at the address given above.

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Geologists, sent to prospect in the Congo Free State the 970,000 square miles of land conceded as a mineral grant five years ago to a company in which Thomas F. Ryan is heavily interested, have reported that they have found large amounts of gold, iron, petroleum and diamonds. The finding of diamonds was a surprise. Two hundred and forty were found near Kambambay and some of them are on the way to America now.

MIAMI DISTRICT REVIEWED

Owing to the merger or consolidation of the Inspiration and Live Oak companies' properties in the Miami district, Arizona, which is now practically completed, together with the prospect that sooner or later the Miami and Keystone will be included, the following article descriptive of these properties and the conditions surrounding them, by so competent and impartial a writer as W. R. Ingalls, editor of the Engineering and Mining Journal, will be of keen interest to Mines and Methods readers at the present time. The article is taken from the Engineering and Mining Journal of the 13th instant, and in full reads as follows:

Four mines at Miami, Ariz., have been opened on the great deposit of disseminated copper ore that exists in that district. From east to west these are the Miami, Inspiration, Keystone and Live Oak. They are opened upon what is really the same orebody, although there are certain breaks in it, to which I shall refer. The ore is a schist mineralized chiefly with chalcocite. Up to the present time a total of about 66,000,000 tons of ore is claimed to have been developed in the four mines above mentioned.

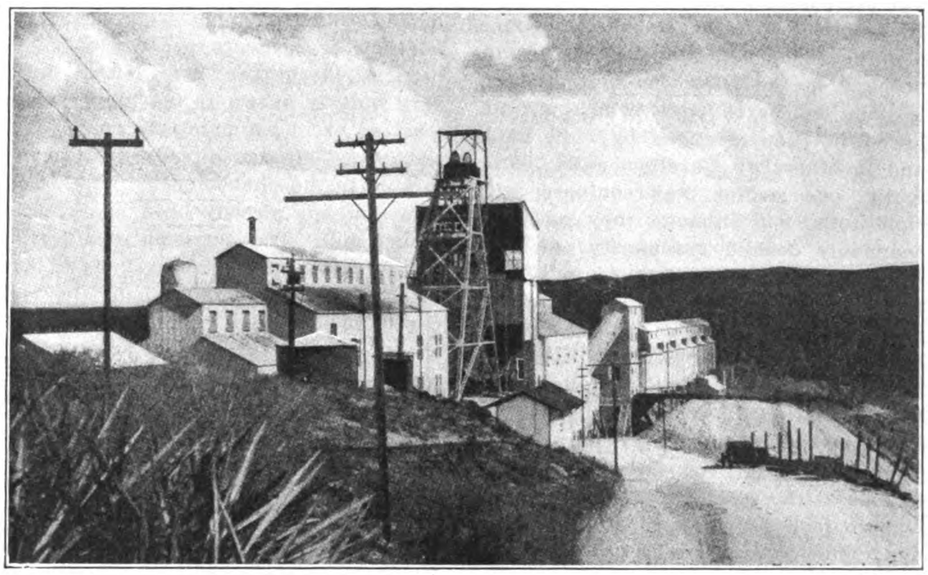
THE MIAMI MINE.

The only producer of the Miami district at present is the Miami Copper Co., which is now mining and milling from 2,400 to 2,500 tons of ore per day. This is being done with five sections of the mill. When the sixth section is completed and the mill is thoroughly tuned up, its capacity will undoubtedly be about 3,000 tons per day. The sixth section will probably be ready for operation by the end of January, 1912. The foundations are ready for two more sections (each of 750 tons capacity), but there is no immediate plan of building upon them. Eventually, one or both of them will probably be completed for the milling of the ore of neighboring companies. With milling capacity for 3,000 tons per day, the Miami itself is adequately supplied, in view of its present ore development.

According to the last official report of this company, it has developed 18,000,000 tons of ore averaging 2.58 per cent copper. Since then no attempt to increase the reserves has been made. It would not be good policy to do so. It may be said, however, that the management expects to add to the reserves both with depth and laterally, and there seems to be sound reasons for such an expectation, especially as to the extension of payable ore to greater depth than yet estimated.

METHOD OF DEVELOPMENT.

The Miami development has been chiefly by blocking out the ore in the old-fashioned way. In doing this, about 100,000 ft. of drifts, raises, etc., have been run. No other of the "porphyry" mines has done anything like so much of such work in proportion to the volume of orebody. While it is pleasant to learn at other mines that stoping is checking closely with the estimates based on drilling, nevertheless a superior confidence is bound to be felt in development that has put the ore actually in sight. Above the 420-ft. level the Miami has about 8,000,000 tons of ore, a large part of which has already been prepared for mining. If anything, the management has anticipated the requirements of mining too far ahead; in other words, has expended too much money in development in advance of mining. This, however, will all come back in course of time.



Surface Plant of the Miami Copper Company.

The Miami orebody occurs in the form of a submerged mountain with twin peaks. The highest horizontal section shows only two small patches of ore—the two apexes. Succeeding sections show them to be of increased size, until finally they merge together in one great area of ore. The extraction of this orebody has been begun at the top, and at present is being done chiefly by square-setting, the objects being to take out the ore cleanly below the capping and form a thick mat of timber between the capping and the ore in order to keep them separate when the caving is fairly in progress. This system of mining is designed to extract the maximum percentage of ore without dilution, and is performed at a relatively high expense for timber, the expense for which at present comes to nearly 25 per cent of the total cost of mining. The mining of the Miami orebody is, in fact, being done at present under the most unfavorable conditions. Not only must the timber mat be formed, but also all prongs and tongues of ore extending into the capping must be extracted now, if ever. This involves a good deal of relatively costly hand mining, which will disappear when the extraction by caving is fairly in progress.

COST OF MINING.

In spite of the relatively unfavorable conditions of beginning the extraction of ore and the operation at only partial (about 60 per cent) capacity, the cost of mining has been lower than was originally estimated having been only about $1.20 per ton (of which about 30 cents is for timber), and there is no doubt whatever that this will be further reduced as operations come into full swing. It is to be remarked that the method of mining introduced in the Miami mine is designed to secure a high percentage of ore extraction, but what this will be has not yet been determined. Of course, it is possible in such mines to extract nearly 100 per cent of the ore, but it may be less profitable to do so than to stop short of such arithmetical perfection.

I will not undertake to describe the mining methods or equipment, which doubtless will be done later by the engineers who are responsible for them. For the present it is sufficient to say that Messrs. Channing, Gottsberger and Lawton have done highly creditable work, both in their planning and in their execution. The mine is so laid out that the ore is delivered through a main gallery, at present on the 420-ft. level, to a large shaft of great capacity through which it is hoisted by compressed air engines and delivered directly to the mill.

THE MIAMI MILL.

The Miami system differs from that of most of the porphyry mines, in that the mill is built right by the shaft, the water being pumped to it, instead of carrying the ore a more or less distance to the water. The decision between carrying the ore to water and water to the ore depends, of course, upon the comparative expense. At Miani the cost of water is about 6 cents per ton of ore. Such a low figure is attainable only when there is economical use of water.

In laying out the Miami mill, so excellent advantage was taken of a rather difficult and forbidding topography that the result leaves but little to be desired. The ore passes from the bins in the headframe of the shaft to the crushing house, and thence by belt conveyor to the mill proper. In the latter the first crushing is done by Burch rolls, which are followed in some sections by chile mills and in others by Hardinge mills. Originally, one section was equipped with rigid rolls, but although they gave the commonly desired granularity of product, in this case they failed to release fully the mineral, for which crushing to pass a 60-mesh screen seems to be necessary. As between the chile and Hardinge mills, it is rather strongly indicated that the latter will become the favorite.

The pulp is washed on Deister tables. The concentrates run through a tunnel to bins at the foot of the hill. The tailings go to a dewatering plant below the mill, which operates with marvelous efficiency. The total quantity of water required in milling a ton of ore is nine tons; the quantity of new water supplied is only two tons. The dewatered tailings are discharged into a commodious pond formed by a dam across a small ravine. As discharged into it their copper content is not high.

The ore delivered to the mill has been averaging about 2.5 per cent copper. The ratio of concentration has been 20:1 to 22:1, the concentrates assaying about 40 per cent copper. The extraction of copper has been about 75 per cent. In spite of the fine grinding to which the ore must be subjected, the loss of copper in slime is low. It is expected that the extraction in milling will eventually be raised to nearly 80 per cent. Considering the character of the ore and the excellence of the mill equipment, it is not improbable that such a remarkably high extraction will eventually be obtained when it has been learned how to operate the mill to the best advantage.

DESIGN AND CONSTRUCTION.

In the matters of design and building, the Miami mill is at the present time the last word in mill construction. There is no other concentrating mill of which I am aware that has so much purely structural excellence, so much floor space, so much lighting (both by day and by night-, so unobstructing a belt, shafting and launder plan and so much cleanliness. Here is a mill in which a visitor may go in his best clothes without fear of harming them.

Some criticisms have been directed toward the Miami engineers upon the ground of their apparent extravagance. I use the word "apparent" advisedly, the cost of the Miami mill per ton of annual capacity not having been excessive even when compared to other mills of decidedly inferior construction. But even if some apparently unnecessary outlays were made in the Miami mill, I am, nevertheless, of the opiinon that the money was extremely well spent. An addition of 25 cents per ton of annual capacity in the first cost, let us say, is very quickly offset by the ability to extract an extra percentage of copper from the ore. This has already been demonstrated in the phenomenally high extraction that has already been made in the Miami mill. The provision of a commodious, well constructed and well kept plant improves the morale of the men. Given such a plant they are likely to adapt themselves to its conception, whereas if put to work in an inconvenient sloppy plant, they are more likely to absorb the spirit of the engineers and themselves become careless.

The Miami mill has been compared to a magnificent mansion, fitted up with appropriate furniture. If, at any time, it may be desirable, it is an easy matter to change the furniture. In the Miami mill the furniture is the machinery and special apparatus. If, at any time, it may be necessary to change the machinery because of alterations in the milling qualities of the ore, or because improvements in the art have led to the development of better forms of machinery, adaptation to either condition is easy in the Miami mill, because of the foresight and broad conception of its engineers. From this point of view the elaborate construction of this mill is not only a direct means of immediately making more money, but also is an insurance against adverse alterations in conditions in the future.

INSPIRATION COPPER CO.

Going westward from the Miami, the orebody spreads out, or at least becomes less thick than it is in the Miami, and deflects to the southwest, the general trend being shown in the accompanying map. The orebody is faulted in the Inspiration property, as may be surmised from the peculiar shape shown by the map. Toward the Keystone line the orebody is broken by a fault that has thrown it down in the Inspiration territory and produced an area on the dip of the fault wherein no ore is to be expected. Another fault is known to exist in the neighborhood of the line between the Keystone and Live Oak property. Besides a vertical dislocation at this place, there also appears to have been a heave of the Live Oak orebody to the northwest. The faulting of this district and perhaps other geological conditions have not yet been adequately studied.

Up to the present time the work of the Inspiration Copper Co. has been confined chiefly to prospecting development, which has been both by churn drilling and by underground work, chiefly the former. A good deal of underground work has been done, but nowhere near to the same extent as was done by the Miami Copper Company.

The developments in the Inspiration have disclosed the existence of an orebody of about 120 ft. average thickness, with a maximum length of about 3,800 ft. and maximum width of about 1,600 ft. It is estimated that this orebody contains about 30,000,000 tons of ore, averaging 1.95 per cent copper.

The Inspiration is undoubtedly a very valuable mine, but in comparison with the Miami it is at the disadvantage of a materially lower grade of ore. It follows from this that if the extraction of the ore were to be conducted by the same methods as in the Miami mine, the cost per pound of copper product would be very materially higher. It is likely, however, that the mining of the Inspiration ore will be done by a cheaper method of caving, perhaps by suitable modifications of the methods employed at Bingham and at Ray. This will afford much cheaper ore at the expense of a lower percentage of extraction. I am, however, favorably disposed toward such systems when introduced under suitable conditions, and believe it to be not unreasonable to expect that the extraction of ore may be as high as 83 per cent. Any such result would, of course, go a long way toward offsetting the disadvantage of the lower grade ore. However, it is not to be expected, not even under the most favorable combination of circumstances, that Inspiration can produce a pound of copper so cheaply as Miami.

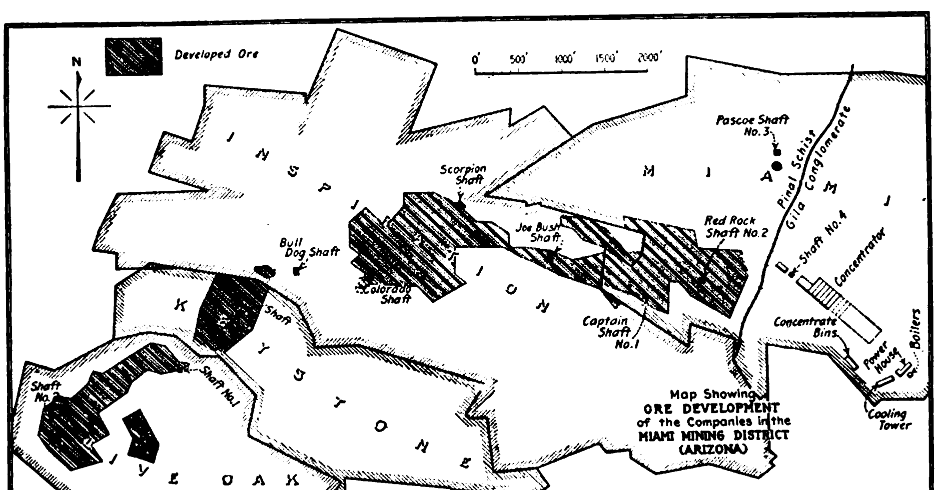
A considerable part of the Inspiration orebody is so situated that it can be extracted through an adit level. Just what use will be made of that entry, and, indeed, just what will be the plan for the mining and milling of the Inspiration ore, has not yet, so far as I am aware, been finally decided.

THE KEYSTONE PROPERTY.

Adjoining the Inspiration on the west is the property of the New Keystone Copper Co , which is an interest of the General Development Co. The surface of the country is noteworthy at this place for a remarkable coloration of the country rock by silicate of copper. Unfortunately the copper content of the surface exposures is not sufficiently high to be commercially valuable. The lines of the Keystone property proved to have been laid out in such a way that this company did not secure a large portion of the orebody.

As in the case of the Miami, the development of the Keystone mine has been chiefly by drifts, winzes and raises. It is only recently that any drilling has been done. The underground work was laid out in a thoroughly systematic way, upon two levels, viz: The 150-ft. and 250-ft. This work has disclosed an orebody about 400 ft. in width and 70 ft. in thickness. At the date of the last annual report of the company, last summer, it was estimated that 2,000,000 tons of ore, averaging 2.25 per cent coper, had been substantially prepared for mining. This ore is in the part of the property adjacent to the Inspiration. In going toward the west the Keystone ore dips downward, wherefore the drifts of the 150-ft level and then of the 250 ft. level pass out of the ore into the oxidized capping.

A winze put down from the 250 ft. level to the west of the line beyond which the ore had dipped below that level rediscovered the ore and gave a more correct understanding of its position than was possessed when the earlier work was done on the 250-ft. level. Inasmuch as the sinking of winzes is relatively expensive, recent exploratory work has been confined to putting down churn-drill holes from the surface at the corners of 100 ft. blocks. These have beeen proving the western continuation of the orebody, but its amount and grade have not yet been estimated. Near the Live Oak line the fault, previously mentioned, may cut off some of the ore, but probably to no great extent. It is reasonably to be expected that about 1,500,000 tons of ore will be added to the Keystone reserves, making a total of about 3,500,000, which may be somewhat increased if the basis of estimating be reduced to 2 per cent copper.



Map Showing ORE DEVELOPMENT of the Companies in the MIAMI MINING DISTRICT (ARIZONA)

The Keystone mine is favorably situated for operation. The ore seems to grade off into the capping and a high percentage of extraction can perhaps advisably be effected by taking in a little of the capping at the expense of a slight diminishing of the average copper content of the product. The shaft is adequate in size for the extraction of 350,000 tons of ore per annum and from the preesnt outlook the whole orebody can be commanded from the 350-ft. level. The Keystone mine has not sufficient ore to justify the erection of a modern mill, and its ore will probably be treated in a section of the Miami mill that may be added for this purpose. The Miami mill is in view from the Keystone shaft, about 8,000 ft. distant and about 350 ft. lower, wherefore the ore may easily be delivered by aerial tramway, right of-way for which over the Inspiration ground is possessed. The Keystone mine is under the same management as the Miami.

LIVE OAK.

The Live Oak is the most recently developed of the mines of the Miami district, and the work in it up to date has been chiefly prospecting by drilling, although considerable underground work has also been done. A great deal more of the latter will be necessary in order to prepare the ore for mining, in which respect this property is more backward than either the Inspiration or Keystone.

In the Live Oak area the orebody pitches rather sharply to the west and in the western part it lies at a depth of about 800 ft. According to the estimates of the Live Oak engineers, they have developed 15,000,000 tons of ore averaging 2.1 per cent copper.

GENERAL OBSERVATIONS.

So far as known, the Miami district has only one orebody, disregarding its local separation by faulting. This is situated in the flank of the mountain rising from the northern side of "Miami wash," which is a branch of Pinal Creek. This mountain is cut by transverse ravines and valleys, producing a rough and irregular topography. The Arizona Eastern Ry. Co. extended its line from Globe along Pinal Creek, 10 miles to the town of Miami, above which the Miami mine is situated. The power plant of the Miami Copper Co. is at the foot of the mountain, at the terminus of the railway. The concentrates loading bins are near-by. Timber and supplies for the mine and mill are elevated to the mine by an inclined railway. The water supply for the mill is obtained from the Old Dominion mine at Globe, whence it is conveyed by pipe line, by gravity, to Burch. From Burch it is pumped to a tank above the mill, the distance being about four miles and the lift about 575 feet.

There does not seem to be any chance that the Miami-Inspiration-Keystone-Live Oak orebody will extend into any other property, except perhaps at the western end, and its existence adds no values to other properties to the north and south in the district beyond creating the hope that a similar orebody may be found. Prospecting up to the present time has given no support to such a hope. As to the western extension there is a suspicion that another fault has dislocated the orebody, and that beyond the Live Oak it is perhaps to be looked for to the north of what would otherwise be the line.

The Miami-Inspiration-Keystone-Live Oak orebody has now been rather closely delimtied, but all of the companies will probably add somewhat to their reserves. In this respect the chances of the Miami Copper Co. are perhaps the best.

It is not to be doubted that a consolidation of the four adjoining mines would be of economic advantage. By agreement they have adopted the sideline principle, wherefore no litigation is to be expected, but under individual ownership there will be troublesome mining problems along joint boundaries. There would be economy in capital outlay by concentrating the milling in one plant and there would also be economy in operation. Finally, there would probably be economy in smelting the concentrates. At present the Miami product is shipped to distant Cananea. A better contract was made there than could be made at Globe, only ten miles distant. It would seem, however, that the concentrates of the Miami district ought to be smelted at home.

FUTURE OF CONCENTRATION

By M. P. BOSS.*

Following the introduction of the Frue vanner the public held complacently the thought that that machine would do about all that could be done in concentration. The years that have elapsed since have unveiled additional complexities in proportion as understanding has increased. Sizing and classification have long been in a measure appreciated, but even today are broadening into wider and more universal practice, and are evidently destined to much greater consideration by the general public. It has been and is customary to measure success by profits of treatment, quality of work often being sacrificed for quantity; and often the loss is a final and permanent one. This matter may yet run counter to the conservation tendecy, and thus stimulate a desire to get all that mechanical genius can get—to get out by automatic mechanical means what can now be gotten out by a batea through skillful hand manipulation. At the present stage of the art little progress can be expected by haphazard means. A thorough understanding of the principles involved in the obstacles that yet so thwart engineers is essential to cope with today's problems. This is particularly true in slime treatment. New devices bring hopes, to be followed by disappointments, yet the why and how is continually becoming better understood.

In all concentration two active agents are involved, impellant energy and retardation. Retardation may be liquid and non-directing, or it may be rigid and guiding. In a feed composed of true spheres of absolutely equal size, a concentrate could undoubtedly be completely segregated from a gangue of but little less specific gravity, even if the material was so fine as to be classed as slime, by machines now on the market. In true spheres 'impellant energy' (as of gravity) is in ratio as the cubes of their diameters mutiplied by their specific gravity, while 'liquid retardation' (as in precipitation) is in ratio as the squares of their diameters. This unfailing law is the bogey that is the cause of the greatest troubles in intelligently manipulated concentration. Two spheres of equal size but of unequal specific gravity would meet, in liquid precipitation, equal resistance, their displacement being the same, while the 'impellant energy' would be greater in the heavier sphere. Thus a large grain of gangue will sink faster than a small grain of concentrate. This is a clear reason why thorough sizing is desirable. The closer the sizing, the easier and better the dressing. It is easy to size a coarse material, but the difficulty multiplies with fineness, and in slimes one particle may be several times the diameter of another, an associated particle. From this rises the difficulty with slimes, a difficulty which probably never can be wholly overcome, so that there is little hope of slime treatment through 'liquid retardation' (precipitation or longitudinal hurling).

Rigid and guiding retardation, as on a table, or in a batea, introduces other principles, the horizontal plane estopping precipitation and the finer particles finding their way through the interstices between the larger grains and resting upon the bottom, where they are in a measure protected and are less affected by currents that sweep along the coarser grains. The efficiency of this decreases with depth of material and is a factor of grain diameter. The bed should be thinnest with slime, as a thick bed brings into play the 'liquid retardation' law, that precipitates the larger grains of gangue faster than the fine grains of concentrate. These are principles to consider in regard to riffles and to table-deck treatment, to avoid as much as possible ill effects from liquid retardation. When a concentrate particle has once reached bottom all effort should be made to keep it there. To this end riffles should be so designed as not to have a turbulent raising effect below them, unless material is very closely sized or of widely differing specific gravity.

The foregoing implies that all unencased concentrate material might be segregated from a gangue, even if only slightly heavier, when properly classified. The term classified, rather than sized, is used here advisedly. Material can be thoroughly sized by screens only. Classified is a broader term and includes hydraulic classification, which is a process based on the law of liquid retardation, wherein the heavier particles are smaller than those that are of lighter specific gravity. As we have seen, the latter is more suited to lateral table-deck treatment and the former to liquid retardation. In looking at the acres of concentrating machines in one of the great modern plants of today and realizing that the same machines are greatly overworked for commercial reasons, one quite naturally drops into computing the percentages of the total area that is actually segregating concentrate from gangue, and it is small.

From the present viewpoint, where is the relief? As has been noted, no space is wasted. Yet it is quite probable that in some future day more work will be done on a less area. About as the flying machine was to human travel a half dozen years ago, so centrifugal concentration is viewed today. Yet an impellant energy many times augmenting that of gravity may be developed by high centrifugal action, some like characteristic existing in both, yet with complications abounding for future solutions. When the capacity of present machines has been greatly increased without increase of cost, then a better quality of work may be expected. While very great progress will likely be made in the near years to come, there will likely be ample field for study for many years.

* In Mining and Scientific Press, January, 1912.

BILL AND THE "SUPE"

Now listen to me, while I tells to you,
The tale of the Supe an' Bill McGrue.

Bill he was takin' a little mope
After drillin' his holes in the stuffy stope,

An' settin' down on a timber car
He lights a match to a bum cigar.

He scarcely more than gits a light
When a guy in overalls heaves in sight.

"Takin' a rest?" says he to Bill.
"You bet," says William, an sets right still.

"Aint you got nothin' at all to do?"
"I have," says Bill, "when Im ready to."

"What would you do?" says the stranger guy,
"If the shift boss happened to wander by?"

"I'd sit," says Bill, "like a tired bloke,
An' take my time for my rest an' smoke."

"Do you know," says the stranger, "who I am?"
"I don't, says William, "nor care a damn!"

"Well, I am the Superintenaent here!"
Bill's grin extended from ear to ear.
"The Supe" he says, "of the hull big mine?
Thats bully," he says, "that's grand, that's fine;

A mighty good job fer a man to git
If I was you I would tend to it!"

Then Bill leans back on the empty car
An' goes on smokin' his bum cigar.

Benton Braby in New York Times.

Water softening, where the hardness is due to lime sulphate, may be accomplished by the addition of barium carbonate. Barium sulphate is produced and lime carbonate forms, both of which are nearly insoluble, and will precipitate. Barium hydrate may also be employed, which has the advantage of decomposing the lime salt with the formation of CaO, which will reduce the soluble lime bicarbonate to the insoluble carbonate. The high cost of barium salts is an obstacle to its wide use for this purpose.

METHOD OF ESTIMATING DISSEMINATED OREBODIES

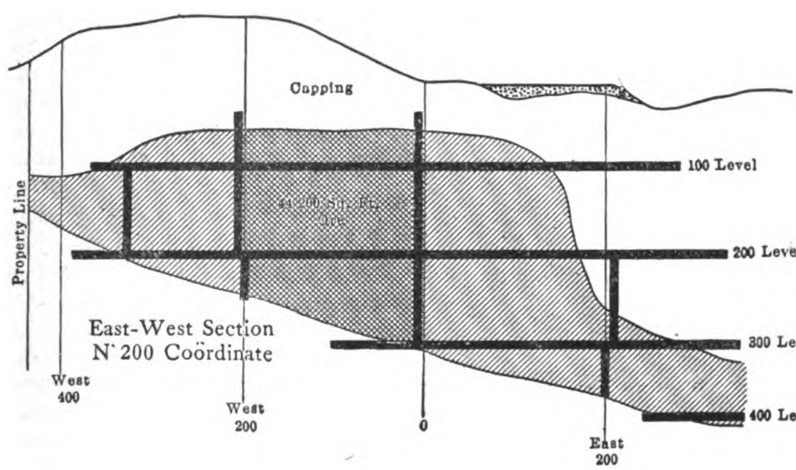
By FRANK H. PROBERT* and ROY B. EARLING.†

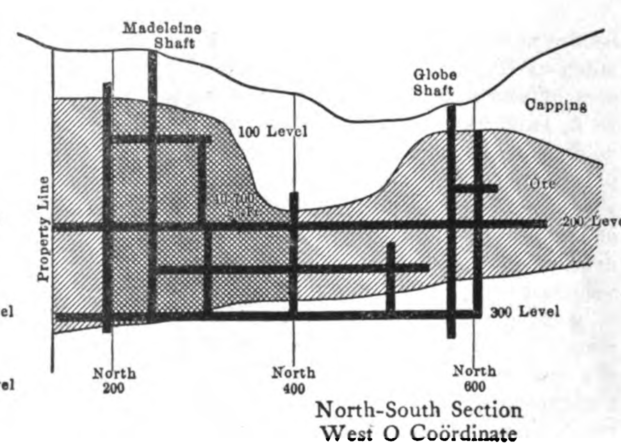
The following practice has been adopted at the Ray Central property, at Ray, Ariz., for estimating tonnage and value of ore developed. Inasmuch as the method can be applied at any property where disseminated ores are developed it is worthy of detailed description.

The property has been laid out and all work done along rectangular co ordinates, all workings being numbered according to the distance in either direction from the zero point, for example N 400-E 600-E is a drift driven east from a point N 400 E 600. All drifts and crosscuts are run along these co-ordinates with winzes and raises connecting levels at points of intersection. In this way the orebody is first split into 200-ft. blocks to be later subdivided. Cross and longitudinal sections at intervals of 100 ft. and level plans are used in the computation, upon which are plotted all underground workings, churn-drill holes, assays and major geological features. The standard scale used is 50 ft. to the inch. All maps are brought up to date at the end of each month and blueprints showing progress, accompanied by the report of the engineer forwarded to the respective officers of the company.

Low-grade ores require constant and accurate sampling. The copper occurs as finely disseminated particles of chalcocite, chalcopyrite, oxide or native in a silicious schist, or occasionally in the intrusive rocks to which the orebodies owe their origin. To distinguish between commercially mineralized schist and waste is impossible except by careful sampling. All underground openings whether in ore or country rock look monotonously alike, hence the necessity for accurate sampling and assay maps.

Samples are taken in 5-ft. sections starting from a co-ordinate or transit point, care being taken to first clean down the walls. A continuous groove 1½ in. deep and 3 in. wide is cut in each wall. Particular care is taken to secure about the same amount of material from every part of the 5 ft. section to prevent the enrichment of the sample by any small seam of high-grade ore which might occur. About 35 lb. are taken per sample. As the drift advances the groove is continued. The samples are sacked underground, dried, crushed, quartered in split dividers and the final pulp put up in duplicate, one for permanent filing, the other for immediate assay. All determinations are made by electrolytic assay, the apparatus being of the rotating anode type. The results are recorded on the maps and complete numerical and classified card files are kept in the fireproof vault at the mine office. To avoid the possibility of error, frequent check samples are taken in stretches of from 50 to 100 ft. The laboratory work is also checked by composites and re-assaying of individual samples.





Scale $\frac{1}{1200}$

MEASUREMENT OF TONNAGE.

The first step in computing tonnage is to define the workable limits of the orebody on the several maps, taking each set of sections separately. Local economic conditions naturally determine the minimum grade that can be profitably mined, so that in sketching in the areas of commercial ore the limits are defined by the assays. Any marked irregularity is, of course, avoided, the object being to outline the orebody as it will be mined. A run of low-grade assays will often be included in a block while a small tongue of high-grade might have to be discarded from the calculation. If a working has been discontinued in ore, an allowance is made for the probable extension of the orebody a distance of from 5 to 50 ft., depending on the proximity of other workings, the uniformity of the ore and geological conditions. Here the personal equation of the engineer figures in the estimate and intimate knowledge of the district is necessary.

Each set of sections is compared and correlated with the other sections and plans, and altered so that they represent a definite orebody of concrete form. Areas are always reduced rather than added to in making the sections conform. Figs. 1 and 2 are reductions of actual sections used in the computation recently made for the shareholders of Ray Central.

ORE MEASURED IN 200-FOOT BLOCKS.

The cubic content of the orebody is now determined by taking blocks 200 ft. square, of variable depth, designated by the co-ordinates between which they lie, viz., N 200-400, W., 0-200. At Ray Central longitudinal and cross-section maps are available at intervals of 100 ft. so that in calculating any given block, six sections have to be used, three north-south and three east-west as shown in Figs. 3 and 4. These maps show the sectional area of the orebody on each face and through the middle of the block, the areas being measured either by planimeter or by counting the squares on cross-section tracing cloth superimposed on the map, and multiplying by the factor

*Consulting engineer and †Chief engineer, Ray Central Copper Mining Co., Ray, Ariz., in Mining and Engineering Journal, Dec. 16, 1911.

necessary to give square feet. Taking either set of three sections the volume of the block is calculated by the prismoidal formula, which is.

$$V = L\left(\frac{E + 4C + E'}{6}\right)$$

Where V is the volume, E one end area, E' the other end area, C the area of

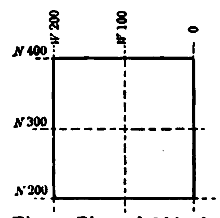


Fig. 3 Plan of 200-ft. Block

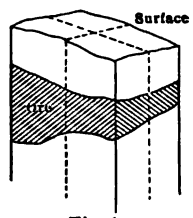


Fig. 4

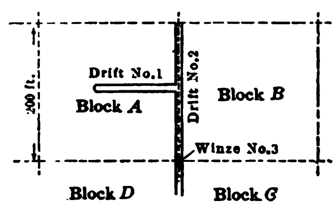


Fig. 5 Plan

center section, and L the length. Inasmuch as there are two entirely separate sets of sections, north-south and east-west, two results are obtained for the volume of each block, which should be approximately the same. If the conditions are such that the two sets of sections should give equally correct results, the average of the two is accepted as the volume of the block. For full blocks 200 ft. square the measurement of volume is simple, but irregular fractional blocks on the edge of the orebody cannot be as accurately estimated. Where, owing to the form of the block, three faces are presented by one set of sections and only one or two by the other set, the result obtained from the first series is accepted.

Throughout the Ray District the ratio of 12½: 1 is used in the conversion of volume to tonnage. The total tonnage is obtained by adding together the tonnages of the individual 200-ft. blocks.

CALCULATION OF AVERAGE GRADE.

The average grade of the orebody thus delimited is determined by the average assay values of the individual blocks. In a block containing both high- and low-grade ore, irregularly distributed, it is obvious that an arithmetical average of all assays in such block would be incorrect. Due weight must be given to each run of assays according to the number of times it figures in the computation.

Referring to Fig. 5, if all assays were given the same weight in computing the value of block A, and subsequently the assays in block B were averaged to give the value of that block, then the assays in drift 2, which is on their common line, would be used twice, while those in drift No. 1 would be used only once. In the same way after all adjacent blocks had been figured the assays in winze No. 3 would have been used four times. In other words the assays in workings along co-ordinates would have twice the representation, and those in the winzes and raises at the intersection of the co-ordinates, four times that of the interior workings, and unless this is guarded against the results cannot be accurate.

It is, therefore, necessary in order that each assay have the same representation in the final result that they be given different factors in individual blocks, as follows:

All assays in interior of a block, a factor of 4.
All assays on side faces of a block, a factor of 2.
All assays at corners of a block, a factor of 1.

In estimating the value of the Ray Central orebody the ratio of ½, 1 and 2 is used, instead of 1, 2 and 4 to facilitate the work, viz., 46 assays in drifts along a co-ordinate line totaling 116.07 are figured as such, whereas 103 samples giving 217.78 from winzes at the corner of a block figure as 51½ samples of 108.89, so that in the block shown, instead of having 488 samples totaling 1027.98, we

DATE Jan. 1, 1911 CLASS Actual
ENGR........... BLOCK N 200-400 W 0-200

	Section		Area in Square Feet	Total
E-W SEC.	N200 300 400	33,500x4	44,200 134,000 14,200	

$$192{,}400 \times \frac{200}{6} = 6{,}412{,}000$$

	Section		Area in Square Feet	Total
N-S SEC.	W 0 100 200	32,000x4	40,700 128,000 20,700	

$$189{,}400 \times \frac{200}{6} = 6{,}313{,}000$$

ACCEPTED (ave.) 6,362,000 cu.ft.
509,000 tons

ASSAYS

Map	No.	Total	Factor	No.	Total
100' lev...	73	146.72	1	73	146.72
200' lev...	63	127.24	2	126	254.48
"	115	244.09	1	115	244.09
250' lev...	54	103.17	1	54	103.17
300' lev...	22	46.67	1	22	46.67
Sections...	103	217.78	½	51½	108.89
...	46	116.07	1	46	116.07
...	12	26.24	2	24	52.48

TOTAL 511½ 1027.57
AVERAGE ASSAY 2.098 per cent.

FIGURE 6

figure 511½ samples giving an assay total of 1027.57 making the average assay for the block 2.098 per cent.

The general assay of the whole orebody is obtained by adding the "tons per cent" of component blocks and dividing by the total tonnage. Summarized the estimation involves:

(1) Computation of tonnage for individual 200-ft. blocks by prismoidal formula.

(2) Computation of average assay for individual blocks with assay factors according to situation.

(3) Computation of total tonnage by addition of block tonnages.

(4) Computation of general average assay, using factors for block averages according to tonnages.

All block tonnages, assays and computations are kept in a loose-leaf book on special forms, Fig. 6, provided for the purpose.

WHAT IS HURTING PORCUPINE

A prominent mining man, in the course of an interview with the Canadian Mining Journal, says that publication, stated that he had twice or thrice offered to pay the price asked for certain prospects in Porcupine, on condition that he first be permitted to spend a considerable amount of money in investigating. In each case this offer was unqualifiedly rejected. The person in question was amply able to carry out any undertaking that appealed to him. He was not only ready and willing but anxious to be responsible for the preliminary development of any reasonably promising claim. But everywhere he found owners asking impossibly high prices and imposing impossibly rapid terms.

This is one general cause of the present decline of public interest in Porcupine. Another incidental cause is the suppression, or non-publication of Mr. Robbins' report on the Hollinger. Still another is the superfluous and glittering generalities that are being published about the Dome, ostensibly from headquarters.

On its own merits Porcupine must stand or fall. Assuredly it needs sane advertising. More assuredly it does suffer from indiscreet booming.

It is high time that the mine owners and operators of Porcupine get together and devise a practical scheme of publicity.

The writing of prospectuses is an art that can be acquired only by long experience. It is rarely that one sees a properly balanced presentation of facts and opinions. The tendency is, of course, so to use the engineer's report as to give a highly favorable view of any enterprise. A result is that many engineers are falling into the habit of making their reports serve the purpose of the prospectus. This is a lamentable tendency, a tendency that should be guarded against most rigidly.—Canadian Mining Journal.

RACIAL COMPOSITION OF MINE WORKERS

By W. J. LAUCKS.*

The importance of immigration labor in the metalliferous mines of the west is shown by the fact that slightly more than two-thirds of the employes are of foreign birth. The racial classification of the alien mine workers is quite different, however, from that of the wage earners in the smelting and refining industry. Among the latter the southern and eastern Europeans are predominant, while the metalliferous miners are of races from Great Britain and northern Europe. The proportion of native Americans engaged in mining is also much larger than that in the smelters and refineries.

RACIAL COMPOSITION OF MINE-WORKERS.

A recent and exhaustive investigation of the government has developed the fact that one third of the metalliferous mine workers of the west are of native birth. About one-half of these are descendants of parents born in the United States, and about one-half are native born of parents who migrated to this country from England, Ireland, Germany and Canada. Forty European races are represented among the immigrant mine workers. The north Europeans, or the Danes, Dutch, English, Finns, French, Germans, Irish, Norwegians, Scotch, Swedes and Welsh, constitute two-fifths of the total number of employes. Members of the southern and eastern European races, among which the North Italians, Croatians, Dalmatians Herzegovinians, Montenegrins, and Slovenians are most prominent, form only one-sixth of all those at work in or about the mines. Of the remaining mine workers, the largest racial element consist of Mexicans with a proportion equivalent to about 6% of the total number employed.

GEOGRAPHICAL DISTRIBUTION OF EMPLOYES.

About one-third of the employes in Colorado, Montana and Arizona are native born, but in California the proportion of native born is little more than half as great, the percentage being only 18. Among the foreign born races, the English range in relative importance from 11% of the labor supply at the California mines to 20% at the Montana mines. The Irish show a very much greater variation. In Montana they constitute about one-fifth of the total number of employes, while in California they are a negligible quantity. The North Italians exhibit an even greater variation in relative importance than do the Irish, their proportion in the labor forces ranging from 4% at the mines in Colorado and Montana, and 7% in Arizona, to 36% at those in California. The Mexicans are almost exclusively employed in the Arizona mines, where they comprise about one fourth of all the employes.

The large proportion of Mexicans at these mines, and their practically entire absence in the other districts, is explained largely by the proximity to Arizona of the Mexican border, and the further fact that most of the immigrant Mexicans employed are part of a nomadic labor supply which travels back and forth through the border states and northern Mexico. The Croatians, Finns and Swedes are not represented in the California mines, and the Herzegovinians and Montenegrins have no representation in either the Colorado or Arizona districts. The Croatians and Finns attain their greatest relative importance at the Montana mines, the Swedes are relatively most important in the Colorado district, and the Herzegovinians and Montenegrins have their largest proportions in the California mines. The French and other Canadians show the greatest numbers at the Montana mines, and the Slovenians in the mines in Colorado.

RACIAL DISPLACEMENTS.

The racial changes in the operating forces of the mines during the recent years have been the same in all districts. Native Americans and older immigrants from Great Britain and northern Europe, principally the English and Irish, constituted the original body of mine workers. Some of these came direct from their native countries, while others, owing to the pressure of competition of recent immigrants from southern and eastern Europe, migrated from the bituminous and anthracite coal mining fields of the east, where they had been first employed.

Many of the English came from the mines of Cornwall, and the majority of the members of this race were skilled miners, mechanics, or engineers before they emigrated to the United States. Within recent years large numbers of these earlier employes have left the metalliferous mines. Some have been induced to enter other industries by the offer of higher wages. Others have engaged in small business enterprises in the mining towns or the neighboring cities. Still others have bought farms. The places left vacant by their withdrawal have been, and still are being filled to a considerable extent, by native Americans and by British and northern European immigrants, who have migrated from the eastern or middle western mining areas, or have come from abroad.

Of late years, however, these sources of labor supply have been insufficient, and mine operators have found it necessary to resort to the more recent immigrants from the south and east of Europe. As a rule these southern and eastern Europeans have made their way into the mining communities through employment on railroad construction or maintenance of way work. The number of recent immigrants applying for work is usually greater than the number of places to be filled.

No discrimination in wages has been made in employing recent immigrants. They have been paid the prevailing rate of wages. The presence of such a large force of available workmen, willing to be employed at the prevailing wage scale, has had the effect, however, of retarding any increase in rates of pay which might otherwise have occurred. This tendency to a decline in wages from this cause has also been largely resisted in Montana, and to some extent in Colorado, by the activity of the labor unions. Furthermore, the existence of labor organizations has had a pronounced effect in causing the migration of certain classes of workmen to certain districts. The distinct tendency of native Americans and British immigrants to move into Montana and other northern mining fields, may be accounted for in large measure on the one hand, by the higher wages obtaining in the northern mining fields under a regime of collective bargaining, and, on the other hand, by the labor troubles in Colorado. As a consequence, relatively few southern and eastern Europeans are found in the unionized territory.

OCCUPATIONS MOSTLY GENERAL LABOR.

Practically all of the recent immigrants, as might be expected, are employed as general laborers in and about the mines. Most of them have been farmers or farm laborers in their native countries, and have had no experience in mining. The foremen, engineers and mechanics are either native Americans, the native-born descendents of British or northern European immigrants, or foreign-born Germans, Scotch, English, Norwegians, Swedes, Irish and Canadians, who have had training before

*In Mining and Engineering World. January, 1912.

immigrating to the United States, or have acquired proficiency as mine workers in other mining areas of the United States.

HOURS OF LABOR.

The length of the working day in the different districts ranges from 8 to 12 hours. In Montana, where the employes are unionized, the working day is 8 hours, and the working week 6 days. At the Colorado mines, where the employes are not unionized, the hours of labor vary from 8 to 12 per day, and the working week in a great many of the mines is 7 days. The men employed underground at these mines, however, in accordance with a state law, work only 8 hours per day, and few of those employed above ground work daily more than 9½ hours.

At the Arizona mines the underground employes work 8 hours per day, and most of the mechanics and others employed above the ground work 8 or 9 hours. The longest working day formerly was found at the California mines but by a recent legislative enactment the working day for underground employes has been limited to 8 hours.

DAILY EARNINGS.

About four-fifths of all the adult mine workers earn $3.50 or more each day. A considerable proportion, or about one-eighth, have daily earnings of $4, or more than that amount. Those who earned less than $3.50 are found chiefly in the groups of employes earning $1.75, but less than $3.50, which aggregate about one-fifth of the total number. Less than 1% earn less than $1.75 per day.

The level of wages in Montana is higher than that in any of the other districts. Of all the Montana employes, 96% earn $3.50 or more daily, and 14% $4 or more. No daily wage of less than $2 is paid to any employe. The greatest range of earnings is shown in the Arizona district, where Mexicans and North Italians receive a daily wage of $1.25 to $1.50. The earnings of the Americans are much higher. The greater number receive $3.50 or more daily, a considerable proportion $4 or over.

The general level of earnings at the Colorado mines is somewhat lower than that of the earnings at the Montana and Arizona mines, although the range of earnings at the Colorado mines was not so great as that at the Arizona mines. The principal wage group for the Colorado mine workers is that of employes earning $3, but under $3.50 per day, which includes about one half of the total number. Of the remainder, about one-fourth receive a daily wage ranging between $2.50 and $3. The lowest general level of earnings is that of the California metalliferous mine workers. About four-fifths of the California wage earners get less than $3 per day, as compared with corresponding percentages of 28, 0.1 of 1, and 35, respectively, for Colorado, Montana and Arizona. The principal wage group for the employes of the California mines is that of those earning $2.50, but under $3 per day. This group includes 75% of the total operating forces. The comparatively high wages in the northern or Montana districts, is due to the predominance of Americans, English and northern Europeans, and to trade union activity. In Arizona and California, the unfavorable showing as to wages arises from the weakness of labor organizations and the prominence of Mexicans and southern and eastern Europeans in the operating forces.

CHARACTERISTICS OF IMMIGRANT LABOR.

More than one-third of the total number of foreign-born mine workers have been in the United States less than five years, and one-fifth have been in this country five, but less than nine years, or in other words more than one-half have resided in the United States less than ten years. More than one half of the immigrant employes are married, but 27% of the total, and a considerable higher percentage of the southern and eastern European married employes, have left their wives and children abroad. More than two-fifths of all the miners of non English-speaking races have not acquired any speaking knowledge of the language. One fifth of the foreign-born employes can not read in any language, and a considerably greater proportion are unable to read English. About one-half have become fully naturalized, and one-fifth have signified their intention of becoming citizens. In all respects the southern and eastern Europeans, as compared with the British and northern Europeans, exhibit comparatively little tendency toward permanent settlement and assimilation.

EDISON'S NEW SCHEME

Thos. A. Edison's idea is to concentrate ores with as little human power or purchased material as is possible. He is now working upon the same lines of a power to separate mineral from gangue that he worked upon in the production of electric light; that is, to make natural forces do the work instead of grinding rock between steel faces as is today practiced in the use of Cornish rolls. His idea is further to concentrate dry, so as to make commercial orebodies that are located far away from water, and while he says that the use of a little water in this system is beneficial, yet he can save by the dry process within 5% of the saving that he can make by the partially wet system. Edison proposes to do away with costly concentrating tables, and to entirely abolish the use of stamps, and when his own rolls are too large for the product to be treated, the use of a smaller Edison crusher is to be used. Another promised step in advance of present concentration systems will be the lightness of the equipment, and the small cost of installation, admitting of the establishment of a plant any place, provided power can be obtained, and a daily treatment of from ten tons of ore upwards.

While electricity plays an important part in the new system, there is nothing yet made public as to the general process. With the exception of Hon. W. A. Clark and Henry B. Clifford—the latter responsible for turning Edison's attention to sulphide ore concentration—no mining men have so far been allowed to visit the laboratory. From Mr. Clifford it is learned that the operation is simple and anything but startling. It is the adaptation of Edison's ideas of crushing and concentration and final division of the various metals by the application of a new force—until now—never successfully used in ore treatment. Mr. Edison is making no extraordinary claims. He simply says that he feels he will make a little higher saving, at a little less cost than any system today in use, and that if power can be obtained the process will work with or without water.

Experiments are being made upon Clear Creek and Gilpin county, Colorado, ores, also Anaconda and Clark's Butte City ores, Coeur de Alene lead and zinc sent by the American Smelting & Refining Co., as well as tungsten from Boulder County, Colorado, and the Bassick mine of that State.

As an evidence of faith the inventor and Mr. Clifford have in the new process, the latter says: "We will pay the freight upon ton lots of sulphide ores high in silica, carrying lead, zinc, iron or sulphides of copper, and make reports to the owners free of all charge. Shipments may be made in sacks, tagged with the name of the mine. Write and give description and we will advise you whether to ship or not. Send small sample with letter to Henry B. Clifford & Co., 17 Babcock Place, West Orange, N. J."

The efficiency of a water wheel is the ratio of its output in power to the total power of the water and head used.

The amount of pull on a tape will have a very appreciable effect upon its length; ordinary light 100 foot tapes will stretch 0.01 to 0.02 ft. with an increase of 10 pounds in the pull over the ordinary pull.

ELECTROSTATIC WORK AT CANANEA, MEXICO

By F. S. MacGREGOR*

The property of the Calumet & Sonora Mining Company is about two miles from Cananea, Mexico, and includes a large deposit of galena, chalcopyrite, pyrite and zinc blende. The wet concentrator makes high-grade lead concentrate, copper-zinc middlings and tailings. As there had been no way to utilize the middlings, they were piled pending the discovery of a successful method of treatment. At the same time the ore mined was selected so as to make a mill feed containing as much lead as possible with the minimum of zinc.

ELECTROSTATIC PLANT RECENTLY COMPLETED.

After investigating various methods, electrostatic separation was found to be the most suitable, and J. N. Houser, the superintendent, proceeded with the erection of such a plant. This was put into operation during the first week of August, 1911, and the work since then has fully equaled the results obtained in the preliminary tests several months previous.

The plant is in a frame building, shown in the accompanying illustration. Above the bins for finished products are two floors for separators, and in a tower are two screens for sizing. The middlings are trammed in mine cars from wet concentrator to the mill, and a platform elevator lifts the cars to the level of the feed bin (shown at the left of the mill). Before dumping, the car is weighed and sampled.

Part of the mill feed is taken from the stock pile, the rest comes from the concentrator. As the major part of this stock pile has stood for some time, there has been a solvent action of the copper from the chalcopyrite and other copper minerals and a precipitation of the copper from the solution thus formed on the zinc-blende particles, rendering them good conductors.

As the separation of the zinc from the other sulphides depends on the difference in conductivity, it was necessary to alter this condition. To do this the stock-pile ore is dumped into the tanks beyond the first feed bin and given a bath of weak potassium-cyanide solution. The cyanide is pumped from a tank below, and after using is drained through the filter bottom and used for the next tank. This solution dissolves the minute film which is formed on the zinc, and the difference in conductivity is restored.

CONDUCTIVITY DIFFERENCES INTENSIFIED BY COPPER-SULPHATE SOLUTION.

In this case natural causes have accomplished what may be done artificially —by giving a zinc product containing barite, rhodonite or other heavy gangue a bath of copper-sulphate solution. After drying, the zinc may be repelled from the heavy gangue, which could not be removed by tabling in the first place.

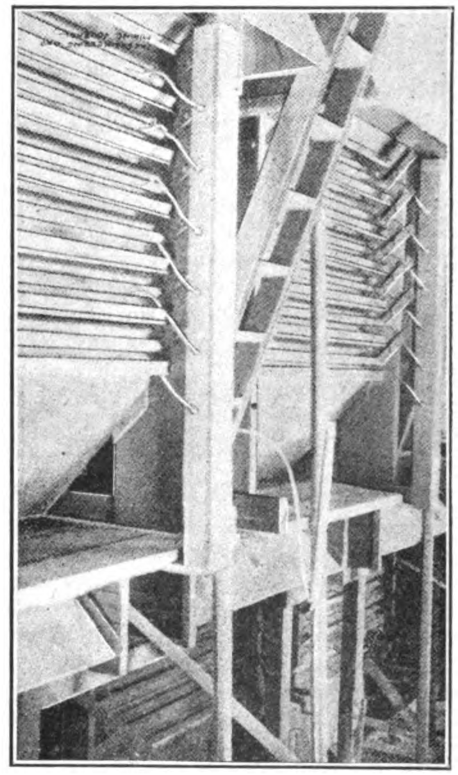
Under these tanks and bins runs a conveyer belt, and over it a traveling automatic feeder. By this arrangement the mill can be fed either from the stock pile or with fresh middlings. The belt delivers to the drier, which is of the cylindrical type.

From the drier the ore passes to No. 1 elevator, which delivers to an oversize (2 mm.) trommel on the first floor. The oversize passes to a small set of rolls, and the undersize to No. 2 elevator, which delivers to the screens in the tower. Three sizes are there made, 2 mm. to 20 mesh, 20 to 40 mesh and through 40 mesh.

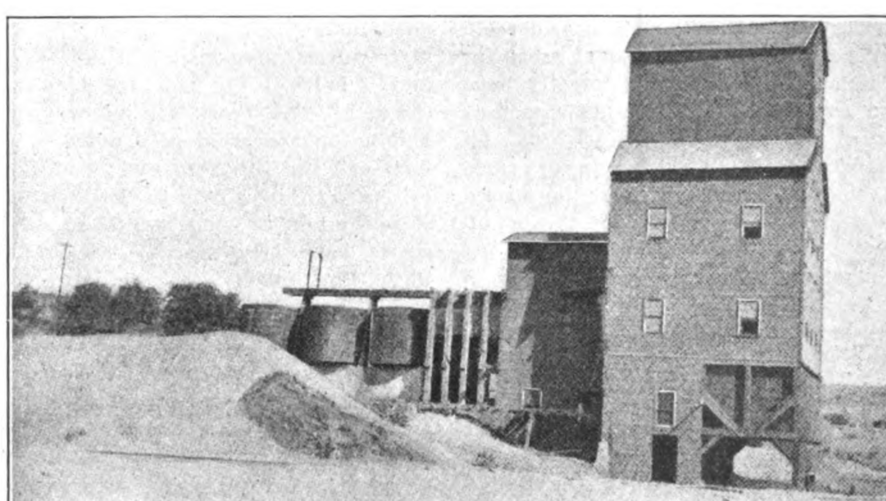
The material above 20 mesh is separated on the Huff roll-type separator. The fine material passes to separators of the Huff toboggan type, which has been used only recently. The American Zinc Ore Separating Company, in its plant at Platteville, Wis., has developed, for the treatment of the fine material, a type which has no revolving parts, except a slow-speed feed roll at the top. As shown in the illustration, it consists of a series of curved surfaces over which the ore slides by gravity. This type is adapted for fine sizes only, the roll type being adapted to the coarser material.

FORMER WASTE NOW PROFITABLE.

The finished products are termed the "copper" and "zinc" and fall directly to the bins; these are shown at the lower right-hand corner of the mill. From these bins the products may be drawn off into wagons and hauled to the railroad.



Huff Electrostatic Separator at Calumet and Sonora Mill.



Calumet and Sonora Forty-Ton Electrostatic Plant.

A 20-h.p. electric motor drives the plant, power being obtained from the power plant of the Greene-Cananea Copper Company. The separating plant has shipped regularly since starting and has given no trouble. About 40 tons per day are handled, approximately 20 tons being the daily output of the wet mill and the rest from the stock pile. In practice the mill is run on one class of material until the other has accumulated suffi-

*Metallurgist with Huff Electrostatic Separator Company, 60 India street, Boston, Mass., in Engineering & Mining Journal.

ciently to make a several days' run. The stock pile assays: Silver, 3 oz.; zinc, 30; copper, 7; iron, 15, and lead, 3.5 per cent. The present wet-mill middlings assay: Zinc, 40; copper, 5; iron, 10.5, and lead, 1.5 per cent. The zinc product averages 55 per cent zinc, 5 per cent iron; and the copper product 9 per cent zinc, 16 per cent copper and 10 oz. of silver. Only three men per shift are required—an American shift boss and two Mexicans.

As can be seen both of these products are of value and can be economically smelted. Heretofore this material has been lost, as there was no market for the two mixed. Not only has this saving been effected, but the problem of mining has been simplified, enabling any stope to be mined whether it furnish lead or zinc, where previously zinc had been avoided.

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MONTANA TOPOGRAPHIC MAP

The United States Geological Survey is constructing a great topographic map of Montana and has already surveyed nearly two-fifths of the State at a cost of a good many thousand dollars. When completed the map will be not only the largest but the most detailed and exact map of Montana in existence. The surveys thus far made include many areas considered to be of the highest economic importance, particularly the mineral-bearing regions, although considerable portions of the more important areas for irrigation, agriculture, and forestry have been covered. The topographic map is a base for engineering work of all classes, as well as a guide map for ranchers, tourists, miners—in fact, for everyone desiring a knowledge of the out-of-doors through exploration. From the standpoint of the Geological Survey, a topographic survey is most important as furnishing a necessary base for all detailed geologic investigation, a considerable amount of which has been prosecuted in Montana.

THIS YEAR'S SURVEYING ACTIVITIES

During the present season the United States Geological Survey topographic engineers have been and are now at work on the survey of the areas known as the Midvale and Nyack quadrangles, lying just south of the new Glacier National Park, a fine map of which was completed last year. The work in the Midvale quadrangle will be finished this year, but it is doubtful if the topographers will complete the survey of the Nyack quadrangle before wintry weather makes surveying impossible in the high altitudes. The surveys of the Brockton and Sand Butte quadrangles, in the extreme eastern part of the State, will be completed; these quadrangles lie partly within the Fort Peck Indian Reservation. Other work includes profile surveys of Clark Fork from St. Regis to Lake Pend Oreille and township surveys of some 200 square miles or more in the southwestern part of the state—south and southwest of Butte, in the vicinity of Melrose. This area is being mapped with a view to future detailed geologic investigations of the phosphate deposits recently discovered by the Geological Survey.

In the survey of these areas in Montana seevn topographic engineers and twelve assistants, accompanied by experienced mountaineers performing the duties of cooks and teamsters, have been at work this year.

The maps covering the present field season's work will be published and available for distribution in about a year, and notice will be given of their completion. In the meantime, as soon as the office drafting is completed, a small edition of photolithographic copies of the maps will be printed for the use of engineers, surveyors, and others having urgent need for the information contained therein before the regular maps can be published.

The government's survey of Montana is being undertaken piece by piece and in widely separated areas, as has already ben indicated, each map as issued representing a rectangular area called a quadrangle. The maps are on three regular scales—approximately 1 mile to the inch, 2 miles to the inch, and 4 miles to the inch. The Nyack and Midvale maps will be on the scale of 2 miles to the inch and the Brockton and Sand Butte on the scale of 1 mile to the inch. Besides the regular maps several on special scales have been issued, such as the Butte, the Helena, and the Marysville special maps.

VALUE OF TOPOGRAPHIC MAP.

The value of a topographic survey of any area is generally understood and probably almost everybody in Montana appreciates the adantages of having the government's topographic maps. They show all physical characteristics of the areas mapped that would be legible on the scale used—hills, slopes, valleys, streams, etc., and the altitude of many points. In addition to exactly portraying natural features, they show all the works of man—railroads and bridges, wagon roads and trails, towns, even individual houses. The rancher who buys one of these maps can therefore locate his home and note the elevation above sea level of the ranch house and of any portion of his ranch and the range.

In fact, the map is a guide which shows the relative position of all features of the country to the farmer, the miner, the prospector, the hunter, or the automobilist, as well as to the experienced surveyor or engineer. Thousands of these topographic maps of areas in Montana have been sold and distributed by members of Congress, and the demand is constantly increasing. They are recognized as indispensable to engineering and land development.

SOLD AT NOMINAL COST.

Topographic sheets are sold by the Director of the Geological Survey at Washington, at the nominal rate of 5 cents a copy or $3 a hundred if at least 100 copies of any map or maps are purchased, a price estimated to cover only the cost of paper and printing. The survey will also furnish without charge an index map showing the quadrangles which have been mapped in Montana.

The making of this map of Montana is but a part of the construction of the topographic map of the whole United States which the Geological Survey is completing as rapidly as Federal appropriations allow. At the present time about 37 per cent of the area of the United States has been thus surveyed and the maps engraved and printed.

———o———

The ultimate strength of rivets in structural steel work, assuming that the distribution of the load was uniform on all rivets and that the friction of the plates is negligible, has been determined to be from 49,000 to 80,000 pounds to the square inch for steel.

———o———

Chills are metal molds used for certain castings, such as car wheels, where a hard surface is wanted, this being accomplished by the sudden cooling of the hot metal as it comes in contact with the comparatively cold surface of the mold.

———o———

When zinc dust is shaken in water in the presence of air, hydrogen and hydrogen peroxide are produced, but in the absence of all traces of oxygen the hydrogen peroxide is not formed. Hydrogen is formed whether oxygen is present or not.

———o———

Sand used for cement work should be composed of hard siliceous material, free from vegetable loam, clay, sticks and organic matter. It should preferably be of coarse grain or of graded size with the coarse grains predominating.

———o———

Zinc blende is occasionally rich in gold. It is frequently high grade in silver and has at times been mistaken for tellurium, as was the case for several years at the Carson Creek mine, in California.

ELECTROLYTIC ASSAY OF CYANIDE SOLUTION

By C. CRICHTON*

Some years ago Mr. Erskine, chief metallurgist to the Kleinfontein group, had his attention drawn to an article in an Australian journal, giving a description of an apparatus for the assay of gold-bearing solutions by electrolysis, and as this method as opposed to the usual precipitation or evaporation processes seemed to indicate a great saving in labor and time expended he decided to give it a trial.

The results obtained from the first experimental run were in every way satisfactory, and during the four years in which, at the Kleinfontein group central administration assay office, this process has been in constant use no inaccuracies in the results obtained have been detected. From time to time check assays of the solutions have been made by means of evaporation with litharge, the values shown by the two methods being identical.

The estimation of metals by means of electrolytic deposition is in general use in most laboratories, the only difference between the determination of gold and, say, nickel or copper, by this means being that in the latter case the increase in weight on a platinum cathode is noted, and in the former a lead cathode is used and the gold obtained by cupellation. The apparatus at present in use at the above assay office consists of four oblong frames 2 ft. 10 in. by 3 in. by 6 in., connected in parallel and each holding eight beakers. The frames or boxes are provided with two copper rods.

ANODE CONNECTION ROD.

The anodes consist of ordinary 5-16 in. arc lamp carbons, and are held in position in the center of each beaker by means of clamps fitted to a horizontal copper bar which runs parallel to and 6 in. above the top of the box. By means of a slot and thumb screw the anode connection rod is attached to two uprights fixed at either end of the box, so that each section of eight carbons may be either lifted clear of the beakers or lowered, as required, in one movement.

CATHODE CONNECTION ROD.

This runs along the front side of the frame, slightly above the top and about 2 in. from it; at suitable intervals along the rod are soldered eight single flexible insulated wires, forming a connection for the lead cathodes.

DESCRIPTION OF THE CATHODES.

The cathodes are made from ordinary assay lead foil, a suitable length being 9 in., and as the foil is usually obtained in strips 36 in. long a good quantity of the necessary lengths can be obtained in a short time by cutting the strips of foil into four equal portions. About a dozen of the lengths are placed together and inverted V-shaped pieces cut out from along the edge intended for the bottom of the cathode; this is to allow for the better circulation of the ions through the solution. Arrangement has to be made for connecting up with the flexible wire from the cathode rod; for this purpose a strip about ¼ in. broad is all but severed from one end of the foil and is folded over, forming a terminal. The two ends of the lead are now brought together and connected by folding the edges; to ensure a smooth surface and circular shape a glass bottle having a slightly smaller diameter than the inside of the beakers in use will be found to be convenient for this operation. Very little time is occupied in making the cathodes. A native can, during a very few hours, make a sufficient number for 200 or 300 assays.

The necessary current for the deposition of the gold in solution on to the cathode is obtained from three 2-volt accumulator cells, which, being connected in series, give a terminal pressure of just over six volts. The current varies, of course, with the resistance offered by the solution through which it passes, i. e., the stronger the solution is in KCN the greater will be the amperage. For example, a solution having a strength of 3 per cent KCN passes 0.1 of an ampere, and a slime solution (0.02 per cent KCN) will take a current of about 0.04 ampere. The accumulators are charged from a direct current lighting circuit through a suitable lamp resistance, and connection can be effected between the lighting circuit and accumulators, or accumulators and electrolytic apparatus, as desired, by means of two-way switches.

Little remains to be said except that perhaps a few details regarding the modus operandi may be of interest. The usual number of solutions assayed each day is 22, which are sent up in marked bottles and placed in the beakers belonging to the apparatus, which are prepared the previous evening, so that as soon as connection is made no further attention is required. The time required for the complete deposition of the gold is four hours, after which period the carbons are removed clear of the beakers, the current is switched off and the lead cathodes disconnected and removed to a hot plate to dry. When dry these are folded into a small compass and cupelled with a little silver, parted and weighed, the values being reported to the cyanide works manager by 11 a. m. Although from start to finish this process occupies five hours, only a few minutes are expended in actual personal attention, and the measuring out of the quantities of solutions can be done either by the cyanide works shiftsman, or as in our case by the reduction works sampler. I might mention that if 20 A. T. of solution are required for use instead of 10 A. T., the same time only is necessary for the complete deposition of the gold on to the cathodes.

Precautions should be taken against having the carbon anodes in contact with gold-bearing solution in the absence of any current passing through. Negligence in this particular results in gold being precipitated on the anode.

In the event of a solution affording too great a resistance to the current, the addition of a small quantity of KCN will remedy this and accelerate the deposition of gold.

It has also been found advantageous to add a little ammonia to solutions which deposit salts.

I regret that I cannot give the name of the author to whose article I have already referred, neither have I the name of the journal in which it appeared.

*Presented to the Chemical Metallurgical and Mining Society of South Africa, Sept. 16, 1911.

MINE EXAMINATION EXPERIENCE

Several months ago the writer was commissioned to make an examination of a group of mines in Mexico, writes a mining engineer to the Mining and Engineering World. The republic of Mexico is a rather large country, so this story might fit in almost anywhere down that way. Before leaving for Mexico I was supplied with copies of two separate type-written reports on the property I was about to examine. These reports had been made by two different men, each of whom signed himself "Mining Engineer." In addition to these type-written reports there was a description of the property printed in the form of a neat folder, which had been prepared and intended, if not used, for the purpose of selling stock in the company.

The mines were in charge of an American, a fellow townsman of the men who were putting their money into this venture. I made particular inquiry about this superintendent, as I was desirous of knowing whether there was any incentive for him to deceive his friends. I learned that he received only a small salary—$150 per month; that he was a co-owner with the others, and his only chance for making money out of the enterprise was to so manage it as to make it a successful concern. The two type-written reports on the property indicated that these people were in unusually good luck in securing so good a group of mines, yet, notwithstanding the promising outlook, there was still much development work to be done, machinery to purchase and install, and much more money and time would still have to be spent there before any hope could be entertained of making the operation profitable.

So evident was the need of more money that this association of friends and neighbors began to think it might be necessary to call upon some others to come in and share in their good fortune, and incidentally, in the meantime, to supply some of the sinews of war now so necessary to success. In order to properly present the proposition to their personal friends and to the public, it was deemed essential to have an examination made which would corroborate the reports already in hand and bring everything up to date.

I was the one selected to make this final examination, and this story is merely a brief outline of my experience on that trip, including a hint of the character of the kind of report I was obliged to submit to the hopeful owners upon my return. I must say these fellows were about as clean and decent a lot as it has ever been my fortune to meet among those engaged in the mining game. They were absolutely straight, and if they had a good thing they wanted to be sure of it, and, if not, they did not propose to take advantage of their friends and blow them in to get even themselves.

I studied the several reports carefully in order that I might be familiar with the property upon my arrival on the ground. The descriptions in the reports were intelligent, and I could detect no discrepancies that seemed to be of importance or which suggested that all was not right, so I soon gained a very fair idea of what the property was like before I had crossed the border line into the "Land of Manana." * * *

I found the superintendent of the mines without difficulty. He was standing in the doorway of an adobe house, the best one I had seen on the trip thus far. He certainly was agreeable enough, and seemed very glad to see me, and we were soon partaking of a good meal supplied by a variety of canned goods from the stock in the little store he was conducting here. I soon learned a number of things. First and foremost, Mr. Superintendent was doing a lucrative business here with the inhabitants for twenty miles each way up and down the river, on the company's capital, selling them all their provisions, clothing, and various other things, at a profit of 100 per cent and up; second, he had been up the hill to the mines but twice since his arrival in camp several months previous, but this, as I afterwards learned, did not make so much difference; third, he seemed very well satisfied with the way things were going. His salary and the profits from the store made him a very comfortable income, and he was prosperous, whether the mines were or not. That afternoon he took me up the mountain and showed me around, and after explaining as well as he could, told m to "go to it."

To say that I was astonished at what I saw would not be telling the truth. I found here just about what I had anticipated—only worse. The type-written reports described one of the mines of the group as having a vein twelve to twenty feet wide, which outcropped from the bottom of the canyon up the side of the mountain, the summit of which was 800 ft. above the river. On this claim I found no vein at all, but on the summit of the hill there lay a flat sheet of quartzite, 30 ft. in thickness, and which was a remnant of a formation which had once covered many miles of this region. I observed similar remnants of the same formation on several of the neighboring hills. This quartzite contained no value whatever.

On another claim the reports conveyed the information that the ore had been "so rich that thieves—the 'gambocinos'—had stolen it." I found a small vein in extremely hard rock. The vein was pinched at both ends and at the bottom, and the best ore I could find would not assay $2 per ton.

On a third claim, according to the reports, there was a quartz vein six to twelve feet in width, carrying abundance of free and visible gold. This vein in the widest place I could find was about two feet across. Two tunnels 100 feet apart, had each been run in on the vein about 100 feet. In these tunnels the average width of the vein did not exceed two inches, and the greater part of the vein was a mere seam. At one place in one of the tunnels there was about four inches of ore, four feet in length, that here and there showed a little free gold. The average value of the ore in this vein was less than $3 per ton over a width of two inches.

At a fourth place a shoot of high-grade copper ore was described in the reports. The ore was high-grade malachite, but an ordinary ore sack or a wheelbarrow would hold the entire amount. It was only a little pocket in the greenstone.

At the fifth place, and the last, there really was a good-sized vein. It was from four to twelve feet wide, well defined, and outcropped at intervals for a mile or two across the country. At one place on this property a shaft had been sunk about 120 feet, and a drift run south twenty feet or more, at a depth of eighty-five feet from the surface. This work had been done in broken ground, which was of medium hardness and of no value. About 125 feet from this old shaft an ore-shoot outcropped boldly, the rock being extremely hard. The shoot had a trend to the northward, towards the shaft. In this hard vein several Mexican miners were laboriously sinking a hole, having reached a depth of twelve feet. Progress was very slow and they still had fifteen feet to go to get as low as the collar of the shaft nearby. Samples taken from this shoot of ore did not indicate that the property would soon be startling the world by its phenomenal output, though it would perhaps startle the stockholders when they were called upon to make good the deficit on the operating cost.

The mining work was in charge of an American miner. I asked him what he thought of going down in the shaft and driving through the comparatively easy ground to the ore shoot, which would be reached in a short distance, and at a depth of 115 feet, which it would take some time to reach in the new shaft and cost a great deal of money. He replied he had not thought of it, and made some sort of complimentary remark about my practical ideas. I started to walk away when he called after me. I stopped and he came up to me and asked with earnestness if I knew where he could get another good job. I learned that over $10,000 had been spent in the development of this vein on an adjoining property and no profitable ore had been found. The ore looked well and the vein was of good size. It possessed, in fact, every desirable feature except value.

When I returned to my home and submitted my report, the owners were astonished at the revelations therein made, and particularly at the duplicity of their fellow townsman and friend, their superintendent. They paid the remainder of my fee promptly, and even went so far as to say it was the most sensible money they had as yet put into the enterprise. This is not an unusual instance. It is altogether too common.

Good, and honest men, men of business experience and generally acknowledged to have sound judgment, invest thousands of dollars on the advice of some acquaintance, whose knowledge of mining amounts to nothing. His report may seem plausible and honest, but unless he has the experience he cannot safely pass upon the property as a business proposition, and when this lack of knowledge is coupled with a tendency to be dishonest the investors are "up against it."

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CONTENTS:

The domestic gold output is derived not only from ore but also from gravels of placer mines. A considerable portion of the gold output is also from copper, lead and mixed base-metal ores. Exact figures for quantities of gravel washed are not available, but it is estimated that the volume was about 80,000,000 cu. yds., with an average value per yard of 12 cents for the United States proper and about 4,418,000 cu. yds., with an average value of $3.66 per yard for Alaska in 1909; and about 100,000,000 cu. yds., averaging about 11.5 cents per yard in the United States proper, and 3,800,000 cu. yds., averaging about $3.20 per yard in Alaska in 1910.—Mining Science.

STARTLING DECEPTIONS OF UTAH COPPER

The fifteenth quarterly report of the Utah Copper Company, covering the last quarter of the year 1911, although exceptionally quiet and modest in tone nevertheless, upon casual scrutiny, discloses startling deception and inconsistencies, regarding the alleged cost per pound of production of copper. And—by implication—the report shows very great economic advantage of underground mining as compared to extraction of the ore by steam shovels.

Of the total tonnage of ore mined and treated for the quarter, the report states that "about 73% was mined by steam shovels and about 27% came from underground mining operations," that "the average assay of the ore treated during the quarter was 1.418% copper," (28.36 pounds), and that "the average cost per pound of net copper produced during the quarter * * * was 7.85 cents, as compared with 7.56 cents for the third quarter of 1911." The proportion of tonnage of ore mined for the third quarter is given in the report for that quarter as "76% by steam shovels and 24% derived from underground," and the grade of the ore is stated as being "1.4829%"—29.60 pounds of copper. The higher costs per pound of copper produced for the fourth quarter is attributed to "the decrease in average assay value of the ore and the increased cost of operations during the winter months."

In order to arrive at a fair conclusion as to the comparative cost of the production of copper by the respective methods—as shown by the several reports of the president and manager of the Utah company—it will be necessary to quote briefly from previous annual reports. Manager D. C. Jackling in his report for the year 1907, and to January 24, 1908, page 14 says:

JACKLING'S UTOPIAN METHODS.

"The primary development of the property was laid out with a view to underground mining by caving methods and, until the starting of the Garfield plant, practically all the ore extracted was mined in this way. The operations of steam shovels have, however, proved so satisfactory and economical that underground mining is being abandoned as rapidly as possible. At the present time about 25% of the total tonnage extracted is coming from underground work, and practically all of it from the north side of the canyon.

"There are some advantages in continuing underground mining in some portions of the property, because the ore mined in this way is taken from the ore bodies lying directly beneath the capping, RESULTING IN THE CAPPING CAVING INTO THE OPEN STOPES AND BREAKING ITSELF, SO THAT IT IS NOT NECESSARY TO BLAST IT FOR STEAM SHOVELING. (The caps are ours.) On the north side of the canyon we have a high point of ore, containing about 1,500,000 tons which will be mined entirely by underground methods, as it will be more economical to mine it in this way than to strip it and mine by steam shovels, on account of the expensive preparation necessary to operate the shovels and remove the cap at this high elevation. When the ore is removed at this point, the overlying capping will drop to a level conformable with the surface in the surrounding vicinity, AND WILL EVENTUALLY BE REMOVED BY STEAM SHOVELS, as the adjoining areas are stripped. WITH THE EXCEPTION OF THIS NECESSARY PIECE OF UNDERGROUND WORK WE EXPECT THAT NO FURTHER MINING OF THIS CHARACTER WILL BE DONE, AND THE ENTIRE PROPERTY, ON BOTH SIDES OF THE CANYON, WILL BE WORKED BY STEAM SHOVELS."

It may be here observed that underground mining of the section above referred to was completed and the "caving in" and "breaking of the capping itself" —including a large area of NEIGHBORS' GROUND—was fully accomplished some three years ago. And, although the capping actually BROKE ITSELF UP into excellent condition for steam shoveling, no attempt has since been made to shovel up and remove it, the shovels being meanwhile required in more productive service on other parts of the property.

In the annual report for the year 1909, page 10, Manager Jackling says: "DURING THE YEAR THERE WAS A GRADUAL DECREASE IN THE QUANTITY OF ORE MINED BY UNDERGROUND METHODS, AND BY THE END OF THE YEAR THIS METHOD OF MINING WAS PRACTICALLY DISCONTINUED. During the first quarter of the year the ratio of underground ore to the total ore mined, was in excess of 21%. During the last quarter less than 3% of the total ore mined came from underground. The averages for the entire year were 13% of underground ore and 87% of steam shovel ore. A considerable portion of the underground mined ore CAME FROM THE DEVELOPMENT WORK."

PRODUCTION AND COSTS.

Although no information was given in the report for this year—1909—as to the copper contents of the ore, nor the number of tons treated, it was unofficially stated that the average for the year was 1.89% or over six pounds of copper per ton in excess of that contained in the ore treated for the year 1910 and over eight pounds in excess of that contained in the ore treated for the year 1911. The cost of copper produced for 1909 is stated to be "8.787 cents per pound," and compares with 8.069 cents for the year 1910, and an average of 7.70 cents a pound for the two last quarters of 1911. Of the ore mined for the last quarter of 1911—as previously stated—27% was derived from underground mining—and compares with 24% for the previous quarter (no figures are given for the first half of 1911) and 18% for the year 1910, and 13% for 1909 and, although the copper tenor of the ore has shown gradual and persistent depreciation, it will be observed that the HIGHEST COPPER CONTENT of ore treated and HIGHEST COST OF PRODUCTION prevailed during the year 1909, during which period much the largest proportion of ore treated (82%) was obtained by operation of the steam shovels. And that the LOWEST GRADE OF ORE TREATED, AND LOWEST COST OF PRODUCTION prevailed during the latter half of 1911, when the ore obtained by underground mining reached its highest proportions. In fact, the cost of production of copper, as clearly shown by these reports, ROSE AND FELL IN ALMOST EXACT RATIO as the proportion of ore mined by the respective methods varied in their RELATION TO EACH OTHER. And this, in addition to the fact that the cost of the ore mined by steam shovels is further supplemented by the cost of stripping which for each ton of ore mined by that method adds an additional burden—which must be met at some time by the shareholders—of MORE THAN ONE AND ONE-HALF TIMES the entire cost of each ton of ore MINED BY UNDERGROUND METHODS by the Ohio Copper Company upon similar ground, and under precisely similar conditions to those which obtain in respect to ores mined by the Utah company.

This relative disparity in the cost of production of copper, by the respective methods would seem to give hope of the early abandonment of the steam shovel fiasco, as was finally done in case of the many silly and absurd attempts that were made to extract the copper from the ores without possession of elemental knowledge of the business, and by the use of devices and practices in direct violation of all modern methods. And this hope might be further encouraged by the fact that during the month of January of this year, the proportion of ore obtained from underground was in excess of 36% of the entire volume of ore mined and treated for that month.

The actual tonnage of ore treated for the month of January, 1912, was a little more than 490,000 tons, of which about 170,000 tons was obtained from underground mining. Approximately 140,000 tons of this ore was obtained from the Barnsdall-Pay Roll claims, and the balance from irregular fragments of ore-bearing ground which still remains on the east side of the canyon in the original Utah grounds. But, although there is urgent need for application of some change in methods in this as well as all other departments of the company's affairs, no change can be expected until the present struggle of the insiders to distribute sufficient of the treasury shares to recoup their enormous advances to the stripping deficiency funds shall have been rewarded with some measure of relief which, for the immediate future, seems hopeless.

THAT INVESTORS MAY KNOW.

In order that bona fide investors in the shares of this company may form rational conclusions regarding the practical effect of the company's mining methods upon their individual holdings, some brief observations respecting the cost of stripping and its possible liquidation should be of interest. The number of cubic yards of capping removed during the first quarter of 1911 is not given in the report for that quarter, but that of the last three-quarters is stated in the respective reports as follows: Second quarter, 1,395,504 cubic yards; third quarter, 1,595,095; fourth quarter, 1,520,058 cubic yards, being an average of a little more than 1,500,000 cubic yards for each quarter, and a total of over 6,000,000 cubic yards for the year. From the total sum of costs for that work done for the year 1910, as deduced from the auditor's report, we find that the cost was a little more than 41 cents per cubic yard. Applying that rate to 6,000,000 cubic yards removed in 1911, we find the total cost was $2,460,000, the same being equal to 2.64 cents a pound for the entire copper product of the year which, if added to the assumed cost per pound of copper produced—7.85 cents—as stated in the last quarterly report, would show an actual cost of production per pound of copper for the year of 10.29 cents. One would not have to pursue the analysis much farther to disclose the fact that THE SUM DISBURSED IN DIVIDENDS for the year 1911 EXCEEDS THE ACTUAL NET EARNINGS for the period by many hundreds of thousands of dollars.

Of course we are aware that it is claimed by the management that payment of these costs are being properly deferred, and that they are to be distributed over a series of years, upon the pretense that large areas of ore-bearing ground is being stripped IN EXCESS of the daily requirement of their mills. But we have repeatedly shown that this is not true of the present, and from the very character of the ground never will be true in the future. On the contrary the increased extraction of ore by underground mining is due SOLELY to the fact that the stripping is now farther from providing the requisite daily supply of ore than ever before, notwithstanding the fact that the number of shovels employed in stripping in proportion to the quantity of ore mined by that process is more than three times what it was during the year before named, when the proportion of ore mined by steam shovels was greatest. But if we could for the moment assume as true the statements of the management in this regard, it would be very difficult to find justification for piling up from year to year of this enormous indebtedness against the corporate property for the sole purpose of preserving the proceeds of sale of the mine's product for payment of dividends. And moreover, the evil tendency of this practice is all the more flagrant in view of the fact that it is the purpose of the management to liquidate those constantly accruing burdens by involuntary partition and sale of the company's share capital and thus, whilst the corporate operations are—by the payment of liberal dividends in cash—given the appearance of prosperous activity, the relative share capital of each shareholder is being pared down in inverse ratio with each new issue of shares.

TREMENDOUS COST OF STRIPPING.

With the evident purpose of disposing of certain criticisms of this journal, it was recently unofficially announced by one of the organs of the Utah company that there remained to be removed only 30,000,000 cubic yards of capping which, at the ratio of progress made for the last quarter, would be accomplished within five years. Assuming for the moment that this be a fair estimate of the truth (which it is not) the total cost of this work will be $12,300,000 which, added to the unpaid cost of similar work for 1911, gives a total sum of $14,760,000 to be provided for by additional issue and sale of share capital. At the present quoted market price—$55—per share this will require the issue and sale of 268,369 shares, or an increase of the present share capital and corresponding paring down of the value of relative interests of present shareholders of over 17 per cent.

In addition to the foregoing, there appears to be a debit balance of nearly $1,800,000 still carried in the form of deferred debt, due for stripping for the year 1910, and it is understood that some two and one-half million of dollars incurred in the construction of the Bingham & Garfield railroad in excess of a like sum covered by an issue of mortgage bonds, is also to be liquidated by the issue and sale of Utah shares; so that, when all these sums are covered by the issue of shares present holders, if they remain with the ship, will find themselves possessed of about 60% of their present proportionate interest.

Nevertheless, from a speculative viewpoint, we think that Utah stock bought upon recessions from the present price, and sold upon forced advances will afford fair scalpers' profits. Besides, operators dealing in this way, incur no risk of immediate loss because brokers for the pooled interests are always on hand to take any offerings which would "shade" the market in order to avert serious collapse. Moreover, the continued upward "washing" of quotations should ultimately reach an altitude that will attract the emotional public plunger, and then everybody else can sell out.

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All mining camps have their periods of stagnation and low production and most all of them, worth figuring, "come back" with systematic regularity. Park City and Pioche have enjoyed a good, long snooze and, judging from reports emanating from each they are about ready to "make their presence felt" again. With 60c. silver and $4 lead these camps will not be long in making the world take notice. Park City, in particular, is rapidly being whipped into shape to more than double its present output.

GUGGENHEIM METHODS vs. "AMALGAMATED" INDUSTRIES

The mendacious character of the stuff which the subsidized press are required to publish in aid of stupendous promotion fakes, is forcibly illustrated in the following, which we excerpt from "Walker's Weekly Copper Letter, published in the Boston Commercial of February 10th:

Ray Consolidated is now treating about 3500 tons of ore daily and earning from $70,000 to $75,000 monthly. Next Monday and thereafter its concentrates will be delivered to the new smelter located at the mill. This will effect a saving in freight and treatment charges equivalent to one and a half or one and three-quarters cents per pound of copper produced, and consequently will immediately increase the company's monthly net earnings to about $120,000.

At present Ray Consolidated is treating ore that averages about 1.85% copper. This is considerably below the average of its whole deposit, which is 2.17%. The recovery in concentration is now better than 70% of all the values contained in this low grade ore, or 26 pounds to the ton. * * *

Assuming the lower sum—$70,000—stated as the monthly earnings, a net profit of 2.34 cents per pound of recovered copper is indicated, being sixty-one cents per ton of ore treated. By adding 1¾ cents a pound to the sum now received for the copper recovered from these ores which it is said will result from reduction in costs of shipment, etc., as soon as deliveries are made to the smelter now being constructed at Hayden, the net profit will be increased to 4.09 cents per pound, or $1.06 per ton of ore treated, which should afford a very satisfactory margin of profit, even if no further improvement should result from remodelling of the concentrator—which has been in process for several months past.

Immediately following the statement quoted above, Mr. Walker enters upon a discussion of the recent annual report of the Giroux Consolidated company's mines (which is a Cole-Ryan, or Amalgamated Copper Company owned property) and says:

Wire advices from Duluth say it was announced at the meeting that 4,010,000 tons of concentrating ore, averaging 2.14% copper, is now blocked out ready to mine in the Morris-Bunker Hill mine; and that the porphyry ores fully and partially developed are estimated to aggregate 17,000,000 tons, averaging about 1.90% copper, which is approximately the same grade as those of Nevada Consolidated. In addition to this 17,000,000 tons, there is a very large tonnage of ore in the Giroux property that carries about 1% copper and which may, at some time in the future, come to have value. * * *

The figures in the foregoing form a basis upon which it is possible to make a rough calculation as to the present value of Giroux stock. The 17,000,000 tons of porphyry ore should be worth $4,000,000, figuring on the basis of the recent Live Oak transaction; and the 300,000 to 500,000 tons of 3¼% smelting ore developed in its Old Glory deposit should readily yield $1,000,000 of profit.

The 1,500,000 authorized shares of Giroux Consolidated are selling in the market for about $6,500,000, and, assuming the management's summary of demonstrated and assured ore is correct, these porphyry and smelting ores probably could be sold in the ground for $5,000,000. It would seem, therefore, that all the company's future prospects in the limestones, which include its deep shaft in the Alpha area, are selling in the market for $1,500,000, or only $1 for each share of its stock. * * *

Now, the report which was thus discussed by Walker, also gave details of a contract whereby from 900 to 1200 tons of Giroux ores were to be treated—concentrated and smelted—daily by the Nevada Consolidated company at its Steptoe plant for a period of five years. And it is explicitly stated in the report that "your directors have formally approved of the contract and estimate that we can make and market our refined copper for about 9½ cents a pound."

Recovery of the copper contents of the ores of Nevada Consolidated are officially stated as ranging from 71% to approximately 75%, and it is understood, and confidently hoped that the latter figure will eventually be exceeded. Practical treatment of several thousand tons of Giroux ores at its own experimental mill, gave average recoveries of 71% of the copper contents of the ore. At the latter rate of recovery ore averaging 2.14% copper would yield 31.38 pounds of copper per ton of ore treated, and deducting 9½ cents a pound to cover all costs—as stated in the report—from an assumed price of 14 cents a pound for the metal, would leave a profit of 4½ cents a pound of copper produced, showing a net profit of $1.41 per ton of ore treated. Applying this gain to the 4,010,000 tons of 2.14% ore, shows a net value of $5,662,120 derivable from the 4,010,000 tons referred to alone, OR MORE THAN $662,000 IN EXCESS OF THE VALUE CREDITED TO THE ENTIRE PROPERTY by the syndicated statement published and copyrighted by Walker and Dukelow.

And again: If we assume—and the assumption is manifestly fair—that the 17,000,000 tons of ore containing 1.90% copper, as shown in that portion of the report quoted by Walker—should yield a profit equal to that which he claims will result from the treatment of Ray ores containing only 1.85% copper—when its ores are treated at the smelter at Hayden—which profit, as we have shown, will be only 4.09 cents per pound of copper produced and equal to $1.06 per ton of ore treated, these 17,000,000 tons of Giroux ore alone would have a total recoverable net value of over $18,000,000, A SUM EQUAL TO $12 PER SHARE UPON ITS ENTIRE CAPITAL STOCK. Or, if it were possible only to derive from the Giroux ores the equivalent of that being obtained from the treatment of Ray ores, under its present burden of excessive transportation and smelter charges, viz., "2.34 cents per pound of copper produced," or only 61 cents per ton of ore treated the net profit derivable from those 17,000,000 tons of Giroux ores would be $10,370,000, or $6.91 per share capital, leaving entirely out of account all other resources indicated in that portion of the report quoted by Walker. No comment is necessary or could adequately characterize such dastardly abuse of journalistic license.

These observations are not made for the purpose of directing attention to the probable great value of the Giroux property, as indicated by the report under discussion, nor to disparage the assumed demonstrated importance of the Ray Con. mines. On the contrary, we think the Giroux report sufficiently concise and complete as to require no elucidation by us. On the other hand we believe the Ray Con. orebodies to be of vast extent, and possessed of generous enrichment of cuprous sulphides which, with the exercise of modern skill intelligently directed (which will come in course of time) should yield liberal returns to the favored few into whose hands the shares are involuntarily finding lodgement becaues of the successive failure of the promoters' frantic efforts to effect profitable public distribution.

But we beg to suggest to the managing heads of these corporations, which have so long, strenuously and unsuccessfully sought to unload their wares upon the public, that the exercise of a little conservatism in the character of the material supplied to their publicity agencies would probably be productive of better results. Nevertheless, we think it will be necessary in the end to return to the mines for any legitimate profit of the future. Evidently the public have been "stoped" to a finish.

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Rapid drilling by hand is not accomplished by use of heavy hammers and forceful blows, but by hammers of proper size handled by men who know how to strike the blow that will cause the drill to cut and keep the bottom of the hole clear so that the drill is working on solid rock and not on a lot of loose fragments. This is an art, and is only learned by experience.

UNTERMYER IS CHAMPION

We present herewith an excellent photograph of Mr. Samuel Untermyer of New York City who—we think—enjoys the distinction of having received the largest fee for the smallest amount of professional work done, of any lawyer who ever practiced his profession outside of a court of justice in any state in the Union. The peculiar character of the service rendered by Mr. Untermyer is of especial interest in this day of "corporate dissolutions," and was as follows: In the early part of December, 1909, Mr. Untermyer was employed by the Boston Consolidated Gold and Copper Mining Company (of which Mr. Samuel Newhouse was then president) to negotiate a consolidation of the property of that corporation with that of the Utah Copper Company, for which service it appears that he was to receive for his services—if successful—a fee of $50,000. It

SAMUEL UNTERMYER

was also arranged with the American directors of the company that a fee of 25 cents a share should be collected from the holders of each of the 775,000 shares of capital stock of the Boston Con. company under pretense that such sum was required to cover the cost of transfer of the shares to the Utah company. This was accordingly done, and the amount —$193,333—was paid over to Mr. Untermyer, making a total sum of $243,333.

Now, it so happened that both parties to the proposed consolidation were equally anxious to arrive at terms upon which consolidation could be effected, but neither was aware of the ardent desires of the other in this regard. Mr. Untermyer, however, in the exercise of the natural instinct of a great lawyer and diplomat—which he is—soon discovered that the anxiety of the Utah people for immediate consummation of a consolidation was at fever heat, which of course rendered his task extremely easy, though he carefully guarded the fact from the Utah emmissaries. And here is where he "got in his fine work." "He would, sacrifice the interests of his clients' and compel(?) their consent to the terms proposed by the Utah company on condition, first, that the Utah company should reimburse the Boston company in full the fee of $50,000 which he, Untermyer, was to receive as part compensation for his services as its attorney and counsel; second, give to him 3,200 shares of the stock of the Utah, which then had a market value of about $62 per share, or a total value of $198,400; and, third, pay to him—the "aforesaid" Untermyer—in cash the sum of $582,250, making a grand total of $1,023,983, all of which was agreed to in writing, signed by the respective parties thereto on the 20th day of December, 1909, but final consummation of the transaction was delayed by an injunction issued by a judge of a United States court in and for a district in the State of New Jersey, until about the 29th of January, 1910, when the injunction was dissolved, the consolidation accomplished and the money and stock paid over and delivered to Mr. Untermyer.

We are advised that for Mr. Untermyer's services in procuring dissolution of the Jersey injunction he was paid by the Utah company a further fee of $25,000, though we do not vouch for this latter statement; but we offer our hero upon the previous record as champion getter of "easy money."

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If the price of silver would remain at 60c. or better, a price it attained during the present month, it would make a difference of nearly $800,000 to the silver-lead miners of Utah during the year, as compared with 1911, without counting any additional production that the better price would sure to bring about. But there is reason to believe that silver, like copper, is being juggled a good bit just now, and the future is hard to forecast. Maybe the rejuvenation of China, following the much-desired ending of the revolution, will bring about a wave of commercial activity and reconstruction in that country that will call for a great deal of silver, and the price will remain strong. On the other hand, there is no assurance that the manipulators of modern finance, so-called, will not pull off some scheme to upset any plan that would tend to bring silver into its own again. To help out the situation as much as possible locally, it is suggested that the Commercial Club's committee on mining communicate with Senator Reed Smoot and beseech him to get out his "urim and thummim" and do a little revelating for the good of the cause.

INSIDE AND OUTSIDE OF RAY CON-CENTRAL DEAL

In the proposed consolidation of Ray Central with Ray Consolidated mines we have a practical exemplification of "low down" and "high up" methods of finance which should make the adherents of the Guggenheim system turn green with envy. Not that there is anything startling or unusual in the proposed proceedings whereby a consolidation of these properties is to be brought about —when the past record of the participants is considered—but when we realize the fact that Ray Con. has been on the verge of collapse for almost a whole year for lack of funds with which to "remodel" its UNFINISHED concentrator, and for which reason it had been compelled to surrender to the Guggenheims its widely advertised INTENTION to build, own and operate a smelter of its own, and, after having exhausted all hope of "drill hole" development of another twenty or thirty million tons of ore upon its own property whereon to base a plausible justification for another convertible bond issue of its own in order to provide funds for its pretended imperative enlargement of its concentrator—just to think that such a "PUDDIN'" should, AT THE VERY CRUCIAL MOMENT, fall into its lap, seems almost too good to be true. But after all, consummation of the "deal" seems to present no formidable difficulties.

It appears that the inside push of the Ray Con., whose credit had become exhausted had, by "hook or crook"—chiefly the latter—secured control of a majority of the shares of Ray Central, after its managers had failed to float an issue of bonds which, if cashed, would meet all immediate needs of Ray Con. The scheme appeared all the more attractive because, with consolidation, Ray Con. would have the Ray Central with its seven and a half million tons of developed ore, and the money received from the bonds as well. And all that was required of the "Rcy Con. push" in return was to have the secretary issue and deliver to Ray Central shareholders —which had become identical with the "Ray Con. push"—237,500 new shares of Ray Con. stock. With these explanatory observations, the entire proceedings become at once clear and simple; and ultimate results no doubt will prove entirely satisfactory to all concerned except the "outside" "INVESTOR," who may wish to hold his shares for promised dividends and expects to stay with his holdings until he gets his share of the profits which are to come from the Ray Central orebodies. For his benefit we submit a few figures to show how he will come out.

When the deal is closed Ray Central's allotment of shares will give them an ownership of 15.62% of the combined share capital and the outside investors' present proportionate holdings of Ray Con. will be reduced accordingly; but if he lives until all the ore is exhausted —including Ray Central—he will receive partial compensation for the initial reduction in his relative share.

It is claimed that Ray Con. alone has fully developed 78,000,000 tons of ore which, at 8,000 tons a day, would supply their concentrator at full capacity for about twenty-seven years. For convenience we may assume that this ore will yield a net profit, available for payment of dividends, of only one dollar per ton, or in all $78,000,000. At the close of the twenty-seven years Ray Central holders will have received of the profits $12,203,600 and all of the 7,500,000 tons of ore contributed by that corporation will remain intrenched.

Now we will assume that our "outside investor" is still there, and remains to the end and that the Ray Central ore will yield a net profit of $1.25 per ton, or a gross sum of $9,375,000. Of this sum Ray Con. shareholders—including, of course our friend, the outside investor—will receive in dividends 84.38% of this total sum, or $7,910,062, and the Ray Central will receive $1,465.938 which, added to the sum received from profits upon Ray Con. ore, will make a grand total of $13,669,541 received for Ray Central's ore. But, notwithstanding the foregoing disparaging analyses of the proposed combination, we advise our outside friend to take his medicine smilingly. Ray Con. needs the money in order to avert a worse calamity; and, with the consolidation consummated, we think cheap speculators can clip off profitable gains by buying on recessions from present quotations and scalping off small profits on all advances, because the "inside push" must continue to support the market by taking in all offerings which cut under advanced quotations.

WELCHES ON DIVIDENDS

According to the Salt Lake Evening Telegram, recognized as the explicit mouthpiece of the Utah Copper Company on this end of the line, no less an authority than Manager D. C. Jackling declares that the Utah Copper Company will not increase its dividend rate for some time to come, "even though copper metal prices should be firmly established at 14c. to 15c. a pound." But the paper lets the manager down easy in quoting him on this subject, because the news had already been released by some "inside interest" to the Wall Street Journal, which slaps the expectant, confiding purchasers of the company's shares as an "investment" in the following brutal fahion:

> "The Utah Copper company positively has not the matter of an increase in its dividend rate under consideration, nor will it take up the matter now, nor next July, nor next October either, for that matter.
>
> "We are running the company as a manufacturing enterprise, not a stock jobbing concern. On an ultra conservative basis the company would be paying no dividends at all at the present time, but it did not seem necessary to keep the stockholders waiting for two or three years before receiving any returns on their investments. The company has a tremendous amount of stripping to do, and it is our intention to accumulate as large a working capital to take care of the stripping operations and to enlarge and improve the plant as shall be necessary to keep it thoroughly up to date and for other improvements that may be required from time to time.
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> "It makes no difference if copper goes to 20 cents a pound, Utah will not increase the present dividend rate in the immediate future."

Last September, it will be remembered by readers of Mines and Methods, George L. Walker came to Utah to make an examination and report on Utah Copper. With the certain approval of the management, he gave the proposition the wildest boost that any mining enterprise probably ever received. In it the prediction was made that Utah would be made to earn, including the contributions of Nevada Consolidated, $7 a share on 13c. copper and $9 a share when copper should sell at 15c. NOW WE ARE TOLD BY THE COMPANY'S OFFICIALS THAT NO ATTEMPT WILL BE MADE TO INCREASE THE $3 A SHARE RATE FOR A LONG TIME TO COME, even though, if reports are to be given credence, the company finds a ready sale for all the copper it can produce at better than 14c. a pound.

The Wall Street Journal's authority is made to say that the company "on an ultra conservative basis would now be paying no dividends at all." The interview brings out other admissions that are equally interesting as showing that ALL THE TIME Mines and Methods has been fairly presenting the real condition of affairs as they exist; that the company NEVER HAS BEEN DOING WHAT IT CLAIMED and that it is still figuring on bringing its plant up to date; that it still has a tremendous amount of stripping to do and that a large reserve fund must be accumulated to meet these requirements.

It must be galling to the management to be compelled, at the end of seven years of strenuous work, with millions of money at its disposal, to stand for a statement to the public which shows how utterly futile its efforts have been; to what little purpose these millions have been expended, particularly when the entire burden must rest on the shoulders of a manager who has had absolutely free rein and who has been paraded by his associates as "the greatest engineer in this or any other country."

COPPERETTES

Cables from Paris indicate that the French are in no particular hurry to give Ray Consolidated and Chino "standing room" in the Coulisse, or Curb department of the Paris Bourse. Wonder what the trouble can be?

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Have you ever noticed how regularly the "sales" of Utah Copper on the New York Stock Exchange just about equals the sales of all other copper stocks quoted. Once in a while Ray and Chino will be given a lift, but not often. It is nothing to see "sales" of Utah Copper run up to 6,000, or even 16,000 shares, when Associated Press reports declare the market is stagnant. The strength displayed by Utah Copper is something wonderful to behold.

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The following dispatch to a local paper is quoted because it helps to emphasize what an "ideal steam-shovel proposition" Utah Copper really is:

BINGHAM, Feb. 23.—Edward Leaton was killed here yesterday by an embankment caving in at the Utah Copper mine. Leaton was a steam shovel engineer and was working on the highest level of the mine. The embankment caved in, almost burying the steam shovel.

A few days before that a train got away from the crew on Copper Belt high line, which connects with the steam shovel pits. In this accident men were killed and others maimed, while cars were reduced to kindling and the locomotive and some of the cars rolled down the mountain side wrecking buildings in the town of Bingham. There is simply no denying the fact that steam-shoveling conditions at the Utah Copper are ideal.

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When the third quarterly report of the Utah Copper Company for 1909 was issued, in November of that year, the management apologized for not having its stripping advanced to a point where underground mining could be entirely dispensed with. The report said: "The tonnage of underground ore mined was further reduced during the quarter to 14% of the total ore mined. At the close of the quarter underground work had been entirely discontinued, with the exception of a moderate amount of development work, and IN THE FUTURE ALL BUT AN INSIGNIFICANT PORTION OF THE TONNAGE, which will come from development, will be extracted by steam shovel mining." After discussing briefly what was being done in the matter of stripping, the cost of that work, etc., the second following paragraph winds up with these words: "We direct attention to this feature in order to indicate the distinct advantage and economy of our being NOW ABLE TO PERMANENTLY DISCONTINUE UNDERGROUND MINING, as above discussed."

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Copper is the most highly contraband article in war next to gunpowder, and the essential part of preparation in any international strife is that copper be gotten into the country. This is the real reason why large American financial interests are willing to neglect American railroad and industrial shares and take up with "coppers."—Boston News Bureau.

In the parlance of the gambler that's "getting down to cases." And on its face it is gross deception. No one knows better than the News Bureau that American financial interests are NOT "taking up with the coppers" to any appreciable extent; the wish is father of that thought. Only once before have we heard of such an argument in support of fake copper stock buying as that Europe is getting ready for war and is afraid that it will run short of copper for the manufacture of cartridges—as told in a paragraph preceding the item quoted above—and that was several years ago in this city when President Keith, of the Walkover Shoe Co., explained at a love-feast given in his honor by the management of the Majestic Copper Company, that he was buying into the proposition because of the amount of copper used in his business; he was able to see where a tremendous saving could be affected by getting the material direct from the mines to make the copper shoe nails or tacks absorbed by his factories.

AUSTRALIAN RADIUM

The experimental production of marketable radium bromide indicates the further development of what may prove one of the most important Australian mining industries of the future. Within the next few days the shareholders in the Radium Hill Company will meet in Sydney to receive a report setting forth the financial position of the company, as well as the facts connected with the establishment of treatment works at Woolwich, on the Parramatta river. The financial position on June 30 shows that on the books closing there was a credit balance of £1,251 12s. 4d., after allowing for outstanding liabilities. The works will be under the management of Mr. S. Radcliff, formerly director of the Bairnsdale School of Mines, the gentleman who treated 31 tons of radium ore sent to Bairnsdale from the company's mine at Olary. Regarding the results obtained from this ore, the directors remark:

"This ore has been treated and, as will be seen from Mr. Radcliff's report, under difficulties. As far as Mr. Radcliff can judge from the results of treatment to date, he anticipates that the company will receive, when treatment has been completed, not less than £1,800, and not more than £2,500, worth of radium from the whole parcel, which is equal to anything between £60 to £80 per ton of crude ore."

According to figures and information supplied by Mr. Radcliff, it is anticipated that the annual expenses will not exceed £15,000, and it is expected that in the first twelve months not less than 2 grammes of bromide will be produced, worth (according to the latest reported sale of radium bromide—viz., £15,000 a gramme), £30,000; so that there should be an annual profit to the company of at least £15,000 from the radium alone. It is believed that in addition about £7,500 worth of uranium oxide (the production of which is included in the above estimate of costs) will be recovered, thus making the profit £22,500. With increased plant—at present there is only one furnace—there would be increased production. On October 10 Mr. Radcliff notified that he had "produced radium in marketable form." Recently Mr. Radcliff visited the mine at Olary, and estimated that between Nos. 1 and 2 shafts there were 5,600 tons of ore, containing 162,400 lbs. of urnaium oxide, and 20.8 grammes of radium as bromide. In concluding his report, he says: "It is of interest to note that the latest estimate of the total amount of pure radium salts which have ben prepared up to the present time is ten grammes. Your property, therefore, contains in this one block of ore alone more than twice the world-existing stock of pure radium bromide."—Sydney corespondent London Mining Journal.

LEACHING APPLIED TO COPPER ORE*

Fifteenth Article Reviewing Results Accomplished, With Special Reference to Lixiviation With Solutions Formed by Passing Electric Current Through Liquors Containing Chlorides

By W. L. AUSTIN.†

The passage of the electric current through an electrolyte consisting in whole or in part of a solution of sodium chloride, and then employing the said solution for leaching copper from its ore, constitutes a means of obtaining solvents upon which have been based a number of patents issued during the past twenty five years.

It matters not in what manner the original lixiviant may have been prepared, one and all solutions containing chlorides of the alkalies, alkaline earths, or iron, after they have passed over roasted ore and through electrolytic vats a couple of times, are for all practical purposes equally efficient solvents under equal conditions. In every case the active agents are ferric and cupric chlorides, with which may be associated under certain conditions free chlorine, hypochlorous salts, and other combinations containing chlorine. Solutions of chloride of sodium, or of ferrous and cuprous salts mixed with chloride of sodium, after being subjected to an electric current of suitable density, and allowed to act on copper ore, will take up metals such as copper, silver, lead, etc., present in the ore, and the resulting liquors will possess practically the same leaching qualities, at the same temperature and per unit of active reagent, after the contained copper has been deposited from them through electrolysis.

The original lixiviant may be prepared by electrolyzing a simple solution of common salt ($NaCl$), (whereby chlorine and various compounds of chlorine and oxygen are produced, according to conditions existing in the vats when applying the current), or a mixture of ferrous sulphate and salt may be treated in the same manner, producing ferric chloride, etc., or recourse may be had to some more complicated and expensive method of obtaining the desired end, such as first electrolyzing a sodium cholride solution in a separate vessel, using iron anodes. Inasmuch as the essence of all such methods is regeneration of the solvent-liquor, that is, re-use of the solutions after the copper has been removed from them in the electrolytic vats, the manner of preparation of the original lixiviant has no practical significance. The preparation of fresh solutions for each batch of ore treated being too expensive in most cases, the choice of a method for obtaining the original lixiviant will of course depend upon the cost of raw materials used. The treatment of raw or roasted ore by an electrolyzed solution of sodium chloride is all that is necessary to furnish the desired lixiviant.

SIEMENS & HALSKE FURNISH PRECEDENT.

Messrs. Siemens & Halske of Germany, one of the most important and enterprising industrial firms of Europe, were among the first to take up the metallurgical treatment of copper-ore with electrolytically prepared solutions. This firm employed both sulphate and chloride lixiviants in the processes introduced by it, as is evidenced by letters patent granted to Werner Siemens. The early experiments made by the firm upon a small scale were so successful that a brochure was issued in 1891 describing the methods in detail, and the firm demonstrated its confidence in the practical value of the process by installing a plant at its own copper mines in Russia. This way of testing the economic worth of a new process is the right one, for no new metallurgical method has a demonstrated value until it has been placed in competition upon a working scale with established processes. It cannot be assumed that tests of processes made in a comparatively small way in laboratories are going to prove equally successful when applied commercially.

The characteristics of the Siemens & Halske process have been described in a former article and need not be repeated here; but it is thought desirable to again call attention to the electrolytic treatment of chloride solutions by Siemens & Halske, illustrating as it does the fact that more than twenty-five years ago lixiviants for copper ore were obtained by electrolyzing solutions containing sodium chloride.

In proof of this statement reference is made to United States Patent No. 415,576, dated November 19th, 1889, granted to Werner Siemens, covering the invention referred to below. On October 30th, 1886, letters patent for the same invention had already been granted by Italy.

In the specifications to patent 415,576 it is stated that the invention "consists in the following process: subjecting a solution of a salt of the metal which it is desired to obtain and of a ferrous salt to the action of a cathode-plate, whereby the desired metal will be deposited and the element or elements in chemical combination therewith will be liberated; subjecting the outflowing liquid to the action of an anode-plate of insoluble material—such as carbon, platinum, or lead, or of a plate covered with platinum—the said cathode plate being separate from the anode-plate by a non-metallic diaphragm which is impervious to the solution, but which allows the electric current to pass, whereby the free elements liberated by the cathode-plate will be caused to enter into chemical combination with the ferrous salt, converting the latter into a ferric salt, and, finally, lixiviating ore containing the metal to be extracted with the solution of ferric salt obtained from the anode-plate, whereby the metal will be dissolved and the ferric salt reconverted to a ferrous one, and a solution obtained with the same chemical constituents as that first passed under the influence of the cathode-plate, or, instead of subjecting the electrolytic solution to the action of a single pair of plates only, several anode and cathode plates may be used, and the solution subjected successively to each, as will be hereinafter more fully described and claimed."

SULPHATE SOLUTION PREFERRED.

Mr. Siemens, judging from the text of his patent specifications, evidently preferred to employ sulphate solutions in lixiviating copper ore, but the specifications to which reference is made also cover "an analogous method for the electrolytical separation of copper" by chlorinization, as witness the following: "The electrolytical liquid then consists of cupric chloride ($CuCl_2$) and ferrous chloride, ($FeCl_2$), from which in the galvanic cells copper and ferric chloride (Fe_2Cl_6) are obtained according to the following equation: $CuCl_2+2FeCl_2=Cu+Fe_2Cl_6$. The ferric chloride thus formed possesses the power of converting sulphide of copper not decomposed by roasting into cupric chloride, ($CuCl_2$),

† Mining Engineer and Metallurgist, Riverside, California.

and also of converting, with the aid of a solution of chloride of sodium, (NaCl), cuprous chloride (Cu_2Cl_2) into cupric chloride. In either case ferric chloride is reduced again to ferrous chloride. Thus, also, in this process the solution is regenerated so that it becomes again suitable for electrolysis, and no polarization takes place."

It is evident from the foregoing that in the Siemens patent, (which expired five years or more ago), the patentee pointed out the application of an electrolytically prepared chloride solvent in the treatment of copper ore containing oxides or sulphides of that metal, which solvent was obtained by electrolysis of a solution containing sodium chloride and salts of iron. Assuming that at the start the solution contained only sulphates derived from leaching a roasted copper-ore with water, the addition of sodium chloride for the purpose set forth in the patent specifications would produce chlorides of iron and copper. Therefore the regenerated lixiviant resulting from passing the original lixivium once through the electrolytic cells, would contain ferric chloride, accompanied by free chlorine and the various chlorine salts generated by electrolysis of solutions in which sodium chloride is dissolved, or which contain iron chlorides and other salts naturally present when a copper-ore is leached.

Claim 1, in the Siemens specification reads: "The process which consists in lixiviating ore with a solution containing a ferric salt, subjecting the resulting ferrous solution at the cathode of an electrolytic cell to the action of a current of electricity, whereby the metal in solution is deposited, then subjecting the remaining liquid to the oxidizing action at the anode, whereby the ferrous is reconverted into a ferric solution, which solution is again used to lixiviate ore."

When a solution containing the chloride of any metal is used as a lixiviant for copper-ore, as described in the Siemens specification, and when antecedent to electrolysis sodium chloride is added to the liquor to dissolve any cuprous chloride formed, or for any other purpose, then there is established the fundamental principle for the preparation of a chloride lixiviant through electrolysis of a chloride of sodium solution, and any other method of preparing a similar lixiviant only constitutes a variation of the basic principle without affecting the essential point at issue.

HOEPFNER DEVELOPS THE SAME IDEA.

Carl Hoepfner was another who made use of a chloride lixiviant in leaching copper ore. His claims to novelty are set forth in United States Patent No. 507,130, issued October 24th, 1893. The same process was patented in Great Britain April 23rd, 1885.

In his patent specifications Hoepfner states: "I first form a solution of cupric chloride ($CuCl_2$) by means of a solvent of cuprous chloride and chloride of silver, as for instance, by dissolving the cupric chloride in a saturated solution of chloride of sodium, calcium, or magnesium. The ore, matte or pyrites are reduced preferably to a pulverulent condition and are then leached out with the cupric chloride solution, whereby the latter is converted into a cuprous chloride solution. * * * The silver may, however, be extracted from the cuprous chloride solution, and hereinafter called the electrolyte, simultaneously with the copper by electrolysis. To this end the electrolyte is rapidly passed through series of anode and cathode cells of an electrolytic apparatus hereinafter called the electrolyzer, whereby silver only will be deposited at the cathodes first brought into contact with the electrolyte, while the copper will be deposited at the succeeding cathodes, these metals being deposited in the order of their position in the electrolytic series. In this electrolytic separation of the copper and silver the electrolyte is supplied to the anode and cathode cells in two separate streams, the cells of unlike name being separated from each other by a diaphragm impermeable to the electrolyte but affording free passage to the electric current. As stated the metals, silver and copper, will be deposited at the cathodes, while the electrolyte at the anodes will be converted by the chlorine liberated, from a cuprous to a cupric chloride solution, which is afterward mixed with the solution flowing from the cathodes for use as a leaching agent in the treatment of fresh materials, the solution flowing from the cathodes being substantially free from metals. The chlorine liberated at the anode acts in *statu nascendi*, resulting in the generation of electro-motive force that is not only favorable to but assists in the separation or extraction of the metals and conversion of the electrolyte. * * * Inasmuch as cupriferous ores contain more or less iron which may enter into solution in the preparation of the electrolyte, the repeated use of the regenerated cupric chloride solution would result in an accumulation of an excess of iron, which is undesirable. This is also avoided by treatment of the electrolyte with carbonate of lime. The removal of the iron may also be effected by injecting air or oxygen into the electrolyte, which results in the formation of oxychloride of copper that acts as a precipitant for the oxide of iron, but a small quantity of copper, comparatively speaking, being necessary. * * * I prefer to employ diaphragms made of parchment paper reinforced on one or both sides by textile fabric or leather, veneer, gelatine, asbestos, or the like, as described in my application for Letters Patent of the United States, Serial No. 378,616 filed January 21, 1891."

Thus it is seen that Hoepfner prepared a lixiviant for leaching copper from its ore by dissolving cupric chloride in a saturated solution of sodium chloride, passing the said lixiviant through the ore, and then electrolyzing the resulting lixivium. Of course, after the copper had been removed the regenerated liquor was practically identical with the Siemens solution, but Hoepfner thought an excess of iron chlorides to be detrimental to the operation—in any event, he preferred to work with cupric chloride instead of the ferric salt. Therefore he tried to remove as much of the iron as possible by the use of carbonate of calcium. If he had succeeded in removing all the iron his electrolyzed liquor would have contained as its active agents cupric chloride, dissolved chlorine, and the different combinations of chlorine and oxygen, etc., which are produced under such circumstances according to conditions existing in the electrolytic vat. Except for the fact that Hoepfner attempted to remove the iron, and intentionally left some cupric salts in the electrolyzed liquor, there was no essential difference between the two solvents: the efficiency of both depends largely upon the dissolved chlorine and chlorine compounds.

USE OF CALCIUM CHLORIDE ADVOCATED.

As shown in the above specifications, Hoepfner, among other chlorides, contemplated the use of calcium chloride in his process. The advantages of the calcium salt are emphasized by Charles S. Bradley, (United States Patent No. 1,001,562), because, in addition to other good qualities, it assists in rendering the waste products of the operation insoluble and facilitates filtration. It is inexpensive, readily obtained or manufactured in the vicinity of the work, and easily regenerated for continuous use in the process.

In the Bradley process the ore is roasted to convert the copper and iron sulphides into copper sulphate and ferric iron. Then calcium chloride is added, changing the sulphate into chloride: $CuSO_4+CaCl_2=CuCl_2+CaSO_4$. Here it will be observed that the copper content is in soluble form, whereas the calcium sulphate which does not contain any values is insoluble, and hence precipitates. In other words, calcium chloride solution takes up only the values, as distinguished for example from a sodium chloride solution which in the reaction referred to would produce sodium sulphate which, being soluble, would remain in the carrier. The complications arising from the presence of soluble substances other than the values in the carrier, are to this extent eliminated.

The employment of calcium chloride presents another important advantage in the subsequent operations. The solution loses calcium, which goes into the formation of the calcium sulphate as above indicated: the chlorine, however, is conserved in the copper chloride. Regeneration of the carrier, and precipitation of the values in a highly concentrated form, may thus be accomplished in a simple and rapid manner by introducing calcium carbonate, which is an inexpensive substance: $CuCl_2+CaCO_3=CuO+CaCl_2+CO_2$.

Furthermore, it is found that the difficulty which is usually met with in filtering, settling or otherwise separating solids from liquids in operations of this kind, is largely done away with, for by maintaining calcium chloride in the solution clogging is prevented and the flow of the liquid through the separating medium is facilitated. Oxychlorides of iron and copper, which, if permitted to remain, would clog the oxidizer towers, are removed by hydrochloric acid generated in another part of the operations: $Cu_2Cl_2O+2HCl=2CuCl_2+H_2O$.

In the Bradley process the final cupriferous product is copper oxide, which apparently it is the intention of the inventor to smelt. There is no electrolytic treatment involved, but the method outlined has so many points in common with Hoepfner's process that mention is made of it at this point for the sake of comparison. The apparatus indicated in the drawing accompanying the patent specifications is designed for continuous treatment of the cupriferous material. Stationary vats and decanting vats are particularly avoided as necessarily intermittent in operation and limited in capacity: the use of vacuum filters is indicated. The solution of calcium chloride acts both as a solvent and as a carrier, circulating through the apparatus from beginning to end, and when regenerated it is returned to the cycle of operations without change of state. The chloridizing of practically the entire values takes place in the solution drum and not in any preliminary roasting process, and there is no tendency to overload with chlorine salts requiring expensive processes of elimination. The solution is automatically restored to proper condition, with calcium chloride in excess of the amount normally required for taking up the values. No additions of the salt are necessary, other than the amount required to make up for the slight waste that may occur. The patent specifications are voluminous and contain matter of interest to those engaged in the hydrometallurgical treatment of copper ore. There are eighty-seven claims to novelty of idea.

THOMAS W. LAWSON IN HYDROMETALLURGY.

The Bradley process is presumably the one referred to in the 252-page pamphlet issued by Mr. Thomas W. Lawson about three years ago, in which he made mention of a wonderful copper process that was about to be brought before the public. Mr. Lawson stated in the aforesaid pamphlet: "Three men, two of my associates and myself, have invented and perfected and are at the present time commercially operating a process which solves the copper problem which for hundreds of years has balked the scientists and inventors of the world, and solves it in a way which is marvelously simple in its commercial practicability. * * * In the solving of this great problem the same men who made the invention have carried it through the experimental stages, and then the commercially experimental stages, and then into the complete commercial plant, where the layman, without knowledge of chemistry or mining, in an hour's investigation can grasp not only what the invention accomplishes, but its value to the world, and its unprecedented earning possibilities—and all this without the world, or even those interested in the copper industry, suspecting what these men were attempting. To realize the difficulty of this accomplishment it must be borne in mind that before it could actually be proved that a process for the extraction of copper from the ore would work successfully upon a commercial scale, it was necessary to secure a plant; and to test such a plant, to obtain hundreds of tons of different varieties of copper ore, which could only be procurred from the different going mines. * * * From research Mr. Bradley proceeded to the laboratory; from the laboratory to an experimental plant; the experimental plant was dismantled and a commercial plant erected; in the large plant hundreds of tons of different ores from different mines in different parts of the country have been treated and are being treated today, and the completed commercial operating plant is indisputable proof that Mr. Bradley * * * has solved the copper problem, and in a wonderfully simple and effective manner."

It was proposed to capitalize The Process Company on a basis of $90,000,000—900,000 shares of common stock at $100. In addition there were to be 300,000 shares of preferred stock at $100, and $30,000,000 in 8% bonds, convertible into 8% preferred stock. The pamphlet reads like a tale from the Arabian Nights, but no hint as to the nature of the process was given the public until the recent appearance of the Bradley patent.

GREENAWALT ALSO ELECTROLYSES SALT SOLUTIONS.

Greenawalt, (United States Patent No. 973,776, dated October 25th, 1910), has also made use of the same basic idea, (the electrolysis of a solution of common salt), to obtain a lixiviant for treating copper-ore. Greenawalt states in his patent specifications: "The first step in the chemical process consists in combining chlorin, generated from metal chlorids by electrolysis, with sulphur dioxid produced by roasting concentrates or sulfid ore, in the presence of water, to form acid."

The Greenawalt process has already been described in Mines and Methods, Vol. III, pages 339-342, and reference is made to it here only for the purpose of pointing out the analogy with the foregoing methods mentioned, for in this process the solvent used is again prepared by electrolyzing a solution containing common salt, to obtain chlorine compounds which here also constitute the active agents present in the lixiviant. The Greenawalt process is an advance over those previously referred to, in that sulphur-dioxide is passed into the saline solution, thereby producing sulphates which in turn react with the sodium chloride present to form other chlorides and hydrochloric acid. The Greenawalt process is essentially an electrolytic process, and sodium chloride is the only chemical substance which it is necessary to provide in addition to those, (Fe, SO_2, etc.), derived from the ore itself. Sulphur-dioxide obtained by roasting sulphide-ore is the reagent consumed, for theoretically at least there should be no loss of chlorine. If the ore is roasted, salt may be added during the roasting, in which case lixiviation of the roasted pulp with water, and electrolysis of the lixivium to deposit the contained copper, affords the means for regenerating the lixiviant necessary to continue the cycle of operations. The introduction of sulphur-dioxide into the bath, effects constant reproduction of hydrochloric acid and is an important improvement upon preceding processes. However, in all the cases mentioned, (except the Bradley process), the essential feature of the several methods is regeneration of the active chlorine compounds of the lixiviant through electrolysis of the lixivium derived from the ore. It is therefore a self-evident fact that the manner in which the original solvent liquor is prepared, and the style of apparatus in which the operation is carried out, are merely details, and do not materially affect the basic principle involved.

ABOUT LEACHING VESSELS.

It has long been recognized that the chemistry of wet-treatment methods applicable to copper-ore is much further advanced than are the mechanical features of the processes advocated. Whereas there are available numerous solvents for mineralized copper, suitable refractory substances out of which vessels might be constructed of sufficient size for commercial use, able to withstand the prolonged action of mordant liquors, are not conspicuous. In cyanidation of gold and silver ore vessels of requisite size for economic handling of large quantities of pulp are made from materials which would not withstand for one day the action of electrolyzed chloride-solutions of suitable strength for use as lixiviants of copper ore. Wooden apparatus has not proven satisfactory: all inexpensive metals in common use and metallic alloys are speedily attacked: cement structures disintegrate. Earthenware and glass vessels, of large dimensions, are difficult to construct and liable to break. The lack of suitable vessels such as might be employed for operations on an extended scale, has been a serious obstacle in the path of hydrometallurgy of copper. However, experiments involving a new principle of construction are being made which hold out the hope of overcoming difficulties heretofore encountered; but the apparatus has not yet been subjected to the test of continuous use for a sufficient period to form an accurate opinion regarding its merits. At present it would appear probable that vessels of any reasonable size may be constructed from cheap material which will withstand the corrosive action of any lixiviants likely to be employed in leaching copper from its ore.

With regard to the type of apparatus best adapted for leaching purposes, one point seems to be fairly well established by experience: agitation produced by mechanism placed WITHIN the vessel in which the leaching is being carried out, should be avoided when making use of chlorine solutions. Such contrivances are quickly rendered useless through attrition and corrosion. They are applicable to intermittent laboratory work where they can be carefully watched, but cannot be relied upon in commercial operations.

It is desirable where possible to agitate a pulp with the lixiviant in effecting extraction of metallic salts, and for this purpose revolving drums have been repeatedly used. If the reaction can be quickly carried out, continuously operating drums, (such in which the pulp and lixiviant continuously pass in at one end and out at the other), have manifest advantages. Such drums might be arranged in series, one below the other, where reactions call for more time than that available in a single drum. However, as a general thing, sizing the pulp, and treating the coarser part in large vats by a solution-circulating system placed outside the vats, will answer in most cases. The fines may be handled separately by agitation, if necessary; but upward percolating solutions are very effective.

[NOTE.—In our last issue (January, 1912) a typographical error occurred in relation to the table at bottom of page 383. "Grams per 100 cc. solution" should read: Grams per 1000 cc. solution.]

McQUISTEN TUBE MILL

A staff correspondent of the Mining and Engineering World gives the following interesting account of the successful installation and operation of the McQuiston tube mill process at Mullan, Idaho:

"The new McQuisten tube process, for the recovery of zinc and lead slimes, has been demonstrated to be a success at the Morning mine, owned by the Federal Co., at Mullan, Ida. This is the first tube mill of its kind to be placed in practical operation. The machines are manufactured by the American Direct Concentrating Co., of Salt Lake City, Utah. This company has, of necessity, erected experimental plants on different classes of ore, but the Morning mine plant at Mullan is the first to be installed under actual 24-hour working conditions, for the purpose of saving ore of commercial value, from material which, for many years, has been delivered to the tailings piles as waste. Many experiments have been tried on the ore from the Morning mine during the past score of years, some of which have more or less perfected the process of milling and concentration, and have resulted in many important changes in the Morning plant.

"The ore from the mine is of a nature which does not lend itself readily to common concentration methods, the galena ore being mixed with a heavy spar, zinc, iron and barium. The fine grinding necessary reduces much of the material to pulp, or slimes, and in this much of the silver values, and all of the zinc, are lost in the tailings. The mine had never shipped any zinc ore until the McQuisten tube mill was installed. This process has been a success from the start, which is evidenced by the fact that the company is now erecting a new addition to the mill, in which will be installed a new 100 ton unit.

"The present plant is of 100 tons daily capacity, and from this feed is producing 8 tons per day, which product, as it comes from the tubes, will assay 48% zinc, 5% lead and from 6 to 7 ozs. silver per ton. The feed as it comes from the Wilfley tables and Frue vanners will average about 8% zinc and 2% lead, with very small values in silver.

"The tube stands for this mill are of strong and neat construction, being made of ¾-in. iron tubing, and occupy but little space, each stand covering actual floor space about 10 by 4 ft. 8 ft., and can be crowded close together, if necessary, with just walking space between each unit. The cost of the plant is about $125 per tube. There are 16 stands of tubes, 8 tubes in each stand, in a plant of 100 tons' capacity, each stand costing about $1000 or a total of $1600. A 35-hp. electric motor furnishes all the power required for the operation.

"The process is in direct opposition to the concentrating method employed in ordinary milling, where the heavy material sinks to the bottom and the lighter residue is carried off by water. In the McQuisten process the mineral floats off ahead of the waste, which latter is carried on the bottom to the waste discharge.

"The first process is the dewatering of the slimes by a Dorr classifier and an Akins screw classifier. The ore is then treated to an acid bath, 50 lbs. of sulphuric acid being used in a 24-hour run. The resulting material is then mixed with water containing a small percentage of soft soap and coal oil, which the mill men call "the dope." The amount of the two materials used in a 24-hour run are as follows: 1 lb. soft soap and 1 gal. coal oil. After receiving the "dope" the feed proceeds to the tubes, where it passes through a series of 4 tubes, all of which discharge their proportion of clean ore at each end.

"The feed is kept in agitation by a heavy quadruple screw thread, with which the inside of the tubes are equipped. These threads serve to carry the material out of the water, up the sides of the tubes, and turn it over on the surface of the water, where a portion of the sulphide particles of the ore are caught and float over the discharge, while the balance of the feed sinks, to be caught by the next thread, and the process repeated so on through the entire length of the tube, a distance of six feet. The resulting product is clean ore of mixed lead and zinc, which gives the assay returns above quoted. It is then fed to a James table, where practically a clean separation is made of the lead and zinc, the lead going into the first-class discharge, while the zinc being the lighter material, takes the place of what would be the waste from ordinary mine feed. The product is sent to smelters."

SULPHURIC ACID MAKING AT DUCKTOWN, TENN.

By WILBUR A. NELSON.*

Tennessee can boast of having located within its borders the two largest sulphuric acid plants in the world. These two plants are situated in the Ducktown copper mining district, which is in the southeast corner of the state. They belong to the Tennessee Copper Co. and the Ducktown Sulphur, Copper and Iron Co., and they utilize in the making of the sulphuric acid the gases which come from the smelting of the copper ores. These gases are high in sulphur dioxide.

Under normal conditions the flue gases have approximately 3.5 per cent sulphur dioxide, 3.5 per cent carbon dioxide and a trace of sulphur trioxide, and a range in temperature of as much as 200 degrees C. every 10 minutes. From this it would readily be seen by anyone conversant with the reactions of this process that a chamber acid plant of ordinary design would be entirely inadequate to meet such varying conditions. Besides this the flue dust, which carries a large per cent of zinc in the form of impalpable sulphates and oxides, presents a problem in itself which, unless eliminated, will clog up the system of pipes. Moreover, the zinc itself is a valuable by-product to be recovered. It is in special provisions to meet these conditions that the two plants in the Ducktown district differ from the ordinary chamber acid plant.

CHAMBER PROCESS OF ACID MAKING.

In this process the manufacture of sulphuric acid consists in several stages. The first stage is the burning of the pyrites (FeS_2), which contains the sulphur. In this burning the iron is changed to iron oxide (Fe_2O_3), and the sulphur combines with oxygen from the air to form a gas, sulphur dioxide (SO_2). The reaction is $2FeS_2+11O_2=Fe_2O_3+4SO_2$. The second stage is in the combination of more oxygen with the sulphur dioxide to form sulphur trioxide, which is accomplished by the action of the oxides of nitrogen upon the sulphur dioxide. These oxides of nitrogen act as a carrier of the oxygen to the sulphur dioxide. They are derived from nitre ($NaNO_3$) by mixing a solution of this salt with sulphuric acid and subjecting the mixture to the hot sulphur dioxide contained in the furnace gases.

The third stage is the mixture of the necessary amount of water in the form of steam to the sulphur trioxide. This last stage takes place in the leaden chambers.

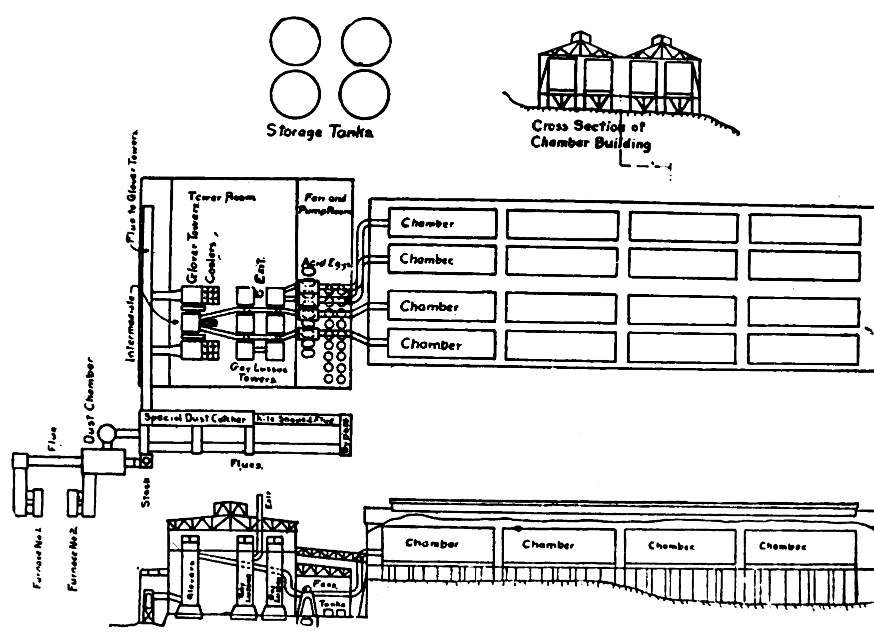
The raw materials used are pyrites (FeS_2), nitre ($NaNO_3$) and water (H_2O). Most of the pyrites used in this locality come from Virginia, Spain and Cuba in the form of fines and lumps. The Virginia fines will average only 42 per cent sulphur, while the ore, which comes from the Rothchilds' mines in Spain, give 50 per cent sulphur.

GLOVER TOWERS.

The functions of the Glover towers are four in number. To set free the nitrogen oxides from the Gay Lussac acids, to cool the furnace gases before they enter the chambers, to concentrate the dilute acid made in the chambers to a shipping acid, which will have a specific gravity of 1.75 B.; and, finally, by means of this concentration, to furnish some of the steam needed in the chambers. The most important of these functions is the setting free of the nitrogen oxides and their concentration so that they can be applied again at the top of the Glover tower. Incidentally, some acid is formed in this tower, for any sulphur trioxide present is absorbed at this point.

The gases from the nitre pots go directly to the Glover tower, which they enter at the bottom and ascend through a checker work of chemical bricks set in sulphur. Ordinary dimensions for such towers are 30 ft. in height by 12 ft. in diameter. The Gay Lussac acid and weak chamber acid (specific gravity 1.6) are mixed at the top of the tower, and are fed by a suitable distributing apparatus into the tower. This apparatus consists of a main pipe, which runs across the top of the tower and distributes the acid into cross-channels, which in turn feed the acid into leuts. There are from 50 to 75 of these leuts, through which the acid enters the top of the tower in small streams. They also act as a hydraulic seal to prevent the escape of the ascending gases. This arrangement causes the acid, which falls as a finely divided spray, to come in direct contact with the hot ascending gases in the best possible manner, and cools the gases, besides condensing the falling sulphuric acid, and producing a small additional amount of acid.

From the Glover tower the acid runs into a series of settling tanks, and from them into a series of storage bins, while the sufficiently cooled gases pass into the first leaden chamber.



Side View and Ground Plan of Ducktown Company's Plant at Isabella, Tennessee.

LEADEN CHAMBERS.

The chambers are constructed of sheet lead, fused together by an oxygen-hydrogen flame and suspended on a wooden frame work. The sides of the chamber are not fused to the bottom, for this would cause buckling of the lead with the changes of temperature. Except for this, the chamber is one continuous piece of sheet lead. The bottom is, therefore, made like a pan, about 8 in. wider than the sides, and with flanges, which extend up about 22 in. The acid collects in the bottom and forms a hydraulic seal, thus preventing the escape of the gases. On the inside sides of the chambers are placed lead channels about 8 ft. long, sloping from both ends to the middle of the trough, where a small pipe leads to

* State Geological Survey of Tennessee.

the outside. Through this pipe the acid drips into a glass tube in such a manner that the fresh acid goes into the bottom and the old acid overflows at the top. In this is placed a Baume hydrometer to measure the strength of the sulphuric acid.

The sulphur oxides, together with the oxides of nitrogen, enter the chamber at a temperature near the boiling point of water. Steam is injected through nozzles in the top of the chamber, and the acid-making process is complete.

From the first chamber the gas is carried by steam suction into an intermediate leaden tower filled with chemical brick, and from the top of this tower it goes into the second chamber. In this manner the gas is carried through the entire series of leaden chambers. From the last chamber the gases go to the Gay-Lussac tower.

GAY-LUSSAC TOWERS.

The main purpose of these towers is the recovery of the nitrogen oxides from the spent gases before they escape into the atmosphere. This is brought about by feeding part of the concentrated acid from the Glover tower into the top of the Gay-Lussac towers, which are made of lead, supported on a steel frame work and lined and filled with chemical bricks. This checker work of chemical brick insures contact between the acid, which is cooled to render it more efficient, and the ascending gases. This cooled acid from the Glover tower absorbs the nitrous anhydride (N_2O_3) and nitrogen tetroxide (NO_2 or N_2O_4), but not the nitric oxide (NO) of nitrous oxide (N_2O), which escape. Only acid with a specific gravity of more than 1.5 can be used in this absorption.

The acid, after leaving the Gay-Lussac towers, goes directly into the Glover towers, where it is relieved of the oxides of nitrogen, and passed into settling vats, and then into storage tanks.

The acid plant, which has just been described, is of the type that most fertilizer companies in Tennessee operate for their private use, and whose entire output they use in the making of acid phosphate. But at present we have another source of sulphuric acid in Tennessee, mainly from the Tennessee Copper Co. of Copper Hill, Tenn., which started a plant in 1906, and the Ducktown Sulphur, Copper and Iron Co. of Isabella, which started a plant in 1908. Both plants were started for the twofold purpose of relieving the damage done to vegetation in the surrounding country by the sulphur fumes, and to utilize a valuable constituent of the ores that had heretofore gone to waste.

These two plants are similar in their essential features to the plant already described, the greatest difference being in the source of gas supply, the control and regulation of temperature, and elimination of dust and carbon dioxide, both of which are very injurious.

TENNESSEE COPPER CO.

The construction of their acid plant was begun in the early part of 1906, and was completed late in 1907. Acid making was commenced about Dec. 1, and the plant has been in nearly continuous operation since that time.

The gases in this plant are drawn from a concrete flue back of the plant furnaces. The first unit of the plant was completed in 1907, and a second unit added later and completed in 1910. The plant at present comprises two octagonal Glover towers 30 ft. across and 50 ft. high; one flue from the Glover tower to the cooling chambers, which is 10 ft. by 20 ft. by 120 ft.; 64 cooling chambers 10 ft. 10 in. by 10 ft. 10 in. by 70 ft. high; 8 cooling chambers 10 ft. 10 in. by 24 ft. by 70 ft. high; 4 lead-lined fans, each with a capacity of 67,000 cu. ft. of gas per minute; 12 old chambers 50 ft. by 50 ft. by 70 ft. high; 6 new chambers 50 ft. by 50 ft. by 75 ft. high; 8 new chambers 23 ft. by 50 ft. by 80 ft. high; 4 old Gay-Lussac towers 23 ft. by 23 ft. and 50 ft. high; 4 new octagonal Gay-Lussac towers, 19 ft. across and 70 ft. high. This, with the necessary coolers, pumping apparatus, and 15 iron storage tanks with a total capacity of 15,000 tons of acid, make this the largest single sulphuric acid plant in the world. To this equipment there is being added two new octagonal Gay-Lussac towers, 19 ft. across and 70 ft. high, upon which work was started in 1910.

To give some idea of the size of the plant the following figures are given, showing the amount of materials used:

The foundations called for 84,400 cu. yds. of dirt to be removed; 50,000 sq. ft. of asphaltum was put in for flooring under the chambers; 1,346,000 chemical brick; 270,000 fire brick and 2,210,000 red brick were used in flues and connections; 7,335 tons of quartz in packing the towers; 550,000 lbs. of asbestos in insulating the flues, and 7,830,000 lbs. of lead for chambers and towers, etc.

On Dec. 31, 1910, the acid plant construction had cost $1,689,925, and at that time the annual capacity was estimated at 168,000 tons of 60 degree acid yearly, or a cost for the plant of $10 per ton of annual capacity. Figuring on a 10-year depreciation period, amortization and interest charges the cost to the Tennessee Copper Co. will be about $1.60 per ton of acid.

DUCKTOWN SULPHUR, COPPER AND IRON CO.

Ground was broken for this acid plant on July 14, 1908, and on June 11, 1909, the fans of the completed works were started. For the first 24 hours a yield equivalent to 83 tons of 60 degree B. acid was recorded.

The plant consists of two Glover towers 12 ft. square and 45 ft. high, a series of dust chambers, four leaden fans of special design, 16 leaden chambers 96 ft. long by 22 ft. 8 in. wide and 30 ft. high, with a total volume of 1,050,000 cu. ft.; six Gay-Lussac towers, and the necessary equipment of storage tanks, pumps, etc.

In operating this plant the gases from the furnaces go into the furnace dust chamber. From this dust chamber the gases pass into and rise through a cylindrical tower, then through a kite-shaped flue into the special dust catcher, which is a rectangular brick chamber containing a system of channel iron. These are held in place by a series of trunnions running along the side of the walls. On one side the trunnions extend through the side wall, the ends being squared, by which means the channel irons can be revolved by a wrench and the contents dumped on the floor, and then be withdrawn through suitable openings underneath. These channel irons are to catch the impalpable sulphates and dioxides, which settle very slowly at high temperatures.

This dust chamber is very important, as it is through the manipulation of its connecting and extension flues that the temperature of the gases is controlled and regulated. From the dust catcher a brick flue runs the entire length of the building, with separate take-offs for each Glover tower. In each of these take offs are placed nitre boxes. Also there is another set of nitre boxes at the end of the dust catcher to be used if the occasion arises.

The next point in the process, where there is any change from the ordinary chamber acid process, is in the leaden chambers, where the contaminating influence of the carbon dioxide is felt. Here special features of a proprietary nature have been introduced, which are said to entirely eliminate the injurious effects of this gas.

In the Gay-Lussac, as in the Glover towers, no changes have been made from the regulation type, except in size.

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The earliest use of asbestos was for spinning and weaving, to make incombustible thread and yarn rope and cloth, and this has continued to be the most important use of asbestos ever since the days of the Greeks and Romans. Only the best grades can be used for this purpose, according to J. S. Diller, of the United States Geological Survey. Thread can now be spun so fine that it will run about 32,000 feet to the pound.

SQUARE-SET MINING AT THE VULCAN MINES

By FLOYD L. BURR.*

Since the invention of the square-set system of timbering by Phillip Deidesheimer in 1860, at the Ophir mine of the Comstock lode in Nevada, it has been used under widely varying conditions in many districts and may be considered to possess in a very marked degree the qualities of safety, thoroughness and general conservatism; while it is always open to criticism on the score of expense. Being used under such varying conditions and by men with widely varying ideas, it is not surprising to find very considerable differences in the dimensions of the timber, the detail of the joints and the general application of the system.

This square-set timbering was developed to take the place of simple props when the Ohpir mine vein suddenly widened out with depth from 4 ft. to about 70 ft. It was of course, entirely impracticable to span such a width between the hanging and foot walls with a one-piece prop or stull timber and in order to produce what would be in effect a prop made up of several pieces, the square-set scheme was devised. The idea was that the compressive stress due to the weight of the hanging wall would be resisted by a series of "caps" butting against each other and held in alignment by other members acting at the joints. This conception of the function of the caps makes them the principal members, the others being more of the nature of auxiliaries. Probably this condition is most nearly true in case of steep dips. However, in the use of the system in general, there are places where the "legs" or the "dividers" may have to carry the heaviest load and indeed they must always carry certain considerable components of the main loads. It must also be borne in mind that the timber is used incidentally as staging from which to carry on the work of mining and to support temporarily considerable amounts of broken ore. These incidental functions of the timbers may indeed have a strong bearing on their manner of use and in the selection of sizes.

There are many systems of details for framing the ends of the pieces to form the joints, depending on the conditions of pressure, cost, facilities for framing, etc., as these conditions appear to the man who directs the mining operations; but it is my belief that timbering is carried out too generally by a blind following of the local time-honored method with little consideration of the actual requirements. To design a joint scientifically one must first decide as to the magnitude and direction of the pressure and stress to be resisted and then dispose the timber in such a way as to best serve the purpose, it being of paramount importance to remember that timber is about five times as strong to resist compression along the grain as it is across the grain.

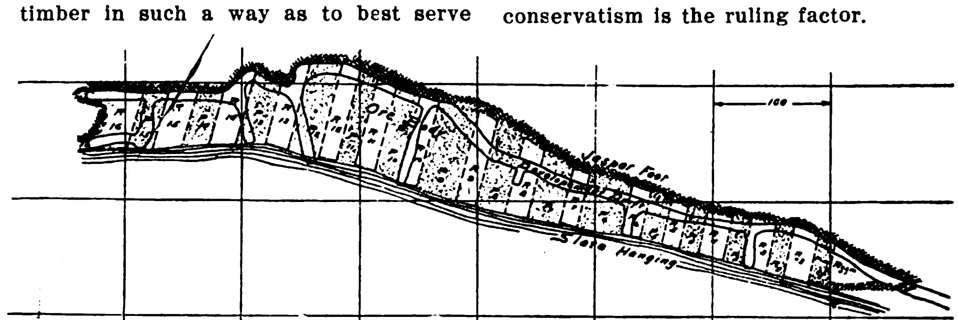


Fig. 1. Plan Showing Development Drift and Outline of Rooms and Pillars.

This square-set system of timbering has made possible and given rise to a number of square-set systems of mining. That in use by the Penn Iron Mining Co. at its Vulcan mines might be called the "square set room and-pillar" system of mining. There are several other mining methods in use at these mines, the most notable of them being the "top-slicing" system, which is sometimes used independently, but more often as an auxiliary to the square set work to mine out the ore pillars left between the square-setted rooms. In the mining of soft or medium ores, the square-set room and pillar method is applicable where the ore body is too wide for stull timbers; where it is so irregular in shape that in following out the limits of the ore the width is liable to vary greatly and unexpectedly; where the condition of the rock back is such that it will not cave down successfully for the top slicing method; where caving methods in general cannot be used for fear of destroying valuable or essential surface works; where previous operations have rendered underground conditions unfit for caving methods; where it is necessary to begin mining on several levels at once instead of progressing only from the top downward; where the output must be forced in quantity or in date; where it is considered essential to recover with certainty all the ore; and in general where conservatism is the ruling factor.

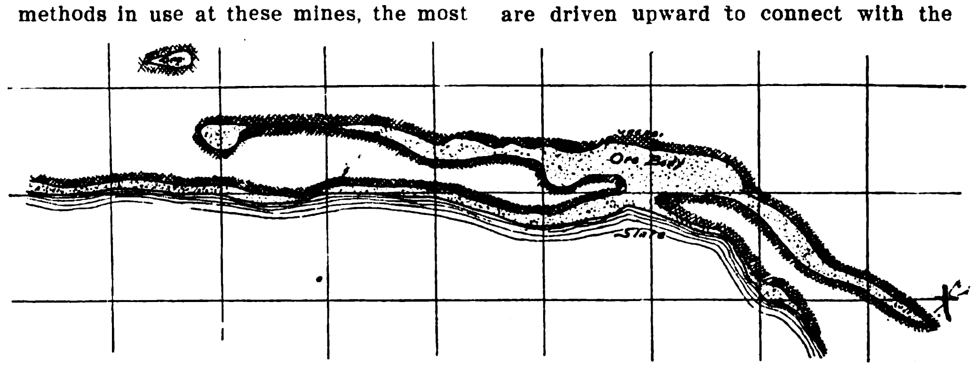


Fig. 2. Plan Showing the Irregular Size and Form of Orebodies Often Met With at Vulcan.

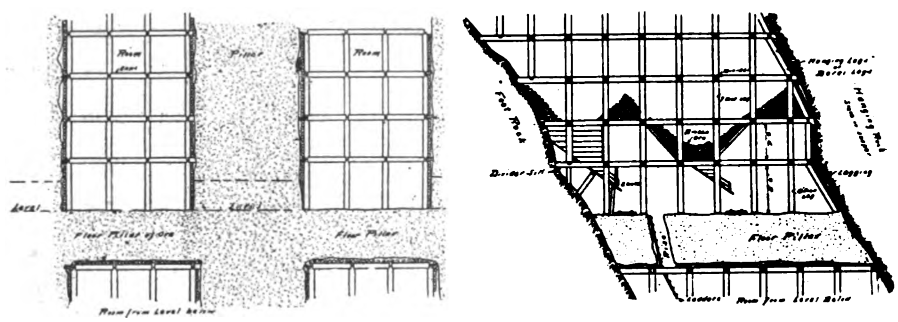
Due to the existence of some of the above conditions at Vulcan, the system has been quite generally used there. Levels are usually established at 100-ft. intervals and when the ore body is encountered the drift is continued throughout the length of the ore, there being no regular practice as to following the foot or hanging walls or drifting in the middle. Some crosscutting is done at irregular intervals, thus defining the general limits of the ore body. Frequently raises are driven upward to connect with the level above for ventilation and for lowering timber.

In beginning the mining operation a line for the timbering is chosen, sometimes paralleling the timberwork on the level above and sometimes being a line parallel to the longitudinal axis of the ore body as nearly as may be approximated from the development done. When there are pillars of ore still unmined on the level above, it is of course considered essential to keep that in mind in the laying out of rooms and pillars, which comes next in sequence. At right angles

* Paper read at Marquette Range Meeting of Lake Superior Mining Institute.

to this longitudinal line which has been chosen for the timbering, rooms are laid out. These rooms are made from two to four sets, or from 14 ft. 10 in. to 29 ft. 8 in. wide and their length is of course the width of the ore body. The intervening pillars vary in width from two sets to five sets.

Fig. 1 shows the plan of a certain level in one of these mines being worked by the square-set system. This ore body is larger and more regular than many of



Longitudinal Section. Cross Section.
Fig. 3. Showing Square-Set Timbering and Scheme of Mining.

them, but the smaller and irregular ones are worked the same way. In this figure an irregular development drift has marked out the limits of the ore in a general way and then rooms have been laid out, leaving pillars between them. The heavy dotted lines are the side lines of the rooms. The area occupied by pillars is shaded. Fig. 2 shows the irregularity in size and shape commonly met with in the Vulcan ore bodies.

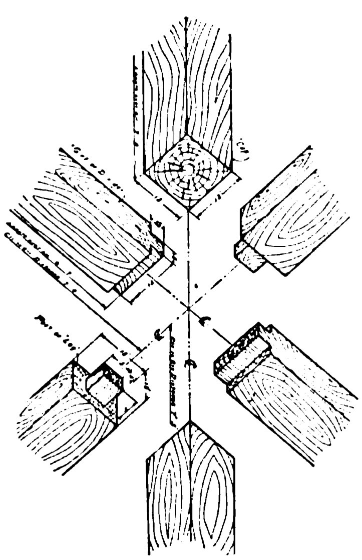


Fig. 4. Dimensions and Detail of Square Set Joint.

As the rooms are gradually cut out on the level, square sets of timber are placed in position and usually a set is placed as soon as there is space for it, thus avoiding large areas of unsupported back. The sets are blocked in place and 7-ft. lagging are laid on top. Usually 9 ft. legs are used for the first floor, while all other floors have 7-ft. legs. These lower legs are usually stood directly on the ore beneath, it not being found necessary to use sills to distribute pressure or to tie the legs together. Years ago sills were used regularly. The only reason for using sills would be to facilitate the "catching up" of the debris when the room has been filled with waste rock and the workings below have progressed up to the level. Instead of using sills, the present practice is to anticipate the beginning of the filling operation by laying down on the floor of ore at the level a sheeting of 10-ft. round lagging, it being comparatively easy to "catch up" this lagging when working up to it in the

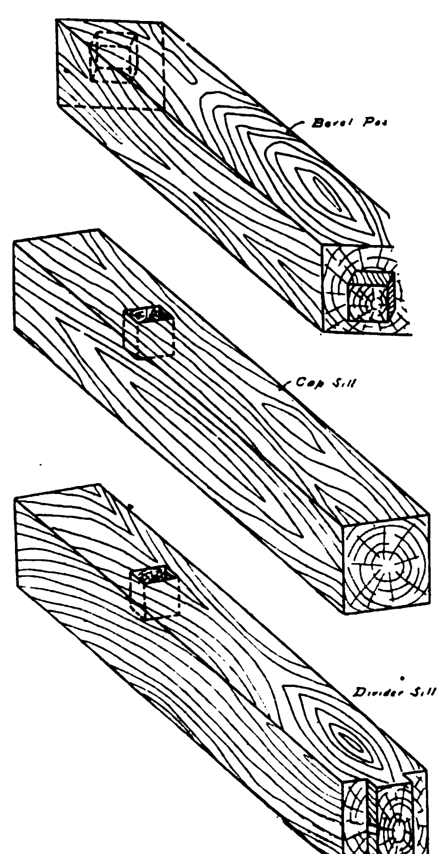


Fig. 5. Detail of Special Members of Square Set.

subsequent operations from below, and to thus avoid the caving down of loose filling material. The sides of the rooms next to the pillars are lagged up outside the legs of timber to prevent the ore from the pillar caving into the room.

After a given room has been cut out and timbered the ore set in height over the whole area from hanging to foot, thus completing the "first floor," the lagging are removed over one set and an opening is cut upward large enough to accommodate a set of timbers, thus beginning the "second floor." This floor and the succeeding floors of ore are in due time mined out one set at a time and the timbering left in its place until the level above is reached, or to a point some 15 ft. under the level in case it is necessary to leave a floor to accommodate haulage ways or other conditions on the level above. In the most usual case when a 15-ft. floor pillar is left, a raise is cut through it connecting to the level above (see Fig. 3).

In blasting down the ore it is allowed to accumulate to some extent on the various lagging floors and occasionally the "stope is cleaned up" by shifting the lagging like the dumpboards of gravel wagons, allowing the ore to fall down into the chutes which have been provided at the level. The various rooms in the series will generally be found in different stages, some being worked nearly up to the limit, while others are barely begun.

In the course of action, the rooms are filled up with waste rock produced elsewhere in the mines by the driving of exploratory drifts and other openings or sent down from surface rockpiles in cars or chutes; or in case these sources do not yield the necessary material, rock is mined for the purpose from suitable places in the hanging or foot walls. This rock is trammed in cars and dumped down from the level above until the room is full. Of course the timbers are left in place and no attempt is ever made to recover them. Before starting to fill a room, a sheeting of split lagging is placed at the side of the room bearing against the lags toward the pillar to prevent the subsequent rock filling from running out when the pillar is being worked later on.

I understand that some years ago at the West Vulcan mine the filling was "puddled in" with water and the result was a material like a water-bound macadam, concrete like in its ability to stand up as a rigid mass. This, I presume, would hardly have required the support of lagging.

Whatever passage ways it is desired to maintain are cored out in the rock filling. These may include a ladderway between levels, tramways on the lower level and suitable mills adjacent to the pillars. These mills are to be used for access to the pillar and for chutes down which the ore is sent when mining these pillars by the top-slicing method. When all the rooms have been worked out and filled, the pillars are usually attacked by the well-known top-slicing method. By this method the ore is mined from the top of the pillar in a "slice" only some 10 ft. in depth and the debris above caved down as each successive slice is removed. At the same time the floor pillar left over the adjacent rooms may be removed.

While the method as outlined might be called the standard method, it is frequently departed from in several ways. Thus sometimes the pillars are worked away as extensions of the rooms by what is known locally as "side slicing." The side slicing has been used considerably. To explain it: Suppose we have a pillar three sets wide between two rooms each three sets wide. After the rooms have been worked out and the square-set timbering occupies the space, it may be found that no severe strain has shown its effects upon the timbering and the ore pillar shows no tendency to cave. Under these circumstances it may seem wise to risk taking off a slice one set wide from one side of the pillar. This then widens the adjacent room to four sets wide and reduces the pillar to two sets wide. This space is of course timbered with square-sets precisely like those in the rooms, progressing from set to set and floor to floor. After this one slice has been successfully cut off from our pillar, we may be bold enough to risk taking off a similar slice from the other side and finally removing the remaining third producing a great room nine sets wide; or it may be considered too risky to do this and resort be made to filling the rooms and top slicing the remaining portion of the pillar.

Sometimes the above described procedure is carried on with the variation that the rooms are filled in the usual manner with waste rock before attacking the sides of the pillars. Sometimes also after the rooms have been filled with waste rock, the pillars are "taken out on timber" as it is spoken of locally. In this scheme the pillar is treated just as if it were a room and the filled room a pillar, the whole three sets width of pillar being mined up and timbered with square-sets.

Taking up now the details of timbering, reference should be made to the sketches. In Fig. 4 the joint is shown in modified isometric projection. The sketch represents 12-in. timbers, but 10 in. and 16-in. timbers are also in use, the tenons on the legs being made 4 and 8 ins. square, respectively. It will be noticed that the framing is extremely simple. A great deal of the timber is framed by machinery, but there is also some hand framing. Both round and square timbers are used.

Fig. 5 shows a "divider sill" and a "cap sill" and a "beveled post," and their use is indicated in Fig. 3. The "divider sill" is used to allow the timbering to progress over the footwall, while the "cap sill" may come into use in a similar way at the end of the ore lens at the foot of the pitch. The "beveled post" or "hanging post" is used in following up the hanging wall.

Contrary to the more usual practice, the caps are placed along the strike of the vein and the dividers at right angles. I am informed that the reason for this is that it is desired to place the overhead lagging in the direction from foot to hanging and since it must take the weight of ore blasted down upon it, it must rest on the stronger members—the caps—the caps being the stronger because they have the greater bearing area on the leg.

The legs are spaced 7 ft. center to center from foot to hanging, while in the longitudinal direction they are at 7 ft. 5-in. intervals.

STATUS OF THE WORLD'S GOLD DREDGING INDUSTRY

By AL H. MARTIN.

In 1911 the gold deposits of the world yielded approximately $466,000,000. Of this immense amount about $20,000,000 was produced by dredging. California leads with $8,000,000; the Alaska-Yukon districts ranking second with nearly $3,500,000. New Zealand, the birthplace of the industry, yielded in excess of $1,500,000. Russia leads the Eastern regions with over $2,000,000. It is estimated that fully 390 dredges are in commission ranging from the native machines of the Philippines and the little Holland-built boats in Dutch Guiana, to the 15-cubic foot monsters in California and Yukon. The dredging industry had its inception in New England in 1867, when the first placer mining bucket elevator dredge was constructed at Otago. The contrivance was a crude affair but the lessons learned resulted in the building of several successful machines. The boats were operated by current wheels, the first steam-operated dredge going into action on the Molyneux river in 1881. In 1889 a large number of gold boats were operating in New Zealand, and the commercial value of the industry had been established. These boats were all small and generally cost less than $20,000 apiece.

The first successful California dredge was commissioned in 1898, twenty-one years after the first New Zealand machine was designed. The present status of the world's gold dredging industry dates largely from this pioneer California dredge, as California operators have solved the problem that heretofore reacted against the universal application of the dredge principle. As a result the California single-lift bucket elevator type of dredge is generally accepted as the world's standard. Practically all the dredges operating in Alaska, Yukon Territory and the various American States are modelled along lines decreed by California practice. Even in New Zealand the tendency is toward the adoption of the larger California type of boats, and dredges of this type are finding favor in Siberia, South America and other foreign climes.

Throughout the world the tide has set strongly in favor of the larger dredges, as the handling of a large quantity of material means a lower cost per cubic yard. In California a majority of the dredges are treating gravel at a total cost of 2 to 3 cents per cubic yard, and operators in other localities are endeavoring to aproach the California record. In Alaska and Russia the costs often run around 10 to 40 cents per cubic yard, owing to the necessity of employing steam or gasoline for power, the thawing of frozen ground, heavy freight rates and other expensive factors. In New Zealand and Victoria several companies are handling gravel with small dredges at costs averaging around 4 to 5 cents per cubic yard. The following table shows the approximate number of dredges in operation throughout the world, based upon recent reports from the various mining authorities of the several nations:

Location.	Dredges Working.	Production.
California	63	$ 8,200,000
Other Am. States	20	1,450,000
New Zealand	100	1,500,000
Australia	75	2,000 000
Alaska-Yukon	40	3,300,000
Russia-Siberia	60	2,200,000
Other Fields	32	1,500,000
Totals	390	$20,150,000

These are approximate figures, based on dredges reported in action at this time. The principal American dredging states exclusive of California are Colorado, Montana and Idaho. Colorado dredges produced about $350,000 in

1911; Montana produced $700,000, and Idaho dredges yielded about $210,000. South Dakota, Nevada, Oregon and Arizona have received some attention during the past year, with small dredges operating part time in Arizona, Nevada and South Dakota. Montana for years has ranked as an important dredging State, and antedated California as a producer with dredges.

The dredging fields of the far north are attracting particular attention at this time, and a marked advance is anticipated during the next few years. The greatest difficulty attending dredging in the extreme arctic sections of Alaska, Siberia and the Yukon is the thawing of ground sufficiently to facilitate its handling. In this work it is necessary to drive pointed iron pipes into the ground through which steam is introduced. The steam is supplied by boilers generally fired by wood or crude oil. From twelve to twenty points are frequently required to thaw the frozen ground as the dredge advances, and this alone costs considerable, 10c. per cubic yard being a very favorable figure. Average dredging costs in many of these districts run about 22c. per cubic yard, with conditions considered propitious. This indicates the extreme difficulties under which dredging companies in the Far North labor. Consequently only ground of remarkable richness can be profitably handled, and this factor will continue to militate against dredging in numerous northern sections. In more temperate portions of Alaska and the Yukon companies are effectively operating at a total cost of 10c. per cubic yard. During 1911 eighteen dredges were operated on Seward peninsula, most of them during the greater portion of the summer. Five more will shortly go into commission, while more are projected. During the colder weather many of these boats operate by keeping the various portions of the dredge heated by an arrangement of steam pipes.

In South America dredging with small machines has progressed for years in Brazil, Argentina, Colombia, Dutch Guiana, French Guiana and other nations. Most of these boats are small and constructed along lines developed by native practice. While the aggregate volume of gold yielded by South American dredges is comparatively small, numerous rich placers offer much promise. Climatic conditions are often unfavorable, and it has been found expedient to build boats with steel hulls to resist the attack of voracious wood-devouring insects. Frequent floods also add to the uncertainties attending operations.

In Russia the dredging fields of Siberia gather importance as the efficiency of the practice increases, and strong foreign interests become more heavily concerned. The small Russian boats are admittedly inferior to American and New Zealand designs, but the natural timidity of Russian capitalists militates against broad advances in dredge construction. Prominent engineers pronounce conditions distinctly favorable for the development of a great dredging industry in the Siberia district, but it is apparent that introduction of boats built along the lines developed by California and Alaska practice will be deferred until outside financial interests become more largely concerned.

A powerful French corporation recently installed an Australian model dredge near Lake Baikal and is said to be planning the erection of a number of similar boats. English capitalists are manifesting renewed interest in Siberian dredging. A majority of the Russian dredges have capacities ranging from 4½ to 5 cubic feet, but most of the newer type are provided with 7 cubic foot buckets. According to official statements some of the ground in the Urals may be profitably worked when the gold content runs as low as 10 to 15 cents per cubic yard, while in portions of Siberia deposits containing less than 20 to 32 cents per cubic yard are unprofitable, owing to unfavorable conditions.

Other regions reporting dredging activities are Terra Del Fuego, in the extreme southern portion of South America, the Malay Peninsula, the Gold Coast Colony and French Guiana, in West Africa. As a whole the introduction of dredging into remote districts has been attended with fair success, when conditions were properly appreciated and dredges were designed for the particular locality selected.

The outlook favors a pronounced expansion of dredging in Alaska, Yukon, Russia and South America, while California and several other American States will probably record a steady gain in production for several years to come. In Mexico and Central America conditions are reported favorable for a more extensive application of dredging principles. New Zealand and Australia show little promise of further gains, but should maintain present rate of production for a considerable period.

HYDROGEN-SULPHID APPARATUS

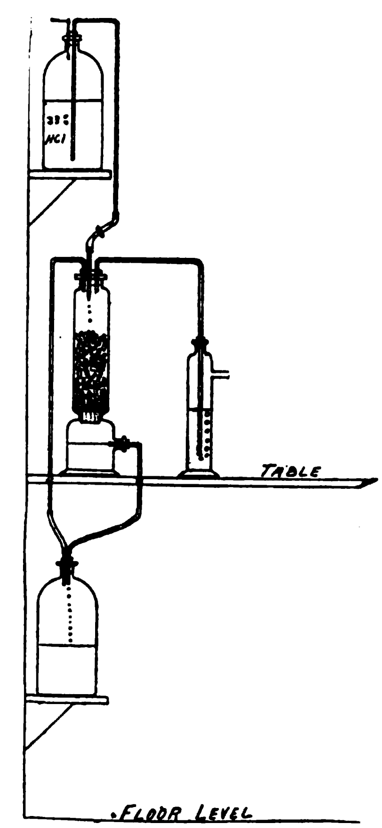
By J. R. HUBER.*

The accompanying sketch illustrates a convenient and satisfactory method for making H_2S in the laboratory. A Kipp generator, owing to the pressure necessary to hold up the acid when not in use, has a tendency to leak around the stoppers and consequently generates most of the time, being a continual source of annoyance besides wasting acid and iron sulphide.

Hydrochloric acid, about 1 to 2, is placed in the upper bottle, the syphon filled and the flow of acid adjusted by means of a screw pinch cock. When no more gas is required the pinch cock is screwed up tight. The generation of gas ceases almost immediately.

By using an 18-in. tower the acid trickles over sufficient FeS to be entirely neutralized when it flows out at the bottom. A large cork with several small holes punched through it serves to hold up the FeS and permits the waste acid to flow into the reservoir below.

Two holes are drilled through the table top, one for the tube which carries away the waste acids and the other for a tube connecting the waste acid bottle



Hydrogen-Sulphide Generator.

with the top of the tower. This tube relieves the pressure in the waste acid bottle, permitting it to be tightly corked, thus preventing any odor of the gas from getting out into the room. The other bottle contains pure water for washing the gas, and after it may be placed whatever purifying or drying apparatus is considered necessary for the work in hand.

FeS in fused sticks is the most convenient form to use. The apparatus is best set up in the hood against one of the walls.

* Metallurgical and Chemical Engineering, December, 1911.

PRINCIPLES AND PROBLEMS OF MINE MANAGEMENT

By CHARLES A. CHASE.*

This paper deals with the relations between the mining community and its principal industry, as well as with the duties of the manager. We all know that the key to successful mine management is a bonanza and yet with that knowledge it seems that we have to search deeper for the root of some of our troubles. This subject looks large, embracing finance, organization and operation, each with its several branches.

The object of the movement, of which this paper is an expression, is to look frankly at our industry and see whether we can discover its fundamental weaknesses and correct them. Business in general lags and, even so, the financial end of this industry does not keep step. By this expression, "the financial end," I mean our external financial relation with the great body of business, the source of capital for development and equipment, as distinguished from our internal economics. I assume that our chief trouble is internal, concerned with organization and technique, and shall devote myself to the phases of management connected therewith, for it seems obvious that the weakness internally has much to do with the distrust which results in withholding capital. I wish, however, to expressly disassociate my discussion from the narrow idea of the duties connected with the position of manager.

Mine management begins with location and we are all involved therein, be we locator, surveyor, superintendent, manager, director, owner or citizen in the mining community. The end is profit to ourselves as individuals, to the industry and to the state. Definite duties fall properly upon the regularly appointed manager, but it is imperative that all the classes enumerated, particularly the business and professional men of our mining communities, understand the burdens they must assume, if the industry is to thrive. Perhaps I may distinguish between the management of mines and the management of the industry, and state that, in the first case, the major burden is with the property manager and in the second case it is largely shared with the local business community. To the broader view of the subject I will address myself largely.

PROBLEM OF THE SMALL MINE.

I wish to deal with broad principles of general application. In a state where most of the individual mining enterprises employ less than 25 men and the individual output is correspondingly small, it is idle to discuss management as it is discussed at Johannesburg, Butte or Bingham. At such places the mines have grown so strong that they are largely independent of the co-operation of their several communities and a discussion of management there is of the technical features of organization, equipment or metallurgy; and, I may say, theirs seems a simpler subject matter than ours.

They have a problem which makes a steady evolution, each year's work, carefully analyzed and compiled, making a secure foundation for the years to come. To us the production of a tithe of the tonnage means the operation of many more properties, each with technical problems as difficult, but without the complete records and the equally available financial resources to supplement our natural resources. We have more problems per ton. The total difficulties are greater and the individual reward is less. On the other hand, the community of small mines offers more positions of responsibility and therein lies one of its rewards.

It is not for us to put aside the work of the large mine as having no lesson for us, for we can with great profit study its directness of attack, rigid avoidance of waste and careful adaptation of means to ends.

The successful mining community is our watchword. Some prospects grow into small mines and cannot become more; others have to be operated on a large scale to be at all successful. The successful nourishment of growth in the early stages calls for the highest skill and the broadest experience. It is appropriate to paraphrase a truism into these words: Take care of the prospects and small mines and the large mines will care for themselves.

HINDRANCES TO MINING DEVELOPMENT.

There are some difficulties which I wish to point out, certain remedies which I wish to suggest, believing that they are worthy of your consideration: First and, unfortunately, not subject to fundamental correction is the mining law, which permits the granting of patent to mineral lands, resulting in tying up in idleness large areas of every proved district in the West. This land is largely held, by virtue of low taxes, waiting for the day when someone, despite high royalties, makes a fortunate strike and gives it a value all unearned by the owner. We can look with some respect at the Mexican law, which rates mining as a public utility and does not grant title in fee simple to mineral deposits. We hear much of the leasing of coal and other government lands; I believe that the leasing of mineral lands would quicken the industry.

Second, inherent in the industry is the geological fact that not all prospects and mines can make good.

Third, is the bad judgment on the part of the prospector and the small owner in exhausting his own resources and those of his friends (which means in the aggregate the resources of the community in money and credit) in development of worthless prospects or of good prospects in a bad way. His faith may be good, but he does not know. This, too, is inherent in the industry.

EFFECT OF INEXPERIENCED OWNERS.

In some industries there is an orderly development of skill through the succeeding stages of apprentice, journeyman, superintendent, manager and owner, the latter a master workman in his industry, with all details of operation, accounting and organization practically a part of himself. Our industry does not ordinarily offer a parallel; in its nature it cannot, when a man of any vocation becomes an owner, but not a master workman, by the mere act of location. Our only approximate approach to an orderly evolution is in the case of the technical graduate, who goes faithfully through the various stages of apprenticeship by some one of various routes and finally becomes a master, be he manager, owner or engineer. There are notable exceptions, great miners who are notable executives without education in the schools, but I am dealing with the average man.

Fourth, and of a parcel with the preceding point. The owner of a prospect or small mine magnifies what he has and persuades an outsider to buy an in-

* Mining engineer, Denever Colorado. Address delivered at Idaho Springs, Colorado, as one of a series of "Practical Talks" given at various mining centers under the auspices of the Colorado Scientific Society during the past fall and winter.

terest or all on too severe terms. The buyer, his ignorance already shown by the terms of the purchase and likely without adequate capital, collapses before he can do sufficient development and construction.

Fifth, the preceding dangers to the property passed and a mine fairly started, it fails for lack of proper organization and lack of technical skill. There is sometimes dishonesty, a final straw.

SUGGESTED REMEDIES.

To suggest what relief I can: I see no prospect that our fundamental law will be changed but I do see that a growth of public sentiment favoring reasonable terms of lease would be of great value. This would best be accomplished by the intervention of the local commercial bodies, which would work out standard systems of leasing adapted to the district or to sections of it, and secure the concurrence of owners of idle property. The terms might be such as would even be comparable with government leasing. I do not contemplate such leasing as will gut property, but terms that will favor development, with little or no royalty on ore recovered in development that is properly planned. This seems to me to be a legitimate and highly desirable community activity.

For the waste in developing hopeless prospects or good prospects in a bad or needlessly expensive way, there is just one help, and that is to secure good advice from a competent man. I mean hopeless prospects when I say it and have in mind those in areas reasonably proved to be hopeless, those in vein systems amply proved to be barren and such as are cut off by faults or in landslide blocks. These will serve as examples of this class, a small class at best, as compared with the fair or good prospects developed on a bad scheme or without any plan at all. For the waste in developing reasonable prospects that do not make good, I see no help with our knowledge in its present state. It seems a proper and necessary part of our work, and, if the work is well planned and skillfully executed, the industry should profit in the long run.

The practice of making sales at too high a price or on too severe terms brings its own retribution to a district, in stagnation, and in monuments in the shape of ill adapted or uncompleted plants. The terms of option and sale are essentially matters of private contract, but where unfair terms and misrepresentation bring discredit upon a district, an enlightened public sentiment may demand that it be heard and may demand good faith and fair terms. This is not chimerical, for I know of a case where a large enterprise is just now being resuscitated after years of idleness, where a good community spirit forced reasonable terms.

This community spirit may fairly show itself in pointing out to intending purchasers that they should safeguard themselves with the best engineering and geological advice, that if they are to take a partially developed property, their only safe plan is to follow a program of development mapped by competent authority and it can well aid in securing the time for the necessary development and equipment, before payments are scheduled to begin.

SALE OF MINING PROPERTIES.

There are two classes of property, at least, to which much of what I have said in this connection does not apply. A bonanza prospect is a law to itself, and a developed mine is subject to sale for cash with fairness to all parties immediately concerned and to the public.

Why the severe terms for prospects of small apparent value and for ill developed mines? The seller lacks faith in the property he is selling or in the ability of the buyer to make a success of the enterprise that he is undertaking. He takes the cash payment as insurance to himself against the poor results of development on the one hand and against the possible failure in management by the new owner on the other. It is not good practice, for this first sum should go into development, which often brings its pleasant surprises as well as its disappointments; and it is ample development that makes mines.

This is something that I believe to be reasonable: If in any mining district there is an orebody that bears the marks of good size and its grade is at or just below what can be worked with the equipment now at hand in the district, it may be recommended to outsiders for development or it may be developed by local people as an investment, with the reasonable assurance that, by the time a large tonnage is ready the means to treat it at a profit will be available. As a case in point in showing the steady progress in metallurgy, I understand that now, for the first time, cyanidation has been made adaptable to certain ores of this district. I say "made adaptable" advisedly, for that is the essence of engineering. I hope that it may prove a success and that you may have the courage and good fortune to develop orebodies of such size as to make the most of this branch of metallurgy. The men who have accomplished this result deserve the appreciation of their fellows.

Let the owner and community offer time for development and demand that development be done; it is at once a safeguard to the buyer and a sure test of his intentions and abilities. I believe that any district of real merit in which the people avowedly stood for this good practice would attract a good class of investors.

ORGANIZATION IS ESSENTIAL.

The failure of the developed mine for lack of organization and technical skill is common and sad. At a time when business in general, your smallest grocer if you please, with his cash register and other appliances, is trying to make light the dark places, our industry remains in general archaic. I know a man of more than average intelligence, who runs a mine with the aid of a pocket memorandum and check book, as far as I can see. When the ore falls in grade, he will either change his methods or break; unfortunately he is not alone in this method.

The necessity of right organization is common to all mines and is merely the application of business principles. To properly organize is to provide the mechanism, the staff of men for supervision and the system of accounting and communication to make their work effective. The aversion to accounting in general among mine operating men results from the inapt and cumbrous nature of some systems in use and inappreciation of the benefits to be had from a good system, fitted to the needs of the individual mine. When a foreman explains that there is a great deal of red tape on the mine, it is a fair inference that the system is wrong or, if right, that man has not been taught to use it. Certainly, properly adapted accounting simplifies the work for manager, superintendent and foreman. There must be many figures, but the working out of the details of the accounting is to be concentrated in the hands of the clerk, where it belongs.

SYSTEM USED AT LIBERTY BELL.

To the student of ways and means, citations from actual experience are of more value than theoretical conclusions and I will now cite to you a particular mine and outline its organization and methods, as a good example. The mine is the Liberty Bell and, the system in use having antedated my presence there, I can speak of it from the standpoint of user and observer. These principles underlie the scheme: the provision of adequate executive supervision; the definite placing of responsibility; the definite knowledge of every expenditure; the definite knowledge of mill results; and the requirement that everyone is in a position of responsibility to tell in the simplest way just what he has done. The staff organization is thus: (1- General manager and president (nonresident); (2) superintendent (resident); (3) chief clerk and cashier, with necessary subordinate clerks and boarding-house steward; engineer, with assistants as required by the work; mine foreman, with shift bosses and mine mechanics; tram foreman, with shift bosses; mill foreman, with one general assistant and shift bosses.

Each department head has well defined duties and a large measure of independence. In the system of reports and accounts is his bond with the superintendent and the latter's best means to gage the work of the foreman. In the figures that come back to the foreman is his opportunity to know his own results. Any good foreman knows in some measure how his work progresses.

He cannot know this exactly without figures and this requires bookkeeping; if he does it himself, it will be at the expense of his essential work.

RECORDS OF THE FOREMAN.

To illustrate the foreman's relation to the general system in telling what he does and what he requires in the way of supplies, I will take the mine foreman, who turns in the following sheets daily: (1) Mine-labor report, which shows on its face how many men of every class were employed, surface and underground. (2) Mine-ore report, which gives the ore and waste produced and, what is to the point, if the tonnage of ore is below standard, the reason must be given there. (3) The daily log, a letter sheet which must go forward every day, blank or filled; if blank the foreman assumes the responsibility o f reporting good conditions. Otherwise the opportunity is at hand to call attention of the superintendent to any condition of the work; and, what is more important to the foreman, it offers him scope for his own ideas; it permits him to make recommendations. This report definitely places the burden of responsibility between foreman and superintendent. (4) Requisition blanks, numbered, form the simple means of asking supplies. Beside the statement of the want, the essential addition is the purpose. The foreman has at hand the list of headings, to which it is customary to charge mine supplies and labor; foreman and shift boss; stoping; underground hauling; tunnel raise; blacksmithing; tracklaying and ditching; heating; lighting; telephones; air plant; electric plant; electric power; locomotives; cars; miscellaneous.

This short list the foreman knows and to the various headings he charges all labor and supplies. It is needless to say that the foreman retains copies of all reports and requisitions. These simple duties performed, he has fulfilled his part in initiating proper records. It is not complicated and cannot be a burden; in fact, the ordering of supplies is almost machine like at the end of each month. In return the superintendent supplies the foreman with the account complete at the end of the month, totals and summaries of all classes of labor and supplies and the cost per ton.

REPORTS OF DEPARTMENT HEADS.

What the mine foreman does is typical of the duties of all foremen; and all reports go to the superintendent. In 15 minutes he will have entered the essential items of every report across his summary sheet. The entries on this sheet are, for the mine: tonnage, total labor, total underground labor, machine shifts; for the tramway, tonnage; for the mill: tonnage, total labor, amalgam product, concentrate product, tons cyanide solution and its value and other current assays. At a glance he can see whether any item shows change from the day, week or month previous.

The sheet is an index, par excellence. In the case of lowered tonnage in any department, the detail sheet gives the reason and so in the case of high labor or any other irregularity. The recurrence of trouble in any quarter suggests that any remedy theretofore applied has not proved adequate. In a word, the signals are automatic, and there is the crux, the simplicity of the system. Foreman, superintendent and manager, all see the daily reports and superintendent and manager see the summaries, and, for all, the clear sheets, with full tonnage and normal labor, show the perfect working machine and allow freedom to study some particular part of the work and to improve practice.

The word distribution is used to designate the name of the account to which the foreman on his requisition signifies that the cost of the item he orders is to go. This is never lost sight of. The order to the supply house, written in triplicate, has the notation on the office copies and, when the bill is received with the goods, it is entered thereon. At the end of the month, there remain only the totaling of the various distributions and the entry in the books. The reports of the various departments are then compiled and analyzed.

STORE AND CONSTRUCTION ACCOUNTS.

The essential remaining features of the accounting may be discussed together. Ideal simplicity would accrue, if each item of labor or material could be given at once its proper and final distribution. This is not feasible, if one is to have the uniformity essential to comparison of results for different periods. The disturbing features are the purchase of some supplies in large quantities and the purchase and erection of machinery, buildings, etc., the former being distributed as used from month to month with exactness, and the latter approximately apportioned as depreciation through the assumed life of the mine. These equalizations are cared for by the "store" and "construction" accounts, respectively. Any purchase of supplies for use through an extended period, or for general use, is charged to the store when bought and then charged to the various departments at actual cost as used. All items going into any permanent construction are charged to their proper construction account, but after the construction is once complete, any further purchases are for repairs or maintenance and are charged off at once as operating expense.

I have given the salient features of a system that has proved of the greatest assistance in working out a difficult enterprise. My object in reviewing it is to drive home the fact that, as it touches the operating man, it is simplicity itself. It eliminates correspondence and conversation, the telephone being left for emergency use. It suits the needs of the staff men of all ranks. It is fundamentally the sort of system that the small mine can adapt with great profit.

This is not a meeting of accountants, but I propose to urge upon our organization the need of propaganda furnishing systems of mine accounting. The one fundamental principle should govern—the greatest accuracy compatible with simplicity and commensurate with the requirements of enterprises in various stages. Such work can be made invaluable.

EFFICIENCY BY CONTINUITY.

I have said that some mines fail for lack of technical skill. The mine I have mentioned was found in the prospect stage by an engineer, who later organized it for operation and has always directed its policies. The resulting continuity in plan and the constant accumulation of a fund of special knowledge have made the difference between success and failure. In the nature of things, not all mines can have this history, but the owners can secure good technical direction from men schooled by years of successful practice.

This may seem an unasked advertisement of the consulting engineer, but it is a statement of a logical course of action and it is the substance of what I have to say. A board of directors or a nontechnical manager, with faith in the engineer, secures the necessary continuity of policy and the accumulation and analyses of special knowledge.

There is no better illustration of the reasonableness of this advice than to draw a parallel with the professions of law and medicine. Men of these professions are essential to the everyday life and this is so because they are recognized as trained men. There are lawyers and doctors whom you do not trust and there are engineers who are not to be trusted. On the other hand, you of this vicinity do not have to think long to recall engineers of continent-wide practice won by sheer force of merit. The engineering schools turn out their annual crop of young men who, with good field training, will become competent. Not all will be great, but the mere fact of their training in the fundamentals will save them and their employers from the commonest mistakes which are so costly. That these graduates do not progress faster is due to the fact that they do not come oftener under the direction of trained superiors in their early years out of school.

RESIDENT AND NOMAD ENGINEERS.

T. A. Rickard some years ago entered a plea for the usefulness of the resident engineer, as against the nomad, as a source of consulting advice within a district, a man who will do intensive cultivation, if you please. For the good of the profession and the industry, there must be nomads, to carry good ideas and to keep the profession broad, where men too much in one place would become narrow. But this requirement becomes less with the increasing dissemination of good technical literature. The idea fits well with some of my own. I have felt that many graduates, who go in for assaying and surveying in our various communities, develop those lines into fine arts, but often shut themselves off from the larger opportunities and responsibilities, with detriment to themselves and the community. Is it not natural that the locator, who employs a surveyor to stake the claim properly, should ask his advice on the larger questions; whether the claim is hopeless; whether he sees any encouraging marks and whether he can suggest the most economical way to prospect it? So, with the owner or manager of property in more advanced stages, needing advice as to organization, operating methods or metallurgy.

To return to the analogy of the other professions; do you know a good local lawyer who does not consult a leader in his profession? The local engineer would have similar connections and would use them. A growing business with the confidence of the community, would mean the gradual growth of an engineering staff and therewith the steady accretion of compilations of engineering data and the mining and metallurgical history of the small mines of the district that is now had only by the larger and well managed mines, a tangible asset to the community and the industry.

The expense of engineering advice is as essential as powder, and more so, for it can give direction to the powder, with resulting enormous savings. Such a system is for the future, but we can gradually change to right lines. New conditions require new methods. The industry has had a chaotic history, in which the wealth of bonanzas has made skill superfluous. In parallel with the exhaustion of our richest deposits, has come the growth of our schools and scientific organizations and their product in men and ideas is the machinery for giving value to lower-grade ores.

There are certain phases of good management of operating mines that I wish to mention. There has been so much said of scientific management and some of the alleged examples are so bad that the expression is almost a byword in places.

EFFICIENCY BY MOTION STUDY.

Yet the principles enunciated are the thoughtful consideration of every mine manager. Conditions vary so widely that it is quite impossible to make any fixed rules for the application of these principles, but each manager must analyze for himself every operation in mine, tramway and mill.

In the operation of the mechanical plant, the results, whether favorable or adverse, are evident and serve as a gage of the management. The equipment and its operation may both be archaic, it may represent the latest approved practice or it may be almost original. Whatever it is in this way, it may be in perfect order or slovenly; each condition reflects its own type of management. Very commonly the mine that hoists by cage and cars represents the archaic type of mind and where this method is in vogue, the entire organization will probably be on a par. That any manager today will use such a method for a large orebody is incomprehensible in view of the well known examples of better practice. Copper Queen methods of moving ore are in point. The train goes by the station and discharges without stopping. In turn, by the use of measuring chutes or fillers, filled from the pocket while the skip is running, the skip loading is almost instantaneous. What a contrast the two types represent, and what excuse can be offered for the continuance in use of what should be obsolete? The ability to halve the time of a cycle in hoisting means that one shift will do instead of two, or one shaft instead of two. The labor ratio between the two methods is likely to be 4:1.

I may cite an instance from my own experience. It was reported that the maximum output of a certain level was 160 tons daily with one locomotive. A reorganization of the tramming crew, adjustments of track with introduction of automatic switches and a few changes in method brought the product of this level to 500 tons for the same one locomotive. The secondary but more important result was that it immediately became possible to concentrate the mining of that tonnage on the one stope; the one level above was the route for all timber and permitted the use of a single power-driven saw. All supervision had its maximum efficiency. This result was no more than natural, following a right analysis of conditions existing with knowledge of the requirements.

MANAGER SHOULD BE ANALYTICAL AND CONSTRUCTIVE.

One type of mind starts with what has been done in the past as a basis for the future and reaches the future result by mere process of addition and multiplication; it assumes that a man who has mined, trammed, timbered and bossed is therefore competent as foreman and superintendent.

The other idea is that, together with a good working knowledge of the details of the work, there must be the capacity to interpret, the analytical mind; and the power to remedy defects found, the constructive mine. It has seemed to me that some of our schools pay too much attention to the petty details of operation, things ephemeral and likely to be obsolete in comparatively little time, and too little time to the purely scientific and fundamental, which will force students to depths sufficient to develop the best that is in them.

There is danger in what is too new, for pioneering is costly. But for almost all mines tried methods, recently developed, perhaps, but accepted and proved, are available. Therefore the use of the untried is seldom warranted. When it is a last resort, skilled direction is particularly necessary. I have assumed that the operator should know and would know the latest accepted methods. I mean just this, for I believe that any manager or superintendent who does not give time each year to visiting other mines will probably become incompetent by reason of his coating of rust. It is essential and he does not need to confine himself to gold or copper or lead mines. Let him visit the coal mines and see to what extent their movements are automatic, automatic because they can not afford to trifle with the handling of coal. Of course, he may be a loyal quartz miner and merely feel glad that he does not have to handle anything that must be moved so cheaply.

LESSONS FROM OTHER MINES.

We have had the grace to copy the coal miner's washery and picking belt with gratifying results. Henry M. Adkinson tells of dump washing and sorting by which material worth $3.73 was converted into $8.36 mill heads at a cost of 21c., and discarding 55 per cent of the tonnage taken from the dump. He goes further and shows that he was able to alter mine-stoping methods at a saving of 50 per cent. in the cost, while the cost of sorting out the somewhat increased tonnage of waste mined with the ore was but a few cents. The net result was excellent. This is an admirable case of nice adaptation of the means to the end.

Concentration of effort is always profitable and in mining it may be made so in driving one heading at high speed instead of two at half that speed. Supervision is easier and the result in doubling the amount of ore available at one time and one place is of great importance. The idea of consolidation of adjoining properties of the same character follows as a corollary. To cite further instances is to reiterate, though there are many examples of extraordinary results from the application of great skill to a poor quality of raw material in the form of ore.

I believe that any community must understand the basic principles of the industry by which it lives. I apply this with special force to the mining communities, which must recognize that any continuous prosperity must have as foundation the principle of intelligently making use of trained men and scientific methods. As for the engineer and manager, to be worthy of his title and to command the respect of the community for his training he must be alive to all the possibilities in his work; his methods must be cleaner cut and his results more certain. To too many, a mining education is merely a license to make a living in mining, without any recognition of the corresponding obligation to the state and the industry. To secure satisfactory results the community and the engineer must each recognize the obligations imposed and unite their efforts for the common good.

SUCCESS IN ENGINEERING

William R. Cox, who is well known as a successful mining engineer, in an address to the students of the School of Mines and Metallurgy, of the University of Missouri, at Rolla, Mo., on Oct. 24, 1911, under the title of "Some Suggestions to Mining Students," gave the following excellent advice, which the Engineering and Mining Journal endorses:

The problem confronting every engineer when he finishes the work required by his college may be formulated something like this:

Given my individual talents, such as they may be, and the training which I have received, what must I do to make the most of them in the long run? How may I develop myself, first, most thoroughly; second, most rapidly to the limit of my capabilities, and convert that development into confidence in myself, the respect of professional friends and the practical benefit of a successful career?

Many difficulties and some failures will be avoided if every one of you will ponder well this first practical matter, the importance of which will be brought home to you forcibly when I tell you that with all the hundreds of graduates turned out annually by engineering schools, every active operator is put to it continually to supply his need of competent, practical, young engineers. This statement you can verify for yourselves. It means that a large proportion of technical graduates do not develop as they should practically; principally because they do not know how to carry forward their education from the point at which the school drops it.

This scarcity of competent men spells opportunity for those young engineers who have the wisdom and earnestness systematically to prepare themselves practically as well as technically to fill the demand which never fails. Be certain that many operators are searching diligently at all times for the right men, and when someone tells you that your profession is overdone, remind him of Webster's remark about "room at the top." All important progressive operators, individual and corporate, have long since agreed that technical men are the best timber for development into managers and directors of large mining enterprises, and it is your responsibility to fit yourselves for the demand always existing for competent service.

Many graduates make the mistake of seeking at once work of responsibility, calling for experience and expert judgment, which they cannot in the nature of things possess. It is a serious misfortune for the young engineer and for his unwise employer when such a man is called to report upon prospects or mines or to recommend their development, equipment, method of operation, with valuations, estimates of working costs, profits and other data of similar character. The trained engineer with years of practical experience has difficulty in avoiding the mistakes, errors of judgment, and other pitfalls awaiting those who must do this kind of work. Do not court half successes or certain failures in permitting a desire for too rapid advancement to crowd you into undertakings for which you are professionally immature.

Avoid all short cuts which seem to promise success and reputation; set your feet steadfastly in the same logical road which attains the summit of the hill when you have climbed honestly and bravely with no attempt at running around the easy contours.

Now as to hill climbing:

I advise you every one to devote a number of years, more or less according to your aptness and your opportunities, to manual labor in every department of assaying, surveying, drafting, office and accounting, underground work, milling and construction. You will earn at least as much in practical work during this period as you would in minor technical positions, and you will come out with a grasp of your business which no man achieves who lacks the persistent courage to carry him through this invaluable apprenticeship. Much of this work and of the conditions surrounding it will be hard, rough and disagreeable; nearly impossible to men accustomed to luxury and soft living, but we cannot discuss the business of mining from a "pink tea" viewpoint.

With the preparation suggested you will be competent for the management of a modest property or for a position of limited authority and responsibility on a large one, and your steady advancement will depend upon your personal capacity and opportunities. You will know your business, and that is the main point after all.

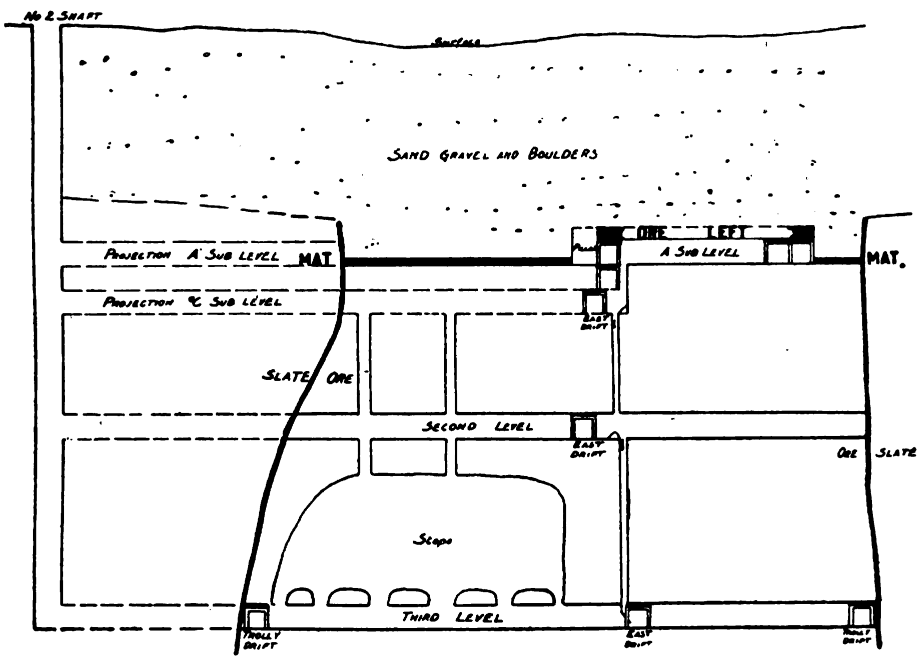
Be careful and methodical in keeping the notes given you in lectures and classes. This work is entirely neglected by a large percentage of students, with the result that much valuable time is lost when you are put to the practical test of gathering information in the field. My advice is to begin early in your college work a systematic method of compiling useful data. A diary supplemented with kodak pictures of plants, appliances, drawings and constructional work will be of assistance all through your professional life.

The carborundum crystals produced in the electric furnace are as hard or harder than the diamond, but they have always been of a dark color. Some success has been achieved in producing them of a colorless and transparent form even superior to the diamond in appearance. They are as yet brittle, however.

TOP-SLICING METHODS AT THE CASPIAN MINE

By WM. A. McEACHERN.*

The Caspian ore body was found in 1900 by churn and diamond drilling. The surface averaged 130 ft. and many of the holes were only chopped into the ledge to determine the best location for a shaft. In January, 1902, No. 1 shaft was started. This was a drop shaft and was landed April, 1902, with difficulty, on account of sand and water. The shaft was continued to 380 ft. From the shaft crosscuts were started on the second and third levels and continued across the ore body. Drifts east and west and then crosscuts, 50 ft. apart, parallel to the main crosscut, were continued to the rock. No. 2 was also a drop shaft and was sunk to the third level. This shaft is used for lowering men and timber.

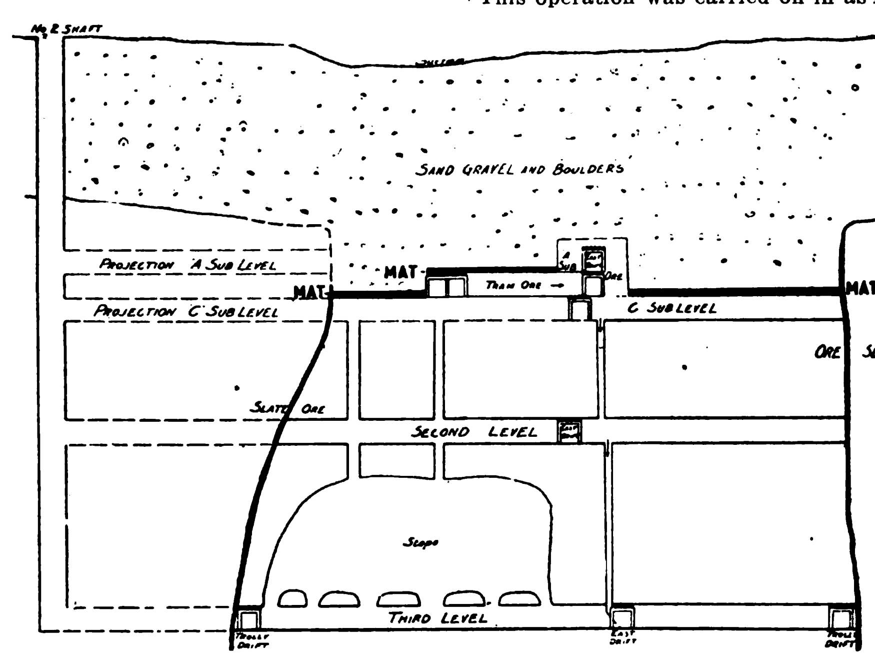


Caspian Mine, Cross Section No. 1.

Stoping—Between the second and third levels, nine stopes were opened up. These were started directly over and about 10 ft. above the back of the crosscut. The method used was back stoping; drilling holes into the back and blasting, then standing on the broken ore and drilling another round of holes. The average size of the stopes was 100 ft. long, 25 ft. wide and 50 ft. high, leaving a pillar of 25 ft. between the stopes.

Draining the Sand—The ore near the ledge could not be mined until the water was drained from the sand. Very little work was done on the first level, now called "C" sub-level, until 1908. This level was then extended and crosscuts started directly over the crosscuts on the second level. Small raises were put up from this level in various parts of the mine. A 12-ft. test hole was drilled ahead of each cut to ascertain the height of the sand, then 6-ft. holes were drilled and blasted. When the test hole reached the sand, 6 ft. holes were again drilled and blasted, leaving 5 to 6 ft. of ore to hold up the sand. Three more holes were drilled to hasten the drainage. Forty-eight raises were put in and some ran with little decrease in water for over a year.

Top Slicing—Top slicing at the Caspian mine is the method by which the ore is mined off at the top in slices 10 ft. thick and directly under the overburden In June, 1908, a raise 20 ft. high was started from No. 5 east crosscut on the first level. This was a cribbed raise and had two compartments, one for ladders and one for ore. The height was determined by the distance to the ledge. When this raise was completed other raises were started and crosscuts east and west were started from them and continued to the rock. This was the beginning of the top or "A" sub level. The crosscuts were timbered using 8-ft. caps and legs and lagging in the back. Connecting the crosscuts on the end completes one slice as shown on the plan. The machine was moved back and another slice 8 ft. wide was started. These were timbered the same as the crosscuts and lagging laid on the floor when the slice was finished the middle legs of the first two sets were drilled and blasted, bringing the overburden to the floor. The mat which prevents the sand from mixing with the ore consists here of 5 ft. of ore left behind, and the caps and legs of timber sets and lagging from back and the floor. The slicing of the pillars was continued until only a 10-ft. pillar was left at the main drift. (Cross section No. 1.) This operation was carried on in as many crosscuts as the demand for ore required and pillars were left on each side of the main drift for the transportation of timber to the two succeeding sub-levels.



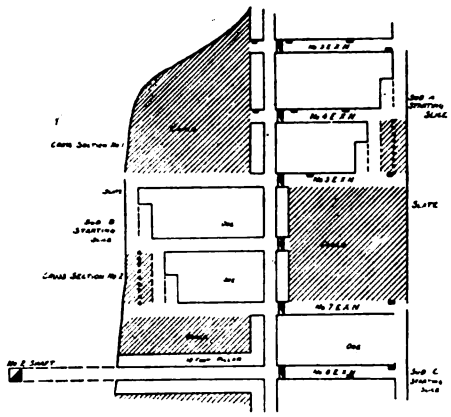
Caspian Mine, Cross Section No. 2.

"B" Sub-Level—The back of this level was even with the mat and is 10 ft. below "A" sub-level. On "B" sub-level

* Paper read at the Menominee Range meeting of the Lake Superior Mining Institute.

there were three points where the operation differed from "A" sub-level:

(a) No back holes were drilled as the ore stripped off the mat.



Caspian Mine—Plan of Sub-Levels.

(b) The timber was kept closely to the breast to hold up the mat.

(c) Boards were used on the floor instead of lagging.

No. 2 cross section shows "B" sub-level on the west side half drawn back, and on the east side finished with the exception of a 10-ft. pillar to support the drip. On the east side is also shown a crosscut in "C" sub-level ready for slicing. In any part of the mine slicing or crosscutting is not begun until the ore is taken out above it.

Sub-Levels Between the Stopes—Within the next ten years, if one sub-level a year is finished, the sub-levels will be down to the stopes. The stopes must be filled with ore and trimmed and then crosscuts run between the stopes to the rock. The pillars will be sliced the same as before.

When the overburden is let down part will rest on the floor of the pillar and part on the filling in the stope. It will be necessary to carefully watch the chutes to the stope as lowering the filling might ruin the mat and allow sand to mix with the ore.

SIMPLE METHOD OF SEPARATING ROCK FROM CLAY

By F. A. KILLIK.*

The method herein described was installed at the Totok gold mine, Celebes, Dutch East Indies, for the purpose of separating a large proportion of stiff, wet clay from the ore delivered to the mill. This clay occurs with the quartz and formerly gave great trouble in the bins, breakers and automatic feeders. The ordinary puddler did not prove a suitable machine for effecting the necessary separation, on account of its high cost of installation, heavy running charges and other drawbacks, and therefore it became necessary to find a better method. Owing to the fact that water under pressure was available at the mine, the present plant was devised and has proved eminently satisfactory in the reduction of labor and other costs, besides being beneficial in other ways. The author is not aware that any description of a similar method has been published and hopes that a detailed account of the process may be of use to others confronted with a like difficulty.

GENERAL DESCRIPTION OF PLANT.

No. 1 Plant—Fig. 1 shows a strongly constructed V-shaped hopper A, made with watertight joints and set at an angle of 25 degrees to the horizontal; the front or mouth of this hopper is 4 ft. wide and is closed to within 2 ft. of the level of the washing plate B. Six inches in front of this is an adjustable board C 10 in. wide, set so as to form a space between it and the plate B, which is 4 ft. wide, 4 ft. long and has a fall of 3 in. It is boarded in at the sides from a height of from 3 to 4 ft.; fitted under the forward end is a grizzly D 4 ft. in width, set at an angle of 45 degrees, the bars of which are 10 ft. long and spaced ¾ in. apart.

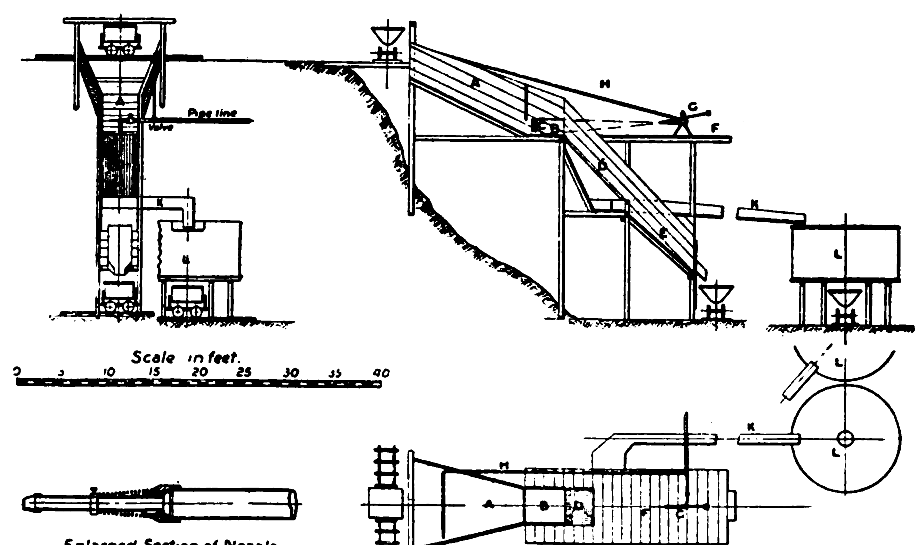


Fig. 1.

The ore bin E is placed 18 in. below the grizzly at an angle of about 38 degrees from the horizontal, the boarding around the bin being extended up both sides of the grizzly. The bin front is of the usual construction, fitted with an adjustable door and butterfly in the chute.

The timbers carrying the washing plate are extended some 15 ft. and supported by the front posts of the bin. Upon this extension is the operating platform F about 18 in. above the level of the washing plate. A pipe line is provided, terminating in a nozzle G controlled by a valve. The nozzle G of the washing pipe is afforded change of direction by means of a ball-and-socket joint of simple construction, the details being shown to scale in the sectional drawing; it wil be noticed that the ball-and-socket joint is kept tight when the high pressure water is shut off by means of a spiral spring that keeps the two parts in bearing. A lever is clamped closely to the nozzle for the purpose of directing it where required; this is attached in position by a bolt on a bridge support in the same manner as is practiced with hydraulic monitors. A ¾-in. pipe H, with a controlling valve, is taken off the pipe line at a convenient point before it reaches the nozzle, and this pipe is carried up above the hopper, over which it is extended by a right angle bend provided with perforations, for the purpose of spraying the material as it is dumped into the hopper from the trucks above.

A waste rock "sollar" is built below in a convenient position for sorters. Immediately under the grizzly compartment is a wide launder K, closed in to prevent loss from splashing, the bottom being well inclined to one side, where it is narrowed down and connected with a launder leading to settling tank L.

The hopper A, as also the sides of the grizzly compartment and bin, are lined with ⅛-in. flat steel sheets; for the bottom and sides of the washing plate B old side plates from mortar boxes are used. The settling tanks L are of the usual construction, with filter bottoms

* Bulletin No. 87, Institution of Mining and Metallurgy, London.

and bottom discharge doors, and of a size and number suitable to the capacity of the plant.

The total height, as shown in Fig. 1, is 28 ft., but to meet the circumstances of the installations the measurements may be reduced in the following respects. The hopper may be shortened, the grizz'y cut down to 6 ft., or somewhat less, and the ore bin below the grizzly set at an angle of 35 degrees and shortened.

Plant No. 2—This varies from that al ready described in having a fine, removable screen M, under the grizzly and a baffle-board N, set at right angles to the latter to throw sands on to the screen; a second small bin R, to take the product remaining on the screen, together with shaking tables O, and blanket tables P, as shown in Fig. 2.

OPERATION OF THE PLANT.

If a large quantity of ore has to be handled it must be ascertained if the fines (say the material passing on 8 or 10-mesh screen, after contact with mercury on the shaking tables, are worth collecting and milling. If so, the plant would be constructed according to the arrangement shown in Fig. 1, using the grizzly only, with settling tanks. If, on the other hand, the fines be poor enough to discard after mercury contact, an 8 or 10-mesh screen must be placed immediately below the grizzly, as shown in Fig. 2. The fines passing the screen are led to shaking tables, the first two compartments of which contain mercury, and they are run at a speed to give some 200 shakes per minute. After this treatment the sands are run over a wet blanket table and thence into the catch-box.

Should the material to be treated contain but a small percentage of rock, and this not of sufficient size to act as a disintegrator on the plate, rock must be added to this point, and the opening exposed to the water jet diminished to prevent too rapid feeding. The larger pieces of rock on the plate may be retained there by a few bars through which the fines and water pass.

The material dumped into the hopper is subjected to a constant spray of water by means of the sprinkling pipe H, which thoroughly moistens the clay and aids the subsequent disintegration of the charge when it is attacked by the water jet.

When the hopper is well filled water from the nozzle is caused to play upon the opening; the rock washed out lies on the washing plate and sets up a grinding action upon the material. As the washing process continues, the rock accumulates on the plate and is gradually worked forward until it drops into the bin below, the fines and water passing through the grizzly, whence they are conveyed by launder to the settling tanks. The hopper should be well supplied during the time of filling the settlers, and the flow of water maintained in order to prevent settlement of slimes in the tanks which would hinder their subsequent draining.

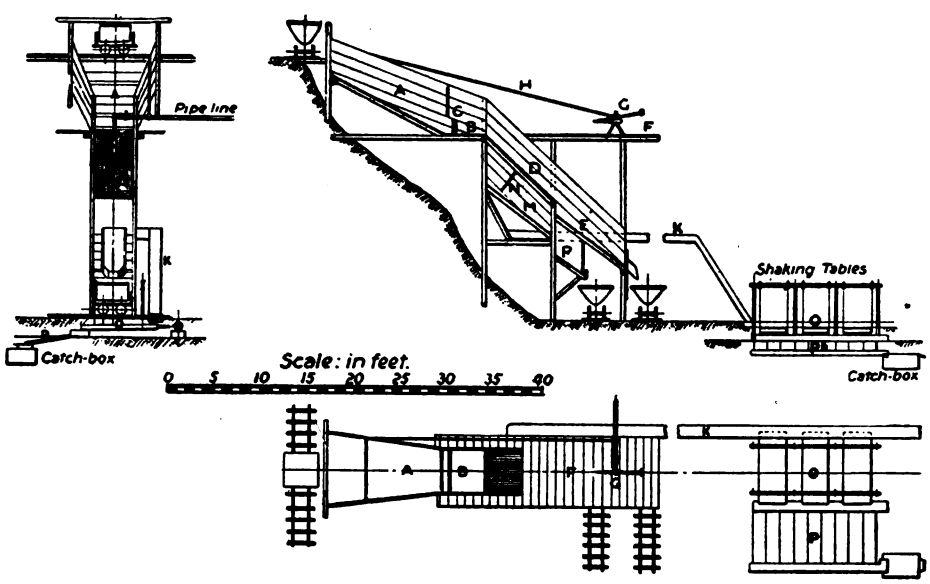


Fig. 2.

The material actually being treated at the mine with one washer is about 200 tons per 24 hours, and consists of:

Rock retained upon ¾-in. grizzly, 30 per cent assaying 10 grams of gold per ton.

Fines passing grizzly, collected in settling tank, 23 per cent, assaying 16 grams.

Waste rock sorted out, 7 per cent.

Slimes discarded, 40 per cent, assaying 1 gram.

The pressure of water at the nozzle is about 125 lbs. per square inch, but if necessary a lower pressure could be used efficiently. A ⅞-in. nozzle is fitted, but the valve is never opened full, from 15 to 20 cu. ft. of water per minute being used.

Cost of treatment per ton, based on 200 tons per day actually treated. Labor at eight hours per day:

	s.	d.
Hydraulicking (3 natives at 1s per day)	3	0
Sorting and trimming (12 natives at 10d per day)	10	0
Discharging tanks (4 natives at 10d per day)	3	4
Total	16	4

On total amount treated, equals 0.98d per ton.

On total amount recovered, equals 1.8d per ton.

The cost of treatment by the older method, with puddlers and shaking tables (on contract), upon the basis of 400 tons daily of material, containing 21 per cent rock, 6.5 per cent sands, 10 per cent waste sorted out and 62.5 per cent passed away over shaking tables, was, on total amount treated, 3d per ton, and on the total amount recovered 11d per ton.

Upon this material the costs under the new method would be:

On total amount treated, equals 0.92d per ton.

On total amount recovered, equals 3.2d per ton.

These figures do not include the power for driving the puddlers, etc., required by the older method, which would amount to 0.6d (per ton) of material treated, and 2d on the product recovered.

The disadvantages of the older system, compared with the new, were:

1. Higher first cost.
2. Power required to drive puddlers.
3. Great wear and tear of plant.
4. Increased labor.
5. Lack of continuity.
6. Increased time required for cleanup.
7. Excess of water required.

The advantages of the new method are:

1. A continuous plant working almost automatically.
2. No gold settling anywhere except in the tanks or upon the shaking tables.
3. Uniform flow of water, facilitating good running of the tables.
4. Minimum wear and tear.
5. Constant feed of rock into bins, assisting sorting.

In Boston there is an equivalent of 1,232 16-candle power electric lamps for each 1,000 of population; in New York, 859; in Chicago, 730, and in San Francisco, 660. European cities show much smaller figures, St. Petersburg having 440, Vienna 246, Paris 185 and London 184.

Mines and Methods

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CONTENTS:

It is announced that the Utah-Karns Tunneling Machine Co. is going to supply a machine for the running of a real (cross-my-heart-and-hope-to-die) tunnel for the Newcastle Reclamation Co., down in Iron county, this state. The tunnel is to be nearly a mile in length and it is promised that about 1,000 feet a month will be driven. If we remember correctly the Utah-Karns Tunneling company planned to run a tunnel in the Snake Creek district, south of Park City, for Uncle Jesse Knight a few years ago; but, other than the boosting that was given the company and its machine by the exploitation of the "contract," nothing came of it. The announcement this time carries about the same odor that emanated from the Snake Creek deal, and we notice that great stress is being laid on the value of this contract in the tunnel company's stock-offering advertisements.

FORTHCOMING REPORT OF UTAH COPPER CO.

Before another issue of this magazine will have made its appearance, the annual report of the Utah Copper Company should, if custom is followed, be in the hands of shareholders. Judging from previous compilations and the character of information that has been "released" from the company's publicity bureau and palmed off on the public through "stock market letters" and the subsidized press, the document will be equally as remarkable, in point of ingenious construction, as any of its predecessors and, as was the case one year ago, the shareholders are going to be officially informed that ANOTHER TREMENDOUS INCREASE IN THE AMOUNT OF DEVELOPED ORE HAS BEEN ADDED TO THE RESERVES. In order to pave the way for this announcement and to prevent, as far as possible, the sharp criticism that must come from those who have been kept in ignorance of what has been going on during the past twelve months, the company's press bureau, about the end of February, worked off on the Boston News Bureau and other "purveyors of news" a story the SEEMING object of which was to compare Utah Copper with Amalgamated shares as an investment—to the great advantage of the former, of course.

Two-thirds of the way down through the story referred to, without even beginning a new paragraph, or treating the matter as anything more than a presentation of the figures to make the showing desired in the discussion of the respective merits of Amalgamated and Utah Copper, is the following innocent and unobstrusive sentence: "The directors of the company HAVE STATED PRIVATELY (the caps are ours) that Utah Copper has RESERVES of 300,000,000 tons of ore, or an amount to last forty-three years, treating 7,000,000 tons per annum."

The use of so much space for the surreptitious promulgation of this bit of news, and the use of an imaginary inquirer upon whom to expend the energy, makes it worth while for Mines and Methods to quote the News Bureau fully, as follows:

It is not an easy matter to make the comparison mentioned in your communication, as it might almost be said that there is no such thing as "actual values" as applied to copper stocks, there are so many contingencies which must be allowed for, such as varying recoveries from the ore, varying costs of recovering the refined copper and varying prices at which the product must be sold.

In the case of the porphyry mines, fairly accurate determinations can be made as to the size of the ore body and the copper contents thereof. With these figures in hand estimates can, of course, be made as to earnings on various prices for copper, barring, of course, accidents and interruptions to operations. The vein mines are not able to give any esmate as to the life of their ore bodies, as it is impracticable from a mining standpoint to make openings too far ahead of extraction.

These are factors which must be borne in mind in any attempt to make the comparison you request. Then again, Amalgamated is not a "mining property," it is merely a corporation holding the shares of other companies.

We will endeavor, however, to give you a brief comparison along the lines suggested:

Amalgamated has outstanding 1,538,879 shares, and against this capital there is in the company's treasury 3,132,500 shares of Anaconda, or better than two for one. It also owns the United Metals Selling company. In addition the company has a surplus of $4,000,000 in net cash assets.

Anaconda can earn $3 per share on 14-cent copper assuming its annual production to be 275,000,000 pounds of copper. Amalgamated, therefore, is showing just now an earning capacity of $6 per share, or 9 per cent on the present selling price of 67.

Utah Copper is showing an earning capacity of about $4.50 per share, or 8 per cent on a selling price of 57. Demonstrations as to the future, however, can be made with respect to Utah Copper, which cannot be made with respect to the Amalgamated. The directors of the company have stated privately that Utah Copper has reserves of 300,000,000 tons of ore, or an amount sufficient to last forty-three years, treating 7,000,000 tons per annum.

It is costing the company not far from $1.50 per tor to "strip" the mine, transport, concentrate, smelt, refine and sell its product. On 14-cent copper there should be a profit to the company of $1.30 per ton. Applying this profit to 300,000,000 tons, there works out prospective profits of $390,000,000, or $241 per share on 1,619,000 shares—all bonds converted.

Thus, it is apparent that the company has an average earning capacity on 14-cent copper of $5.50 per share for forty-three years. According to the amortization tables these profits reinvested at 5 per cent give the stock a present value of $96.50 per share.

Of course there is much that is theoretical and academic in these calculations, but nevertheless they are the calculating methods of conservative experts, the only fluctuations to occur in the final profits being those dependent upon the fluctuating price of copper. Fourteen cents is generally recognized as a fair average, as this is the price at which copper has averaged over the past ten years.

With Utah Copper at 57 and average

profits of $5.50 per share per annum, the return on the present selling value is 9½ per cent. Utah Copper has not as yet reached its maximuum capacity, and in view of the calculations which can be made on the basis of present claimed ore reserves, there would seem to be greater security to the investor in the purchase of Utah Copper than in the purchase of Amalgamated with its indeterminate "life." No account of course is taken of the speculative possibilities of either.

Anaconda, which forms the basis of all Amalgamated's calculations, is assumed to have a productive capacity of 275,000,000 pounds per annum, at a cost of 9 cents per pound. Utah Copper is estimated to have a productive capacity of 140,000,000 pounds of copper per annum at a cost of close to 7½ cents per pound.

Even those who keep in touch with the Utah Copper Company's affairs and who are familiar with the easy methods they have of increasing developed tonnages—on paper—will experience some surprise when reading that during the year 1911 the mine's resources expanded from a trifle more than 200,000,000 tons (as officially claimed in last year's published report) to 300,000,000 tons. And many will wonder how such a seemingly impossible thing could happen without the market getting so much as a breath of what was doing—or had been doing—until a few weeks previous to the issuance of the annual report. Possibly we can throw a little light on the subject in advance of the official promulgation of the news.

Of course the company will not claim that this new tonnage has been developed as a result of steam shovel operations—it can hardly be expected to do that in the face of the reports during the year which acknowledged that stripping was not developing reserves fast enough to permit of a cessation of the underground methods of mining. As a matter of recorded fact it was necessary during the year to obtain a constantly increasing percentage of ore for the mills by underground methods, the last quarter averaging 27% of the total tonnage handled. This percentage was increased to 36 in January of the present year, while the rate for February was fully as high, as we have previously shown.

Such being the case, we must look elsewhere for an explanation of the development that has made such an enormous new tonnage of ore available during the last twelve months; and that necessitates disclosing what has evidently been cherished as a state secret by the Utah management, so that the news might be sprung impressively in the annual report, and so account for the new reserves of 100,000,000 tons.

A short time ago the Utah Copper Company completed the sinking of a drill hole some 900 feet deep on the line of the limited brecciated zone which borders the Quinn fissure, and claimed that values had been encountered all the way down. This drill hole is located at a point about 300 feet northeasterly from the point of junction of the Quinn fissure with the stronger mineralized zone which deflects to the northwest, passing obliquely across the easterly end of the Barnsdall ground into Col. Wall's Alamo-Jay Gould groups and on into the Highland Boy, as heretofore particularly decribed and illustrated with maps and photos in this journal, and upon which all steam shovel and underground mining operations have been directed for the past eighteen months.

This drill hole is located less than 300 feet westerly from the boundary lines of Wall's Starless group, through and beyond which, to the east, the Quinn fissure has been developed in the Bingham-Butte company's property, where a tunnel is now being dirven to demonstrate its value at greatly increased depth, and where exploration is relied upon to bring additional substantial results, results which seem to be assured by this new drill hole development.

As to results obtained from sinking this particular drill hole we defer to the Utah Copper Company the privilege of first publication. It is evident, however, that if ores of commercial value have really been discovered by this development, their extraction must be by some method other than by the steam shovel. The facts are, however, that this is merely a "scout" hole, sunk for the purpose of information as to the character of ground in the immediate vicinity of the underground drift or tunnel which is now being extended from the Mascotte tunnel of the Ohio Copper Company to a connection with the Hayden drill hole, sunk from the bottom of the "big pit" and which connection is now so nearly completed as to begin to draw off the water which has heretofore obstructed the operation of shovels in the bottom of the pit.

This extension of the Mascotte tunnel, insofar as it has penetrated Utah ground, and which will shortly intercept the Hayden drill hole at about 800 feet below the surface of the pit, is being exhaustively sampled by a corps of experts in charge of Engineer Henry Crumb, evidently in the employ of someone other than the Ohio Copper Company, so that announcement may soon be expected that arrangements have been made for transportation facilities and underground mining methods—from the Quinn fissure zone.

Thus we have the first evidence of a resort to sane methods of mining Utah ores. But, as we have repeatedly heretofore shown, this departure will leave the Bingham & Garfield railroad, with its terminal ramifications, from 1200 to 2000 feet UP IN THE AIR, and about three and one-half miles distant from the point at which the ores will reach the surface on a branch of the lines of the Rio Grande railroad, which serves the Ohio Copper mill.

HOW TO FIGURE PROFITS

In these strenuous times no paper that lays claim to being up-to-date in its mining news department fails to do its best in "plugging" for the "dissiminated porphyry" mines. They know something is expected of them and they strive to make good. They frequently get off wrong—sometimes when they know better, and at other times when they don't.

On the morning of St. Patrick's Day the Salt Lake Tribune's mining department, under the displayed headlines reading "Profit Not on Tonnage Figures; Occurrence of Ores Must Also be Taken Into Consideration," offers the following symptoms of the writer having listened to the befoggled argument of a night-outer. If you cannot quite make out what the writer, or the "mining man" he is supposedly quoting is trying to get at—take another drink and try again. Here is the "dope:"

A new feature of the estimated earnings of the porphyry coppers has been brought out by a Salt Lake mining man, who says that the developed tonnages and estimated profits cannot be always ascertained under stated given costs of production, for the reason that under different mine conditions the costs of handling are increased or decreased according to the occurrences of the ore. If a certain tonnage is developed and the costs of handling are accurately ascertained, these costs need not apply to all parts of the mine. Should the ore be found scattered over a large area, it is obvious that the mining costs will increase in proportion to the amount of work necessary to get at the deposits. Once the deposits are reached, then, of course, the dead work is passed and will be practically nil as long as the work continues in the ore body.

On the other hand, if the ore is found in lenses in different parts of the territory and it takes considerable driving to get to them, the profits are not as great as if the deposits were continuous. Again, if the ore is demonstrated to be continuous over a large area, the extraction costs are reduced. These facts must be taken into consideration, it is argued, when estimating profit on disseminating ore. Under given conditions a mine with half the tonnage of another property may be as valuable as the larger property because of the reduced costs of extraction and the concentration of the work. This condition calls for the ore to be all in one deposit and mined in a systematic and economical manner.

While in making estimates on the earnings of different properties the mining costs have been figured as an average to meet all conditions, yet the same costs of handling cannot be applied to different properties which have the same grade of ore and occurring in like quantity, because the distance between the different ores must be taken into consideration before a logical estimate can be made.

This difference in costs of handling and in ore occurrences is shown by the records made by some of the porphyries to date. Up to the present time, Utah Copper, Nevada Consolidated and Chino have been demonstrated to be the only steam shovel propositons. The lowest cost will probably be attained by Chino, since it is already operating at a cost of 7 cents per pound for the copper produced. At one time, by using the profits from the Nevada Northern railroad, Nevada Consolidated showed a cost of about 6 cents, but is not producing at this rate at present. It is true that the ore at times is lower grade on account of surface ores coming in, but as the work progresses, this difficulty is overcome to a great extent.

Of the properties that have lower grade ores underground where caving systems must be used, the argument brought forth in the costs of getting to the ore holds true perhaps to a greater extent. Here the difficulty is likewise encountered in getting a clean product, and when waste comes in that waste must be hoisted. But the idea of the costs of getting to the ores is emphasized, for in a body such as the Miami, which is of a little better grade and more compact than some others, it is brought out that greater profits can be made.

With these facts as a working basis, the estimates made on developed tonnages must be estimates made on the ore occurrences and the abi.ity to get the output mined in the most economical manner.

In answer to several inquiries as to the location of the much-talked-of new gold camp of High Grade. It is located in the extreme northeastern corner of California, almost on the line between California and Oregon, and about eight miles from New Pine Creek, a station on the Nevada, California and Oregon railroad which, according to the maps, is on the Oregon side of the line. Colorado, Nevada and Southern California interests appear to be doing the boosting for the district, which is claimed to be full of merit and due for a boom this spring, after the snow is gone.

In Sydney last month, on two successive days, two workmen were electrocuted. One man was a rock-driller working on the sewer outfall works at Long Bay, and his death was caused by the current short-circuiting with a rock-drill which he was handling. The second case was that of a fireman employed at Saxton and Binns' timber yards at Pyrmont. He was carrying a small flexible extension electric hand lamp, when, owing to a short circuit occurring, a current of 240 volts passed through his body, death being instantaneous. Such accidents are fortunately of rare occurrence, but they serve to show the necessity for all electrical apparatus to be properly insulated and carefully installed.—Australian Mining and Engineering Review.

The use of uranum and its compounds are relatively few and not extensive, the principal use being in the manufacture of yellow glass and for yellow glazes for pottery and to a small degree as a chemical reagent. The attempt to use uranium in steel manufacture seems to have been given up as it apparently imparts about the same properties as tungsten and is very much more expensive.

Linseed oil added to whitewash adds to its durability. Sulphate of zinc and salt help to prevent flaking.

UNUSUAL SOLICITUDE OF UTAH COPPER COMPANY IN BEHALF OF COL. WALL

R. C. Gemmell, assistant general manager of the Utah Copper Company (whose picture is here given) put another "hot one" over Col. Wall recently when he secured an order of the judge of the Third District Court granting exclusive possession of a strip of Col. Wall's Car Fork property about 3,500 feet long, for the purpose of constructing a high voltage electrical transmission line. The route selected is over that portion of the grounds alleged by Col. Wall to contain his most valuable deposits of copper minerals, and in and upon which his chief mining development work is being directed. The line also occupies a central position over and across that part of Wall's property which has heretofore been appropriated in like manner for the dumping of waste or overburden from the Utah Copper property. The line branches out from the company's transformer station, which is upon grounds theretofore donated to the Utah Copper Company by Col. Wall and is reached by the main power line extending from the Magna plant, the last 3,000 feet being upon a circuitous line located upon and passing over Wall's Starless property in Main Bingham, the right to construct which was also granted by Col. Wall without any consideration or value.

The objective point to be reached in the construction of this new line is stated in the bill filed in the District Court as the town of Upper Bingham. Now, the distance from the transformer station to the terminal station indicated, in the town of Upper Bingham, in a direct line over grounds owned exclusively by the Utah Copper Company, is about 3,000 feet and a line constructed upon this route would be comparatively straight, following the bed of the gulch and county road, where no steam shovel operations or surface mining is contemplated or possible. To reach Col. Wall's Carr Fork property it was necessary to branch off at something more than a right angle to the north from the direct course to the objective point, as indicated, passing over property owned by the Utah Copper Company and other parties for a distance of about 2,000 feet. From the point at which the line leaves Col. Wall's property the distance to the terminal objective point, as stated, is probably 7,000 feet, the lands being owned by the Utah company, but situated outside of its mineral belt; so that, in order to reach a point from which the people of Upper Bingham are to be served, as stated in the petition, a distance of nearly two miles is traversed in preference to the direct line before mentioned to Upper Bingham.

An interesting feature of the testimony upon which the order of possession was procured consisted in a letter written by Manager Gemmell to H. C. Goodrich, chief engineer of the Bingham & Garfield railroad and the Utah Copper Company, which was read to the Court and which, in pathetic terms, enjoined Chief Engineer Goodrich, if possible, to select a route for the desired line without further intrusion upon the property of Col. Wall, and in an earnest effort to carry out the wishes of Manager Gemmell Chief Engineer Goodrich declared, under oath, that he had exhausted his entire engineering ability without result, other than as before indicated.

According to Consul General Thomas Sammons of Yokohama, a new process for the electrolytic recovery of zinc has been successfully worked out by Chitaro Yoshida, the proprietor of a copper mine in Iwashiro province, Japan. The zinc ore is dissolved in the electrolyte, and from this liquid the zinc is precipitated by electrolysis. The process is simple, but several obstacles have been found. For instance, the presence of a small particle of copper, antimony or arsenic is enough to render the process futile. One of the defects of the process heretofore has been the spongy form of the zinc which adhered to the cathode. To prevent this carbon was tried instead of lead in the anode. The carbon was coarse and dissolved in the sulphate of zinc, and the zinc which gathered on the cathode was then found to be refined to a degree rarely surpassed by the imported metal. During 1910 Japan exported 24,747 tons of zinc, valued at $383,485, and imported 11,581 tons.—Mining Science.

At Stratton's Independence mill, in the last fiscal year, the wear and loss of steel in the chilean mill rolled-steel tires was 0.43 lb., and in the dies 0.19 lb. per ton of ore crushed.

UTAH COPPERETTES

When the Utah Copper Company finally admits that steam-shoveling at its Bingham mines is a failure and it changes to underground methods, wonder what it will do with that $5,000,000 sky-line railroad?

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It may be interesting to the "plain people" who may be shareholders of the Ray Consolidated to know that, by the peculiar methods of finance adopted by the Hayden, Stone-MacNeill-Jackling syndicate, in the exchange of Ray Central for Ray Con. shares, the syndicate was able to secure its shares on a basis of about $13 a share for Ray Consolidated as against $16 for the p. p.

****

It has been discovered that the sudden disappearance of the water from the bottom of the big pit or shaft of the Utah Copper Company, being sunk by the steam shovel method and which has now attained a depth of about 100 feet below the surrounding surface, was not due to connection with natural subterranean caves, as had been suspected, but simply to the near approach of junction with the drift from the Mascotte tunnel, which has now reached a point beneath the big pit and probably contacted with the Hayden drill hole.

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The Copper River & Northwestern railroad, the 195-mile line built by the Guggenheims to supply transportation for the ores from their Bonanza mines, in Alaska, admitted to contain profits of not over $5,000,000, cost approximately $22,000,000 to construct and equip. The amount has been variously estimated at $13,000,000 to $25,000,000. It is stated on good authority that the house of J. Pierpont Morgan & Co. is "holding the sack" on that proposition, and that strenuous efforts are being made to unload it on the government.

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One of the local "units" of the Utah Copper's subsidized press slipped a cog the other day when it approvingly quoted the following item from the New York Evening Post: "By the rate at which it is disappearing, the statistical surplus of copper metal will presently quite vanish, and then, no doubt, it will be possible to prove statistically that the world consumes more copper than it produces, without any visible surplus to draw upon. SO FAR FROM BEING STAMPEDED BY STATISTICS, CONSUMERS EVIDENTLY HAVE AN OBSTINATE BELIEF IN AN INVISIBLE SUPPLY."

We understand that the visit of President Chas. M. MacNeill, of the Utah Copper Company, whose portrait is given herewith and who left for the East again Saturday last, has had to do with the forthcoming annual report, which will likely be issued the latter part of April. This report, it is understood, will present another surprise to the "plain people" of the Utah company by the announcement of the development of another 100,000,000 tons of ore during the last year and of which no previous notice has been given, except some "private" tips that have been handed out to favored members of its press syndicate, as indicated in another article. It will be hoped by the friends of the investors in securities of this corporation that the reflex action of this announcement will have a more exhilarating effect than that which followed the premature announcement of the development of 96,000,000 tons of new ore reported for the first time in the issue of the report for 1910.

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It is said that the excessive snows at Bingham have accumulated on the north or sheltered side of the ranges to such an extent as to seriously interfere with the dumping of Utah Copper waste or overburden on Col. Wall's mines and workings, so that, unless there be an early abatement of snow-fall or the intervention of warm weather, which will remove the icy burden from the surface, it will be necessary to resort to the old dumping fields in the valley on the east side of Bingham, some eight miles away, and which can now only be reached over a great number of back-down switches in their railroad tracks. This result will of necessity add some 15c. a ton of ore, or a little more than three-quarters of a cent a pound to the cost of copper production for the succeeding one or two months. In view of this possible calamity it is said that the entire managerial and manipulatorial force of the Utah company are engaged in fervent prayer for warm rains and sunshine, which will restore the necessary dump and aid in the demolition of Wall's workings by the floods that must ensue.

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The large mills treating the copper porphyry ores have brought about a rapid development in roller mills more familiarly known as high-speed Chilean mills. In crushing tens of thousands of tons of ore a day, certain merits must be found in this type of intermediate crushing device; but when one considers the renewal of large tires and die rings, screens, bearings, pinions and gears, the query appears, will this type of crushing mill endure in mills of great capacity?—Frank E. Shepard, president of the Denver Engineering Works, in a paper on "Progress in Mill Construction."

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There is said to be absolutely no truth in the rumor that the Utah Copper management is dickering for control of the Mascotte tunnel, at Bingham, in order that it may have that avenue enlarged sufficiently to permit of moving in steam shovels to work the ground in the company's property at the bottom of the Hayden drill hole, the conclusion being that preparations are being quietly made for a resort to the only rational and economic method of extracting these ores—by the underground system of mining—which, in the adjoining Ohio Copper grounds, was secured for the month of February, this year, including development, at a cost only slightly in excess of 24c. per ton, and which compares with 26c. a ton as the lowest cost attained by the Utah Copper Company for extraction by steam shovel, after the removal of the surface at an additional cost exceeding 75c. a ton for every ton of ore obtained by the steam shovel method.

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Taxation of ore reserves is proposed in a bill now before the legislature of Idaho. This might well be called, "A Bill for an Act to Discourage Stability and Economy in Mining."—Mining and Scientific Press.

Idaho should not stand for it. You can just bet your last penny that any such a proposition as that will be strangled quickly if it ever is proposed in Utah. Our mines, and particularly those with ORE RESERVES aggregating THREE HUNDRED MILLION TONS and more, were not created for purpose of taxation. But, if such a law should happen to be passed in this state, it would be worth the price of admission to see the tonnage figures that such companies would, under oath, report.

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One of the latest market bulletins to come from the East says "good sales are reported in Utah Copper." Good!

IMPROVED METHODS OF ORE CRUSHING

Wall's Improved Rolls Seem to Overcome the Failures of Old-Style Mills and Meet the Requirements of Modern Practice in Every Essential Particular.

Minimum Power and Maximum Capacity Features of Devices Here Described, Resulting in Granular Products Free Erom Refractory Slimes.

Before describing and reviewing the results attained by the Wall crushing rolls advantage is here taken of the opportunity to reproduce an article from the pen of Mr. C. Q. Payne, a well-known engineer of New York, on "Progress in Roll Crushing"—which appeared in the Engineering and Mining Journal on the 17th of last month—because Mr. Payne, while granting roll crushing first place in the art of preparing ore for concentration, calls attention to certain inherent defects, the elimination of which he declares are still unsolved problems.

Mines and Methods desires to give full credit to Mr. Payne for having fairly and lucidly explained the state of the art of ore crushing as it is and has been for a long time understood, and for the purpose of comparison we reproduce his article, together with the results attained by the use of a new type of crushing rolls devised by Col. Wall and now being submitted to severe practical tests at the Ohio Copper Company's mill at Bingham, which will be more particularly decribed and illustrated further along in this article. We quote Mr. Payne as follows:

CRUSHING ORE WITH ROLLS IS DEVELOPING NEW ART.

The art of crushing ores and other materials by means of rolls is one of comparatively recent origin. While the first record of the use of rolls with iron crushing surfaces dates back to the year 1806, when they were employed in Cornwall, their principal development has taken place during the last 30 years.

To Stephen R. Krom belongs the credit of being the pioneer in introducing the belted high-speed roll, which was originated and developed in this country. His notable contribution to the art was in the use of a single bedplate or frame for supporting the roll shafts, and to which levers holding the movable roll bearings were pivoted. He also made use of steel tension rods to support the crushing strains, and of hammered-steel tires for the crushing surfaces. These changes brought the design of crushing rolls to an advanced stage.

Following closely thereon, about 1885, W. R. Eckart conceived the idea of the swivel or ball-and-socket support for the roll shaft bearings. This is an excellent mechanical conception, especially for bearings held against a spring pressure, and while it may not be necessary for all types of rolls, yet it has been quite generally adopted by other designers of rolls and illustrates the refinement which roll construction has now reached.

THE EDISON "GIANT" ROLLS.

Other engineers, as for example, Argall, Vezin, Rogers and Sturtevant, to mention only a few among many, have also given the closest attention to the various details of rolls, such as the frame, springs, bearings and shafts, and have developed many novel and original designs. It has remained, however, for the boldness and originality of Thomas Edison to extend the field of crushing rolls in two directions, and to cause them to exercise new functions. In developing crushing machinery for his portland-cement works, Edison constructed "giant" rolls, having a diameter of 6 ft. and a length of 7 ft. With these he was not only able to challenge the long established position of the jaw and the gyratory crushers as primary crushers, but even to leave them in the rear. By means of projecting knobs on the roll surfaces, he utilized the stored energy of the revolving rolls, and was able to shatter masses of rock of so huge a size that they could not otherwise be made to enter the rolls, thus saving the expense of block-holing and sledging, which is usually charged to quarrying. This work has had successful applications in crushing limestone, and there remain also possibilities of the extension of this new use of rolls to still harder rock.

In going to the other extreme of size reduction, Edison has also utilized rolls in pulverizing cement rock. For this purpose, rolls with sectional, corrugated chilled-iron shells 30 in. diameter by 18 in. face, are provided with shafts 18 in. diameter. The rolls are forced together with a spring pressure of 100 tons. The feed material, which has passed a ¾-in. screen opening, is thus reduced in a single operation, at the rate of 60 tons per hour, to a size of which 94% passes 100-mesh screen. This use of rolls carries the principle of choke crushing to so extreme a limit as to involve practically a new function. It would appear at first sight, however, that there is less margin of profit for rolls in pulverizing than in mass reduction, and only a close comparison of the final products obtained and the respective costs per ton can determine the relative economy of rolls for pulverizing when compared with the tube mill and other types of grinding apparatus.

ROLLS FOR COARSE CRUSHING ARE BEING MADE HEAVIER.

Irrespective of the part which rolls may play in the future in their relation to the two extreme limits of size reduction, there is no doubt that they have achieved for themselves a secure position in crushing products of intermediate sizes. This is partly due to their large capacity and low cost of operation. It is also due to the fact of their mechanical simplicity, which involves the principle of the toggle lever in overcoming crushing strains exerted by particles brought within the angle of nip of their surfaces. Since their revolving masses also serve to absorb their own "peak loads" when properly fed, a moderate and fairly uniform application of driving power is able to accomplish a considerable amount of effective work in splitting and shattering rock fragments.

Perhaps the most distinctive advantage of rolls is that their construction permits them to apply the principle of "arrested crushing" to a greater range of sizes than is possible with any other type of crushing apparatus. The crushing pressure exerted by the opposing roll surfaces during the angle of nip is instantly released and ceases when the rock fragments reach the horizontal diameter of the rolls, where the open space between them permits the material to be discharged. Roll crushing thus permits most careful and accurate stage reduction within a wide range of sizes, and avoids pulverizing and sliming an undue amount of the softer minerals of an ore, in crushing it to the size at which they will unlock sufficiently from the inclosing gangue to permit their being concentrated. For those ores, therefore, which require concentration, the use of rolls in preparing them for jigs, shaking tables, or magnetic separators has become almost the universal practice. This applies to many iron, copper, lead and zinc ores. Gold and certain silver ores, both those which require concentration and those which do not, are in a class by themselves.

The modern tendency to reduce milling costs by increasing the mill capacity has demanded a greater duty from rolls than ever before, and in the larger mills rolls are now employed from 36 in. up to 54 in. diameter, and from 15 in. to 28 in. width of face. Such rolls are used mainly for coarse crushing; that is, they take the product from the jaw or the gyratory crusher of 1½ to 2½-in. size, and reduce it to about ½ in. These coarse or No. 1 rolls are then followed by other rolls, set closer together for finer crushing, and possibly by others which re-crush certain middlings products obtained in the process of ore treatment, or even tailings, dependent upon the nature of the ore and its association. Rolls of this general character require massive construction and excellent workmanship. Rolled-steel tires can now be obtained up to 54 in. diameter. Special hard steels, such as chrome and manganese steels, are also used for certain ores, either in the form of tires or of plates bolted to a central mandrel. In this way the life of the crushing surfaces has been much prolonged.

Marked progress has thus been made within recent years in the field of coarse crushing by means of rolls, in response to the greater demands of modern mill practice, and this progress has been largely brought about by increasing the dimensions of the rolls and adopting a more massive construction, as well as a better design, combined with a wider choice of steel adapted to different ore requirements than has heretofore been available.

ROLLS FOR FINE GRANULATION NOT YET PERFECTED.

On the other hand, it must be admitted that up to the present time rolls designed for fine crushing, where the ore requirements demand a maximum granulating effect and a minimum pulverizing or sliming effect upon the crushed product, have made little progress compared with rolls designed for coarse crushing. In fact, rolls, as heretofore designed, can hardly be said to have held their own; and since little assurance of their satisfactory operation can be had in connection with an ore which must be reduced to pass a 20 or 30-mesh screen while retaining the crushed material in a granular condition, rolls have been assailed on all sides by various types of ball mills and other pulverizing apparatus, which claim to accomplish the function of granulating an ore successfully, but usually by means of some reduction in the time during which the pulverizing effect takes place. While there may be an overlapping territory at the limit of fine granulation where pulverizing apparatus may be so adjusted as to perform the function of approximate granulation with sufficient success to make their use advisable, yet it is clear that a crushing force exerted upon material placed between walls which do not touch when at their minimum distance apart, must produce a distinctly better granulated product than when it is crushed between walls which are brought into physical contact with a grinding pressure.

With the presumption of advantage thus on the side of rolls, even down to the finest sizes, the fact remains that heretofore rolls have proved unsatisfactory and inefficient, from lack of control over the granulating action as the roll faces wear, and also from their small capacity.

In looking more closely into the cause of this inefficiency, it is evident that the effect of the irregular wear of the roll faces becomes a more serious matter in fine crushing than in coarse crushing, for the reason that in the former, since the faces must be brought quite close together, the ratio of the sectional area due to irregular wear to the total areal opening between the rolls is greater than in the latter case. Hence any ridging, grooving, or corrugating of the roll faces permits a considerable proportion of the particles in the feed stream which enter the depressions to pass between the rolls without being crushed. This reduces the capacity of the rolls, measured by the amount of undersize or finished product obtained. Another difficulty arising from irregular wear of the roll faces is due to the fact that when out of parallelism rolls tend to exert a certain component of the crushing pressure at right angles to the diameter of the rolls, or in the direction of the axes of their shafts. This produces an end thrust upon the roll shafts, which, transmitted by means of collars to their bearings, causes them to heat and the shafts to cut, thus absorbing power wastefully, and still further reducing the crushing efficiency as measured by the power consumed to operate the rolls in relation to the amount of finished product obtained.

Rolls used for fine crushing thus show a decreasing efficiency in proportion to the wear of their roll faces until a point is reached where it becomes necessary to stop the crushing operation, and to restore the faces by chipping, grinding, or machining them until their surfaces are parallel. This involves loss of time and of mill capacity, besides expense and a wasteful use of the roll shells.

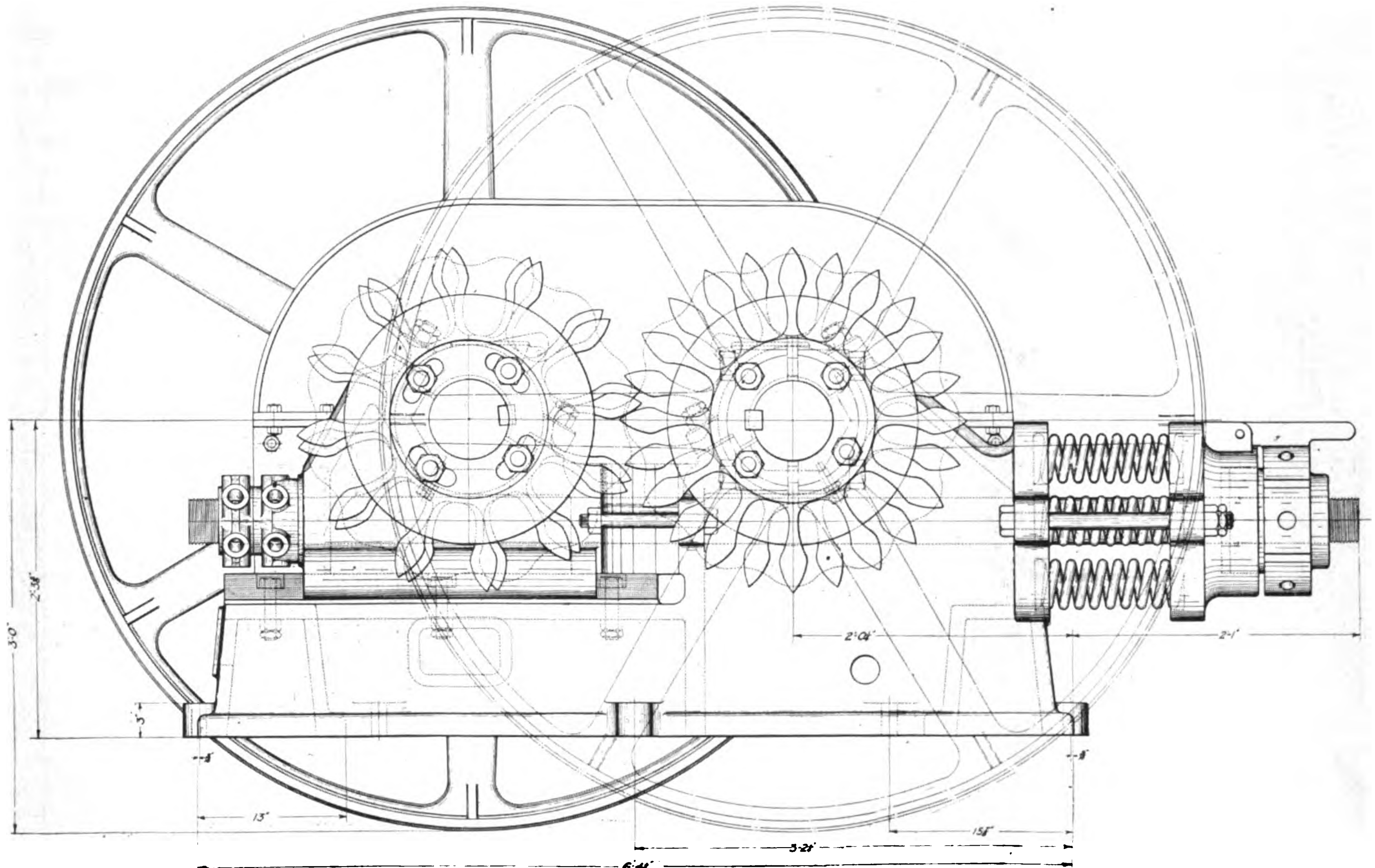
While a certain amount of choke crushing is usually advisable in fine crushing, in order to offset some loss of capacity, the best results can only be obtained, where the prime object is to granulate an ore, when the roll faces are maintained parallel, and when the feed consists of sized material in order to avoid packing and pulverizing it in passing it between the rolls. It seems clear from the above considerations that further advance in the art of fine granulation by means of rolls can only be expected by means of certain refinements of function whereby the roll faces can be maintained parallel while they undergo wear.

THE WALL CRUSHING ROLLS.

The Wall crushing rolls are of two types—corrugated and plain straight faced—similar in construction in every respect, so far as the crushing parts are concerned, to the Cornish rolls referred to by Mr. Payne, except that one roll of the latter type is mounted vertically above the other, as is clearly shown in the accompanying drawings.

There is now in operation at the Ohio Copper mill twelve pairs of the corrugated rolls and eight pairs of the vertical type, the corrugated rolls being utilized for a coarser crushing, superseding a large and small type of disturbing, so far as practicable, the daily output of the mill.

The corrugated rolls are 30 in. in diameter by 20-in. and 3 in. thick and are driven at a speed of about 125 to 150 revolutions per minute. The shells are manganese steel and the rolls are geared together with cast-steel finger gears so as to keep the corrugations of each shell in proper mesh with the other. They were originally placed to receive the product of Blake crushers which delivered sizes from cubes of 2½ in. down and were set to crush to about ¾ in. But subsequently the Blake crushers, which were of two stages, were discarded and type, it may be said that prior to discarding the Blake crushers the first pair of corrugated rolls installed was fed with the Blake crusher product, ranging in sizes from about 1¾ in. down—as the same was delivered from an elevator with an excessive flow of water—at a rate stated by the manager of the mill at 1,000 tons a day, the entire product being reduced to ¾-in. and smaller. Under these conditions the rolls were operated for nearly five months and were subsequently placed to receive a smaller product (of about 1 in.) and upon this have continued to operate for about three months longer, and are still in operation



(PATENTED APRIL 4, 1911)

Wall's Improved Corrugated Crushing Rolls—Side Elevation.

Blake crushers and receiving direct from the bins the run of mine ore and effecting a gradual reduction down to about 12 m.m. in size, the coarser material (in small proportion, however), ranging in size up to eight-inch cubes, the rock being quartzite of average hardness.

The installation of these rolls has been exceedingly slow and tedious owing to the fact that they were placed in a section of the mill already occupied by crushing rolls of the Gates manufacture of the Cornish type, and it was thought to complete the installation of the new machinery by replacing the old a piece at a time without the run of mine ore was delivered to the rolls direct from the bins, thus sending to the rolls rock ranging in sizes up to 8-in. cubes. The proportion of the larger sizes, however—that is, ranging from 4 to 8 inches—would probably not exceed 20% of the entire mass. The remarkable feature of this performance is found in the fact that these larger pieces are produced and passed through the rolls without the slightest jar. The larger pieces, owing to the high periphial speed of the rolls, are simply hammered into fragments before they reach the nipping or crushing point of the rolls.

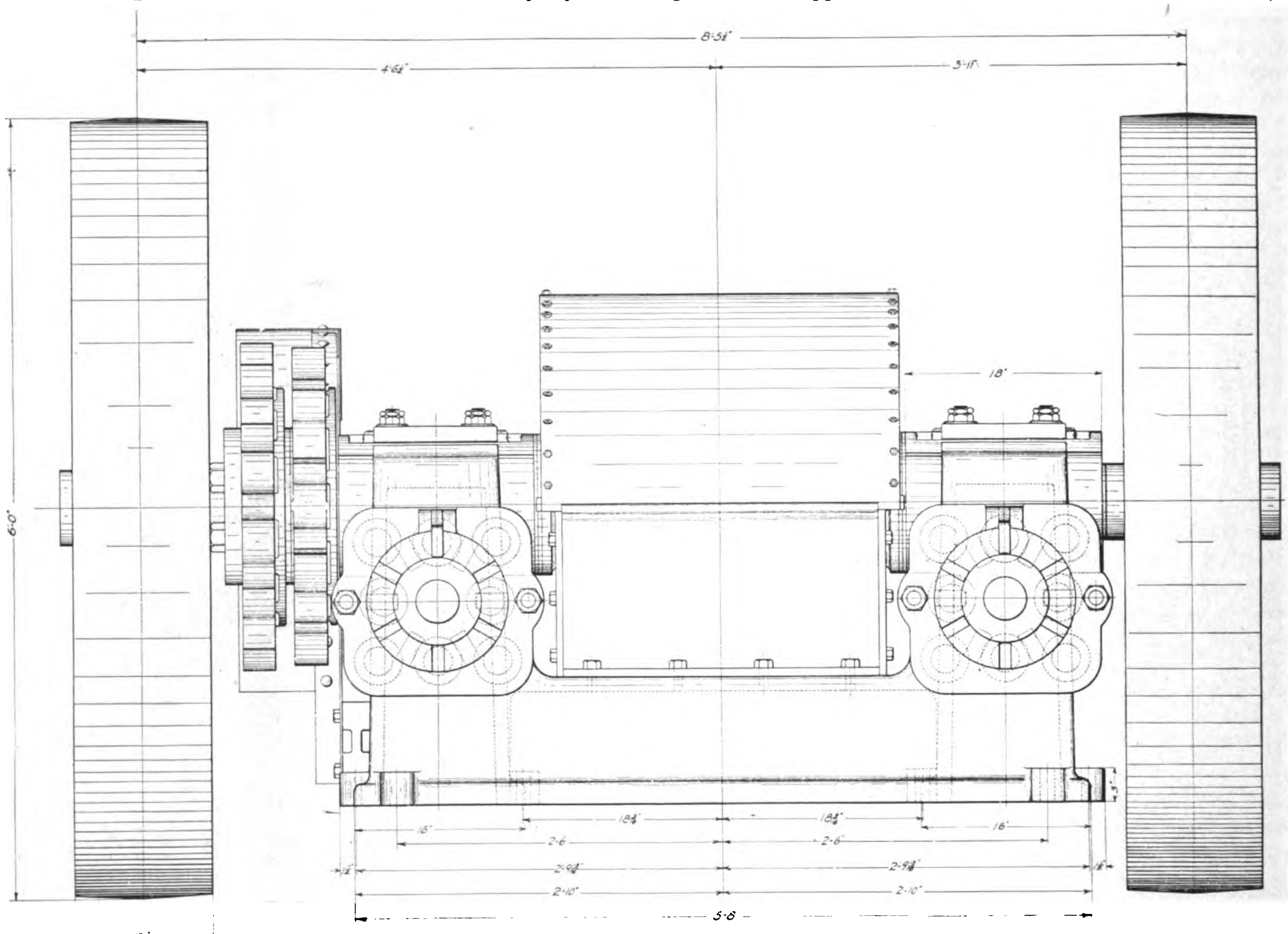
To indicate the relative capacity of these rolls as compared with the Gates with effective results. The first four months compares with the work done by the Gates rolls upon the same material, minus all material less than 1 in. which has been previously screened out, leaving to be passed through the rolls—as estimated by Superintendent Kidney—about 450 tons. A test of the power consumed during this work was made which shows that the corrugated rolls required 18 h. p. only, as against 39 h. p. consumed by the Gates rolls. The shells of the Gates rolls which were of rolled steel, and therefore of perhaps 40 to 50% less durability, have been changed several times, the highest estimated product during the life of those shells being somewhat less than 20,000 tons.

To sum up, it would appear that the same metal, upon similar work, and delivering a given quantity of finished material, would have a durability of from four to seven times greater if used in the corrugated form, to that of the plain face or Gates type; that the power consumed would be in excess of 2½ to 1 in favor of the corrugated form or crushing faces. Using the corrugated rolls in series of gradual reduction the pulp is readily reduced from ¼ to ⅜ of an inch without return of oversize.

As we understand it no attempt has been made or will be made to offer these rolls on the market until the installation at the Ohio mill has been completed. We are advised, however, that one set has been installed at the sampling plant of the International Smelting Company at Tooele, Utah, and is giving satisfaction.

In respect to the vertical rolls we are advised that eight pairs—42 inches in diameter by 16-inch face—have been installed in the Ohio mill and at this writing have been in operation a little more than three months, treating from 300 to 400 tons per day of material which had passed a 12 m.m. screen, the entire mass—without any return—being reduced to about 3 m.m. and smaller, the resultant pulp being perfectly granular and entirely free from amorphous slimes. The faces of the rolls continue perfectly true as when started, being free from annular grooves or flanging of the outer rims, suchh as result inevitably from the use of the ordinary type of Cornish rolls in common use.

The crushing is done by the Wall vertical rolls—as indicated in the specifications of the patent quoted herewith—entirely by the weight of the upper roll, no spring pressure being applied. This is made possible by the fact that the feed is distributed upon the lower roll some distance from the point of crushing contact and is carried forward upon the face of the lower roll in a sheet the thickness only of the larger grains. A portion of the rolls are set so as to take the product from this crush with the result that a very large percentgae of the feed is reduced to the ultimate size desired for treatment, namely, about 30-mesh. When the installation of these Wall rolls at the Ohio mill shall have been completed the Chile mills now in use may be retired.



Wall's Improved Corrugated Crushing Rolls—End View.

WALL'S PATENTED VERTICAL ROLLS

In presenting a description of the Wall patented vertical rolls we are reproducing the original patent drawings and specifications, in which the inventor seems to have clearly anticipated and set forth in a masterful manner all of the difficulties and deficiencies encountered in the old form of rolls, as so ably set forth by Mr. Payne:

To All Whom It May Concern:

Be it known that I, Enos A. Wall, a citizen of the United States, and a resident of Salt Lake City, in the State of Utah, have invented a certain new and useful Improvements in Ore-Crushing Mills, of which the following is a specification.

My invention relates to that class of ore crushing mills designed to receive ores or rock which has been previously broken into fragments of two inches and smaller in diameter and to reduce the same to the smallest possible size consistent with the production of a perfectly granular pulp, and having this object in view I assume the following conditions to be self-evident and indispensable—viz., that the crushing surfaces must not "grind" or "slip" upon themselves nor upon the material sought to be crushed and that such crushing can only be effected by direct pressure—such, for instance, as would result from the passing of the wheels of a car moving in a straight line upon a smooth track over pebbles placed upon the rails. The "pulp" resulting from such contact, though infinitely fine, would still maintain granular or angular form. A crushing-mill operating upon this principle will possess the highest degree of durability and require the minimum of propelling power; but it is not economically practicable to reduce particles of the size mentioned—i. e., two-inch cubes—to fine powder at one operation, nor with same form or type of crushing-face, for reasons that are familiar to those skilled in the art. On the contrary, machines should be adapted to crush two-inch cubes to about one inch, one-inch cubes to half-inch, and half inch to one-fourth inch, which size and smaller may be reduced at one operation sufficiently small to pass through a thirty or forty mesh wire screen or to the smallest size desired for effective concentration, amalgamation, or lixiviation processes. Of all gradations that of "finishing" or fine-crushing is most difficult and the resulting character of the pulp most important. If the granular or crystalline structure of the particles be destroyed, as by abrasion between the sliding or grinding faces of the crushing-mill, they become at once impervious to the percolation of "leaching" solutions and absolutely refractory to all known processes of concentration. All "grinding" or attrition mills in common use produce an excessive proportion of such refractory slimes and are therefore subjected to excessive abrasion of the crushing or grinding faces. The ordinary so called "Cornish" rolls of the various types are effective to a degree; but as at present arranged, side by side in horizontal plane, the crushing is accomplished by oblique pressure upon the ore particles, which results in the parting or grinding off of a portion of all particles passing between the crushing-faces, and consequent abrasion of the roll-faces into annular grooves, thus rapidly destroying their efficiency. These rolls are secured in place a short distance apart, according to the degree of fineness to which it is desired to reduce the material and are held in position with strong spring-buffers or other yielding devices, which places the entire crushing strain upon the journal-bearings of the rolls, thus involving the application of much unnecessary driving power, while the continued shock resulting from vibration of the springs makes it necessary to provide ponderous bed-frames and expensive foundations.

My invention is designed as an improvement upon my crushing-rolls patented December 22, 1885, No. 332,987, and upon the various types of so-called "Cornish" rolls in common use; and it consists in part in placing one roll directly above the other and in contact therewith, the purpose being to effect the crushing of the ores or other material by means of the weight of the upper or crushing roll alone and without the intervention of springs or other pressure devices. The upper roll is journaled in bearings held loosely in guides formed of the opposite sides of the main frame, so as to admit of unobstructed up-and-down movement, and the lower roll is journaled stationary in bearings secured to the main frame. My upper or crushing roll having this free up-and-down movement, unobstructed by pressure-springs or other similar devices, will travel upon the lower roll, producing a crushing effect precisely similar to that which would result from rolling in a straight line over a flat smooth surface. It is of the utmost importance, however, in order to obviate any grinding effect that both rolls be made to revolve at the same speed, and to insure this result, in addition to having both rolls belted to revolve at the same speed, I provide light steel

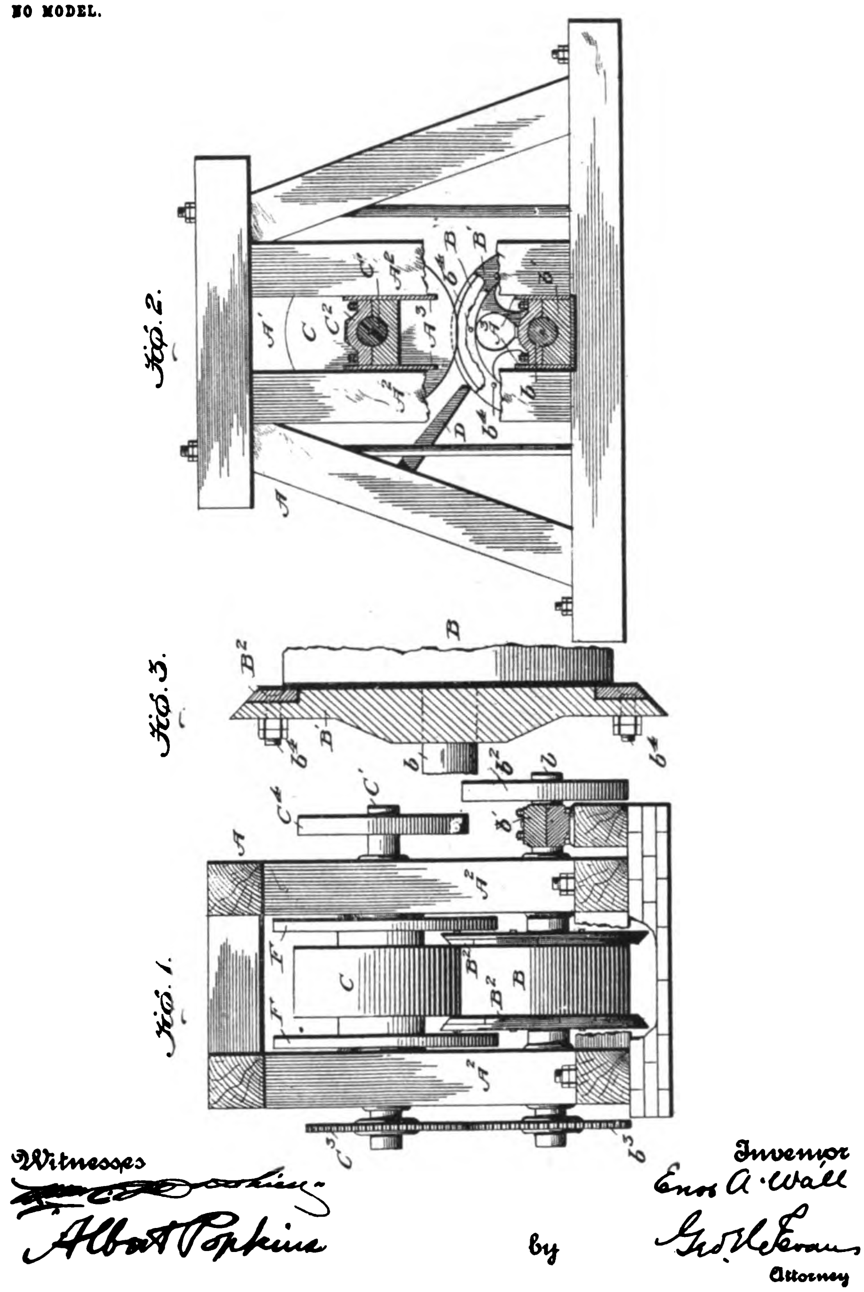
No. 755,725. PATENTED MAR. 29, 1904.

E. A. WALL.

ORE CRUSHING MILL.

APPLICATION FILED FEB. 6, 1903.

NO MODEL.



gears, the only office of which is to hold the upper roll back from any tendency to slip upon the lower roll, due to momentum added by the heavy balance-wheels hereinafter referred to and to the inequalities of belt-driving.

To give additional weight and momentum to the crushing-roll, it is provided with two heavy balance wheels. The combined weight of the balance-wheels and the crushing-roll to which they are attached must be sufficient to crush the largest pieces of ore fed to them to the degree of fineness desired. It is evident now that if the feed be introduced in such volume that the sheet of ore spread upon the lower roll be of greater thickness than the larger particles—i. e., if one grain of ore piled upon the top of others—the resulting product will be less finely crushed than if spread out in a sheet of the thickness only of the larger particles, from which it will be seen that the degree of fineness of the pulp may be readily controlled by regulating the volume of feed, which being automatic is in the highest degree simple.

In order that the point of contact or crushing-point between the roll-faces shall at all times be provided with the desired volume of feed, the ore is fed upon the lower roll through a chute of the width of the face of the rolls. This chute must be placed at an incline, upon which the ore particles will readily fall by gravity, the supply being constant and controlled in volume by automatic devices, such as are in common use and not necessary to here illustrate. The ores will then in the fall be spread out in a sheet of the width of the rolls and practically of uniform thickness. This sheet of ore is discharged upon the lower roll as far as practicable away from the point of contact with the upper roll. The material will then be carried to the crushing-point with the peripheral velocity of the rolls and will be crushed by "direct" pressure of the upper roll, the production of all refractory slimes being thereby avoided. In order that the material shall be retained when fed upon the lower roll, "shields" or guard-plates are attached to the lower roll, projecting a few inches beyond the outer rim of the lower roll and overlapping the ends of the upper roll, as provided in my crushing-roll patent before referred to, thus forming a continuous trough into which the ore is fed and by means of which the feed is uniformly spread to the extreme outer rim of the roll-faces, and thus a perfectly even wear is insured. In practice I find that the projecting portions of the shields or guard plates in time wear by contact with small ore particles falling between them and the ends of the upper roll. To overcome this difficulty, I provide the inner faces of the shields with removable plates of hardened metal made in segments and secured to the shields by means of short bolts.

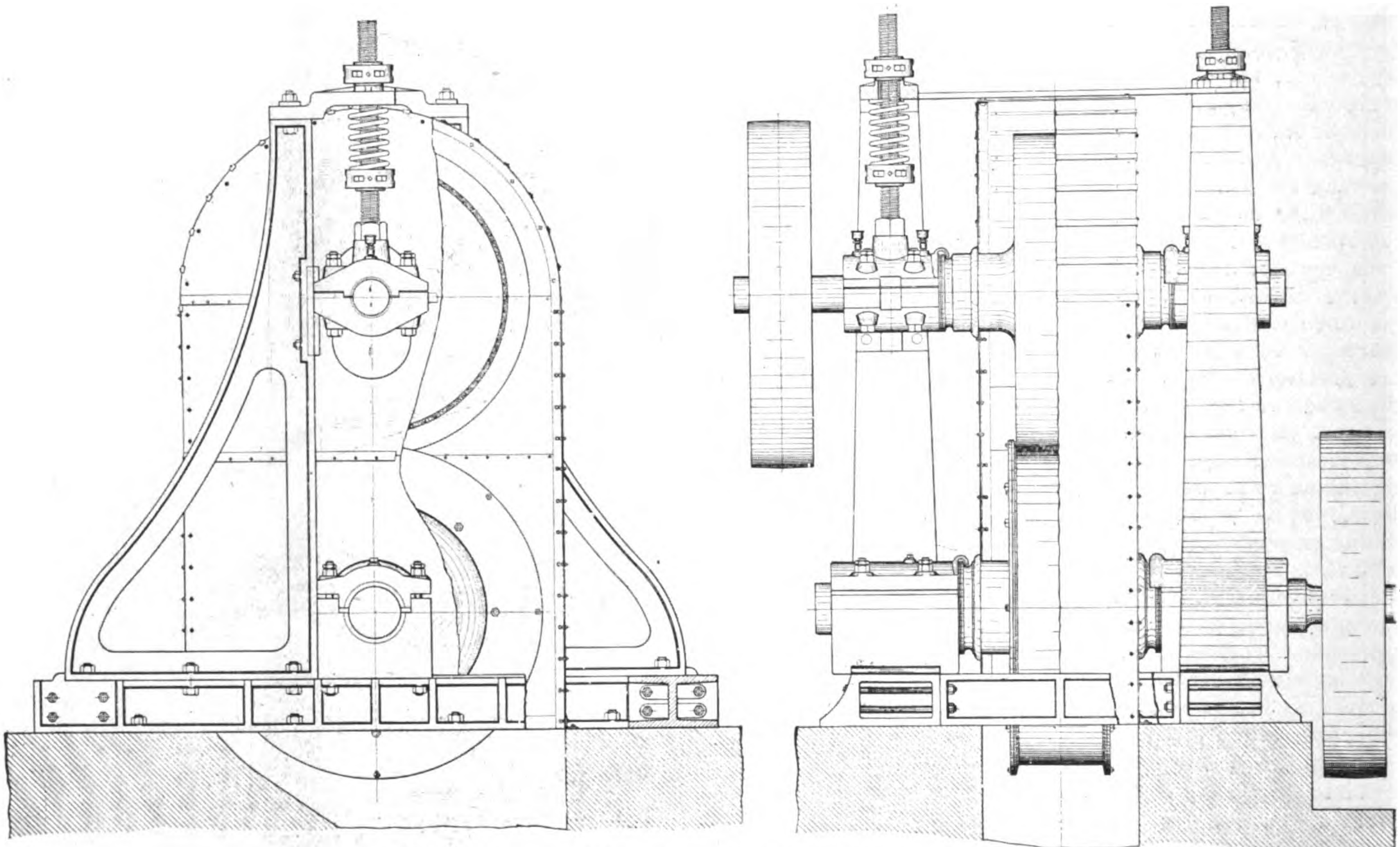
I accomplish the above objects by the mechanism shown in the accompanying drawings, in which—

Figure 1 is an end elevation of my crusher. Fig. 2 is a side elevation, partly in section; and Fig. 3 is a detail view of a portion of the lower roll with its shield and wear-plate.

A designates the framework formed, preferably, of timbers or beams bolted firmly together and having vertical guideways A^1 at its opposite sides. These guideways A^1 are formed by the uprights A^2, the adjacent sides of which are provided with metallic linings or wear-plates A^3.

B is the lower roll with it shaft b mounted in fixed bearings b^1 within the lower end of the guideway A^1, and the ends of the shaft extend beyond the sides of the frame, one end of the shaft being provided with a drive pulley or wheel b^2 and the other end having a light steel gear-wheel b^3.

The ends of the roll B are provided with shields B^1 in the form of rings which are of greater diameter than the roll and bolted thereto. In order to compensate for the wear which takes place at the juncture of the shields and ends of the roll, I provide the inner sides of the shields with removable segments B^2, which may be readily removed by first loosening the shields from the roll and then removing the bolts b^4. In order that the segments B^2 may lie flush with



Side and End Views of Wall's Vertical Rolls—From Working Drawings.

the inner faces of the shields B', the latter are provided in their inner faces with annular recesses or grooves which extend to the peripheries of the shields, and these grooves extend inwardly within the radius of the crushing-roll B, as shown in Fig. 3, so as to fill the angles between the ends of the rolls and inner faces of the shields without spacing the shields away from the ends of the roll.

C is the crushing-roll, having its shaft C^1 mounted in the vertically-sliding bearings C^2 within the guideway A^1 and having a driving-pulley C^4.

The rolls B C are belted to rotate in opposite directions.

The crushing-roll bears at its lowest portion on the highest portion of the lower roll, and so exerts its full weight on the material, which would not be the case with a crushing-roll arranged out of vertical alignment with the lower roll, for then some of the force of the upper roll would necessarily be taken up by the inclined guideways and much friction would result also in moving the crushing-roller upward and outward. In my mill the whole weight of the crushing-roll is exerted, and as the roll is absolutely unrestricted in its up-and-down movements by springs of any sort the sudden shocks and strains to the frame-work incident to the use of springs is entirely avoided, and so the frame-work may be entirely of wood, save that the wear-plates A^3 should be of thin plate metal. The cost of heavy cast frame-work is therefore done away with.

The weight and momentum of the crushing-roll is increased by two heavy fly-wheels F F, one at either side, and one end of the shaft has a thin steel gear C^3, which meshes with the lower gear b^3. These gears b^3C^3 are of the same diameter and serve merely to hold the crushing-roll against slipping upon the lower roll and against moving any faster than the lower roll, and so cause the formation of a perfectly granular pulp, and thereby avoid the production of refractory slimes.

D is the chute of the same width as the face of the roll B and serving to feed the material in a thin even sheet to the rolls, the point of delivery being as shown in Fig. 2, as far from the crushing point as practicable.

The chute may be supplied from any of the well-known automatic feed mechanisms, not necessary to show here, as they are well known and not claimed herein.

The shields will serve to prevent the material from falling beyond the sides of the rolls, as they form a sort of guide-trough.

In crushing ores from sizes of two-inch cubes to half-inch the crushing-surfaces should be corrugated, as provided in my Patent No. 332,978, above referred to, because this form of crushing-face admits of a much smaller mean diameter in order to secure the necessary grip or "bite" upon the material to be crushed; but where a fine product is desired, as in reducing material one-fourth inch in size to "thirty mesh" or smaller, I prefer that the rolls be constructed with plain crushing-faces and of diameter of at least thirty-six inches.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. The combination with a frame and a lower roll mounted in fixed bearings therein, of an upper driven crushing-roll having free vertical movement toward and from the upper side of the lower roll, to crush the material passing between the rolls, and an independent driving means for rotating the upper roll in an opposite direction to the lower roll and at the same rate of speed.

2. The combination with a frame and a lower roll mounted in fixed bearings therein, and provided with a pulley for belt-driving, of an upper oppositely-driven crushing-roll having free vertical movement toward and from the upper side of the lower roll and provided with an independently-driven pulley of the same size as the pulley of the lower roll.

3. The combination with a frame and a lower belt-driven roll mounted in fixed bearings therein, of the upper crushing-roll free to move vertically, belt-driven in the opposite direction and at the same rate of speed as the lower roll, and means for preventing slipping and faster movement of the upper roll due to independent belt drives.

4. The combination with a frame, a lower belt-driven roll mounted in fixed bearings therein, shields at the ends of the roll and removable plates flush with the inner sides of the shields and overlapping the ends of the roll, of an upper-crushing-roll having free vertical movement and belt-driven oppositely to and at the same rate of speed as the lower roll.

5. In combination with the crushing-rolls, one roll being placed above the other and journaled in bearings secured in guides in the main frame, so as to admit of free yielding up-and-down movement, the shields or guard-plates at the ends of the lower roll, and over-lapping the ends of the upper roll sufficient to form a trough for the retention of the material to be crushed and to permit its being carried forward upon the surface of the lower roll across the point of crushing contact, and heavy balance-wheels attached to the main shaft of the upper roll at opposite ends of the said roll and within the frame, substantially as and for the purpose herein specified.

6. In combination with the one roll being placed above the other and journaled in bearings secured in guides in the main frame so as to admit of free yielding up-and-down movement said rolls being belt-driven, the shields or guard-plates at the ends of the lower roll and overlapping the ends of the upper roll sufficient to form a trough for the retention of the material to be crushed and to permit its being carried forward upon the surface of the lower roll across the point of crushing contact, the heavy balance-wheels attached to the main shaft of the upper roll, and gear-wheels placed upon the ends of main shafts of the crushing-rolls and engaged in such manner as to control the speed of the upper roll and prevent its slipping upon the face of the lower roll, substantially as and for the purposes herein specified.

7. In a crushing-mill, a roll having end shields of greater diameter than the rolls, and provided on their inner faces with annular recesses extending inwardly within the radius of the roll and segmental wear-plates removably secured in said recesses, flush with the inner faces of the shields.

8. An ore-crusher comprising, a main frame having vertical guideways, a lower belt-driven roll having its bearings fixed, annular shields at the ends of said roll, an upper oppositely belt-driven crushing-roll in the vertical plane of the lower roll and having an unobstructed movement to and from the face of the lower roll, meshing gears of the same size on the shafts of the said rolls to prevent slipping and faster movement of the upper roll due to inequalities of belt-driving, and a feed-chute of the same width as the face of the lower roll and delivering thereon, substantially as and for the purposes herein specified.

In testimony whereof I affix my signature in presence of two witnesses.

ENOS A. WALL.

Witnesses:

WILLARD HANSON,
W. R. SMITH.

———o———

Tire punctures may be sealed by the use of a mixture made of 4 oz. of pumice (pulverized), 2 oz. of dextrin, and 10 oz. of water. Force the paste into the tube through the valve, after the insides have been withdrawn, by means of a small metal filler. It is claimed that this paste will close a good-sized hole and enable the machine to proceed for many miles without detaching the tire; in fact, in one case a tire so repaired is said to have remained fully inflated for a week. When the tube is patched care should be used to see that all of the paste is removed from it.

AUTOMATIC LANDING CHAIR

An extremely simple and effective device for the automatic landing of cages and skips has been invented by F. C. Wright of Denver, who has placed the exclusive manufacturing rights to his inventions in the hands of the F. M. Davis Iron Works Co. of Denver.

The striking feature of the landing chair is that it may be left at all times, if desired, ready to receive the cage, but the cage may be landed or not as desired without requiring the attention of a station attendant or cager. When desired, the chair may be locked out of the landing position, but it is impossible to lock it so that the cage cannot pass.

Reference to the accompanying sketch will give a clear understanding of Mr. Wright's device. Letter A shows the chair proper, pivoted freely in the metal frame D. Letter B shows the trip which is normally held in the position shown by full lines by means of a weight C. When the cage descends, the trip B is carried down, striking the dog A and folding the trip and dog back into the frame, which allows the cage to pass freely. When the cage is rising, the dog is pushed back into the frame and the trip is raised to the vertical position as indicated by the dotted lines. To land at any station, the cage deck is droped a few inches below the station to allow the trip B to return to the horizontal position, then the cage is raised a few inches to allow the dog A to fall into the landing position. To lower below the station the cage is raised above the trip B a short distance, then is dropped through to any station below.

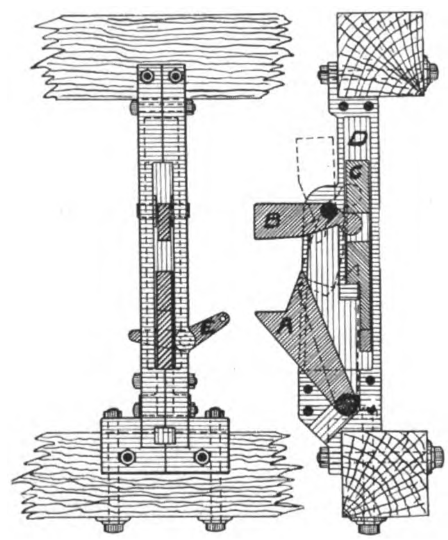
It will be seen that the means of secvuring this result is very simple. The hoisting engineer has only to stop the descending cage at a point just below the chair, then lift it just above the chair drop the cage in place. In the case of the ascending cage, the deck is stopped just above the station and then dropped in place.

Mr. Wright's patents also cover a system of skips for use in vertical shafts, the feature of the system being that the skip may be dumped on either side of the shaft, either on the surface or underground, all as desired by the skip tender.

The skip body is hinged to the lower side of guides of the usual form and is locked to the top of the guides by an automatic latch. The hoisting rope is attached to a bail which is secured to the body.

The dumping is performed by a form of landing chair as described above. A special chair is fixed in the guide timbers with other chairs on either side at a slightly higher elevation. When the skip is landed for dumping, the guides are held stationary and are automatically unlocked from the body while the bottom of the skip body lands on the side chairs, on one side of the shaft center. By lowering, the engineer causes the skip to dump. The direction of dumping is controlled by the skip tender locking one pair of chairs out of the shaft by means of a bell cord. Waste may be dumped at one side of the shaft and ore at the opposite side. By placing a set of chairs above any worked out stope the waste may be dumped underground on either side of the shaft. The skip passes freely through the underground dumping chairs as in the case of the cage.

The landing and dumping chairs are of heavy forged steel working parts mounted in a cast frame. They are designed to suit any load and to fit any size guide timbers.



Wright's Automatic Landing Chair.

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FEW THINGS WORTH KNOWING

The great pyramids of Egypt are built of limestone, and they stand upon a limestone plateau.

****

In order of their money value, coal, gold, manganese, petroleum, salt, saltpetre and mica are the seven principal materials mined in India.

****

A jet of compressed air directed against the heated ends of work that is being forged will revive the heat and also blow off all dirt and scale.

****

The Bunker Hill & Sullivan Mining & Concentrating Co. paid dividend No. 172 of $65,400 on January 4, 1912. This makes the total amount of dividends paid $13,225,050.

****

Unless solutions entering zinc boxes are fairly strong in free cyanide, it is advisable to allow strong cyanide solution to drip into the first compartment. Better precipitation is obtained thereby, and the formation of the troublesome "white precipitate" is largely avoided.

****

The metals that do not readily ozidize on exposure to the air are gold and platinum and to a less degree silver, copper aluminum and zinc. Tin resists oxidation, though ordinarily tin plate oxidizes rapidly, as the central part is either iron or steel.

****

To find the thickness of lead pipe required when the head of water is given, multiply the head in feet by the size of pipe wanted, express decimally and divide by 750. The quotient will give the thickness required in hundredths of an inch.

****

Experiments show that salt up to 10 per cent does not decrease the ultimate strength of mortar. The amount of salt required to lower the freezing temperature is approximately 1 per cent of the weight of water per degree F. below freezing.

****

The work in foot-pounds done by a pump is the product of the weight in pounds of the liquid pumped and the height in feet through or against which it is lifted. The power is the work done in a unit of time and the horse-power is the work per second in foot-pounds divided by 350.

****

The preservation of iron in concrete is again attested in the demolition of an old gasometer at Hamburg, Germany. This structure was built about 1852 and when taken down the iron anchor bolts which had been completely encased in a cement concrete were found to be as fresh and bright as new iron, with no traces whatever of rust.

****

The Wellhouse method of preserving timber consists in first steaming it in a cylinder for from one to three hours. A solution of zinc chloride and glue is then forced in under pressure, after which tannin is injected. The glue combines with the tannic acid in the wood and is precipitated as an insoluble compound while the wood retains the zinc. An excess of tannic acid is added to precipitate the glue.

****

According to the building laws of the city of New York, reinforced-concrete structures shall be so designed that the stresses in the concrete and steel shall not exceed the following limits. Extreme fibre stress in compression, 650 lb. per sq. in.; in direct compression, 500 lb.; in shearing, when all diagonal tension is resisted by steel, 150 lb., and 40 lb. in shearing when diagonal stresses are not so resisted.

LEACHING APPLIED TO COPPER ORE* (XVI)

TREATING ON THE RECOVERY OF THE SILVER AND GOLD CONTENT OF AN ORE

By W. L. AUSTIN.†

Most copper-ore subjected to metallurgical treatment by wet methods contains variable quantities of the precious metals and the recovery of these becomes important in many cases. The actual quantities of gold and silver in a given ore may be so small as to be neglected in the assay office, yet the aggregate recovered in a year's operations can be considerable. For instance, in the annual report of the Utah Copper Company the income account for the fiscal year ended December 31, 1910, credits operating revenue (milling ore) with 39,837.9 oz. gold, and 381,331.22 oz. silver recovered. On the basis of 4,340,245 tons treated, this would amount to 0.0091 oz. gold, and 0.087 oz. silver, per ton of raw ore, or less than 25 cents—an amount too small to be accurately determined in commercial assaying. These figures refer to the porphyry-ore alone and do not include "sulphide-ore" operations: they indicate to what proportions an apparently insignificant quantity of the precious metals can attain when present in a leaching-ore, and which can be recovered by making use of a competitive process. It is only in exceptional cases that loss of the precious metals in leaching copper-ore can be ignored.

In considering the recovery of the gold and silver content of a copper ore by leaching methods, the question arises as to whether this can be most economically accomplished before the copper is precipitated, or whether it should be saved simultaneously with the copper, or whether recourse should be had to an independent operation subsequent to the copper leaching. The problem has often presented itself, and various methods of solving it have been suggested and carried out, differing according to the lixiviants employed.

CYANIDATION OF RESIDUES.

One way of meeting the difficulty which is often advocated, is cyanidation of the residues from the copper-leaching operations. This method of procedure is, however, open to the objection that inasmuch as acid lixiviants are usually employed, their removal from residues before applying cyanide solutions is very difficult to accomplish, and unless this is done their presence results in heavy consumption of cyanide, and consequently undue expense is incurred in this method of treatment. Furthermore, in the generality of cases the precious metals are present in such small quantities that the employment of a separate process for their recovery—cyanidation for example—is inadmissible, and if they are to be saved at all, this must be accomplished during the copper-leaching process proper.

The method which has met with most favor by advocates of copper-leaching methods, has been chloridization of the gold and silver, and their removal, in the early stages of the leaching operation. Chloridization can be effected either in the dry or wet way, the choice of method depending upon circumstances. When an ore is roasted, (and with most leaching processes a preliminary heat-treatment of the ore before applying the lixiviant will be found desirable), salt (NaCl) may be introduced into the furnace and the chlorides formed by the action of this reagent can be more or less successfully removed in soluble form. The same results have been accomplished by treating roasted ore with powerful chlorine lixiviants without applying salt in the roasting process.

With regard to the method first mentioned (removal of the precious metals prior to the copper), the practice in Europe in treating pyritic ore residues from sulphuric acid works has been to roast them with salt, and then to leach with hydrochloric acid. In the manufacture of sulphuric acid the "burned" pyrites constitute a by-product, valuable for smelting into pig-iron; but before being used for this purpose the copper, silver and gold contained in them are removed by leaching. To obtain satisfactory results it is necessary to observe certain precautions in roasting an ore which it is intended to leach; but this subject will be reserved for a future chapter—its consideration at this time would lead to a wide digression.

The residues from the pyrites burners of the acid works are generally assumed to contain silver in the form of sulphate and gold in the metallic state. By roasting with salt the result is indicated in the following formulae:

$$Ag_2SO_4+2NaCl=AgCl+Na_2SO_4$$

$$Au_2+3Cl_2=2AuCl_3$$

These chlorides are assumed to go into solution in a salt lixiviant, in which cases the metals may be thrown down together with the copper, by the use of scrap-iron, as indicated in the following:

$$2AgCl+yNaCl+xH_2O + Fe = 2Ag + FeCl_2+yNaCl+xH_2O$$

$$2AuCl_3+yNaCl+xH_2O + 2Fe = 2Au+2FeCl_3+yNaCl+xH_2O$$

The precious metals would then have to be separated from the copper in a subsequent refining operation, for even if fractional precipitation is resorted to, the metals will be more or less mixed.

Another way of recovering precious metals from a cupriferous solution is by employing sodium iodide, (Claudet's method), with the addition of sugar of lead, (lead acetate), or tannin, to the solution to assist in clarifying it. The reaction is indicated in the following:

$$2AgCl+yNaCl+xH_2O+2NaI = 2AgI+(y+2)NaCl+xH_2O$$

$$2AuCl_3+yNaCl+xH_2O + 6NaI = 2AuI+4I+(6+y)NaCl+xH_2O$$

These compounds of the precious metals with iodine may then be treated with sulphide of sodium, and in this way sodium iodide is regenerated and the precious metals are thrown down as sulphides:

$$2AgI+Na_2S=Ag_2S+2NaI$$

$$2AuI_3+3Na_2S=Au_2S_3+6NaI.$$

Claudet's method appears to have been extensively used at one time. It is referred to in Berg und Huettenmaennische Zeitung 1871 pages 20, 120, 413; 1872 page 150; 1875 page 62; 1881 page 348; 1882 pages 137, 232; 1885 pages 233, 563; 1886 pages 239, 252. Iodide of silver is almost completely insoluble in sodium chloride solutions, and the precipitate separates out in about 48 hours. It consists chiefly of sulphate of lead, (the lead derived from the lead acetate), and the silver salt. It is reduced by metallic zinc whereby the iodine is recovered for further use. As cuprous chloride interferes with the process by producing iodide of copper, all the latter metal must be present in the lixivium as

† Mining Engineer and Metallurgist, Riverside, California.

cupric chloride when the soluble iodide is added. The acetate of lead solution used for clarifying consists of about one-half pound of this salt dissolved in a ton of liquid. The tannin solution is made by dissolving six lb. glue in 100 lb. of water, and mixing with from 300 to 400 lb. tannin solution made by boiling white-oak bark in water. Precipitation of gold and silver by zinc iodide was employed at Oker in Germany: the process was also an integral part of the Longmaid & Claudet process.

The treatment of residues from acid works by the method referred to was used in England near Newcastle and Liverpool, also in Germany at the Duisburg copper works. It has also been in use at Hemixem near Antwerp, and at Natrona in Pennsylvania. Gold was found to go into solution in the leaching and was precipitated together with the iodide of silver. At the Tharsis works near Newcastle the silver recovered contained from one to one-and-a-half per cent gold, while at Widnes it carried about 0.28 per cent.

GERMAN METHODS.

At Duisburg in Germany it was the practice to first give the ore an oxidizing roast, then grind it with NaCl and roast a second time. After proper chloridization it was leached with dilute hydrochloric acid. The precious metals were then first removed by Claudet's method, after which copper was precipitated by means of iron.

At Koenigshuette in Upper Silesia, Rio Tinto pyrites were burned for acid and the residues leached. The roasted ore was given a treatment similar to that employed at Duisburg up to the production of the lixivium, but then the auriferous silver was precipitated by means of metallic copper, and the copper in turn by electrolysis. In 1887 there was produced at Koenigshuette 560.46 metric tons of copper 100% fine; 521.525 kilograms of silver and 0.7527 kilograms of gold. It is interesting to note that the copper slime-precipitate made at these leaching works when examined under the microscope was found to be crystallized. It had the characteristic arborescent crystallization of native copper, and analysis showed that it contained: 80% copper; 18% iron; 2% insoluble residue; and 0.003% silver (30 to 33 grams).

At the Stadtberger works in Westphalia silver is separated from copper by partial (fractional) precipitation of the latter metal. The Stadtberger ore carries chalcocite, malachite, azurite, cuprite, and copper sulphate. It is crushed to about one inch size, and then leached with dilute hydrochloric acid in vats holding 75 metric tons. All the silver is said to go into solution; the assumed reactions between the chalcocite and the copper chlorides are indicated in the following formulae:

$$Ag_2S+CuCl_2+yCuCl_2 + xH_2O = 2CuCl + (y-1)CuCl_2+2AgCl+xH_2O+S$$

$$Ag_2S+2CuCl+yCuCl_2+xH_2O = 4CuCl + (y-2)CuCl_2+2AgCl+xH_2O+S$$

The argentiferous lixivium is treated with scrap-iron in such a manner that only one half of the contained copper is precipitated. The whole of the silver is said to go down with the first half of the copper:

$$4AgCl+yCuCl_2 + xH_2O + (y+2)Fe = 4Ag+yCu+(y+2)FeCl_2+xH_2O$$

The argentiferous cement-copper is washed, refined in a reverberatory furnace, and cast into anodes for electrolytic separation of the two metals.

FRACTIONAL PRECIPITATION.

Fractional precipitation has been made use of elsewhere for the separation of silver, notably at Oker in the Lower Hartz mountains in Germany, where silver was thrown down out of a solution holding the chlorides of that metal and copper by means of sulphuretted hydrogen or sulphide of sodium. In this way the whole of the silver is said to have been carried down with the first six per cent of the copper. Snelus suggested blowing finely divided metallic iron into a chloride solution containing silver and copper whereby the first twenty per cent of the copper precipitated is said to carry down with it eighty per cent of the silver content.

To separate silver from copper when the two metals are precipitated by means of metallic iron from saline solutions, it has been proposed to roast the precipitate and then dissolve out the copper with sulphuric acid. Also to make the material into a paste with water and mixture of salt and soda, and then roast in a reverberatory. The silver chloride could then be removed from the oxidized copper by means of brine. These references to the work of former metallurgists are mainly of historic interest; but they illustrate the fact that the problem is an old one, and sometimes a hint may be obtained which can be turned to account in solving present difficulties.

The old Hunt & Douglas process was another of the leaching methods which aimed to remove silver before precipitating copper. One disadvantage of this process, (leaching copper oxide by means of ferrous chloride dissolved in strong brine) which was introduced at several mines some years ago, was, that silver could only be precipitated from the saline solutions after all the cupric chloride had been reduced to the cuprous salt, because silver chloride in solution is not readily separated from the mixed chlorides of copper by passing over finely divided metallic copper. Furthermore, the Claudet process could not be employed, because, when the solution contained cuprous chloride an insoluble copper iodide was formed. The difficulty may be overcome by digesting the boiling solution with a soluble sulphide until all the copper is thrown down, and then precipitating the silver by other means; but there is nothing to commend this mode of procedure.

The above method was later modified by the patentees in that the ore was roasted so as to form sulphate of copper which was leached out by means of water. Sufficient sodium chloride was added to the solvent to convert the copper present into cuprous chloride, any silver being converted by the cuprous salt into silver chloride and remaining with the gold in the roasted residue. The presence of a large quantity of concentrated brine is necessary to hold the cuprous copper in solution. Then sulphur dioxide was forced through the liquor to change any remaining soluble cupric salt into cuprous chloride. Silver could afterward be removed from the roasted residues by either lixiviation or smelting: gold by chlorination. The advantages of the modified process were that gold and silver did not go into the copper solutions.

To meet difficulties presented by the previous methods a third was devised. In this latter process oxidized copper-ore was attacked with a solution of common salt and ferrous chloride. The resulting clear and neutral lixivium, separated from ferric oxide but containing cupric and cuprous chlorides, was next treated with sulphur dioxide to convert the cupric into cuprous chloride with separation of free acid. From such an acid cuprous solution any silver present can be separated by metallic copper, for it is well known that silver, when present as chloride in sodium chloride solution, may be readily removed by filtering the liquor through a layer of finely divided metallic copper. But metallic copper at once converts cupric into cuprous chloride, so, as a preliminary it is necessary to change the cupric into cuprous chloride by treating the hot solution with sulphur dioxide. Another way of removing the cupric salt is by filtering the solution, near the boiling point, through a layer of coarsely ground matte or rich copper ore.

With reference to the solubility of silver chloride in hot concentrated solutions of the alkali chlorides, or chlorides of ammonia, calcium, zinc, etc., Fresenius states that on sufficient dilution with cold water the dissolved portion separates so completely that the filtrate is not colored by introducing sulphuretted hydrogen. Hahn found that 2.385 grams of silver chloride could be dissolved at 20°C in a litre of solution holding 30.7% ferrous chloride (specific gravity 1.419), and that 0.836 grams could be dissolved at 30°C in the same quantity of liquor holding 44.48% cupric chloride (specific gravity 1.5726). Further information relative to the solubility of silver chloride in solutions containing other chlorides will be found in Transactions of the Amer. Inst. of Mining Engineers, Vol. X, page 24.

In the Jumau process when precious metals are present, the copper solutions are treated with sulphur dioxide at a raised temperature, but under ordinary pressure. By this means, it is stated, the precious metals alone are precipitated in metallic condition, and are separated antecedent to the copper (Eng. & Mining Journal, July 18th, 1908, page 132). This process, (U. S. patent No. 883,961), was described in Mines and Methods, Vol. II, page 259, and involves leaching an ore with an ammoniacal solution. It was subsequently modified as set forth in U. S. patent No. 930,968.

DEPOSITION OF PRECIOUS METALS SIMULTANEOUSLY WITH COPPER.

With reference to those processes which aim to deposit the precious metals simultaneously with the copper, several may be mentioned. Greenawalt, (U. S. patent 973,776, dated October 25, 1910), recognized the fact that copper ore usually contains variable quantities of other metals, and that these metals must be taken into account in applying a leaching process which is expected to produce commercial results. He comments on the generality of leaching methods requiring one, sometimes two, additional treatments to extract the gold and silver occurring with the copper, and has essayed to remove this objection in the process he advocates.

It has been repeatedly observed that cupric chloride, when warm and in the presence of the chlorides of other metals, acts readily on silver and its compounds in an ore to form silver chloride, thus: $Ag+CuCl_2=AgCl + CuCl$. Greenawalt states that from 80 to 90% of the silver may in this way be extracted with the copper, especially if the ore is given a chloridizing roast. Hence, if an ore contains considerable silver, it may be desirable at times to leach with a fairly concentrated solution of base-metal chlorides in the beginning, to remove as much of this metal as possible.

If there is gold in an ore the content of free chlorine in the lixiviant may be increased, but the solubility of chlorine in water is limited. Chlorine is also only sparingly soluble in a strong solution of chloride of sodium. Such a solution is, however, a fairly good solvent for silver as well as for gold. By the indirect method of combining chlorine with sulphur-dioxide and water, to form acid, any desired strength of acid solution may be obtained for leaching the copper, and at the same time a chlorine solution of sufficient strength for the gold.

The acid chlorine-solution, charged with chlorine, may be prepared either from copper chloride, or from common salt, by electrolysis. It requires 1.7 lb. salt to produce one pound of chlorine, and five pounds chlorine will, ordinarily, extract the gold from a ton of average copper-ore. This chlorine is not lost, for it is ultimately converted into base-metal chlorides in which form it is again used to extract copper and silver from new charges of ore.

Mention is repeatedly made in the foregoing, of leaching with hydrochloric, or other acid solutions. Such active reagents were formerly only available in the vicinity of chemical works, and were unattainable at reasonable cost in remote mining districts. But this has all been changed in modern times by the perfection of electrolytic methods. Nowadays, anywhere that power can be had at reasonable rates, acid reagents in any desired quantity may also be cheaply obtained. This feature has altered the whole aspect of hydrometallurgy of copper, and has done away with many of the difficulties which beset former metallurgists who attempted to work with weak reagents, or such as were at the time very expensive.

When gold and silver occurring in an ore have been brought into solution in the manner indicated above, they may be electrolytically deposited with the copper, or separately if desired, by varying the strength of current. In case the copper is to be subsequently refined, there would, however, be no advantage in separate deposition of the metals.

GREENAWALT PATENT CLAIMS.

In relation to recovery of the precious metals by the Greenawalt process, claim 13 of his patent specifications reads: "A process of extracting copper from its ores containing gold which consists in treating the ore with an acid chlorid solution to dissolve the copper; electrolyzing the resulting copper chlorid solution to deposit the copper and liberate chlorin; bringing the chlorin so liberated, in contact with the solution in the presence of sulphur dioxid; applying chlorin in excess of that combining with the sulphur dioxid, to the solution, to dissolve the gold; returning the regenerated acid chlorid chlorin solution to the ore, and repeating the cycle, as before, until the copper and gold in the ore are sufficiently extracted."

Claim 14 reads: "A process of extracting copper from its ores containing gold which consists in treating the ore with an acid chlorid solution to dissolve the copper; electrolyzing the resulting copper chlorid solution to deposit the copper and liberate chlorin; bringing the chlorin so liberated, in contact with the solution in the presence of sulphur dioxid; subdividing the solution; applying chlorin to the solution in excess of that combining with the sulphur dioxid to dissolve the gold; returning the regenerated acid solution, containing an excess of chlorin to the ore, and repeating the cycle, as before, until the copper and gold in the ore are sufficiently extracted."

Claim 26. "A process of extracting copper from its ores containing other metals which consists in treating the ore with an acid chlorid solution to dissolve the copper and silver chlorid; applying sulphur dioxid to the solution to convert the cupric chlorid into the cuprous chlorid; electrolyzing the cuprous chlorid solution to deposit the copper; electrolyzing salt to generate chlorin and caustic soda; adding the chlorin to the solution to dissolve the gold and other metals contained in the ore; and from time to time adding the caustic soda to the solution to purify it by precipitating out the base elements and regenerating salt."

APPLICATION OF SO_2 TO COPPER LEACHING.

As to the application of sulphur-dioxide, derived from roasting ore, to a bath containing copper chlorides, with the view of producing free acid, it will be recalled that this has been repeatedly done by metallurgists. The plan was an integral part of the new Hunt & Douglas process, and was described by the patentees in 1887. In fact the amount of work done in the field of hydrometallurgy has been so extensive that it would be difficult to suggest a new idea, or combination of ideas, which has not already been applied in practice, or mentioned in the literature of the subject.

The Mosher-Ludlow process, (U. S. patent No. 911,254), is another case where the precious metals are extracted simultaneously with the copper. Here the lixiviant used is a solution containing ammonia. It is briefly described in Mines and Methods, Vol II, page 259, and there is a more detailed article in "Electrochemical and Metallurgical Industry" of March, 1908, from which the following extract is made: "Where the percentage of copper is large the aim is to first extract as much of the copper as is possible by plain ammonia, and to leave the gold and silver values to be subsequently extracted with a weaker ammonia solution containing fractional percentages of potassium cyanide. But instead of working in this way it may be preferable in many instances to add the cyanide at once to the ammonia and to simultaneously extract all the values, including copper, gold and silver, with an ammoniacal solution containing one to several pounds of cyanide per ton. The object aimed at is to reduce the consumption of cyanide to a minimum in the presence of copper, by substituting ammonia as the solvent for the copper, thereby permitting the minute amounts of potassium cyanide added to the ammonia solution to simultaneously extract gold and silver values. To recover the metallic values from the ammonia cyanide-copper-gold and silver-bearing solution, it is passed through the continuous boiling-out still, to precipitate the copper as CuO. The boiled-out solution holding the gold and silver values is agitated with the least amount of zinc dust, or passed through zinc boxes to recover such gold and silver as the boiled-out solution may contain."

DEPOSITION OF PRECIOUS METALS SUBSEQUENT TO COPPER.

Coming now to the third case, the extraction of the precious metals subsequent to the copper, the applicability of an additional treatment for their recovery will, of course, depend on the quantity of these metals present in a given ore. In the Froelich method, (Mines and Methods, Vol II, page 68), the precious metals are left partly in the almost wholly decoppered residue; partly go into the lixivium. In the residue they will be respectively in the forms of metallic gold and insoluble AgCl; in the lixivium there will be some AgCl dissolved in the base-metal chlorides, and perhaps some gold chloride. Froelich's method is a treatment of roasted ore in an agitator with hot concentrated ferric chloride lixiviant, with especial emphasis laid on the use of a special form of agitation. By such treatment much of the silver will naturally remain in the residues, for it has long been known that when argentiferous ore is boiled with ferric chloride, silver, after a time, goes into solution, but is apparently reprecipitated, probably by the ferrous salt.

It is suggested by Froelich that the recovery of the precious metals from the residues may be effected through leaching with cyanide of potassium, or ammonia, in an agitator; but that is not a desirable method of procedure, for reasons already given. Recovery of that portion of the gold and silver present in the lixivium, he adds, may be accomplished by passing a weak electric current through the liquor for about three hours. In electrolysis it is well known that gold and silver separate out of the electrolyte when using a low potential more readily than is the case with copper. When the precious metals are deposited with the copper they may be recovered in the anode-mud by a subsequent electrolytic refining in the usual manner.

With this method of treatment it would appear that the precious metals must be to a large extent lost, unless present in an ore in such quantity as to warrant separate extraction by some subsidiary method applicable to the case. The same may be said with reference to leaching with ferric sulphate by the Siemens & Halske process, for when silver is present in an ore undergoing treatment by that method, it had to be extracted subsequently to the copper in a separate operation, or left in the tailings. In some experiments made by Jones, (Proceedings of the Colorado Scientific Society, Vol VI, page 46), wherein he attacked finely divided metals with solutions of ferric sulphate, it was found that silver, copper, antimony and bismuth were readily dissolved, which was not the case when dilute sulphuric acid was used. Gold precipitated by aluminum from a solution of the chloride, when boiled for about ten minutes with a strong ferric sulphate solution was apparently not attacked, a result which has been confirmed by others. In further experiments where ferric chloride was substituted for ferric sulphate, lead dissolved readily, as did copper, bismuth and antimony. Mercury became dirty grey, as though mercurous chloride were forming, which was thought to be probable. Gold did not dissolve, and after boiling for ten minutes only a trace of ferrous iron could be detected in the solution in which it was treated. In an experiment recorded by H. N. Stokes, (Economic Geology, Vol I, page 650), gold leaf when heated in a solution containing two parts ferric chloride to one part hydrocloric acid, went completely into solution, and was subsequently reduced again to metal at a lower temperature by the ferrous chloride formed.

BRADLEY'S TREATMENT OF THE PRECIOUS METAL QUESTION.

In the Bradley process the patent specifications have very little to say about recovery of gold and silver. In this process calcium chloride is the lixiviant used, and it will be remembered that in the Hunt & Douglas process it was found that calcium salts might be introduced into the process, but their presence was objectionable when silver was to be extracted. In the Bradley patent specifications the following references are made to extraction of the precious metals: "There will also be small quantities of gold and silver present in the ore which can be brought into solution by making all the copper into cupric chlorid and all the soluble iron into ferric salts, and then adding a small amount chlorin, chlorous or chloric compounds. The chlorids of silver and gold being soluble in calcium chlorid solutions, may be precipitated with the copper or separately. * * * Any gold and silver present in the solutions may be carried down during the precipitation of the iron, aluminum and copper and subsequently removed or separated therefrom, in any preferred manner known to those skilled in the art."

In the case of a process which depends upon conversion of copper into sulphate by roasting, and subsequent lixiviation of the metal as sulphate, the gold will, of course, remain in the residues. The amount of silver which will be found distributed between the residues and the lixivium, will depend upon the manner in which the roasting has been carried out. An ore can be roasted so that nearly all the silver is brought into the sulphate form, and then this metal can be leached as sulphate, (the old Ziervogel process); but it is a delicate operation, and leaves the copper behind as oxide. In roasting an ore for lixiviation of copper sulphate, probably most of the silver and gold will be found in the residues. This would be the case in applying the Laszczynski process.

Much more might be written about attempts of different hydrometallurgists to meet the precious metal question in connection with copper leaching; but sufficient has been said to indicate that, except in special cases, it is best to remove all the valuable content of an ore which can be brought into solution in one leaching, and to avoid subsidiary operations where possible.

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A new artificial abrasive, known as corubin is produced from the slag resulting from the reaction between aluminum and chromium oxides. It is practically pure alumina, containing a trace of chromium oxide, which gives it a red color. On account of the high temperature at which it is manufactured it is free from combined moisture. It is produced in three grades; coarse, medium and fine, and is sold only in the portion of two parts coarse to one each of medium and fine.

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A new explosive is reported to have been invented by B. F. B. Wright, former professor of chemistry at Harvard university. The new explosive is said to be almost as safe as dynamite and about three times as powerful. It is said that it will not damage anything unless exploded in an air-tight chamber. The new explosive will stand 275 degrees of heat without igniting, so the danger of spontaneous combustion is obviated. It will not freeze and can be used 15 minutes after being compounded. Dynamite must be stored 90 days before it can be used.

MAMMOTH COPPER SMELTER MEETS FARMERS' DEMANDS

By AL H. MARTIN.

The mines and smelter of the Mammoth Copper Company are located near Kennett, Cal., a town located on the main line of the Southern Pacific railway. The company commenced the erection of the plant in 1905, a short time after the Mountain Copper Company had demonstrated the feasibility of treating Shasta county copper ores by pyritic smelting. In 1906 the smelter went into action, and has been kept in practically continuous operation since. The plant is regarded as one of the best examples of pyritic smelting practice in the world, and numerous improvements made from time to time have steadily increased its efficiency. Not only has the Mammoth Copper Company maintained constant activity since the inauguration of work, but it has successfully defeated all efforts of the farmers to close the plant because of alleged fume annoyance. The smelter is the largest active plant in California, and the company produces approximately three fourths of California's total annual copper output.

MINING AND TRAM SYSTEMS.

The Mammoth ores carry sulphide in the form of massive pyrites, with considerable chalcopyrite occurring. The ores carry about 4 to 5% zinc, while gold and silver values frequently range from $1.10 to $1.50 per ton, sometimes higher. The ore is mined through adits and cross-drifts, the topography of the country and strike of veins favoring economical mining. The orebodies have been comprehensively explored by diamond drilling, and an enormous reserve demonstrated. As the ore is broken in the mine it is loaded into mine cars and hauled by electric locomotives. These are supplied with a direct current at 550 volts. The locomotives haul the cars to the upper terminal of the gravity tram system, where the cars discharge into the bins.

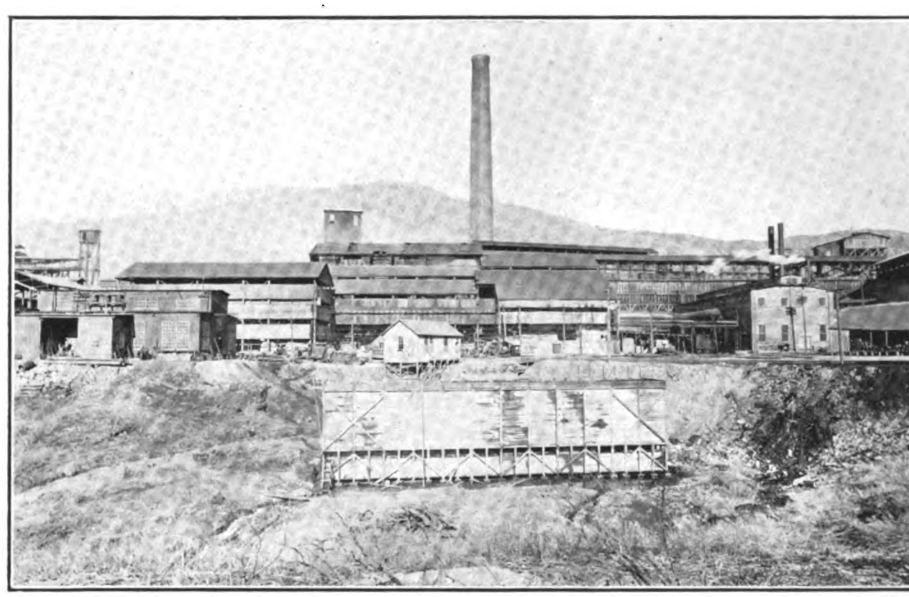
In the tram system, steam, gravity and electricity are employed, the method being influenced by the varying demands imposed by natural conditions. The mine is located 2300 ft. above the smelter, and the gravity portion of the system includes a 4000-ft. mountain slope with a 1700-ft. fall. The tremendous surplus of energy developed by the gravity railroad is utilized to operate a compressor. The bins at the lower portion of the tramway discharge directly into standard-guage railroad cars. The ore received from these cars is crushed, sampled automatically and distributed to three groups of receiving bins. These bins are so arranged that the ore is fed to cars running on tracks below, on the same level as the furnace charging floor.

OPERATION OF MATTING PLANT.

The ore and flux from the bins are drawn off into side-dumping cars, after being properly proportioned. An electric locomotive draws the cars to the blast furnace, and the charge is mechanically delivered directly to the furnace, the feeders commanding each side of the furnace alternately. Each furnace takes a charge of 425 tons. Of this about 326 tons consists of sulphide, with the remainder composed of siliceous ore, limestone, furnace by-products and coke. About 4% of coke is used, experience proving this amount the best for greatest commercial profit. At times the company has found it possible to operate the furnace with 1% of coke, but results were not as satisfactory as when a higher ratio was employed. The furnaces are provided with steel water jacketed hoods, and have a dimension of 50 by 180 ins. at the tuyeres. The plant comprises five matting furnaces, but at present only three are operated. Seven cycloidal blowers, each operated by a 225-hp. motor, deliver the unheated blast at a pressure of 2 5-8 lbs. The blowers deliver 13,764 cu. ft. of air per minute at 111 revolutions. The matte flows into 16-ft. steel settlers, which are tapped by cast-steel ladles. The product is gathered by a 50-ton electric crane, driven by a 75 hp. motor, and delivered to the converter department. The slag passes into 5-ton cars which are hauled to the dumping ground by an electric locomotive.

CONVERTER EQUIPMENT.

The converter building is equipped with two hydraulically-operated stands, eight 96 by 150-in. shells, two 50-ton electric cranes, two pneumatic tamping machines, auxiliary hoists and other machinery. A pressure cylinder, with 18-in. diameter, turns each shell half-around with a 7-ft. stroke. The shells are so arranged that each is permitted to make a complete revolution. A 12-600-cu. ft. Nordberg blowing engine delivers the blast at a 13-lb. pressure. The blower is operated by a 750-hp. electric motor, and the air delivery is regulated by the action of the inlet valve in the air cylinder, according to the amount consumed by the converters. The shells and stands are of the Allis-Chalmers type. Two 50-ton electric cranes, actuated by 75-hp. motors, serve the converters. The cranes have 50-ft. spans, and each are provided with two 15-ton auxiliary hoists. The copper is directly cast by the converters into iron molds, cooled and shipped to Chrome, N. J., for refining.



General View of Mammoth Smelter, Kennett, Calif.

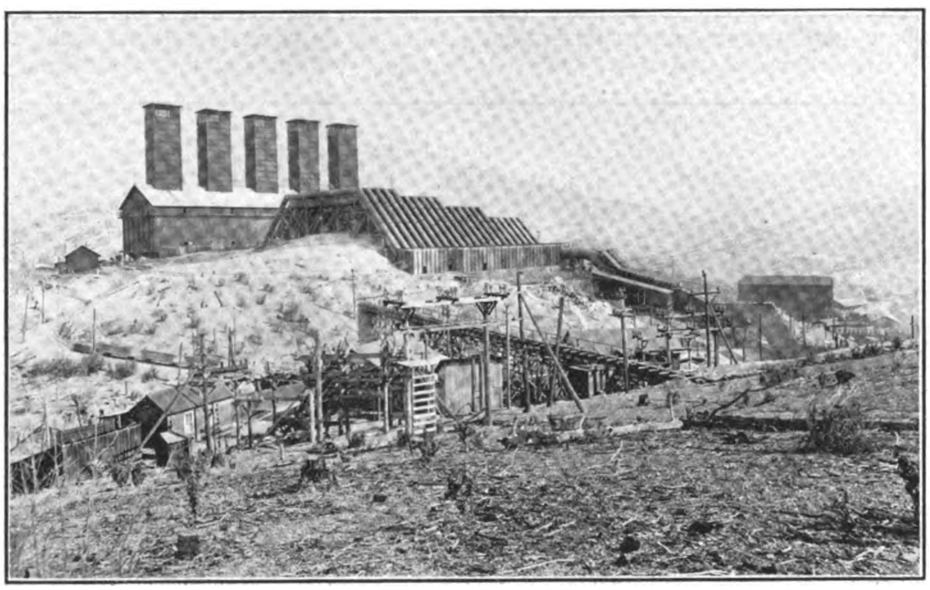
The lining for the converter shells consists of crushed quartz and clay and is thoroughly prepared in two 7-ft. mortar mills. The material is placed in position with the aid of two pneumatic tamping machines, reinforced by a hydraulic jib crane, secured to one of the steel columns of the building. The tamping machine is fashioned on the principle of the rock drill, with a heavy cast-iron jacket to absorb vibrations. Oil burners are employed to dry the lining. One shift in the lining room supplies material for three blowing shifts.

ONLY PLANT OPERATING ON SHASTA COPPER BELT.

The Mammoth enjoys the distinction of being the only active smelter on the Shasta copper belt. This result has been achieved by the adoption of demonstrated effective methods for the control of noxious fumes, rather than by costly experiments with methods of unproven merit. As the gases leave the steel gooseneck downtakes of the blast furnaces they pass into two brick flues 260 ft. long. The converter gases join the fumes from the blast furnaces near the point of entry. The dust settles through the hopper bottoms of the flues into a brick and steel settling chamber. Four 8-ft. steel pipes guide the gas into a second steel collecting chamber terminating in a steel flue having a diameter of 15 ft. This continues into a second building where two Sirrocco fans, driven by two 400-hp. motors, are installed. The fans force the gas through another steel collecting chamber and into the eight banks of cooling pipes. Each bank or compartment contains five pipes, each 200 ft. long and arranged in rising, horizontal and downslanting sections. These pipes discharge into a steel distributing chamber where the gas temperature is further reduced by the admission of atmospheric air. From this chamber the fumes are forced through short pipes into the baghouse.

BAG HOUSE AND GAS COOLING.

The baghouse contains approximately 3000 woolen bags, 34 ft. long by 18 in. wide. The bags are shaken into rows of hoppers located directly beneath by a mechanical shaking device. The fumes are collected and a portion mixed with the settlements in the pipes and sent to the briquetting plant. The remainder is sent to a storage pile to await the devising of a method for the recovery of the zinc content. The present equipment of bags and cooling pipes permits the operation of three furnaces in cool weather, and a ninth compartment of cooling pipes will soon be installed to facilitate a maintenance of present capacity in the hot summer months. The prime duty of the cooling-pipe equipment is to reduce the temperature of the gases to such a point that the fumes will not burn the costly woolen bags.



Baghouse and Banks of Cooling Pipes, Mammoth Smelter.

The three active furnaces deposit about 25 tons of material per day in the baghouse. This consists principally of zinc oxide and sulphate, with considerable silver and some gold. The 4 to 5% of zinc carried by Mammoth ores forms oxides in the furnaces and neutralizes the harmful properties of the noxious gases. A device has been provided for the admixture of reagents with the gas to prevent injury to the bags by sulphuric acid and other chemicals, but thus far its employment has not been necessitated.

FUME CONTROL IS A SUCCESS.

The baghouse has been in commission nearly two years, and has given complete satisfaction in every respect. The efficiency of this annex is apparent when it is stated that the Balaklala, Bully Hill and other large smelters are idle as a result of the smoke agitation. The Balaklala attempted to solve the question with a costly installation of the Cottrell process, but results were far from satisfactory and the big plant has since lain idle. The Mammoth was about the first company to undertake the subjection of the fumes, and its signal success indicates what may be done by other companies in this respect.

A peculiar aspect of the fume-control question at Kennett, is that the atmospheric conditions have always favored the Mammoth people. Cross-currents of air drive the smoke up Backbone and Squaw creeks, where practically little value in the way of agriculture or timber exists. This feature assisted the company prior to the installation of the baghouse, and has probably had the result of increasing the efficiency of the annex to a slight extent. The gardens, orchards and farms around Kennett compare favorably with any found elsewhere in the fertile Sacramento valley, and this condition is particularly striking since the baghouse and cooling pipes went into commission.

WORKS TREAT CUSTOM ORE ALSO.

In addition to treating its own ore, the Mammoth Copper Company handles large quantities of custom material, receiving shipments from numerous points in California and Nevada. The company is a subsidiary of the United States Smelting, Refining & Mining Company, and much of the Mammoth's success in solving the fume question is probably due to the experience gained by the parent company at Midvale, Utah.

Since the installation of the baghouse the two giant smokestacks formerly employed have been dispensed with, and one has been lowered. The other will probably be dismantled soon. Thus every particle of smoke is forced to pass through the cooling tubes and bags. Splendid facilities have been provided for repair and maintenance work, and the plant is practically self-sustaining. An abundant water supply is derived from a mountain stream, with the Sacramento river made accessible, should occasion compel, by means of two centrifugal pumps. The ditch and flume line is over three miles long. G. W. Metcalfe is general manager; J. H. Kervin, smelter superintendent.

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White lead is composed of a combination of lead carbonate and lead hydrate, it is supplied to the trade ground in linseed oil.

HISTORY AND GEOLOGY OF SITKA MINING DISTRICT

By ADOLPH KNOPF*

The first attempts at lode mining in Alaska under the American regime were undertaken in the vicinity of Sitka in 1871. This work was done on a quartz ledge outcropping at the falls of Indian River, 1 mile east of Sitka. Although no serious efforts were put forth, the matter aroused some local excitement, and news of the discovery appeared even in San Francisco newspapers. In 1872 three placer miners discovered near the head of Silver Bay the quartz ledge subsequently known as the Lower ledge, but it was considered valueless by them. Some of the ore was seen by Nicholas Hayley, who had previously worked in the mines at Grass Valley, Cal., and the Comstock, and who was then serving in the garrison stationed at Sitka, and the lode was located by him. Late in the same year he discovered the Stewart ledge, which was named after Maj. Joseph Stewart, United States Army. Before 1880 many other ledges had been discovered in the district around Silver Bay. In 1879 a 10-stamp mill was erected on the Stewart property.

Petroff†, writing in 1880, says:

"Discoveries of gold-bearing quartz have been made on Baranof Island, in the immediate vicinity of Sitka, only since the transfer of the Territory, and for a time quite an excitement was created; but now these ledges are scarcely worked at all, being simply held by the owners for further developments or until some process can be discovered for working with profit the peculiar grade of ore existing there."

In the winter of 1880-81 a considerable part of the population of Sitka participated in the stampede that led to the founding of Juneau. After the lapse of nearly 40 years since the original discovery of gold-bearing quartz, none of the properties at Silver Bay have been put on a productive basis. During that time some remarkable mining failures have taken place on Baranof Island, those at Rodman Bay and Pande Basin being well known throughout southeastern Alaska. This state of affairs led to the nearly complete extinction of all interest in lode mining in the Sitka district, and it is only since the discovery of gold ore at Klag Bay on Chichagof Island in 1905 that interest has in some measure revived.

*Extract from Bulletin No. 504, United States Geological Survey, 1912.

† Tenth Census, Vol. 8, Report on the Population, Industries and Resources of Alaska, p 30.

The Sitka mining district comprises Chichagof, Baranof, and Kruzof islands, together with a few smaller islands. The total land area roughly approximates 4,500 square miles, the greater portion of which is included in Chicagof and Baranof islands. Those two islands form in effect a single land mass, gradually tapering southeastward, separated into two parts only by a narrow body of water known as Peril Strait. Its extreme length from Point Adolphus on the north to Cape Ommaney on the south is 150 miles, and the average width is 30 miles. On the east the islands are separated from the other islands of the Alexander Archipelago by Chatham Strait, on the north they are separated from the mainland by Icy Strait, and on the west they are bordered by the Pacific Ocean.

The topographic features of the islands are entirely similar to those of the remainder of southeastern Alaska. The coast line is indented by numerous bays and fiords, many of which, like Tenakee Inlet and Whale Bay, penetrate far inland into the heart of the islands and render territory accessible that is otherwise nearly impenetrable. The relief is rugged and the mountains rise abruptly from the shore, at many places forming bold cliffs, hundreds of feet high, surmounted by precipitous slopes, rising 2,000 to 3,000 feet. The ruggedness increases toward the interior of the islands, and little is yet known concerning the inland portion of this region. In general, the altitudes range from 2,000 to 4,000 feet.

The region is well forested with coniferous species, mainly hemlock, spruce, and cedar, both red and yellow. Jack pine is found in small amount and is limited to open, boggy parks, being apparently unable to compete in the more favorable situations with the other conifers.

On the west coast, as at Klag Bay, the timber line reaches 1,500 feet above sea level, but in protected localities it reached 2,500 feet. The diameter and height of the trees vary considerably from place to place; at Klag Bay, for example, 18 inches appears to be the average diameter, whereas along Indian River, east of Sitka, magnificent trees are common, spruces as much as 6 feet in diameter and 175 feet in height having been noted. As a rule, the supply of timber is adequate for general mining purposes, but the stand of logging timber is comparatively small and is soon exhausted at any one locality.

A thick and luxuriant undergrowth is common in the forest and consists largely of blueberry brush and devil's club, with various other kinds of growth, such as willow, alder, salmon berry, and the high bush cranberry. On account of the frequent rainfall this undergrowth is almost continuously wet, and this feature, together with its jungle-like character and the numerous windfalls of timber, make the forest a formidable obstruction to the prospector.

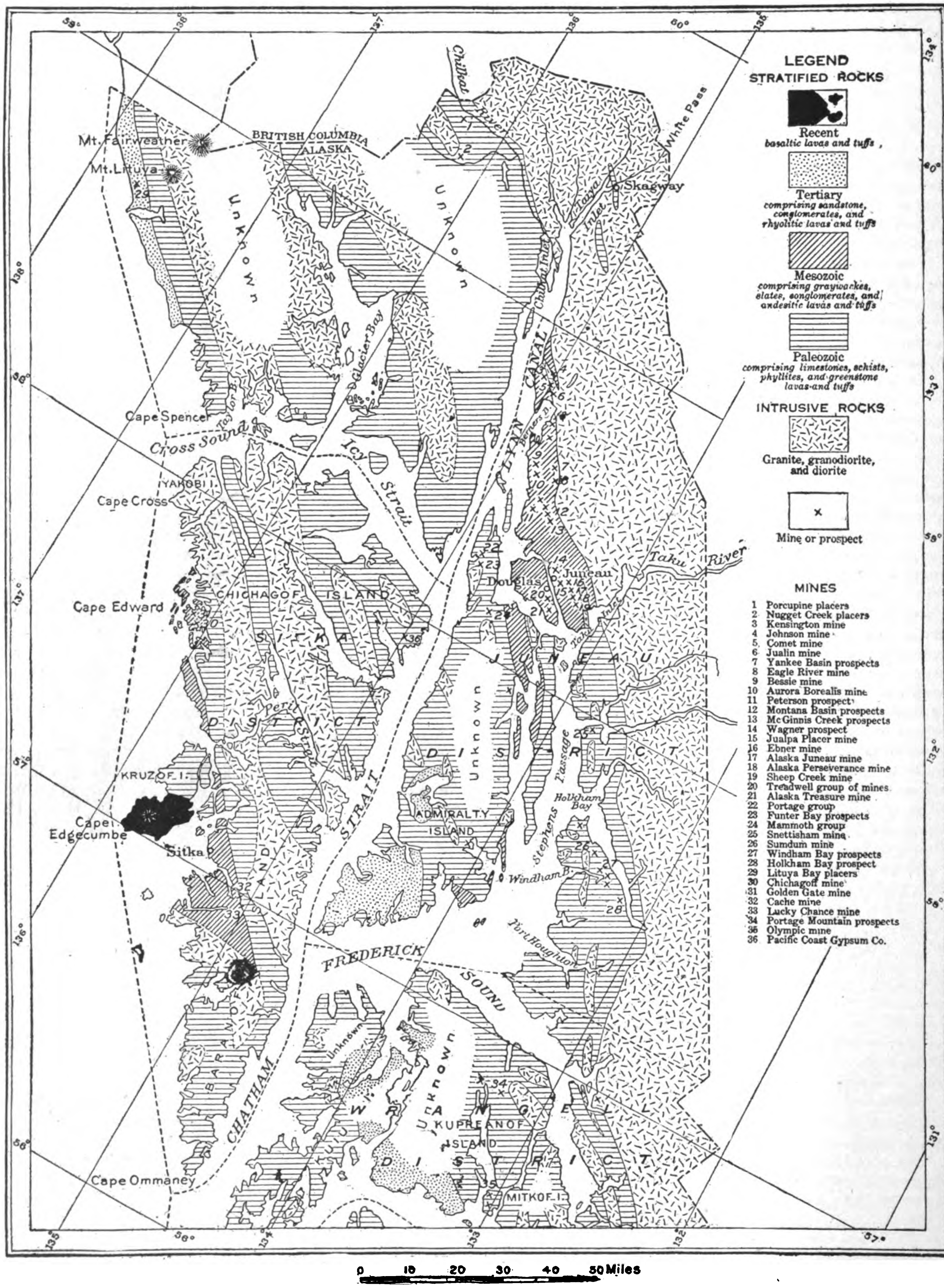
The geographic and climatic features, as well as the forest, impose limitations on the prospector's activities. As the waterways furnish the only means of communication with the centers of supply, which are few and widely separated, a boat, preferably a power boat, becomes a necessary part of the prospector's equipment. The waters are often rough and stormy, the islands are exposed to the open ocean, and in winter the heads of the bays are frozen up—all conditions that tend to restrict prospecting to the summer months. In order to utilize the few favorable months of the year as effectively as possible, prospecting has hitherto been confined mainly to examination of the shore-line exposure and to the country closely bordering the coast.

The climate of the region is cool-temperate and humid. The precipitation is heavy, the number of rainy days is large, and foggy and cloudy weather is of frequent occurrence.

Records have been kept for a longer period at Sitka than at any other Alaska station, so that unusually full statistics concerning the climatic features are available. The mean annual temperature at Sitka is 44° F. The mean monthly temperature for February, the coldest month, is 33°, and for August, the warmest month, 56°, the mean annual range being thus only 23°.

The average annual precipitation, including melted snow, is 88 ins., and the extremes on record since 1868 are 59 and 140 ins. The average number of days during which precipitation takes place is 208. At sea level the precipitation is usually in the form of rain, but there is a considerable snowfall on the mountains, which, even at moderate altitudes, often remains until late in summer.

The present-day glaciation is represented, so far as is now known, by a few small glaciers only, but doubtless a number of others will be discovered when the interior of the islands becomes better known. At Pande Basin, east of Sitka, a glacier occupies the hanging valley at the head of the basin; and another smaller glacier, known as Valdenar Glacier, lies at the head of Green Lake Valley, east of Silver Bay.



Geologic Reconnaisance Map of Sitka and Juneau Mining Districts.

Evidence of a former greatly extended glaciation, of which the present glaciation is the vanishing remnant, is everywhere visible. The deeply fiorded character of many of the waterways is the most immediate token of the former glacial occupancy of the region, and this evidence is corroborated everywhere by smaller and more local features due to glacial action. These consist of polished and striated surfaces and of glacial drift several feet thick containing striated boulders.

At Klag Bay broad, glacially smoothed surfaces were found up to an altitude of 1,300 feet on the flank of Doolth Mountain, an isolated mountain which is too small to have supported an independent glaciation. The smooth, flattish summit, reaching an altitude 2,100 feet above sea level, may itself owe its form to the action of an overriding ice sheet, for the neighboring mountains that attain higher altitudes show serrate profiles. As Doolth mountain practically stands on the shore of the Pacific ocean, these figures furnish a rough estimate of the minimum thickness of the ice sheet as it reached the open ocean during the glacial epoch.

GENERAL GEOLOGY.

The rocks of Chichagof and Baranof islands lie in broad belts that strike northwest and southeast, conforming with the prevailing structural trend of southeastern Alaska. The core of the islands is made up largely of granitoid rocks, mainly quartz diorites, which, as a rule, have been intruded parallel to the stratified rocks. The general distribution of the rocks is shown on the sketch map accompanying this article.

The known mineral resources of the Sitka mining district are gold and gypsum. To these granite may, perhaps, be added as a possible undeveloped resoruce.

The gold is found in quartz lodes, which commonly occupy shear zones in graywacke. Two properties, both situated at Klag Bay, on the coast of Chichagof Island, have so far been put on a productive basis and give strong promise of a prosperous career. The ores, which range in value from $15 to $90 a ton, are of considerably higher grade than the average ore of southeastern Alaska. A large number of ore bodies of the same general character have long been known to occur near Sitka, but owing to the low-grade ores contained in them none have yet been brought to a producing stage.

The ore bodies of the region show neither in their mode of occurrence or origin any obvious or immediate relation to contacts of dissimilar rocks, to dikes, or to other igneous rocks. The principal mineral belt appears to lie along the edge of the slate-graywackle formation bordering the band of metamorphic rocks that flank the diorite occurring in the central portion of the islands. The better known ore deposits are found in graywackle, but this is doubtless a fact of no essential significance and should not deter the prospector from searching in other kinds of rocks. The question is sometimes asked by the prospector whether the formation at some particular locality is favorable. To this it can be answered that experience has shown that no one kind of rocks is more likely to contain gold-ore deposits than another. In point of fact, a more complex set of conditions is necessary than the presence of a "favorable formation." That a favorable set of conditions is most likely to be found in the zones that border the long belts of granitic rocks traversing the region has already been maintained in this report. The indications afforded by present developments point strongly to the conclusion that the entire strip of territory contiguous to the west coast of Chichagof Island offers a more encouraging inducement to the search for new ore bodies than any other part of the region.

LOUISIANA SALT MINES

By PAUL WOOTON*

Since 1790 Louisiana has been a producer of salt. In the early days the supply was obtained from brackish springs that spouted vigorously from the ground over the great deposits of rock salt, that later were pierced by shafts, and today are mined in enormous quantities with the aid of modern machinery. During the war of 1812, when the salt supply from Liverpool was cut off, the Louisiana salt deposits supplied the nation. In the civil war, when the south was isolated by the Union blockade, teams by the hundreds from all sections of the southern states, were to be seen daily at the mines waiting in line for their loads.

With the establishment of peace after the civil war, a more systematic development of the properties was begun, which has led step by step to the highly efficient mining methods of today, permitting of an annual extraction of 300,000 tons at a minimum cost.

The great salt bed which lies along the coast in Iberia parish has been developed at two points, Week's and Avery's islands. While the salt crops out on the nearby mainland, the development has been confined to the islands.

Week's island in Vermilion bay, an arm of the Gulf of Mexico, is 125 miles by rail west of New Orleans. The island lies 204 feet above the waters of the bay, is nearly circular in form, and has a circumference of nine miles. The mine of the Myes Salt Co. is located on this island (at Weeks, La.), and has a productive capacity of 1,500 tons of salt daily. The island has been thoroughly prospected with diamond drills, and is underlaid entirely with the salt deposit.

The theory has been advanced by geologists that expansion, at the time of the crystallization of the brine, caused the island to rise high above the bottom of the bay and the adjoining mainland. Basing a calculation on the expansion having been 5%, they estimate the thickness of the deposit to be 4,000 feet. The deepest drill hole below the present workings shows the deposit unchanged at a depth of 1,200 feet.

The salt lies ninety-three feet under the capping of soil, and is 98.4% pure sodium chloride. It is mined through a 20x20-foot vertical shaft, 650 feet deep. By cementing a portion of the shaft, where sand strata were pierced in the first ninety feet, the mine has been made absolutely dry. The mining is done entirely on one level, and with the perfection of the present system of underground transportation, as the workings advance further from the shaft, it will be a question of years before it becomes necessary to open another level.

650-ft. Level of Myles Salt Mine.

The entire property, including the underground workings, is lighted by electricity. Drills operated by compressed air are used in the faces and stopes, and blasting is done with a special smokeless powder. As there is no foreign matter whatsoever in the deposit, the whole mass is removed, with the exception of occasional pillars to support the roof. The salt is mined up to a height of eighty-five feet above the station level. The great chambers which are left present, when lighted, a sight of unparalleled grandeur. The spectacular effect of the

* In Mining & Engineering World.

myriad crystals reflecting the electric lights is remarkable, and many of the country's noted personages have accepted the hospitality of the owners at the banquets which are served from time to time in this fairy-like palace beneath the surface.

The underground traction system centers near the shaft where the salt is crushed. The crushed material is then hoisted to the surface millhouse and dumped. By gravity it is run over a series of screens, which classify the d f-ferent grades. Gravity then leads the finished products into cars or to the loading floor.

The output is shipped to nearly every country, the world-wide demand being due to its exceptional purity. Classificatoin of the product is based only on the fineness of the crushing, as the salt is all of the same quality. Salt is furnished in lumps for stock and is crushed for grades A and No. 1, for ice cream making and car refrigeration. Grade No. 2 is used in great quantities for curing hides, making brine for pickles, etc. Table and bath salt are made by grinding the product to a very fine mesh. In addition, a special packing salt is provided for the heads of meat barrels.

The steam plant on the property consists of four boilers furnishing 500 hp. The cage with a capacity of four and a half tons, the electric plant, the mills and the machines for the sewing of bags are operated from the one battery of boilers. Oil is used as fuel.

It is the intention of the owners of the property to install an electric haulage system in the mine in the immediate future. The plans provide for a belt line to run near the edge of the present stopes. Branches will be run to this line from points where work is in progress.

The output of the property is constantly increasing, as is the force of employes.

At present the entire output of the salt mines is handled by rail, as the waters of Vermilion bay are too shallow to admit vessels, but with the completion of the projected intercoastal canal, the advantages of water transportation will reduce the cost of marketing the salt, giving this region even more right to be known as the "salt cellar of the United States," than its cane production entitles it to the time-honored sobriquet of "America's sugar bowl."

For chain sheaves, the diameter if possible should not be less than 20 times the diameter of the chain used.

The loss due to valves in pipes has been determined to be about six diameters of length of pipe for a fully open gate valve.

SOUTHERN RUSSIA'S "PORPHYRY" COPPER MINE

By FREDERIC W. CAULDWELL.*

American capital is largely interested in the Caucasus Copper Company, which was formed in London in 1900 for the purpose of taking over and developing copper properties about fifty miles from Batum, which had been worked in the time of the Genoese, several centuries ago.

Up to the present time the company has expended over $8,500,000 on the property, but only recently has it been brought to a stage where the plant will pay operating expenses with a margin of profit. The development of the mining property has been slow because the ore is most difficult to treat, the copper being so finely disseminated through the rock that fine crushing is required, with the slimes resulting therefrom.

A magnetic plant was first erected, but was found unsatisfactory, partly because of the difficulty of cooling large quantities of red-hot ore to the stone coldness required in separating the ore from the silica. Enough of the latter mineral remained attached to the bits of magnetized metal to render the concentrates produced too siliceous for economical smelting.

Water concentration is now being used successfully. It yields a concentrate that can be smelted with less than 15% of oil and gives a recovery equal to that of the low-grade ores of Utah and Nevada.

At the present time an extensive campaign of development is about to start at the mine, and one plant extension is already under way. It is proposed to increase the crushing, concentration, roasting, and smelting equipment to a capacity of treating 1500 and probably 2000 tons of ore per day of twenty-four hours. The plant now treats 500 tons of ore per day. In view of these intended extensions, a description of the equipment and operation of the present plant is given.

ORE OCCURRENCE.

The mines contain at the present time, so far as is known from development work already done, 5,000,000 tons of 3¼% coper ore. It is known that there are extensions to this body far beyond that tonnage which have never been developed, as the present tonnage is sufficient for a number of years to come. It is proposed within the next year to resume diamond drill work to thoroughly test the areas upon which no development work has been done and under which the ore body is known to continue.

The ore occurs on a steep mountain side in a flat body varying in thickness from eighty to 120 feet. The overburden to be removed amounts to one-third of a ton for each ton of ore. The whole of the tonnage of ore thus far developed can be mined with quarry work. It is planned to remove the overburden, 80% of which is soft earth, by means of hydraulic giants, which will be cheaper than steam-shovel work.

These conditions, in connection with the cheap labor, will permit of an exceptionally low cost for mining, which, with a tonnage of 1,500 tons per day, would probably equal the lowest cost obtained at the large porphyry mines in Utah, Nevada, or Arizona. With the mines opened up and the overburden removed it is estimated 2,000 or 3,000 tons of ore could be supplied daily to a concentrator.

MILLING MACHINERY.

The ore is carried from the mine in 4-ton double-hopper cars by a short track to a crushing mill having a capacity of 1200 tons every twenty-four hours. This mill contains four 18x24 in. Blake crushers and eight sets of 15x36-in. rigid rolls. Automatic feeders supply the first pair of crushers, which grind to 2½-in. maximum size. The ore is then carried on a Robbins belt conveyor to a 500-ton bin, above the second pair of crushers, which crush to 1½ in. Automatic feeders are also employed here.

From the Blakes the ore is carried on a belt conveyor to a bucket elevator, at the top of which it is discharged to the two units comprising the eight sets of rolls. Each set of rolls is equipped with its own elevator and trommel, so that the material already fine enough to pass through the trommel is not sent through the corresponding set of rolls, thus decreasing the formation of slimes. The first set of rolls has a ⅞-in. trommel, and the two pairs of fine rolls each a 5-millimeter (millimeter equal .039 in.) trommel.

The ore crushed to a 5-millimeter size, is delivered to an aerial ropeway of the Pohlig system, similar to the Bleichart system in use in the United States, and carried to the concentrators on a 2400 ft. lower level. There it is divided between two concentrators, each having a capacity of 250 tons every twenty-four

* United States Vice Consul at Batum.

hours, and is fed from stock bins by automatic feeders to the boot of a vertical elevator, at the top of which a stream of water carries the ore to six jigs. In these all sizes of ore below 5 millimeters are jigged. The tailings from the six jigs go to revolving screens with 1½-millimeter holes, from which the oversizes go to an Evans-Waddell Chile mill, equipped with 1½-millimeter screens.

The ore from the other compartments of the classifier is sent to a row of ten and six tenths foot Frue vanners. The pulp is divided over the vanners in the proportion required by the tonnage produced in each of the sizes of the hydraulic classifiers. Each of these ten vanners thus treats between twenty and twenty-five tons of ore per day. The tailings from each group of these first-treatment vanners go to a bucket elevator attached to each group. After being elevated the tailings are again classified and treated a second time, a group of twenty vanners re-treating the tailings from the first ten. A fourth row of ten vanners is used to give a double treatment to the slimes obtained from the overflow of the classifier. These slimes are collected in eight wooden tanks, ten feet in diameter and eighteen feet high.

UP-TO-DATE METHODS.

The concentrates produced average approximately 8½% coper, 37% silica, and 28% sulphur. They are sent to concentrate storage bins and from there delivered to MacDougal roasters, 18 feet in diameter, and of the usual type used in the large copper smelters of the United States. The red-hot calcines mixed with limestone are delivered to three reverberatory smelting furnaces, two of which are thirty-five feet in length and one fifty feet. All are fired with oil.

The property is equipped with an excellent machine shop and a foundry of a size usually found only in plants of several times the capacity of this. These large shops are found necessary owing to the distance and time required to obtain spare parts.

The mines and smelter use oil for fuel exclusively. The oil is brought fifty miles from Batum by the company's own pipe line through four-inch Mannesmann high-pressure pipes. The oil used is that produced in the Caspian oil fields and is brought from Baku to Batum in tank cars.

The concentrators are all of the most up-to-date American machinery. In the smelter and the crushing mill the machinery is partly of English and partly of American manufacture of the most improved types. In extending the plant, the company will install equipment on the same general lines as that now in use.

At the present time over 1,100 men are employed in the mines and the smelting works and in construction. The labor is cheap and fairly efficient. A great variety of nationalities is found at work in the different departments. The miners are chiefly Greeks and Turks, with Persians working in the crushing mill. At the concentrators the laborers are Russians, Turks and Georgians. In the machine shop and foundry Russians and Georgians are to be found almost exclusively, while at the smelter the labor is exclusively Persian.

When the company took hold of the property in 1900 it found itself located about fifty miles from the seaport of Batum. The government macadamized military road covered thirty-five miles of this distance and the remaining fourteen miles the company was obliged to construct at great expense. This road had to be built along the face of mountains through rock and sliding soil. During the ten years of its existence the company has conveyed in wagons 10,000 tons of supplies, machinery, and product over this fifty miles of road.

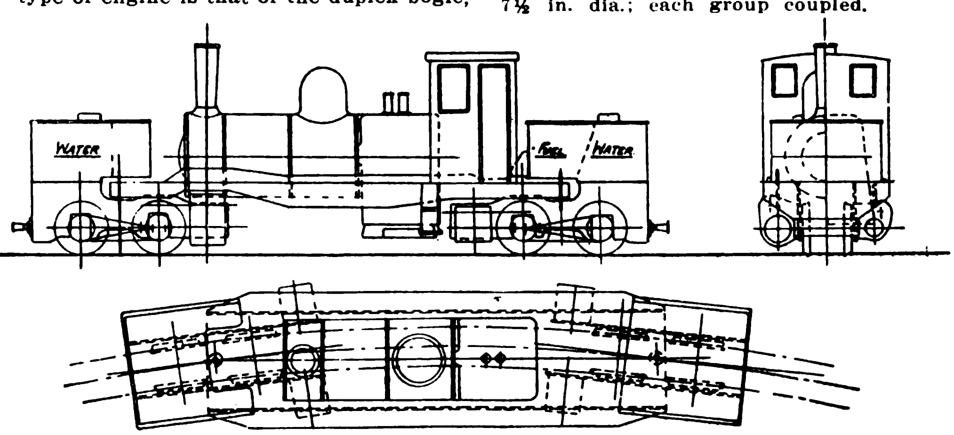
All the copper produced by the company is sold in Russia and commands a good price, as the duty on foreign copper imported into Russia is 5 rubles ($2.575) per pood (36.5 lbs.).

The property in point of ore tonnage developed is today one of the large mines of the world, and there is every indication that with the extension of the ore body known to exist but not yet prospected it will develop into one of the largest. The mining company is the largest buyer of American products in this part of the world.

Locomotive for Sharp Curves

The Tasmanian Government has had a Garratt engine in operation on the N. E. Dundas line (2 ft. gauge) for several years past, and it has proved so successful in negotiating the sharp curves, which are a feature of that line, that railway engineers from all over Australia have visted the district to see it at work, says the Australian Mining and Engineering Review.

The general arrangement of this new type of engine is that of the duplex bogie, but beyond this it has little in common with other known types. Instead of the boiler being placed above the wheels, as has hitherto been the practice, it is carried upon a girder frame slung between two bogies. This allows the firebox to be as wide as the loading gauge if desired, less the distance required for the width of the sides of the cradle frame, which is, in any case, only a few inches. The bogies, with their water tanks and coal bunker, together constitute the greater part of the weight of the locomotive, and give stability to the running; furthermore, the centre line of the boiler portion connecting the two bogies forms a chord of the curve on which the engine may be traveling, and the sharper the curve the greater will be the projection of the boiler weight towards the centre of the curve.



MAIN DIMENSIONS.

Gauge, 2 feet.

Cylinders, 2 pairs; 1 pair h.p., 11 in. dia. x 16 in. stroke. 1 pair l.p., 17 in. dia.

Wheels—4 pairs (in 2 groups), 2 ft. 7½ in. dia.; each group coupled.

Wheelbase—4 ft. each group. Total, 26 ft. 9 in.

Boiler—7 ft. long, 3 ft. 11⅛ in. dia.

Tubes (170)—1¾ in. dia. outs.

Firebox—3 ft. 5 1-16 in. long x 4 ft. 3⅞ in. wide x 4 ft. 2 in. high at front and 4 ft. 0½ in. high at back.

Heating Surface—

Tubes	568 sq. ft.
Firebox	60 sq. ft.
Total	628 sq. ft.
Grate Area	14.8 sq. ft.

Working Boiler Pressure—195 lbs. per sq. inch.

Tanks—

Smokebox end	510 gallons
Firebox end	30 gallons
Total	840 gallons

Fuel Space—1 ton of coal.

WEIGHT OF ENGINE ON RAILS.

	In working order with water and fuel tanks full.		
	T.	C.	Q.
Bogie at Smokebox end..	16	5	1
Bogie at Firebox end....	17	5	2
Total..................	33	10	3
	With water and fuel tanks empty.		
	T.	C.	Q.
Bogie at Smoebox end...	14	1	1
Bogie at Firebox end....	14	13	3
Total..................	28	15	0

Co-efficient of Adhesion Tanks full, 5.3.

Co-efficient of Adhesion Tanks empty, 4.5.

Engine designed to work up grades of 1 in 25, with curves 1½ chains radius.

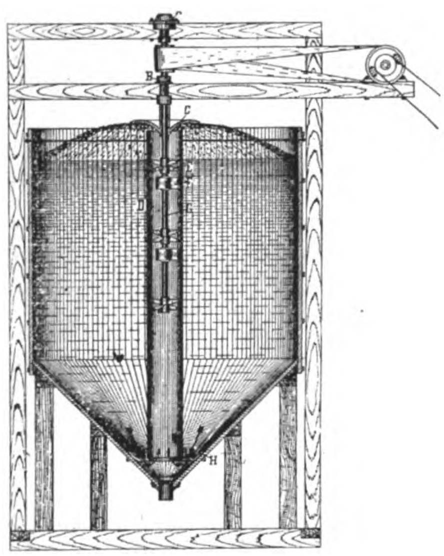
WOOD CYANIDE AGITATOR

The question of durability in an agitator is second only to that of perfect agitation and areation. The P. K. Wood Pump Co. of Los Angeles, Cal., has developed and put on the market an agitator in which is employed as a means of circulating and aerating the cyanide solution, the propeller pump, invented and patented by P. K. Wood.

The accompanying illustration shows this agitator, the interior of which is so constructed that there are no bearings within the solution, consequently no wear on any of the submerged parts of the pump coming in contact with the sand and solution. The shaft G is large enough in diameter to prevent any vibrations without receiving any support from the guides F, which do not come in contact with the shaft G, as the only function of the guide is to control the slight whirling motion imparted to the solution by the impellers E. The two shaft boxing, A and B, are placed far enough apart to prevent any vibration of the shaft where it extends down into the pump casing and solution, thus placing all the bearings beyond the reach of the solution. The shaft and impellers are supported by ball bearings, located on top of the box boxing A, where they are easily accessible.

In operation, the entire solution and sands are kept continually in motion; exposing the entire solution to the air every 10 to 20 minutes, according to the speed at which the pump is operated. The solution is distributed over the surface of the tank by the circular convex deflector C, which may be raised up until it is not reached by the solution, allowing it to flow undisturbed over the pump casing D, or it may be lowered until it forces the solution to the very verge of the tank in one solid circular sheet, or under such pressure that it spreads out in a thin sheet with great velocity, enabling the operator to give more or less aeration to suit his individual views. The amount of power required depends on the diameter of the tank, and the amount of aeration desired. The principal requirement of power being that of distributing the solution over the surface of the tank. Therefore it is preferable to use a deep tank with moderate diameter, rather than one of large diameter and equal capacity, for not only will the smaller diameter and deep tank give better results in agitation with less power, but the first cost will be less, as the cost of the agitator pump depends, not so much on its length, as it does on the volume of solution to be handled, requiring a pump of greater capacity for the larger diameter tank.

The distribution of the solution near to the outer edge of the tank insures perfect and uniform agitation of the entire contents of the tank; for the solution dropping in a heavy circular sheet around the outer edge of the tank creates a current downward around the entire circumference of the tank, which passes over the conical bottom of the tank moving toward the center, undermining the solution, causing it to settle evenly toward the apex, where it enters the pump to be taken up and delivered back again on the surface over and over again continuously. It is obvious that with this mechanical appliance, the entire solution and the sands in continuous circulation, there is no opportunity whatever for the sands and slimes to concentrate at any point in the process of agitation, for should the sand settle rapidly toward the apex of the bottom of the tank, they are immediately taken up by the pump to be discharged on the surface again, leaving no opportunity for the choking up by the sands. If it is desirable to fill the pump with the ore before starting, pipes or scantling may be set in the tank with the lower ends in the apex of the conical bottom. When the pump is in operation, draw these out, and through these openings the solution will be drawn by the pump with such velocity as to tear down the walls of sand and set it all in motion.



Wood Cyanide Agitator.

It is not anticipated that the agitator tank shall be used as a leaching tank, yet this may be done if desired; in which event it would be preferable to use a flat-bottom tank with false conical bottom, with filter covering the flat bottom, and the sides of the tank also if desired, with suitable discharge opening, to which may be attached a vacuum pump if required; and the agitator pump would be kept running during the leaching process, thus aiding the leaching by preventing the settling of the sands and slimes; and as the propeller pump is capable of handling at least 75% of solid matter on a vertical lift, the greater part of the strong solution could be filtered off before adding fresh water.

WIRE ROPE PRESERVATION

When a complaint is made that a wire rope has not given satisfactory service, the first questions asked by the manufacturer are, How was the rope lubricated? What is the condition of the inside wires?

These questions arise, because the experienced wire rope maker fully appreciates that a wire rope is a complex piece of machinery, and knows that the importance of proper lubrication is too often overlooked.

Sometimes a wire rope is covered with a compound too thick to penetrate beyond the outside wires. The effect of this is to leave the inside wires without protection against water and moisture.

Examinations of ropes that have fallen short of the period of good service which might be reasonably expected, frequently show the outside wires in apparently good condition, while the areas of the inside wires have been materially reduced and the whole rope weakened. This is due to the corrosion that could have been prevented by the use of a lubricant which would have reached and protected the inside wires. Because of this, a lubricant or preservative should not only penetrate to the hemp center (in order to saturate it and prevent absorption of water), but it should also thoroughly coat the inside wires of each strand.

This cannot be expected from thick, heavy and sticky compounds and greases frequently used for the lubrication of wire ropes, although made primarily for some other and quite different purpose.

Experience has shown that the best results in the protection and preservation of wire rope by lubrication are obtained only when lubricants made especially for this purpose are used.

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CONTENTS:

Ex-Mayor John S. Bransford returned from a four months' trip to the coast a few days ago. And, say, you ought to see the reception he has been and still is being accorded. People here have learned since the first of the year that they dropped a pearl to pick up a pin when they discarded him for Sam Park. They are beginning to appreciate what an honest, progressive business administration of a city's affairs by a dead square, open-countenanced, fair business man is worth to a community like this.

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During the month of February representatives of the government weather bureau service went out and measured the snow-fall in the mountains for the purpose of determining how short of water this city would be during the coming summer. What's the matter with having a second measuring expedition? It is said there is now more snow at Brighton, at the head of Big Cottonwood canyon, from which the main supply of water for this city comes, than has been known there for many years.

CONGRESS TINKERING WITH MINING LAWS

By the provisions of a bill to amend section 2322 of the Revised Statutes of the United States relating to mineral locations," which was introduced in the United States senate by Senator Reed Smoot on the 5th of the present month, another move is made in the long-pending efforts of a large percentage of those interested in metal mining to do away with the trouble-breeding "law of the apex," so-called. Without in any sense wishing to question the motives of Senator Smoot, it is urged on mining men of the west—and all over the country, for that matter—that right now is the time to inaugurate a campaign that should result in making this measure of revision of the mining laws all that it ought to be. There is little in the measure introduced by Senator Smoot showing that the subject has received any particular attention, thought or study on his part, and it is remarkable that such a proposition could be made by a western senator, engaged in mining, with so evident a lack of knowledge of what will be necessary in the change of present laws governing the location of mineral lands, to meet present day requirements and avoid trouble for the future. This new proposition is known as Senate Bill 6194. It has been twice read and referred to the senate committee on public lands. Mining men who are and should be interested in seeing a comprehensive law enacted should make themselves heard by the committee having the subject in hand. The Smoot bill reads as follows:

Sec. 1. Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, that Section 2322 of the Revised Statutes be, and the same hereby is, amended to read as follows: "Locators of all mining locations heretofore made on any mineral vein, lode or ledge situate on the public domain, their heirs or assigns, shall have the exclusive right of possession and enjoyment of the lands so located and of the veins, lodes or ledges apexing therein, as permitted by the customs, regulations and laws in force at the date of their locations, but from and after the passage of this act the locators of mining locations upon any mineral vein, lode, or ledge, or of a deposit of mineral or minerals in place, situate on the public domain, their heirs or assigns, shall, subject to such other rights as pertain to claims located prior to the passage of this act, have the exclusive right of possession and enjoyment of all the surface included within the lines of their locations and of such veins, lodes, ledges, and deposits of mineral or minerals in place as lie within the block of ground bounded by vertical planes passing through such surface lines, and no such locator, his heirs, or assigns, shall have the right under such location to follow any vein, lode, ledge, or other deposit outside of the limits of such claim.

"Sec. 2. That notice of location of all mining claims, lode, or placer. made after the date of the passage of this act, must be filed for record with the register and receiver of the land district within which the lands are situated within one year from the date of each location, and unless final entry and payment be made for such claims within seven years after date of location, exclusive of the time covered by pending adverse claims, all rights thereunder shall cease."

It will be noted at first glance that the measure is woefully lacking in detail; that, made into law as it is, it would prove a more fruitful source of litigation and trouble of all kinds than does the law it professes to amend. And the law of the apex is only one of many features of present day stumbling blocks found in our mineral statutes. A general revision is needed—a fact that has recently been given particular emphasis in the construction that has been placed on some provisions by the clerical snobs who make decisions for the general land office. A case in point is the recent ruling that the owner of a mining location, before he can secure government title (patent) to his land must first show that he has developed a PROFITABLE, PRODUCING MINE. This is conceded to be the biggest fool ruling of all the fool rulings ever promulgated by the land office, and it serves to emphasize how necessary it is that—if the industry of minig is to be preserved—no "tinkering" with present laws be permitted; that if any changes are made, they be wholesome and comprehensive ones.

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In figuring grade resistance (or assistance) add or subtract 20 pounds per ton for each per cent of grade.

TREND OF THE TIMES

Who is to blame for the terrible, wanton sacrifice of human life which resulted from the wrecking of the mighty ocean greyhound, the Titanic, on the night of April 14? Was it Captain Smith? Was it the company which ordered the ship built? No? Who was it—what was it—then? Everybody has formed or will form some sort of an opinion and these opinions will find expression publicly, or privately and carry weight according to the knowledge or lack of it—training, sentiment, superstition or belief of the individual units of humanity capable of conveying their impressions to others.

The responsibility for this appalling loss of life and the desolation it will bring to thousands who were left behind by those who perished will no doubt be saddled upon some one by what we are pleased to term lawful authority. The company owning the ship will be made culpable for not having provided a greater number of lifeboats and Captain Smith, who probably simply obeyed orders from his employers and went to his death while executing them, is apt to have his memory sullied through some "investigating" report charging that he should never have sailed from Portsmouth without seeing that his vessel was so equipped that shipwreck could not result in loss of life. Such is the trend of the times.

And let us here state that it seemingly is "the trend of the times" which should be charged with the fate of the Titanic and not a few individuals in the mass of millions striving, surging and swaying in the never-ceasing endeavor to outdo each other. A ship is built that sails faster than any previously built and the nervous world never halts till that accomplishment has been surpassed. The largest ship is launched and somebody immediately makes a move to secure a still larger and speedier vessel. Mechanical engenuity is placed at a premium and the new ship is conceived, planned and constructed. The mariner rebels and pleads that the latest effort is tempting fate and the elements; he is laughed to scorn and the world registers a deafening demand for the accommodation the "new floating palace" will provide. The shipmasters and their crews, per force, must either applaud the newest move to defy the elements or pass into obscurity as being "out of date." It is the trend of the times.

The trend of the times—these modern, rushing, hot-foot times—find its most fitting exemplification and definition in the combination of wealth and energy financially and commercially described in the two words: "BIG BUSINESS." It is "big business" that makes the world hum; it is the demands of "big business" that increases the size and speed of ships, railroad locomotives, automobiles, flying machines and balloons; it is "big business" that forms trusts and plans mergers and transforms night into day and day into night; and God has seemingly found it out and has called a halt. His displeasure is being expressed in the warnings given through the disasters accompanying reckless aerial flight; through the ravages of earthquake, typhoon and flood; through the rumblings of war and the almost universal discontent of the masses of the world's inhabitants. The pace has been made too swift; there will have to be a slowing down.

GETTING READY TO UNLOAD

An issue which is about to be offered to the public in a larger way than heretofore is the Guggenheim Exploration Co., which now has its press agents calling attention to the assets piled up in the company's treasury, in the shape of holdings in Utah Copper, bought some years ago at low prices, and which is nearly all clear profit now. It is stated that just before the recent rise in Smelters, the Exploration company bought a large block of stock at an average of $70.

The Guggenheim Exploration shares are to be listed on the New York Stock Exchange, but the par value is to be reduced to $25 by issuing new stock in exchange for the old on a basis of four shares for one now held; the object beinging to make the issue less unwieldy. At present figures, a hundred shares of stock comes to $22,000, a price that does not look very attractive to speculators as it ties up too much capital.

By way of further market news it may be said that Utah Copper has been under quite heavy pressure; some large holder is stated to have been liquidating holdings around $60, selling in 5,000 share lots. Underground work in the Boston ground of the Utah Copper has ceased, as the miners have struck for an increase of pay to $3.50 for miners and $2.75 for trammers.—New York Correspondent Mining and Scientific Press.

Here is a case wherein it would seem to be perfectly justifiable to "take that correspondent into camp." He will surely help kill the game if allowed to roam at large. See how much better it would be if the correspondent quoted above talked like Thomas C. Shotwell who, on the 17th of this month was quoted by the Salt Lake Tribune as follows:

Utah Copper is the one copper stock that has not discounted to any appreciable extent the improvement of the metal market. It is the richest of all the group and is selling comparatively the lowest. Its forthcoming report will show a remarkable increase of ore brought into sight. Buying of the stock is of the best character.

It is understood that a party of copper men will go from New York this week to visit the Utah copper mines. This may be a matter of no importance or it may mean that plans have been revived for the great copper merger that was attempted two years ago. The agreement regarding the output has worked so well that a legally organized trust seems unnecessary. But in view of the collapse of the Sherman anti-trust law it may be that the old plans will be revived.

Some "class" to that kind of "dope," whether it is true or not.

COPPERETTES

On the 15th of the present month more than 1000 Salt Lakers—men, women and school children—journeyed over the $5,000,000 "scenic line" of the Utah Copper Company—the B. & G. railroad—as excursionists to view the wonders of Bingham. It is presumed the drill hole through which 100,000,000 tons of new ore was added to the mine's "blocked out" reserves last year, was shown to the visitors, each one of whom was cautioned not to go too close to the brink of the hole for fear of becoming "giddy" and falling in.

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Judging from the report of the New York correspondent of the Mining and Scientific Press, some big holder of Utah Copper was unloading early in the mouth. Inside interests were compelled to take the stock in blocks as big as 5,000 shares each in order to keep the price up. It is certain that the feverish desire of the pooled crowd to distribute Utah shares with the public at large is not yet being encompassed with any material degree of success, notwithstanding the "buoyancy" so persistently heralded in the market reports and subsidized press.

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The action of the Guggenheim Exploration Company in increasing its number of shares and cutting down the par value of the stock to make it "less unwieldy," and the announcement that the new stock will be listed on the New York exchange, suggests the thought that the company has hit on this scheme of handing the public its large block of Utah Copper, a market for which it has been impossible to make as a separate proposition. The idea seems to be that "if we can't sell Utah Copper stock, let's hand it to 'em in the form of Exploration shares."

* * * *

The annual report of the Utah Copper company is, at this writing (April 23) still withheld from the public. It must be a weighty document this time, and since Mines and Methods "butted into its contents" a month in advance of its official promulgation, the "construction committee" has probably considered it necessary to make some changes. We are sorry that we cannot review the precious morsel this month; but it will keep.

MASON VALLEY MINES AND SMELTING WORKS

By AL H. MARTIN.

The holdings of the Mason Valley Mines Company, to which wide attention is now being drawn through smelter installation, market activities, etc., embraces seven claims and a fraction in the Mason Valley mining district, Nevada. The properties lie about one and one-half miles west of the town of Mason, on the Nevada Copper Belt railway. A wagon road of moderate grade connects the mines with Mason, affording excellent and rapid connections with the main line. Operations commenced at the mines March 1, 1907, and since that date the uncertain prospects have been gradually developed into the most important copper producer in western Nevada. The ore formation is principally limestone, with the ore deposits largely located on the east side of a north and south fissure. Copper sulphides predominate, with some oxidized matèrial near the surface. The veins range from a few feet up to 80 feet wide with values increasing as the fissure is neared. In the lower levels bedded ore deposits have been demonstrated. Diamond drilling has resulted in the intersection of zones carrying chalcopyrite below the main levels. Three large orebodies have been proven along the huge vertical fissure, and these are expected to eventually unite into one main deposit. Ore values range from about 2.25 to 3.75 per cent copper per ton.

MINE IS WELL OPENED UP.

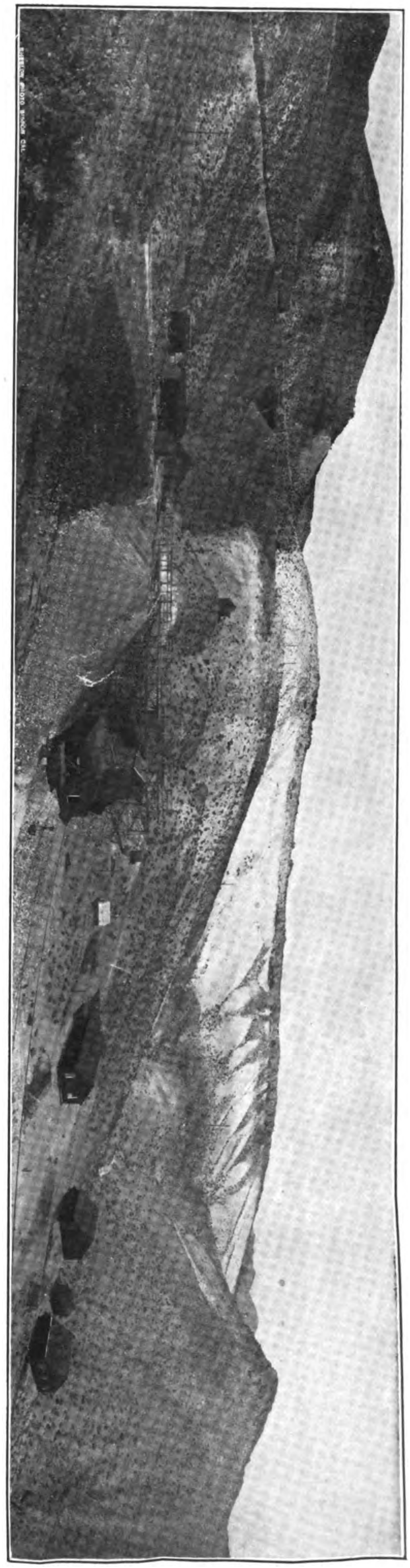
Developments consist of three main crosscut adits, intermediate levels and a comprehensive system of drifts, winzes and raises. In all 15,136 feet of work has been accomplished, according to recent reports of the management. No. 1 adit was driven ninety feet below the outcrops and was the first comprehensive work undertaken. Results proving satisfactory an intermediate level was sent 130 feet lower. Fifty feet below this Adit No. 3 was driven. The deposits continuing to show excellent strength as depth was gained, it was decided to drive an intermediate level fifty feet below No. 3. With the consummation of this work No. 4 adit, seventy feet deeper, and a drift seventy feet below the new adit, were extended. This gave a total vertical depth of 480 feet below surface. Ore shoots were found all the way down, and early in 1911 a diamond drill was installed in No. 4 adit and vigorous prospecting of the North Excelsior claim undertaken. A depth of 760 feet was gained when the shortage of water compelled temporary cessation of activities. The drill disclosed bodies of chalcopyrite ore and as soon as sufficient water is available it is likely that further drilling will be undertaken. Of the total amount of developments accomplished, crosscut adits and drifts represent 9,466 feet, and lateral crosscuts 2,853 feet, while 2,443 feet of raises have been driven, together with 371 feet of shafts and winzes.

In developing the mines drifts have been run north and south following the general trend of the orebodies, while crosscuts have been driven east and west. The ground breaks and stands well, with little timbering required. All of the ore above No. 4 adit is broken down into the levels and loaded directly into the cars. Consequently there is no necessity for hoisting ore above this point, natural conditions being particularly favorable for low mining costs. Until considerable mining at depth is undertaken, pumps will not be used. During the construction of the smelting plant, little effort was made to extract ore aside from that produced in course of developments, and the company has a large tonnage blocked out. This can be extracted with little dead work for a considerable period. With 300 to 500 tons produced daily, it is estimated mining and development costs will not exceed $1.25 per ton of ore.

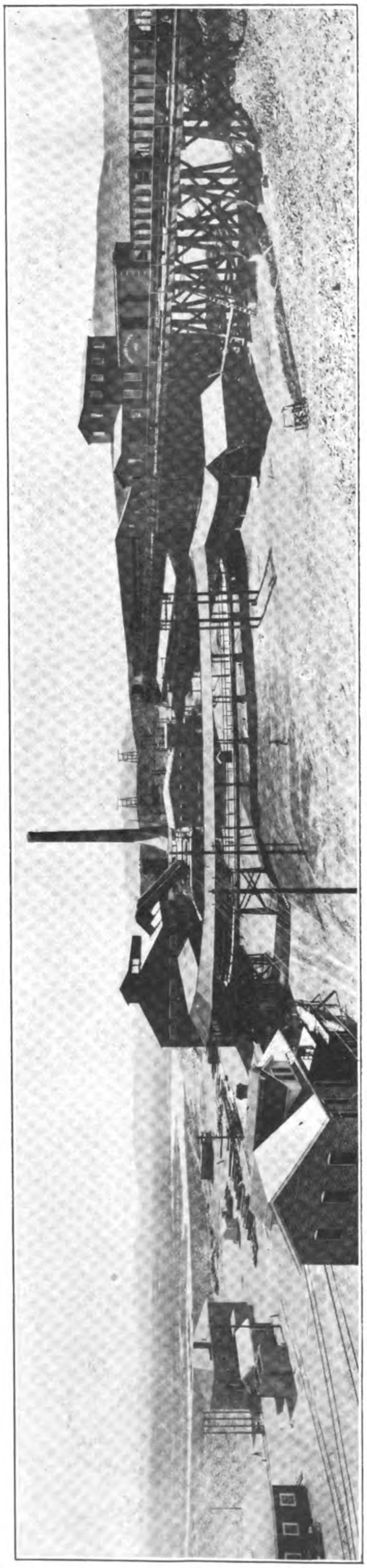
EQUIPMENT AND TRANSPORTATION.

The machine-drills are supplied with power from an Ingersoll-Rand compressor of 576 cubic feet capacity. Seven Ingersoll-Rand and six Waugh machine drills are employed. A Westinghouse C. C. L. induction motor of 100 horsepower delivers 440 volts to the mine machinery. Three Westinghouse 27.5 kilowatt transformers steps down the current from 2,200 to 440 volts for delivery to motors. The ore is shipped to the railway cars at Mason from the mines by an aerial tramway 1¼ miles long. From Mason the ore-cars are taken over the Nevada Copper Belt railroad to the smelter at Thompson, 16½ miles distant. A traffic agreement exists between the railroad and the Mason Valley company for the handling of this ore.

From the railroad cars at the smelter terminus of the railway, the ore is



General View of Main Portion of Mason Valley Mines, Showing Various Operating Tunnels, Mine Terminal of Ore Transporting Tramway, Etc.



Panoramic View of Mason Valley Smelter at Thompson, Sixteen Miles From the Mines—Walker River in Background.

loaded into 50-ton dump-cars and delivered to the sampling mill. The ore is first crushed in a No. 8 gyratory crusher and delivered to samplers of the Vezin type. Between each sampler the ore is crushed before further bulk reduction. The sampling mill has a capacity of 100 tons per hour. After sampling, the ore is received by belt-conveyors and distributed to twenty ore-bins. Each of these has a capacity of 200 tons. Ample coke storage has been provided for a stock sufficient to run the plant several weeks in excess of requirements—to avoid stoppage of operations should interruptions of shipments develop.

MASON VALLEY SMELTER.

The blast furnace building is constructed of steel. Two blast furnaces, each having a rated capacity of 400 tons per day, have been provided, but the solitary furnace in commission is treating from 450 to 500 tons of material per day. Ample space has been provided for the future installation of three more blast or reverberatory furnaces and two converters. The blast furnaces are of the water-jacketed drop-bottom type, with dimensions of 46x300 inches at the tuyeres. Each furnace has 24 jackets, with 25 tuyeres on each side. The spout is at the end of furnace and delivers into a small forehearth. The ore from the bins is dropped through chutes into an automatic scale and is loaded directly from the scale into the charging train. This consists of six cars, operated by an electric locomotive. The cars run directly underneath the scale. Besides the sulphide ore coming from the Mason Valley mines, a considerable portion of the charge consists of carbonate ores from the Nevada Douglas properties, at Ludwig, in the same district. The union of these ores makes a nearly self-fluxing charge, only about 5 per cent of lime rock being required.

From the small forehearth receiving the slag and matte from the furnace spout, the products flow into a large settler. Blast is supplied to the charge by two Connelsville blowers, operated by electric motors. The blowers have a capacity of 275 cubic feet. The blast pressure ranges from 30 to 38 ounces. The blowers are operated by power obtainable from two different stations, to guard against the shutdown of blowers in case of accidents to either one station. The matte varies from 42 to 50 per cent, the company endeavoring to produce a product always averaging over 40 per cent copper. At present the matte is tapped into a casting machine, but it is understood this will probably later be replaced by a large circular settler of ordinary design. The product is sent to Garfield, Utah, for further treatment, but the future plans of the company include the probable installation of converters to transform the matte into blister copper.

The brick furnace stack has a height of 200 feet and is self-sustaining. It has an interior diameter of fifteen feet at the top, and is located about 400 feet above the valley. Large flues and dust chambers have been provided to arrest the fine dust. The Dwight & Lloyd sintering process is used for the sintering of fine ore and flue dust. The slag from the settler is hauled to the dump piles in 20-ton slag-pots, drawn by electric locomotives. The sampling mill building is composed of steel, and the power house is constructed of brick. Three 500 kilowatt oil-insulated, water-cooled transformers are located in the power-house, together with a motor generator, furnishing power to the electric locomotives.

Aside from the main installations, the company has provided machine, sheet metal, blacksmith and carpenter shops. A concrete reservoir has been provided to guard against fire, this being at an elevation to provide a strong gravity pressure. A complete fire-fighting system has also been installed. The plant is one of the most modern in the country and it is planned to gradually enlarge it into one of the largest in the west. The smelter equipment was installed by the Traylor Engineering & Manufacturing Co.

DOES CUSTOM BUSINESS.

In addition to the ore treated from the Mason Valley and Nevada Douglas copper mines, a large amount of gold-bearing custom material is received at the smelter from numerous small mines in territory tributary to the plant. This factor is expected to develop into a highly profitable industry, as hitherto lack of reduction facilities has been one of the greatest factors militating against operation of small mines in this section of Nevada. Thus, the Mason Valley plant is exercising a beneficial effect upon gold mining throughout Mason valley and even as far as the vicinity of Reno. As this business develops, and production of ore increases at the Mason Valley and Nevada Douglas mines, it is probable the second furnace will go into commission before the close of 1912.

Just below the smelter the company has undertaken the building of the town of Thompson, named after President W. B. Thompson of the Mason Valley Mines Company. It boasts a modern hotel and about twenty houses, and is steadily gathering importance. Climatic conditions are favorable. Construction work started on the smelter in November, 1910, and the first furnace was blown in January 6, 1912.

MODERN THEORIES OF ORE DEPOSITION

By E. K. SOPER.*

An ore deposit may be defined as a concentration in the earth's crust of metalliferous minerals of economic value. The term, ore, has been variously defined by different students of the subject, but the following definitions suggested by Ries and Kemp probably cover all cases. In his text-book of Economic Geology, Ries gives the following: "Under the term, ore, are included those portions of the ore deposit of which the metallic minerals form a sufficiently large proportion and are in the proper combination to make their extraction possible and profitable." Those minerals which carry the valuable metallic element within the deposit are called ore minerals. Kemp thinks that a distinction should be drawn between the purely scientific use of the word and the technical usage. He suggests the following definition:

†"In the scientific sense an ore is a metalliferous mineral, belonging to the group of those which have profitably yielded metals to the miner or metallurgist. In its technical sense an ore is a metalliferous mineral or an aggregate of metalliferous minerals, more or less mixed with gangue and capable of being, from the standpoint of the miner, won at a profit; or from the standpoint of the metallurgist, treated at a profit." It is readily seen from a consideration of the above definitions that the test of yielding the metals at a profit is the final one to employ in limiting the use of the term ore, to its correct place. If we accept this definition, it naturally follows; then, that what may not constitute an ore today may become ore at some future date by reason of improved methods of mining or metallurgical treatment. Similarly, material that is ore today may not be an ore in the true sense of the word at a future time, because of a decrease in the market value of the metal or a decrease in the proportion of metals in the rock which is being mined.

The study of ore deposits is a comparatively new branch of the science of geology. The study of the genesis of ores is of comparatively recent date, and the present state of our knolewdge of the subject is far from satisfactory. The earliest contributions to this branch of the science were made by the German geologist Werner, in about 1791. At this date he advocated the theory that "mineral veins and eruptive dikes" were formed from sea waters by chemical precipitation. This theory met with little opposition except from a few, for the subject of ore genesis up to that time had been given little if any attention. Some years later, Hutton, an English geologist, expressed it as his opinion that dikes and veins were formed by the solidification of igneous magmas. Following this, other views were set forth by various students of the subject, until considerable interest was aroused, especially in Europe. Von Cotta developed his theory of fissure veins about 1859, and in 1882 Sandberger and his followers put forward their views on the subject, which later became known as the theory of lateral secretion. They held that ore deposits were formed by leaching of the metals from the rocks in the vicinity of the ore body, and the theory was based on the premise that the country rock must first contain the metals in some form, in order to furnish a source from which the ores could be concentrated by laterally moving solutions. Physical and structural conditions of the deposits, which we now recognize to be of the greatest importance in furnishing evidence of origin, were largely ignored by the followers of Sandberger.

From 1882 until late in the nineteenth century, the Germans led the world in the study of ore deposits. During the last ten or fifteen years, however, the development of economic geology as applied to mining has undergone remarkable development. The recognition of the economic value of this branch of the science is chiefly due to American geologists and it is to their efforts, largely, that we owe this great step forward. Perhaps one of the chief factors in stimulating the study of ore deposits in the United States has been the detailed investigation of a large number of the most important mineral deposits of the country undertaken by the United States Geological Survey.

ULTIMATE SOURCE OF THE METALS.

Geologists now agree that the ultimate source of the metals is in the igneous rocks. While this is an important step, there is still much difference of opinion regarding the sources of the solutions which carry these metals from one point in the earth's curst to another, resulting in concentrations of the valuable minerals in comparatively small areas, thus enriching the rock and forming ore deposits. The chief point under investigation, and regarding which geologists are still in disagreement, is whether the solutions which brought certain deposits to their present position, were of meteoric or magmatic origin. This is an important fact to establish in studying the genesis of a given deposit, for the depth of mineralization will often depend upon the origin of the mineralizing solutions. Unfortunately in many cases, this very important fact is the most difficult of all to establish. It is probable, however, that both meteoric and magmatic waters have played a part at some time in the history of most ore deposits, and it is to be hoped that the investigations of the next few years will add much evidence to this important phase of the subject.

CLASSIFICATION OF ORE DEPOSITS.

Ore deposits are classified into certain groups in order to facilitate their study and comparison. Various methods of grouping have been used by different students of the subject, and each has a certain value. For example, deposits have been classified with respect to their age relation with the country rock: (syngenetic, contemporaneous with the country rock; and epigenetic, of later age than the country rock). Deposits have also been classified with respect to metasomatic processes acting during their formation. Other classifications are based upon depth at the time of deposition, forms of deposits, etc., etc.

In studying a given ore deposit, the first thing to find out is what is there. After having determined what is there, the problem is to ascertain what has happened. If the geologist is fortunate enough to be able to make these important determinations, his problem is nearly solved, and it will require only the correct interpretation of his evidence to enable him to make the proper recommendations regarding its exploitation. Ore deposits assume such a great variety of forms and occur under such variable conditions that it is necessary to have some logical classification as an instrument in their investigation.

*Department of Geology, University of Minnesota.

†J. F. Kemp; What is an Ore? Mining & Scientific Press, March 20, 1909, page 423.

The following classifications by Kemp and Weed are given to illustrate two entirely different systems of grouping. Kemp's classification, based on the methods of deposition and the shape of deposits, is as follows: (*)

Excessively basic development of fused and cooling magmas. Peridotite, forming iron ore at Cumberland Hill, R. I. Magnetite, Jacupiranga, Brazil. Titaniferous magnetite in Minnesota gabbros; in Adirondack, N. Y. gabbros; in Swedish and Norwegian gabbros. Nickeliferous pyrrhotite, in gabbros and diorites derived from them.

(1) Surface precipitation, often forming beds, and caused by:

(a) Oxidation—bog ores.

(b) Sulphurous exhalations from decaying organic matter, (pyrite).

(c) Reduction, chiefly by carbonaceous organic matter, (pyrite from ferrous sulphate).

(d) Evaporation, cooling, loss of pressure, etc., (Hot Spring deposits, as at Steamboat Springs, Mo.).

(e) Secretions of living organisms (iron ores by algae).

(2) Dissemination (impregnations) in particular beds of sheets, because of:

(a) Selective porosity.

(b) Selective precipitation by limestone.

(3) Filling joints, caused by cooling and drying. (Miss. Valley gash veins in part.)

(4) Occupying chambers (caves) in limestone. (Cave mine, Utah.)

(5) Occupying brecciated beds, caused by solution and removal of support, or from dolomitization of limestone. (S. W. Misouri zinc deposits.)

(6) Occupying cracks or monoclinal bends, anticlinal summits, synclinal troughs, often with replacement of walls. (Gash veins in part; galena deposits at Mine la Motte, Mo., etc.)

(7) Occupying shear-zones or dynamically crushed strips along faults, whose development may be slight, closely related to No. 8. (Butte, Montana.)

(8) True veins filling an extended fissure, often with lateral enlargements. (See also under 5.)

(9) Occupying volcanic necks in agglomerates. (Bassic Mine, near Rosita, Colo.)

(10) Contact deposits. Igneous rocks almost always form one wall. Fumaroles.

(11) Segregations formed in the alteration of igneous rocks. (Chromite and serpentine.)

(1) Metalliferous sands and gravels, whether now on the surface (placers, magnetite, beach-sands) or subsequently buried, (deep gravels, etc.).

(2) Residual concentrations, left by the weathering of the matrix. (Iron Mt., Mo. Limonite in part.)

From the foregoing it will be seen that this classification makes no distinction between deposits from magmatic solutions and deposits from meteoric solutions, nor is the depth at which the various deposits were formed considered. On the other hand, the form, shape, and location of the various deposits are all treated in detail.

The following classification by Weed embodies the results of the more modern studies of ore deposits, and includes several types not given above.

CLASSIFICATION OF ORE DEPOSITS.
(After Weed.)

A. Igneous, magmatic segregations.
  (a) Siliceous.
    1. Masses, aplitic masses. Ehrenberg, Shartash.
    2. Dikes, beresite or aplite. Berezovsk.
    3. Quartz veins. Alaska, Randsburg, Black Hills.
  (b) Basic.
    1. Peripheral masses, copper, iron, nickel, Sudbury, Ontario.
    2. Dikes, titaniferous iron. Adirondacks; Wyoming.

B. Igneous Emanations. Deposits formed by gases above or near critical point (365° C. and 200 atmospheres for H_2O).
  (a) Contact metamorphic deposits.
    1. Deposits confined to contact, magnetite deposits, (Hanover, N. Mex.), chalcopyrite deposits, Kristiana type; gold ores, Bannock, Idaho, type.
    2. Deposits impregnating and replacing beds of contact zone. Chalcopyrite deposits, pyrrhotite ores, magnetite ores, Cananea type, gold-telluriun ores, Elkhorn type, arsenopyrite ores, Similkameen type.
  (b) Veins closely allied to magmatic veins and to division D.
    1. Cassiterite. Cornwall.
    2. Tourmaline copper. Sonora.
    3. Tourmaline gold. Helena, Mont., Minas, Geraes.
    4. Augite, copper, etc. Tuscany.

C. Fumarolic Deposits.
  (a) Metallic oxides, etc., in clefts in lava. No commercial importance. Copper, iron, etc.

D. Gas-aqueous or pneumato-hydato-genetic deposits, igneous emanations, or primitive water, mingled with ground water.
  (a) Filling deposits.
    1. Fissure veins.
    2. Impregnation of porous rock.
    3. Cementation deposits of breccia.
  (b) Replacement deposits.
    1. Propylitic. Comstock, Nev.
    2. Sericitic, kaolinic, calcitic, copper, silver, silver-lead. Clausthal. De Lamar, Idaho.
    3. Silicic dolomitic, silver lead. Aspen.
    4. Silicic calcitic. Cinnabar, California.
    5. Sideritic silver lead. Coeur D'Alene, Slocan, Wood River.
    6. Biotitic gold, copper. Rossland, B. C.
    7. Fluoric gold, tellurium. Cripple Creek.
    8. Zeolitic. Michigan copper ores.

STRUCTURAL TYPES OF ABOVE.

Fissure veins, San Juan, Colo.
Volcanic stocks. Nagyag, Cripple Creek.
Contact chimneys. Judith.
Dike replacements and impregnations.
Bedding and contact planes. Mercur.
Axes of folds, synclinal basins, anticlinal saddles.
Bendigo, Elkhorn.

E. Meteoric Waters (surface derived).
  (a) Underground.
    1. Veins. Wisconsin lead and zinc.
    2. Replacements. Iron ores, Mich., lead, zinc.
    3. Residual. Gossan iron ores, manganese deposits, Virginia.
  (b) Superficial.
    1. Chemical. Bog iron ores, sinters. Some bedded iron ores, etc. Clinton ore.
    2. Mechanical. Gold and tin placers.

F. Metamorphic Deposits. Ores concentrated from older rocks by metamorphism, dynamic and regional.

The two classifications given above were not selected because they were considered the best, or because they are especially simple, but for the reason that, as stated above, they are representative, and illustrate two entirely different methods of grouping. Other geologists have devised excellent classifications, each of which has caused certain deposits to be inspected more carefully with definite premises in view. In studying ore deposits there are four or more variables to consider, so that it is almost, if not quite impossible, to express all the features of all ore deposits in a single classification.

In order to place a deposit in its proper class, much detailed study is usually required and even then it may be impossible to secure indisputable evidence which will enable the geologist to properly classify the deposit. Therefore the origin of many known deposits is still in doubt and geologists are constantly changing their views regarding the genesis of certain ore bodies as new evidence is brought to light. Therefore it may happen that after a certain origin has

*J. F. Kemp; Ore Deposits of the United States, p. 53.

been assigned to a new and puzzling ore deposit, later it may be necessary to somewhat modify one's views regarding its genesis as additional data becomes available; because it is often the case that in the early stages of development of an ore body there is an almost complete lack of convincing evidence concerning its origin.

In order to understand the more or less complex processes which operate in the formation of ore deposits, it is necessary to consider first something of the nature of the rocks in which these deposits occur, and the formation of cavities in these rocks in which the ore minerals may be deposited.

ZONES OF THE EARTH'S CRUST.

Van Hise* suggests that the earth's crust may be divided into three zones: (1) an upper zone of fracture, beginning at the surface and extending downward to (2) the zone of combined fracture and flowage, which is underlaind by (3) zone of rock flowage, or no fracture. We know that there are stresses within the earth which are constantly exerting forces in many directions and the intensity and direction of these forces are forever changing. The rocks themselves offer great resistance to the forces tending to deform them, but when the force of their resistance is no longer sufficient to withstand the opposing force or set of forces, euqilibrium is destroyed and a readjustment must follow. This readjustment usually takes the form of some movement or deformation in the rocks and may be apparent at the surface by folding or faulting or earthquakes. The position in the earth's crust at which these strains are acting will determine largely the nature and amount of deformation that may occur. For example, in the zone of rock flowage (zone 3) which is at great depth, the pressure of the superincumbent material would be so great that no fracture could remain open there, no matter how small. This is not difficult to conceive when we remember that it has been actually demonstrated that under conditions of sufficient heat and pressure the strongest rocks are made to flow like plastic bodies. Therefore, should a fissure be produced in the zone of flowage it would be immediately sealed again; and it follows from this that the zone of flowage must be composed of tight, non-porous rock which is quite impervious to waters and gases and therefore cannot be looked to as the seat of deposits formed from circulating solutions. The depth of this zone of flowage below the surface will vary greatly for the different rocks. An exact measurement is obviously impossible, but it has been estimated that at a depth of about one mile the pressure would be so great that shale will crush, and flow, while at a depth of five miles the hardest granite would be rendered plastic.

*Treatise on Metamorphism. Monograph ..LVII, U. S. G. S. 1905, p. 1005.

In the zone of combined fracture and flowage there will be some openings in the rocks. In this region the hardest and strongest rocks such as granite and gneiss, would be fractured by the great forces acting upon them, while if a fissure were to form in the less resistant rocks such as shale and limestone, it would be immediately sealed up again, due to the fact that at this depth the crushing strength of the shale and limestone is not sufficient to resist the tremendous pressure of the overlying material. Thus it is that in the zone of combined fracture and flowage certain ore deposits may form, but these are of a class comparatively rare and they usually show properties which are characteristic of a deep seated origin.

The zone of fracture is that one extending from the surface downward to a depth varying from a few thousand feet in the case of the softer rocks, to ten or perhaps fifteen thousand feet for granites and gneisses. In this zone the great majority of the ore deposits are formed, and by far the most of them are deposited within a mile or two of the surface.

It is not necessary, however, to have an open cavity or fissure existing within the rocks in order to have a deposition of ore either from magmatic or meteoric waters. Watery solutions, especially if they be hot and under pressure, have the power to actually dissolve their way through the rocks, replacing the original rock minerals by new ones as they go. This replacement of minerals by others is known as metasomatic replacement, and there is no doubt that many ore bodies have been deposited in this way. This replacement process is especially active in the more soluble rocks. While no one will dispute the importance of metasomatism in the genesis of ore depoists, the majority of ore bodies are probably deposited in open cavities of some kind. Therefore, in order to more clearly understand the processes of ore deposition under these conditions, it is desirable to study rock cavities, and the conditions under which they are formed.

ROCK CAVITIES AND CIRCULATION.

Rock cavities may be classified (1) with respect to origin; (2) with respect to size or (3) with respect to location. With respect to its origin, a cavity may have been formed either (1) by solution or by (2) fracturing.

A classification according to size would be as follows:

1. Super-capillary openings.
2. Capillary openings.
3. Sub-capillary openings.

In super-capillary openings the water which circulates through them will obey the laws of hydrostatics. In capillary openings, capillary action will control the movements of the solutions, while in subcapillary openings, the cavities are so minute that the water remains in the rock but will not circulate through it. Very few if any ores would be deposited in these minute pores of the rock, and only a comparatively few are found in openings of the second class. Most ore deposits are formed by precipitation from solutions obeying the laws of hydrostatics in super-capillary openings.

Considering openings with respect to their location in the rocks, there are a number of classes, the most important of which are the following:

I. Primary openings.
  (a) Spaces between bedding planes.
  (b) Intergranular spaces — especially in the clastic rocks.
  (c) Vescicular spaces—ingneous rocks, especially in lavas.

II. Secondary openings (most important as channels for mineral bearing solutions.)
  (a) Solution cavities—caves, chambers, sinks, etc.
  (b) Cavities due to mass movement such as shrinkage cracks, joints, fissures, fault planes, etc., etc.

The waters which circulate through the rocks always contain in solution minerals, acids or gases, or all three, and their power to dissolve the rocks is thus greatly increased. This will be especially true if the solutions are under heat and pressure, as they usually are when at considerable depth. It will be readily understood how such a solution entering a minute crack in the rocks would be slowly forced along this opening, gradually widening the fissure as it went, by taking small amounts of the wall rocks into solution and carrying it away. This action will of course proceed most rapidly in the more soluble rocks, so we find that solution cavities reach their greatest development in limestones. Many of the "chamber deposits" and "cave deposits" in limestones have been formed in this way. They were originally small fissures which were widened, and perhaps lengthened, by solution of the walls, and which subsequently became filled with ore. The importance of the solvent power of acidulated water can be more readily understood after studying some of the great cave openings in the rocks produced in this manner. The Mammoth Cave of Kentucky was doubtless produced by the solution and removal of the limestone in which it occurs and it has been estimated that 12,000,000 cubic yards of rock have been removed in its formation.

Cavities due to fracturing may be produced in four ways: (1) by shrinkage of the rock masses; (2) by folding; (3) by faulting; (4) by earthquakes. Secondary fracture cavities are the commonest location of ore deposits because they occur in all kinds of rocks and in countless numbers. Primary openings are also of great importance in the formation of ore deposits, for they make it possible for the solutions to circulate through the rocks between the secondary openings. But the primary openings are only rarely the home of the deposits themselves. The copper bearing amygdaloids of the Lake Superior region is a good example of ore filling primary vescicular spaces in igneous rocks.

DEPOSITS FROM SOLUTION.

Solutions of one kind or another probably play some part in the formation of all ore bodies, but under this broad heading will be considered only those which owe their origin entirely or in the greater part to solutions circulating through openings in the rocks. This includes fissure veins of variable shape and size, stockworks, replacement deposits (in part), chamber deposits, etc. Types such as contact magmatic segregations, etc., which are not clearly related to openings in rocks, are not included under this heading, and will be considered separately later.

It has already been stated that the ultimate source of the metals is the igneous rocks, and geologists are practically agreed on this. But when it is attempted to explain how these metals were brought to their present resting place, complex problems are met with which have yet to be solved. That circulating solutions constitute the chief factor in transporting mineral matter from one place in the earth's crust to another is pretty well established. The difficulty lies in determining the source of these solutions and in tracing their movements through the rocks. One class of writers believes that the chief source of this water is the atmosphere and surface of the earth, and hence they agree that ores are deposited chiefly by these meteoric waters. Others maintain that the ore-bearing waters are primarily of magmatic origin, and are brought up from below with rock magmas. A third class, and this probably includes the majority of students of ore deposits at the present time, believes that both meteoric and magmatic waters have been active as agents in the concentration of most ores. The first concentration of the minerals, it is now thought, was in the majority of cases due chiefly to ascending hot waters. Later these magmatic waters may have come in contact with cold meteoric waters descending from the surface, thus causing a precipitation of mineral matter; or the minerals first deposited by magmatic waters may later have been subjected to the action of oxygenated meteoric waters and reconcentrated. These processes will be discussed more in detail under secondary enrichment.

Disregarding for the present those deposits which are clearly due in part at least, to agencies other than circulating waters, such as segregations from molten magmas, pegmatites, fumarolic and contact metamorphic deposits, there is a large group of ore deposits which doubtless owe their origin to deposition from solution. This class includes the commonest type of mineral deposits, i. e., fissure veins, and most deposits in secondary openings. The deepest mine shaft in the world is down only a little over one mile, and so our knowledge of the earth is exceedingly unsatisfactory.

The theories regarding the formation of ores of the deep zone must usually be based upon what little evidence remains at the present surface. Processes of denudation are constantly at work lowering the surface of the earth, rendering the rocks more porous, and providing channels for the circulation of surface waters. Thus it is that a deposit of ore which may at one time have been buried beneath a mile or even several miles of rock, may now outcrop at the surface. In the case of some of the older geologic formations, it is by no means improbable that even greater thicknesses of rock than this have been removed by erosion. Rain water falling upon the surface of the earth is disposed of in three ways. (1) A part of it runs off the surface into streams and is returned to the seas and oceans; (2) a second portion is returned by evaporation; (3) a third portion (and this is the part that plays the most important role in mineralization), seeps into the ground and into the underlying rocks. Of this water which sinks into the ground, a small portion is held near the surface by capillarity, but the great bulk of it permeates the pores and intergranular spaces of the rocks and forms the great body of subterranean water known as the ground water. The surface of this ground water is called the water table, or the ground water level. This water table is not a flat surface, but broadly speaking, follows the curves of the surface topography. For example, beneath a hill the ground water level will rise; and beneath a valley it will sink. It must be understood, however, that these are only general laws and under certain modifying circumstances exceptions may be noted, as, for instance, a persistent stratum of impervious material, such as clay or shale, may dam back the ground water and cause an unnatural distoration of the water table.

Where such a condition obtains, the water will be under greater hydrostatic pressure and may be forced to the surface to form springs, or it may be diverted in any direction until released from the pressure of its confining walls, when it will once more tend to return to its normal position. The great bulk of this underground water is probably of meteoric origin, although it is impossible to conceive of any condition which would prevent magmatic waters from mixing with this surface water in any proportion should such magmatic water be encountered. That such additions of magmatic waters are constantly being received by the ground water is almost certain.

If we accept the hypothesis of the three zones of the earth's crust, it is seen at once that there is a limit in depth to which this ground water can descend. It certainly permeates the zone of fracture; part of it may even get down into the zone of combined fracture and flowage; but it is quite certain that none of it could circulate in the zone of flowage. As the ground water travels deeper and deeper into the rocks, temperature is constantly increasing. The amount of this increase, so far as we know, is on the average about one degree Fahrenheit for every sixty feet in depth. Furthermore, as it descends, the pressure on the water becomes greater and greater.

Both increase of temperature and pressure are favorable to the solution of mineral matter, and hence the solvent power of the water is constantly increasing as it descends. But at a certain depth which varies with the local conditions, the impermeability of the rocks will become so great that these waters can no longer penetrate them, and they will be forced to spread out laterally and finally rise, due to hydrostatic pressure. During their progress downwards, certain acids and alkalies would be taken into solution, so that by the time these waters reach the lower limit of their journey, the solutions would be capable of dissolving almost any of the metallic minerals which they might encounter. As the solutions rise, it is natural that they should tend to follow the more open fissures and channels in the rocks.

The temperature and pressure are now decreasing and the solutions which may be already supersaturated now would begin to drop part of their load and precipitation would start. Since the upward circulation is mainly along the larger fissures or openings, it follows that the greatest deposition of mineral matter would be along the walls of these trunk channels. Such is probably the case, and it is likely that many filled fissures have originated in this way. Another factor favoring the deposition of minerals along the trunk channels is the fact that the meteoric waters would be almost sure to mingle with water of magmatic origin in these larger openings, and this mingling of solutions of different chemical composition would result in a precipitation of certain compounds along the walls of the fracture. Chemical reactions between the solutions and the wall rock is another potent factor in the first concentration of ores.

As stated before, there is no doubt that certain ores owe their concentration to the action of circulating meteoric waters, but any theory that attempts to explain the origin of the majority of deposits, or even the majority of veins, by this method, must meet with strong objections. The chief of these objections is the fact that meteoric waters do not circulate through a sufficiently extensive zone to accumulate the tremendous quantity of metallic minerals found in many deposits. These waters may circulate throughout the zone of fracture, but it is probable that they seldom reach a depth greater than 2,000 feet, and then it is only when they have followed open fissures in the rocks.

The theory of concentration of ores by magmatic, or juvenile waters was first suggested by Elie de Beaumont* in 1850. Since then the theory has rapidly been expanded, and as a result of the observations made during the last half century, many of the leading students of ore deposits of the present time emphasize the importance of magmatic solutions in the genesis of ores. The most important observations indicating the agency of magmatic waters in ore concentration are:

(1) Igneous magmas contain considerable quantities of water. This is evidenced by: (a) the vast quantities of steam given off from volcanoes; (b) by the experiments of Daubray, who showed that molten granite contains much water vapor which it gives off on rising toward the surface; (c) by the water in igneous rocks, such as obsidian and the natural glasses; (d) by mariolitic cavities in deep seated rocks; (e) by vescicular spaces in volcanic rocks, like pumice, etc.; (f) by water bubbles in quartz; and (g) by contact metamorphic phenomena which indicate the presence of hot waters at the time igneous rock which produced the metamorphism was intruded.

(2) The almost universal association of metalliferous veins and igneous rocks. This is extremely suggestive. Even where the veins themselves show no evidence pointing toward a magmatic origin, the fact that the veins are all close to igneous intrusives (as they are in many districts) and entirely absent when away from the intrusives, is a strong argument for a genetic relationship between the two. This association is especially striking in the case of the gold and copper deposits of North America. Lindgren† has shown that the periods of gold vein formation agree closely with the periods of igneous activity.

(3) When rocks are intruded by igneous magmas they are shattered and fissured and thus pathways are created for the circulation of mineral solutions which usually follow the magma.

This is a very important consideration for in this way openings are prepared for the deposition of the ores which otherwise might not be concentrated in a sufficiently small volume to result in deposits of workable value.

(4) In areas adjoining igneous rocks the conditions would be most favorable for the deposition of minerals requiring the action of hot ascending solutions and vapors. The solutions may be meteoric and be heated by contact with the igneous rocks, but even so, it is probable that they would mingle with magmatic waters in some proportion where the trunk channels of circulation are along or near to the igneous contacts.

(5) The bottom levels of some deep mines are quite dry and dusty. This suggests that the ores may have been deposited by magmatic waters at some time in the past and then the solutions became exhausted or the locality was shut off from the source of the mineralizing agents.

(6) Ores have been concentrated below the lower level of ground water. While it is true that the level of ground water is changing more or less all the time, yet the presence of ores far below the limit of the ground water circulation is more readily explained by the magmatic water theory than by any theory involving complex structural or topographic changes to produce a great diminishment in depth of the ground water zone.

MAGMATIC SEGREGATIONS.

The concentration of certain minerals into zones or masses within a magma during the process of cooling is known as magmatic segregation or magmatic differentiation, and when these minerals are of a metallic nature, ore deposits of this type may be formed. During the cooling of a magma the first elements to separate from the parent mass will be the heavier and more basic ones, such as magnetite, pyrrhotite, etc. If we think of the magma as an igneous rock in a liquid condition, this segregation process may be more clearly understood. The mass is restrained from total and immediate crystalization by its high temperature and the great pressure upon it. Gradually, as these become diminished, the various minerals will solidify out of the mass. The first crystal to form will tend to segregate in the still liquid mass.

Perhaps the most direct agent operating to form ore deposits of this type is gravity, by means of which the heavier part of the mixture sinks to the bottom. Convection currents within the mass also have an important influence in this process of differentiation. It is not necessary that the crystals be formed before segreation may begin. The separation of the heavier and more metallic portion of the mass may take place before crystallization begins, as slag is separated from matte in the furnace. As the solidification of the mass nears completion, there would be left a fluid residue consisting chiefly of an aqueous solution rich in silica; the highly mobile elements such as fluorine, boron and chlorine; and many metals in varying amount.

Ore deposits of the magmatic segregation type are necessarily found only in igneous rocks, which have crystallized slowly, and which are usually of the more basic varieties, such as peridotite, gabbro, norite, diabase, etc. The minerals of these deposits are those characteristic of igneous rocks such as magnetite, pyrrhotite, apatite, cassiterite, corundum, ilmenite, titanite, tourmaline, topaz, emery quartz, feldspar, muscovite, biotite and many others. The metals which are obtained from deposits of this class are iron, nickel, titanium and some copper. The gangue minerals are chiefly quartz, feldspar, pyroxene and mica. An important feature of magmatic segregations is the fact that the minerals composing the country rock are the same as those of the ore deposit, but the proportions are different.

In size the deposits are extremely variable. Some are very large; others small. They are also variable in shape, and in general are quite irregular as to outline. Many are ellipsoidal, while others occur around the periphery of the parent rock. One of the chief characteristics is the intergrowth of the ore minerals. There is an almost complete absence of crustification. The ore often grades into the country rock rather abruptly.

PEGMATITES, OR PEGMATITE VEINS.

Siliceous igneous rocks, especially those rich in potash, often contain pegmatites or pegmatite veins. As these rocks cooled at great depth, the end-products of crystallization, i. e., the more soluble portions of the magma, may have segregated to form veins or tabular masses in the fissures and cracks which were produced in the already solidified portion of the magma. In some cases the

*Bull. IV, Geol. Soc. France, p. 1249.

†Lindgren: Metallogenetic Epochs. Econ. Geol. IV, 1909, p. 409; also Trans. A. I. M. E. Vol. 33, 1903, p. 790.

pegmatitic material may have forced itself into the surrounding rock, making the opening while it filled it.

The association of pegmatites only with rocks of the granitic type has led some writers to use the name "granite juice" for the last portion of the magma to solidify. These end products are more mobile than the parent magma because they contain an excess of steam and other gases. Elements such as fluorine, boron, chlorine, etc., are known as "mineralizers," are also present in the pegmatitic material in considerable amount, and these further increase the mobility of the magma. Therefore, if fissures are formed in the portions of the original magma already cooled and solidified, or in the country rock bordering the granite mass, the pegmatitic material would be injected into them by reason of its liquid condition.

Rhyolites, quartz-porphyries and surface lavas in general never yield pegmatites. For that reason it is believed that great pressure is necessary for their formation, and this condition would naturally exist only in the deep seated rocks. The fissures into which the pegmatites were injected were probably not connected with the surface, for had they been thus connected it is probable that the mineralizers would have escaped. Some deep seated rocks, even those acidic ones rich in potash, are entirely free from pegmatites. This may be due to the fact that avenues existed along which the mineralizers made their escape.

The processes by which pegmatites are formed have been compared to the formation of eutectics in alloys. It is known that certain definite mixtures of some compounds will remain liquid at a lower temperature than any other mixture of the same compound. Furthermore, if the original mixture is in some other proportion than the "eutectic ratio," then the compound of which an excess exists will crystallize first until the remaining mixture has the eutectic composition. This seems to be exactly what happens in the formation of pegmatites.

The minerals found in pegmatites are essentially those of igneous rocks. This of course follows from the fact that pegmatites are essentially those of the igneous rocks. This of course follows from the fact that pegmatites are themselves phases of an igneous rock generally of a granitic type. Orthoclase (potash feldspar) is the most abundant mineral in many pegmatites. Quartz and mica are next in abundance, and these three minerals usually constitute nearly the entire mass of the rock. In general the composition is much less variable than the composition of the igneous rocks. Some varieties of pegmatite consist almost entirely of quartz and orthoclase. The metals contained in pegmatites in workable amount are few, the chief of which are gold; iron (as ilmenite); and tin (as cassiterite). In many instances, the pegmatites grade into quartz veins, which may or may not be gold bearing. The principal minerals of economic value occurring in deposits of the pegmatitic type are the rare gem minerals, such as tourmaline, beryl, rutile, garnet, topaz, kunzite, aquamarine, rubelite, spodumene, etc. Feldspar; quartz and mica of commerce are also obtained almost entirely from pegmatites.

In shape the pegmatites are usually tabular although where they occur entirely within the parent rock they may be quite irregular as to outline. Where they intrude sedimentary rocks, which is comparatively rare, they generally follow the bedding, or planes of schistosity. The deposits vary greatly in size. Sometimes the injected pegmatite sheets are almost paper thin, especially in highly schistose rocks. Again they may be many feet thick and cover acres.

The internal structure of the deposits is characteristic. The crystals are usual ly large and well developed and are commonly intergrown. The variety consisting of an intergrotwh of quartz and orthoclase often presents a peculiar graphic texture, and the rock has been called "graphic granite." Ather varieties containing unusually large crystals of these minerals with mica have been called "giant granite." Sometimes the contact between the wall rock and the pegmatite vein is gradational. Cavities are common and these are often lined with crystals of the rarer minerals. The choicest gem minerals obtained from pegmatites usually come from these cavities. Banded and comb structure is not unknown, but this feature is less common than in true veins. Crustified druses are also developed.

Contact metamorphism has been noted in a number of cases where pegmatites cut sedimentary rocks, but this is usually not intense.

Numerous examples of pegmatites occur in the Appalachian states, where they constitute the chief source of the domestic feldspar, quartz, and mica of commerce. In Maine and in Southern California, many gems, chiefly tourmaline, are obtained from pegmatite veins. In Canada, they furnish the mica of commerce. The monzonite, which is mined from placers, chiefly in the southern Appalachians, comes primarily from the weathering of pegmatite veins. Before the development of the high grade deposits of phosphate rock in the United States, the main supply of mineral fertilizers came from the apetite deposits of Ontario, Canada, where it occurs in pegmatites. Other mineral deposits of economic value are mined from pegmatites, among which are molybdenite, titanium, cassiterite and magnetite. Closely related to pegmatites, is a type of deposit formed by eruptive after action by the combined agency of gases and water. As a magma cools and starts to crystallize, the first portion to consolidate will be the upper and outer surface of the mass. The pressure exerted by the still molten mass within will cause fractures to form in this thin crust, through which the hot gases and vapors can escape. These vapors and the watery solutions which accompany them are doubtless rich in mineralizers such as fluorine, boron and chlorine, and contain dissolved in them most of the precious metals which may have been in the original magma. As these solutions rise through the various fissures and the fracture planes in the rock they may deposit certain minerals such as fluospar, apatite, and the minerals common in pegmatites.

CONTACT METAMORPHIC DEPOSITS.

Contact metamorphism is a term applied to certain characteristic changes which are brought about when igneous rocks intrude certain sedimentary ones; and when metallic minerals are concentrated within this zone of alteration by the same general processes which produced the alteration, the deposits are called contact metamorphic deposits. Contact metamorphism is not produced by extrusive rocks, like basalts, and the glassy rhyolites and andesites. The rocks which produce the typical contact metamorphic changes are usually diorites, monzonites, and granites, and the deep seated porphyries. The changes produced are caused by the solutions and gases from the intruding mass.

The most characteristic alteration is found in soluble rocks such as limestones. Here the lime carbonate is usually converted into a mass composed of calcite, garnet, actinolite, epidote, tremolite, diopside, magnetite, specularite and other minerals. If the original sedimentary is of a shaly character, aluminum rich minerals, such as andalusite and sillimanite are well developed.

The watery vapors given off by the intrusive are perhaps heated above the critical temperature (365 degrees C.) and they are under considerable pressure. Furthermore some of them contain compounds of boron, fluorine and chlorine which are capable of combining with certain metals and silica to form highly volatile compounds. These gases and solutions, together with the steam generated, are forced into the pores and spaces in the intruded rock, and permeate the mass along the contact with the intrusive. The minerals of the sedimentary are replaced by new ones. There is a more or less complete recrystallization of the sedimentary rock. New material may be introduced by the hot solutions, or there may be only a rearrangement of the elements in the original rock to form different compounds. In general large amounts of CO_2 are removed from the limestone, but this loss is compensated for by the addition of silica, iron and small amounts of boron, fluorine and chlorine compounds. Varying amounts of the valuable metals such as copper, gold and silver, may also be introduced by the intruding magmas. Garnet is perhaps the most characteristic of the contact metamorphic minerals, and in some instances shaly limestones have been altered to masses consisting almost entirely of garnet. Where igneous rocks are intruded by other igneous rocks, garnets are very rarely developed. However, other contact metamorphic minerals may be developed along the contact of the two igneous rocks.

The distance from the intrusive to which the contact metamorphism extends is seldom more than 2,000 feet and usually much less. Vogt cites examples, however, where contact metamorphism is apparent as far as a mile from the intrusive. The ore bodies, if any are developed, are usually close to the contact where the changes are most intense.

The typical ore of contact metamorphic deposits is a garnet-sulphide ore of copper. In general the deposits are low grade and are only rendered workable after rocesses of recondary enrichment have taken place. However, there are some large deposits being worked for the primary ore. The ore is often a mixture of the heavy silicates intergrown with sulphides and oxides of the metals. The chief metals mined from contact metamorphic deposits are copper, iron and gold with a little lead and zinc. The deposits are very irregular in shape and detail and in this respect bear no resemblance to veins. They are seldom if ever tabular, but are often broken up and disconnected and localized. They rarely have definite boundaries and the ore is merely an enriched portion of the country rock. In size, they are also extremely variable. Some deposits have yielded hundreds of thousands of tons. The ore is usually low grade and is often difficult to concentrate because of the high per cent of heavy minerals in the gangue. The sulphides are usually segregated in irregular bunches and masses throughout the zone of contact metamorphism. The gangue minerals (chiefly silicates) are often intergrown with the ore minerals. Crustification is never present in ores of this type.

Ore bodies of other types are often associated with contact metamorphic deposits. These may be veins, disseminations or replacement deposits and they may be of the same age as the contact metamorphic deposits. Acidic igneous intrusions do not always cause contact metamorphism of the sediments, and when this alteration is brought about accompanied by a concentration of ore minerals, a second concentration by descending waters is generally necessary before deposits of workable value result. Examples of contact metamorphism may be seen in the Clifton-Morenci District, Arizona; Marysville, Mont.; Coeur D'Alene, Idaho; Cananea, Mex.; and many other places.

SECONDARY ENRICHMENT PHENOMENA.

Most large and rich ore bodies owe their economic value to secondary enrichment by descending oxidizing waters. Primary deposits, in their first concentration, are not often rich in the metals, although notable exceptions are known. Most ore bodies contain rich belts, or shoots, which are formed by the addition of the metallic content of some other portion of the deposit to these local zones. This action is due essentially to the leaching of the upper oxidized and soluble portions of the deposit by cold descending oxygen bearing waters; and the deposition of the metals from these solutions as they reach the lower portion of the deposit and lose their acidity or meet with the primary sulphides.

An ore deposit may be divided into four theoretical vertical zones. These are:

1. Leached zone near outcrop. As the minerals in the deposit become weathered and oxidized, the primary compounds break down to form more soluble compounds. These are attacked by cold acid waters and the metals are carried downward in solution, leaving a lean or barren leached outcrop, or gossan, at the surface, which is often stained brown by the presence of limonite which remains behind on account of its relative insolubility.

2. Zone of oxidized minerals. Below the leached outcrop is a zone containing many of the oxidation products of the sulphides which have not yet been leached by the descending waters. Oxides, carbonates, sulphates and native metals predominate here. Many of these are deposited by the solutions from above, while others are direct alteration products of the primary sulphides. These are mixed with some unaltered sulphides. Both zone 1 and 2 are found above the ground water level.

3. Zone of enriched sulphides. Beginning at the level of ground water, and extending downward for a variable depth, the mineral composition of the deposit undergoes a marked change. Whereas the minerals above the ground water level are chiefly oxidized products, below this level the sulphides predominate. As the oxidized solutions enter this region, they encounter some of the primary sulphides which have been protected from the oxidizing action of air. If these solutions carry compounds such as sulphates, chlorides, carbonates, etc., when they encounter the sulphides of the base metals such as pyrite or blende, a reaction will occur, resulting in a precipitation of the metals from above in the form of secondary sulphides.

4. Zone of primary sulphides. Toward the lower limit of the zone of enriched sulphides these secondary minerals become less abundant and finally pass into the primary sulphides which continue to indefinite depth, or to the lower limit of the deposit.

It is well known that the primary metallic minerals are usually deposited as sulphides, antimonides, or arsenides. In the case of the precious metals, the gold and silver is usually deposited with some primary sulphide of the base metals, to form minerals such as auriferous pyrite, or argentiferous galena. Pyrite or marcasite is a common associate of nearly all ores of copper, lead, and zinc, and they play a most important role in the secondary alteration of the deposits. As weathering proceeds at the surface of these deposits, the pyrite breaks down to form ferric sulphate, ferrous sulphate, and sulphuric acid. The sulphuric acid attacks the sulphides of the deposits and converts them into sulphates, which are as a rule soluble. Descending surface waters now take the sulphates in solution and carry them down until they encounter primary sulphides where the metals are precipitated as secondary sulphides. The depth below the surface at which the secondary sulphides form depends upon the depth of the ground water, the permeability of the lode, the climate, topography, and other agencies.

Another very important factor upon which the amount of enrichment depends is the time element. It would be natural to suppose that in general, Cretaceous deposits will be more greatly altered than Tertiary deposits. This, however, is not always true. Brittle mineral deposits are usually altered to greater depths than are those in which the minerals are tough. This is because the fractures and cracks which readily form near the surface in brittle rocks favor the circulation of descending waters, and the oxidized minerals are more rapidly dissolved. Contact metamorphic deposits usually contain a large per cent of non-brittle silicates. This may be the reason why contact metamorphic deposits seldom show deep secondary alteration.

Metalliferous minerals as a rule weather more rapidly than the common rock forming minerals. This results in an alteration of the ore body to a greater depth than the country rock. In regions where the climate is warm and moist the alteration processes proceed rapidly; where the erosion of the surface is rapid, there is usually but slight sulphide enrichment, for the secondary minerals are removed almost as soon as they are formed. In such localities the primary ore is apt to be close to the surface. This is well shown in the veins in the high altitudes of the Rocky Mountains, where primary ore is often found at the outcrop. In arid regions of flat topography denudation lags behind alteration and alteration extends to considerable depth. In some cases the oxidized zone may extend to 800 or 1,000 feet below the surface. As weathering and erosion proceed, there may be a repeated migration of the metals downward, resulting in a complete rearrangement of the horizontal sequence of the minerals of the deposit. Different minerals vary in solubility and this results in a final arrangement of the metals into zones according to their relative solubilities.

Most deposits contain two or more metals and often several of these are present in sufficient quantity to render their extraction profitable. The combination of minerals found in any one deposit will vary greatly, but certain associations are characteristic. Primary minerals of iron, lead and zinc are often found together, as well as iron and copper; silver and lead; and gold and silver. In the first combination, these primary minerals are probably uniformly mixed throughout the deposit. But after secondary alteration processes have been operative, there is a well defined segregation of the different metals into vertical zones. For example: in a deposit of zinc, iron and lead sulphides, the lead will be concentrated nearest the surface because it is the least soluble and will be precipitated by the first reducing agent with which the descending surface solutions come in contact.

COPPER ENRICHMENT.

The primary ore of copper is usually chalcopyrite ($CuFeS_2$). This is attached by the H_2SO_4 in the oxidized zone and the copper converted into copper sulphate ($CuSO_4$). In nearly all of the copper districts where the deposits show secondary sulphide enrichment, the metal was probably carried down in solution in the form of the sulphate, and was precipitated either as chalcocite, or bornite, by some primary sulphide of the metals. Covellite is probably acted upon by $CuSO_4$ to form chalcocite but the exact reaction is unknown. Chalcocite is the great ore mineral of many copper deposits, and usually constitutes the most valuable constituent in the bonanza zone of secondary sulphides. Associated with the primary chalcopyrite are usually some other sulphides such as pyrrhotite, blende, or pyrite. If the deposit contains primary chalcopyrite and pyrite, chalcocite may be formed directly according to this equation:

$5FeS_2 + 14CuSO_4 + 12H_2O = 7Cu_2S$ (chalcocite) $+ 5FeSO_4 + 12H_2SO_4$

An important factor influencing the depth of secondary enrichment is the permeability of the lode. Where the rocks are tight and relatively impervious, the descending sulphate solutions cannot travel as far as they can where there are free channels of circulation. Again, sealed faults, gouge seams, etc., may dam back these waters and confine the zone of secondary sulphides to shallow depths.

When pyrite reacts with the sulphates, sulphuric acid is always produced and may attack the wall rock, producing kaolin, gypsum, talc, chlorite, etc., depending upon the composition of the wall rock. Therefore these gangue minerals are characteristic of the zone of secondary enrichment and not of the primary ore.

LEAD-ZINC OCCURRENCE.

Secondary processes operating upon deposits containing these two metals always result in a more or less complete separation of the two metals in the upper zone of secondary alteration . Below, in the primary ore, the minerals of the two metals will be mixed in the original proportions.

The only primary zinc ore of importance is sphalerite (ZnS). The two most important secondary ores of zinc are smithsonite ($ZnCO_3$), and calamine ($Zn_2H_2SiO_5$). In the limestone regions, zinc enrichment has often been produced on a large scale, as in the upper Mississippi valley deposits, and in Southwestern Missouri.

In the Upper Missippi Valley deposits, the lead and zinc minerals are associated with marcasite, pyrite, and some chalcopyrite.

They occur in limestone underlain by a carbonaceous shale called "oil rock." Above the level of ground water, lead minerals predominate. Galena, cerussite and anglesite are the chief ore minerals here. Associated with these is some sphalerite and smithsonite. Below the level of ground water sphalerite is the chief mineral, and the oxidized products are entirely absent. This separation of zinc from a primary mixture of lead and zinc is due to the relative solubilities of the minerals of the two metals. Not one ore mineral of lead is very soluble, while the common zinc minerals are quite soluble. Therefore zinc is seldom carried far by secondary processes, and if secondary lead is produced it usually consists of the oxidized minerals and occurs relatively near the surface.

SILVER ENRICHMENT.

The primary ores of silver are chiefly argentite minerals and silver bearing sulphides of the base metals, such as argentiferous lead, zinc, and copper minerals often containing arsenic or antimony. The only salt of silver which is very soluble is the nitrate, but nitrates are uncommon in mine waters. Several salts of silver are somewhat soluble. Silver chloride ($AgCl$) and silver sulphate (Ag_2SO_4) are dissolved to some extent in mine awters.

The rich silver minerals are usually found in the upper levels of mines. The most important are ceragyrite, argentite, proustite, stephanite, and native silver. At greater depth, these disappear almost entirely giving place to the primary argentiferous sulphides of lead, zinc, or copper. The processes of silver enrichment are essentially similar to those operating upon minerals of the base metals. This follows from the fact that most of the silver supply of the world comes from silver-lead, silver-gold, silver-cobalt, or silver-copper ores. The silver minerals are usually the least soluble of all those in the deposit and are therefore concentrated in the upper levels. The chief secondary ores are the oxidized products and secondary argentite, (Ag_2S). The argentite is usually precipitated from oxidized solutions before the sulphides of the base metals because of the strong affinity of silver for sulphur. Therefore, the first sulphide encountered by descending silver-bearing solutions will usually precipitate secondary argentite.

SECONDARY ALTERATION OF GOLD ORES.

Gold occurs native or as a telluride, but the most common occurrence is probably as auriferous pyrite. Gold is relatively insoluble in its native state, but as a chloride or iodide it is quite soluble. It is also soluble in ferric sulphate and somewhat soluble in hot alkaline solutions. Gold is precipitated readily by ferrous sulphate and by organic matter. The precipitation usually takes place as native gold intimately associated with the sulphides of the base metals.

Most gold deposits are richer in their upper levels. This is probably due to "residual concentration," i. e., the weathering of the country rock and the removal of the more soluble minerals leaving the residual gold behind. There is no addition of material in this process but the result is the same, inasmuch as it increases the amount of the precious metal in a given mass of the rock. Portions of this gold may be dissolved and carried to lower levels. Dr. W. H. Emmons* in a paper treating the enrichment of the gold deposits of the United States, shows that the secondary enrichment of gold by descending surface waters depends largely upon the presence or absence of manganese in the deposit. The strongest solvent for gold is nascent chlorine, but nascent chlorine is produced in mineral waters only under certain conditions. In concentrated acid solutions, under heat and pressure, chlorine may be produced from NaCl by the ic salts of iron and copper. But mine waters are cold and dilute, and this action probably cannot take place under such conditions. It is here that the manganese plays its part in gold enrichment, for MnO_2 can release nascent chlorine from NaCl and HCl in cold dilute solutions. The reactions are probably as follows:

(1) $MnO_2 + 2NaCl + 3H_2SO_4 = 2H_2O + 2NaHSO_4 + 2Cl$.

(2) $MnO_2 + 4HCl = 2H_2O + MnCl_2 + Cl_2$.

The nascent chlorine thus liberated is free to convert the gold into the chloride which is thus dissolved and carried down by the descending waters. The gold, in solution as the chloride is precipitated as native gold by ferrous sulphate, $FeSO_4$. Ferric sulphate $Fe_2(SO_4)_3$, does not precipitate gold. Both ferric sulphate and ferrous sulphate are produced by the oxidation of pyrite which accompanies nearly all gold deposits. Therefore it would seem that the gold in solution could not migrate far before it would be precipitated by the ous salt. Th's would certainly be the case if there were no manganese present. But manganese readily converts ferrous iron into ferric iron which does not precipitate gold. Thus the manganese plays a double role in the alteration of gold ores.

Gold deposits containing manganiferous gangues may be expected to show a greater downward migration of gold than will those deposits which are from manganese. It also follows that deposits which contain no manganese would be more likely to form placers than would manganiferous gold ores, for in the latter case the gold would be partially removed from the oxidized zone in solution.

The presence of manganese in the ore will not be sufficient to render all the gold soluble, and much of it may remain behind to enrich the outcrop. The outcrops of gold bearing quartz veins are often pitted or "honey-combed" by the disintegration of part of the quartz and the dissolving of the more soluble minerals which may be imbedded as small crystals in the quartz. Such outcrops are apt to be stained brown by the presence of iron oxide in the form of limonite, and if the deposit contains gold, much of this gold may remain in the honey-combed gossan, thus forming a body of bonanza ore close to the outcrop. The gold in such a deposit is often coated with a thin film of iron oxide, and is called "rusty gold." For that reason it may be difficult at first inspection to recognize its presence in the rock, although it may be there in considerable quantities.

While many gold ores have been enriched by the processes just outlined, yet, in many deposits, the gold content grows constantly smaller from the outcrop downward, and the value of the deposit will depend upon the quantity and richness of the primary sulphide present.

*W. H. Emmons: Manganese in the Secondary Enrichment of Gold Deposits of the United States. Bull. A. I. M. E., Oct. 1910.

The Ray Consolidated report, covering a period of eighteen months, is just out. It is much in the nature of an apology for all that the company has failed to accomplish, with accompanying promises for the future. We'll touch it up next month.

The following is a short accurate method for securing length for a belt. When it is not convenient or possible to measure with line the required amount of belt needed, add the diameter of the two pulleys together, divide the result by 2, and multiply the quotient by 3⅛. Add your product to twice the distance between the shafts carrying the pulleys, and the result is the length for belt.

The materials from which Portland cement is made contain calcium, silica and alumina. The raw materials also contain small quantities of iron and magnesia in some form. The materials are crushed and ground, mixed in proper proportions and burned at a high temperature to a hard clinker, which in turn is ground to a fine powder. Usually during the grinding of the clinker a small quantity of gypsum is added to retard the action of the cement and otherwise improve its quality.

The Powder House at Midnight

By CHAS. I. Duncan, Miami, Arizona

The power-house at midnight shows wondrous and wierd
By some conjuror's hand in the lone canyon reared;
The thunder-bolt's might and the hurricane's power,
Mechanically mastered, like angry beasts cower;
The forces, when free that meant death and disaster,
With a roar of pent rage here acknowledge man master.
Here great generators feed fire to the wires;
Here hum the compressors like titan touched lyres;
The silent condensor moves slow roiling gear;
And like wind on the water there comes to my ear
The mighty crescendo of shaft and of wheel,
The rhythmical cadence of steam driven steel;
The electrical mercury lights shimmer green,
From cross heads reflecting their emerald sheen;
Beneath the steel girders the shadowy crane
Casts sable reflections from carriage and chain,
Majestic and sombre in vast vague of grey
It hovers above like a huge bird of prey;
Each motor in motion vast energy wakes,
Great arc lights glow splendid and force the world shakes,
Grim slumbering titans respond to the thrill
Transmitted for miles over canyon and hill.
At the engineer's touch like a mettlesome steed,
With fiery endeavor at steel harness strains—
Who gives them the spur needs firm hand on the reins.
And while the world rushes to morn's golden glow,
The grim "grave yard' shift passes weary and slow:
Now the whistle's hoarse call greets the rise of the sun—
One shift has been finished, another begun.

Reminiscenses of Stampede for Gold in Nevada Boom

By CLARENCE E. EDDY.*

The name and fame of Goldfield, Nevada, has a lustre that will not soon fade. It is true that the period of sensational speculation is largely past, but development and production are infinitely greater than they were in the boom. The flow of golden wealth, however, is now confined to well-defined channels and does not disseminate with the effervescence of earlier days.

Goldfield today, with its splendid payroll and prosperous business and its mighty output of bullion, is one of the marvels of the western mining world, but the "good old days" when "a poor and honest man" could steal high grade at Goldfield, indeed are gone.

THE ROMANCE OF REALITY.

It is now more than ten years since the discovery of the South Nevada treasure fields marked the beginning of a new era in western mining. It was in fact the discovery of Tonopah by Jim Butler in 1901, that soon resulted in the discovery of Goldfield, and thence the discovery or revival of many a camp of the deserts—Manhattan, Bullfrog, Greenwater, Skidoo, Hornsilver, Seven Troughs, Rawhide, Jarbridge, Ubaheba and goodness knows what—all came from the fact that brave Jim Butler, with the aid of burros and a half-breed Indian, had first broken the silence by the discovery of the grizzled ores of Tonopah, in the midst of the mighty deserts.

A new era, indeed, had dawned in the western mining world. The old days when prospecting and mining had been followed mostly by hardy and adventurous pioneers—horny handed diggers and bewhiskered denizens of the woods and wastes—was now to make room for an infinitely larger influx of people of all stations and professions, and of all "races, sex, color and previous condition of servitude."

The eastern "counter jumper" and nondescript worker and also the society celebrity, millionaire, minister of the gospel, "saint and sinner"—all were to get the mining craze and come to the mighty deserts, as miners, speculators, promoters, business men—anything to get into the game in accordance with the best of their ability or such fortune as might fall to their lot.

*"The Poet-Prospector," Bonanza, Idaho.

People of varying means, from shore to shore of the continent and even from over the seas, began to hear and take notice of the great treasure discoveries in the western deserts.

Investments and enterprises were soon forthcoming from far and near. Every means of publicity was ultimately enlisted in the dissemination of the welcome news, that millions of metallic treasure were being unearthed in the deserts. The good news, from the mere fact that it was good news, if from no other reason, was set forth in publications almost everywhere. The newspapers, even the greater publications east and west, were soon spaced with column after column of accounts and illustrations and even the songs of poets—all in description and praise of the great triumph of the discovery of golden millions in the mighty deserts.

The west having been long a theme in our literature—in drama and song and story—because of its earlier days of gold, was now tremendously to the front, for the drama was to be re-enacted upon a larger scale.

The lingering, romantic conception was that to be in the west you must be "a westerner," in accordance with the approved models of the story books. A westerner was supposed to be a sort of a rugged matinee idol, dressed in unusual garb and adorned with "shooting-irons," and endowed with dramatic heroism. How could all the incoming easterners, from all stations and avocations attain their ideal in the new west? For a new west, after all, it was to be. They would come and try to be truly western in accordance with the ideals of the story books, but the result due to changing conditions, was that withal they could not be as romantic as they had hoped. They could not often find gold in glittering heaps as they had fancied. Many came and wore slouch hats and khaki and high laced boots, and carried "arsenals." But the majority, of course, came on the scene as best they could. The result was indeed a picturesque and impressive population in and about the fast-appearing camps. The eastern clerk had become a proud claim-owner, with unlimited hopes of fortune and at least a strenuous aim at being a true "hero of the west."

PREACHER BECOMES A PROMOTER.

The old prospectors had gathered in with "the real goods." The millionaire was there to see and report to his eastern financial associates. The eastern farmer had become transformed into a prospector, but had retained most of his eastern traits; grocerymen had become mine operators, and artists had become engineers, and preachers had become promoters, while eastern matrons had been transformed into proprietors of mining camp rooming houses and restaurants. The many transformations would take pages to define. Adventurers and adventurers—gamblers, courtesans, etc., had come from all quarters of the globe, with the determination to be wilder and more free than ever. As a new addition to the annals mines, resolved that they, too, would be adventurous and romantic—that they too would drain the cup of adventure in accordance with the way they had sometimes read and dreamed of it as existing in the merry whirl of the mines.

The result was a conglomeration of humanity, such as has seldom been brought together in the history of any boom. Money was interchanging, largely through confidence due to a lack of practical knowledge of the facts and possibilities of mining development. The general idea was that "gold is where you find it," and that anyone was liable to find it in almost unlimited quantities at any time under any big pile of stone or in any ravine or wash or hillside, and hence as it had really been found to exist in great and valuable quantities, at some place near by, and it was considered only a question of a little time and development until it would be further brought to light; that "one man could see just as far into the ground as another," and that digging and staying qualities, however directed, could be depended upon was also a great factor in the general idea of the backers and followers of the boom.

EXCITEMENT INCREASES.

A great, complex, picturesque, varied and intermingled mass of people, intoxicated by the thought and quest of fortune, were gathered upon the deserts. The craze was not limited to the small investor and the naturally venturesome, but substantial capitalists were staking their carefully accumulated means upon the camps and their showings or indications of mineral. Railroads began building to make the fields more available and to avail themselves of the field's business. A mighty climax of industry was culminating upon the deserts. A drama, greater and more modern and really more romantic than ever before in the history of the west, was now upon the stage of events. Goldfield was the soul and radiating centre. Its mining locations had augmented, until they spread for miles upon miles in every direction, and of every name and shape and possible size. Some claimed only a fraction, others ignorant of the limitations of the statutes laid claim under single notices to the scope of a homestead. They were criss-crossed and often conflicting, but still claiming dips, spurs, angles, veins, leads, lodes, ledges, deposits, ramifications, millsites, townsites, damsites, etc.—anything to get to the front for a fortune.

Corporations and capitalizations were formed until laws and language was exhausted to the limit of their scope to describe and depict and define what the claimants and investors were undertaking. Shafts and tunnels and crosscuts—excavations and developments of all kinds—began to scar and transform the ancient, solitary sameness of the desert. The realms of the sun, sand, sage and solitude were to be subdued.

Tents dotted the scene, for an ever-increasing distance, while shacks of boards and barrel staves, and dry goods boxes, and tin cans and even liquor bottles, were being built. The newcomers and prospective millionaires—women and children and men of all ages dwelt at random and almost in the open, for all were ambitious of success in the new fields of gold. Children were turned loose to play with the burros and wild creatures of the desert, and both sexes of all ages and conditions, camped or mingled about as necessity dictated. Many were the romances and experiences of those days, that will never be fully written, for in the constructive period facilities were being employed as fast as available to build the desert metropolis. More and more people came all the time and many went, and many died from dissipation and exposure and are filling desert graves.

GLITTERING GLEAM OF TREASURE.

But the mines developed and golden, high-grade ores began to be mined in great quantities, and the leasing system had come into vogue, whereby parties owning grounds would contract with other parties that in consideration for certain development of the properties, or a percentage of the ore, they would grant for a specified time to the parties of the second part, the privilege of mining the ore.

It was under this system of mining and development that the "highgrading," or "appropriating," of ores by people employed in the mines, came into practice, and reached its zenith. Everybody who worked in the mines, whether they were in any wise a part of the management, were in line with an opportunity to get more or less profit for themselves by appropriating the rich ores that were encountered. It is an admitted fact that sums ranging from a few ready dollars up to tens and scores and possibly even hundreds of thousands, were taken away from the intended claimants of the treasure, by those engaged in high-grading.

In a very short time the constantly augmenting multitude of miners were tumbling over each other in their eagerness to get employed in the Goldfield mines. A job in any capacity around these properties was so much desired and sought after that men speculated and trafficked with each other for the privilege of such employment. Of course a good wage was paid by the operators, but, where it could be consummated it was often profitable for the men to actually buy the privilege of these positions.

THE LEASER'S DILEMMA.

Through necessity in the great rush to get out the rich ores in any manner, before the expiration of their leases, the operators were compelled to hasten. They crowded men into the excavations "as thick as bees." Their attitude was: "Boys, get it out as quick as you can. Dig it, pile it, shovel it, hoist it, haul it; we must succeed to the best possible extent before the time expires. On with the work and get us all you can, for we have no time to question."

And so it was that the leasers worked night and day with all the men that they could crowd into the holes. The profits of the leases were anything from fairly good up to the fabulous, while men came faster and faster and literally fought for room.

In addition to the profits from actual mining of ores, the leases were mostly incorporated and stocked for varying sums, usually not less than $1,000,000, and this stock the investors purchased with eagerness and varying results. But the "profits" in stock came mostly to those wise or fortunate enough to master the game.

The inevitable result could only be that when the lease expired, the leasing stock would have no further profitable basis, and the grounds would pass back to other parties.

THE INVESTOR "GETS HIS."

The unwise investor whose name was legion, did not understand but what stock in a lease was as good as any other, or perhaps better, for did he not hear of the rich ores secured, and were they not an evidence that he would get his? He did "get his," but not as he had fondly hoped. His fate was only a natural consequence of the lack of knowledge on his own part, and the desire and necessity for personal gain that prevails everywhere with "advanced civilization."

More fortunate than the ultimate buyer of these stocks, was the man who got a job during the operations of a lease, for often by slightly smothering his conscience or keeping it soaked in powerful stimulants, he filled his pockets and all the apertures and lining of his clothes, and the crown of his hat and the soles of his shoes, and his dinner-pail, or anything he could get, with the proceeds of his cunning—the rich golden highgrade, dust and ores—which he sold or traded or trafficked in for profit, and to get all that he possibly could, while the opportunity lasted.

There had naturally opened many assay offices as Goldfield progressed, but now there was a new scope and meaning to many of these assay propositions. A new and unscrupulous class of "assayers," or perhaps, many having no knowledge of chemical analyses, set themselves up in the desert metropolis to engage to some extent or another in this high-grade proposition. They purchased or secured clandestinely, and in varying quantities these ores that were being "spirited" from the operations in the rich deposits. Tons upon tons of the precious ores and golden dust passed through the hands of these alleged assayers, whose offices became more numerous than any other kind of establishments in Goldfield.

The procurers of high-grade from the properties at Goldfield did a veritable pawnshop business in their pilfering, with the many bogus assayers acting as "fences," and marketing the proceeds after paying a varying percentage to the "miners." Some special caches of the golden material even reached towards the one hundred thousand mark, and were got out of the country and marketed through varying means. A large book of such ventures and reminiscences might be written could all the facts be gleaned. Some clever rogues even played a sharp trick on their equally crooked neighbors of the bogus assayer type, by inaugurating a make-believe arrest in the guise of officers of the law. They carried away all the rich stores of high-grade that had been accumulated by the "office."

But this condition of affairs could not long abide, for mining at Goldfield was soon to be reduced to a different method, within the full confines of the law. The high-graders had become emboldened, and were drunk with their success, a success which lavishly afforded them means for the more common forms of intoxication. Many boasted and gloated over the measure of their prowess and spent their questionably acquired wealth on games of cards and in the giddy dances and dissipations of the halls and places of indulgence.

A HIGH-GRADE HERO.

One night a bold, burly and begrimed miner stepped up to a crowded bar in a saloon that covered half a block in Goldfield and which was crowded to every wall with a conglomeration of men. There, amidst the clouds of tobacco smoke and maudlin merriment, and clink of coin and glasses, and glare of lights, he thundered:

"Come on, COME ON, you high-graders and promoters and sons of guns—come all of you and have a drink on me. I am a high-grader out at the Mohawk mine and I've got the money, you bet!'

He clapped his handfuls of gold upon the bar, until all were at attention and drank of the firey beverages.

"Drink her down, boys; drink her down," he said. "There's plenty more where this comes from—plenty more—yes, damn it, there's plenty more. Have another drink, everybody! It's free. If you won't drink on me, then drink on this money, and we'll call it on Wingfield, the owner of the mine. But I'm a high-grader and I don't care who knows it; and, damn it, more than half of you are high-graders, you sons of guns. Come on now and have ANOTHER drink, and I'll say its on the whole darned camp."

ZENITH OF THE BOOM.

And so they drank and drank. If there were some that might not have money of their own, it was certain that most had, and the man who had not could live on whiskey. They were soaked with it—sodden with it—drinking and friendly or fighting and scheming, speculating and selling. The stock exchange was in a frenzied boom. The town was building with solid structures, and some establishments costing as high as a quarter of a million were being rushed to completion. Women and men lavished in luxury and finery, for money was flowing in through stock investments from all parts of the world, and the mines, worked by leasers and otherwise were actually producing millions. Just how much Goldfield did produce at this period will never be known, for the legitimate mint records of millions must be admitted to be meagre, because of all the stolen high-grade that went out by devious ways. Automobiles were thicker than farm wagons at a country celebration on the Fourth of July. The days of "plush and velvet," and of champagne and stock certificates and fat incomes on sales of shares, and of typewriters and boosting methods, were at their zenith. The hills and desert valleys resounded to blasts constantly tearing up the earth in and around the desert city.

HALT IS CALLED.

Money was changing hands almost by tons in games of chance; fortunes were changing hands in investments, and a giddy, lurid glare of dissipation and dance hall mirth made the days and nights pass like a drifting haze of dreams.

But the scene was destined to change. Myriads of investors who had lavished their money, often alike on good and bad securities had now begun calling for dividends or rather, more dividends. "What is the matter with the mines?" said the awakening investor. "What is becoming of our legitimate portion of the ores?" said the owners of the claims. "We will curtail the leases," said they. "We will develop and mine our own property under a more direct management. The leasing system as it has existed, is inadequate. Let us call a halt and have a clear and legal adjustment of our rights. We must and will be protected by law in the handling of our property as we choose. Organization is rampant among the workers. No longer limited to legitimate purposes, unionism is becoming a hold-up system, in which the desires and demands of an unlawful element is uppermost. They would secure to themselves, not only high wages, but also a privilege to help themselves constantly to the property of others. Let us, the property owners, demand and enforce our rights under the laws of the United States."

Then, indeed, there were rumblings and sounds other than those of merriment and industry in the mines. A considerable portion of the population was obstinate and loth to part with its illegal privileges, and profitable pilfering of the golden high-grade ores. While the inevitable change was slowly being wrought, came the nation-wide financial crash of 1907. Capitalists were planning, the populace was complaining, labor was combining and the more radical element was in control. Whatever the differing interests and demands, it was realized that established order and recognized laws must prevail. United States troops were sent to the scene, and though but few fatalities resulted at any time, it was apparent that the materials were there for combustion. The self interests of men on opposite sides had been aroused by the presence of gold—gold which most would get in any manner possible, if they could not get it by law or sufferance.

But the claim-owners, of course, were acting under established law and custom. No one could expect them to do other than act in accordance with their property rights. The Nevada State police provision, for some hundreds of armed men, came into existence and the U. S. troops, being withdrawn, the famous Goldfield properties were now to appear upon a new basis, in which capital would be protected in mining its properties in systematic, business-like and substantial way in which the profits above costs, under a free choice of labor would go only into the pockets of those having legal and rightful control.

UNDER THE NEW ORDER OF THINGS.

After some variations and smouldering revivals of the speculative spirit, we find Goldfield today progressing steadily and destined to progress as a great mining camp whose proven ores are largely owned by gigantic companies considerate of the normal needs and requirements of their employes—more generous, no doubt, than would be the "poor and honest high-graders," if they owned the same properties—for we are still at a hazy distance from that point in human progress that has been fancied by some when anything like a fabulously rich gold mine will be free to everybody.

It is a fact that the "poor and honest man" can no longer help himself to high-grade in the desert bonanzas; neither does stock in a thousand-and-one different properties from "Dan to Bersheba," sell as readily as it did in the good old days of the speculative period, when any prospect upon the deserts had more or less of a financial standing.

However, it has been demonstrated of Tonopah and Goldfield and several other of the new camps of the desert, that they are well up with the world's best mining propositions. Nevada, as a matter of fact, is one of the best mining regions in the entire world, and it is also evident that with all the scores of thousands who whirled through the lurid drama of the boom, its soil and treasure resources are practically unscratched and intact.

BUSINESS METHODS APPLIED TO MINING

By GEORGE W. SCHNEIDER.*

When one considers that the scope of the real mining business of the world at large, or even of the United States, is too vast to be readily comprehended by any single person, some idea may be had of the reluctance in attempting a discussion of such a subject as the application of business principles to mining.

The technical part of iron mining, or oil refining is, in itself, a sufficient study for any man who wishes to give a lifetime to it. When one looks at the statistics and finds that the annual mineral production of the United States alone is over two billions of dollars, and the total number of men employed in the business approximately two and one-half million, and of this total output the value of silver is less than 2 per cent; gold less than 4½ per cent; clays, lime, cement and stone, 15 per cent; pig iron, 25 per cent; coal, 30 per cent; an idea may be had of the immensity of the mineral business.

Every man, whether mine manager or not, must have five senses, but the successful mine manager must have five more, which are as follows:

1st. Technical sense.
2nd. Efficiency sense.
3rd. Square deal sense.
4th. Money sense.
5th. Common sense.

The practical mine manager; that is, the man with sufficient sense to make the most practical use of all information available, is bound to be the most successful one. The man who despises education and knowledge may have a reputation as a mine manager, but that is because he is fortunate enough to be on a good mine, which even his bad management can not ruin, or on a mine where the problems are simple, and can be solved fairly well by following the precedent established in his district. On the other hand, the best mine manager is not necessarily the man with the best education. There are men who have achieved distinction, been first-class honormen in each year of their course, have contributed able papers to the proceedings of scientific societies, who are not fit to be put in charge of a one-man show. They have not enough sense to apply properly the information they have acquired, and perhaps they have not the gift that enables men to direct and control others. At the same time, there can be no question but that in addition to the ability to organize and to make use of available information, the more thorough the education the better. No one will contradict this; even the most ardent advocate for the practical man will admit that knowledge of the subjects bearing on mining does not necessarily incapacitate a man for practical work, though he will hold that perhaps a University education does. The difference of opinion is not as to the value of knowledge, but as to the kind of knowledge necessary, and the method of acquiring it.

The gradual exhaustion of the known supplies of the richer free milling, oxidized surface ores, bonanzas and placer deposits has brought us face to face with a condition whereby what was formerly a waste has now to be considered from an economic standpoint.

Necessity is the mother of invention, and consequently ways and means are being devised whereby the different problems confronted may be solved in a manner satisfactory to the end sought. The above involves the development and application of technology, that full advantage may be taken of all the natural conditions.

The first step along this road is a sound foundation of technical training, carried on in after life, assisted by private and public-aided investigation of the natural resources and research work in different departments of science bearing upon the development of the arts of mining and metallurgy.

In former days our miners were schooled in such noted mines as the Comstock and the old districts, such as Cornwall, Georgia, California, Colorado and others, and were much sought after by the newer mining districts.

We now have the mining school which affords a sound technical training supplemented by a certain amount of practical work. The school is ably assisted by our highly efficient technical press, scientific societies, mine operators' association, and national and state research work, such as the U. S. Geological Surveys and Bureaus, which do much towards disseminating technical information.

There is another department of education bearing upon this question which may be determined secondary education. Secondary education as here used means the technical training of the working man by means of private and public schools, Bureau of Mines Rescue Cars—a new and important step adopted by the government for the prevention of mine accidents—correspondence schools, technical press, etc., all of which tends to make a more efficient operator.

The efficient manager is he who obtains the most from his labor and equipment. No matter how practical or technical he may be, a policy must be adopted involving a definite ideal, a working organization, and a distinct end in view.

The definite ideal comprises the method of developing and mining the ore deposits and winning of the metal sought, together with a selection of the equipment necessary.

Here is where volumes may be written on the mistakes from a business point of view in the employment of the wrong mining methods, building of mills before necessary, and where ill adapted, and the selection of wrong equipment. How many mines do we find over-equipped in a fashion after one's neighbor when the economic factors entering into the proposition are entirely different. Most plants are over-equipped, as evidenced by those of the U. S. Steel Corporation, which, after inspection, proved to be 60 per cent efficient. There are many cases where, after the property investigation, an old machine may be found to do the work in question much better than a new one.

To be economically successful in mine operation the proper organization, placing and discipline of the different divisions of the working force, requires careful thought and care.

No matter how perfect the mining or producing, or the organization of any of the divisions, nothing good in the way of successful operation can be accomplished unless each of the other divisions is equally well organized and works in harmony with the rest. A chain is no stronger than its weakest link.

Cost keeping in industrial establishments, as well as in mining work, has of late years been given considerably more attention than it had received formerly, and by detailed investigation the share of the various operations in the general cost of operation has been carefully ascertained. It is a very difficult matter to compare costs of different mines with each other because the conditions may vary considerably in each case. There are, however, some operations which are common to all mine work, as the ore has to be broken from the ground, and has to be transported and the metal has to be extracted. Accessory costs, such as supervision, sampling and surveying should be apportioned among those headings.

*Professor of Mining, Colorado School of Mines.

The extent to which it is carried, however, depends largely upon the personal equation of the mine manager. There are some managers who positively revel in the multiplication of reports. Their mines are fitted up with speed counters, automatic recording pressure gauges, and elaborate systems for counting every candle, stick of powder, and piece of lagging that goes into the mine, and recording where they go. Such men must sigh for a machine that can be attached in some way to the hammer-men to record the number of blows made by each during the shift. At the end of the year's operations these managers delight in issuing elaborate reports, giving the precise cost of greasing the ropes, figured in tons of ore and waste raised, how many brooms were used in the mill, and so forth.

There are other managers who worry along with the ordinary cash book, journal, ledger, pay-roll, and bank books, and who do not pretend to understand any but the pay-roll and pass-book. Yet often, possessing the managerial faculty and having a sound knowledge of the mining business, they accomplish very fine results. When the manager is also the owner, this system (or lack of it) is readily condoned, but in the case of a salaried officer it usually means a slovenly administration.

Between the fussy manager who goes into absurd details, and the slovenly manager who pays no attention to clerical work, there is a happy mean. In cases the problem is happily solved by broadly sketching the system and placing it in the hands of a conscientious accountant who relieves the mind of the manager of the petty details. The responsible head is thus left free to attend to the broader problems that are constantly arising for solution.

The cost sheet is theoretically an infallible index to the efficiency or inefficiency of the operations of a mine. In practice, it is far otherwise. We have no doubt that many of our readers will agree with the statement that methods are unknown for doctoring cost accounts. For example, it is astonishing to see the effect on mining costs of a comparatively small tonnage of easily mined, unpayable ore. Then, too, a few simple changes of method may cut down the cost per ton, but without leading up to the all-in-all of mining—dividends.

There can be no doubt in an experienced engineer's mind that the cost sheets are excellent things, yet they can never take the place of personal supervision or mental effort. Granting freely, as we do, that cost keeping is an essential for the first-class mining administration, it seems to us that it is of paramount importance to use a unit that is logical, which the ton of ore mined or milled is not. It is often urged that the cost sheets should be published for the guidance of stockholders. The cost, per ton, is for this purpose absolutely valueless, and some other unit must be selected. We suggest reporting the costs in terms of revenue obtained, while retaining the costs per ton as memoranda for the management only.

We may dismiss as unworthy of consideration the suggestion that the cost sheets will allow of comparisons being made with other mines. The only comparisons possible are between the accomplishments of different years and of different managers in the same mine. Yet even this must be done with judgment, for conditions may have changed.

Let us take a specific case. Here was a property where the manager, in order to make a record for himself, devoted much energy to cutting down the cost per ton. He paid small dividends, owing to the lowness of the grade of ore. The ore was concentrated and a saving was claimed of 70 per cent, although it is actually only 64 per cent. He was succeeded by a manager who thought less of the cost per ton than he did of dividends. The new manager put more miners at work, although the same tonnage was sent to the mill. The mining, however, was done more carefully, and the value of the ore sent to the mill was raised from $7 to $8.50 a ton. In the mill the new manager was not satisfied with the savings. He replaced the foreman by a much higher-priced man, put more men on the machines, all on the same tonnage. The result was that instead of saving 64 per cent, an actual recovery of 72 per cent was made. His cost sheets showed an increase per ton from $3.95 to $4.72, something that would invite criticism from ignorant stockholders. However, his net earnings went up from 63 cents a ton to $1.40, and the annual profit from about $40,000 to slightly over $100,000. This is a striking example of the fallacy of judging a management by the lowness of the working costs.

Large mining companies usually have admirable systems for transmitting information between the executive head at the mines and the company headquarters.

When, however, the far greater number of small mines are considered, situated often two or three thousand miles from headquarters, we find that in the great majority of cases absolutely no system is used, either at the mine or at the home office. Too often doubt and uncertainty exist on both sides, resulting, of course, in friction, demoralization and inefficiency. The manager is never quite certain as to whether he will receive drafts for payment of the mine accounts, and the directors can make neither head nor tail of what is being done at the mines, in spite of numerous "explanatory" letters and statements forwarded by the manager.

This state of affairs in small mines does not necessarily imply that there is not a sincere desire on both sides to furnish information. The fact is, however, that no system worthy of that name is used in such cases. Letters, while useful enough to explain properly rendered accounts and details of mining and milling operations, can never take the place of the latter. A properly devised system insures full reports each month and such reports that comparisons can be made at periodical intervals; they require care in drawing up, force the manager to work systematically and thus finally bring about efficiency in the management of the mine. It is an absolute truism that the most vigilant check on the management and the hardest taskmaster is a clear and precise report on each month's work.

We venture to assert that if the smaller mining companies would at the outset of their enterprise engage a man of broad experience in mine organization (not a doctrinaire) to devise a system adapted to the needs of the case, fewer failures would be made; the managements, especially in isolated spots, would be more efficient and the unprotfiable nature of some ventures would be sooner discovered than in the case where no proper system of monthly reports exists. Many excellent mining men do not understand how to draw up such report forms; in such cases the services of an expert may be engaged. Directors of mining companies owe it to their stockholders to have frequent, accurate, and systematic reports, as to progress of work, where and how expenditures are made by the manager, etc.

As a general rule, mines are made. By this I mean that from its discovery it is not always self-sustaining, but requires the assistance of capital for the necessary development and equipment to put it on a paying basis.

In the securing of such capital, pools, companies, or corporations are organized and here is where the application of a square deal is very necessary, for what do we find:

In some cases companies are organized having no equity in anything whatever for the protection of the investment, holding, perhaps, only an option or a lease on a number of undeveloped locations situated twenty-five or thirty miles from some noted mine. All the stockholder receives is a gilt letter stock certificate showing how much he has paid, and a highly illustrated prospectus; in other cases, the value of the property and its possibilities are greatly exaggerated by false reports; in others, the organization of the promotion scheme, which involves a large capitalization, is such that possibly not more than 15 per cent of the capital raised ever reaches the mine or prospect for development, but finds lodgment in the pockets of some promoter who maintains a healthy press bureau, a handsome suite of offices, and other luxuries. In other words, we have frenzied finance in all its phases.

When, however, the necessary capital does reach the mine, the interest of the stockholders who furnish the capital should be kept plainly in view, for how many instances do we find where everybody concerned with the proposition has received a square deal, except the stockholder who holds the bag?

Again, the manager owes it to his stockholders to be honest in all his transactions, free from the taking of all bonuses on all contracts or commissions on equipments or supplies bought, for he sells his services to them and if underpaid should not serve.

The manager not only owes it to his stockholders, but to the mine and community to maintain his ore reserves, which means putting another ton of ore in sight for the one mined. How many mines can we find idle today because the management did not get far enough ahead to see the importance of keeping his development in advance for the purpose of maintaining his ore reserve.

The manager in maintaining his ore reserves is called upon to do much work of a prospective nature, and in doing so, benefits the whole community for what he discovers is apt to be common to others, as is strongly evidenced by the recent zinc strikes and discovery of values in the granite in this very district.

And that leads to another point—while new camps are much to be desired, there is nothing to my mind which offers inducements like the thorough prospecting and developing of the mineral zones existing in the old camps, as modern mining and metallurgy have found ways and means of treating ores which were out of the question only a few years back.

When we consider what Mexico is doing in a mining way, and that practically no new camp has been found during the past century, with the possible exception of Cananea, it certainly presents us food for thought.

The owner of the prospect or mine requiring capital for development owes to the one ready to furnish the necessary capital a disposition to meet him on equal terms by allowing the privileges of performing such development work under the terms of a bond and lease, with restrictions as to the removal of ore, etc., and not demand exorbitant cash payments or unreasonable requirements.

The nation, state, and community owe to the prospector and miner such equitable laws and regulations as will encourage the prospecting for and seeking out of new mineral localities. Our business and mining men are clamoring for a new district, so much so that one civic body is furnishing funds to that end, and not without cause, for it is necessary to maintain future ore reserves and nothing acts as a greater stimulant to all business in general than the discovery of a new camp with merit.

The community owes a square deal to the stockholder in so far as it is compatible with the existing conditions, for a failure of any mining venture has a reactionary effect. How many instances have we of failures hurting a camp which could have been prevented if taken in time!

Again the mine management owes it to the community to refrain from contracting debts without knowing how they can be met or the creditors protected.

A square deal to the working man is imperative, be he an American miner, Mexican peon, or South African negro, for no efficiency may be expected from one who is underpaid, underfed, and badly housed. It will be made up in some way, and generally at a disadvantage to the employer.

An American miner receiving $3.50 per day is more efficient and produces more metal at less cost than the East Indian miner who receives 19 cents per day.

Whether the work be performed by task, days' pay, or contract, or a leasing system is in vogue, a just and equitable agreement should be made, entered into, and lived up to by all parties concerned.

Let the Golden Rule be, "Do unto others as they would do unto you," and not, "Do unto others as they would do you, but do it first."

Money sense in mining is the supreme faculty, and a man who possesses this faculty will bring it to bear on every problem he has to face.

The aim of mining is to make money, and one would expect its economic aspect to be understood by those who enagege therein.

The principal phase of the money sense comprises two important factors; first, the ore "in sight" which can be turned into dividends, and second, the prospects for the future beyond what can be considered "in sight." In other words, mine valuation.

Hoover states in his "Principles of Mining:" "It should be stated at the outset that it is utterly impossible to accurately value any mine, owing to the many speculative factors involved. The best that can be done is to state that the value lies between certain limits, and that various stages above the minimum given represent various degrees of risk. Further, it would be but stating truisms to those engaged in valuing mines to repeat that, because of the limited life of every mine, valuation, of such investments cannot be based upon the principle of simple interest; nor that any investment is justified without a consideration of the management to ensue. Yet the ignorance of these essentials is so prevalent among the public that they warrant repetition on every available occasion."

Another phase of the money sense is the economic factor, which embraces such uqestions as—

Government,
Climate,
Transportation,
Water,
Fuel,
Labor,
Metallurgy,
Management.

Each of us is quite sure he possesses all the common sense needed, and this is also an important instinct, since without it we would lack self-confidence, initiative; we would be deficient in the ability to do, to accomplish.

Another term for common sense is "personal factor," which, in some, means much; in others, little. To some it means years of experience, to others, especial adaptation or genius.

Common sense means construction, conservation, or, in other words, making two blades of grass grow where one grew before.

The application of the conservation of natural resources by reclamation, as applied to mining, finds its highest type in this camp, which is known as the camp of many metals. And why? Because you in your evolution have mined that which is required without unnecessary sacrifice. Gold, as is natural, was the pioneer on account of its occurrence and value. Then came silver and lead, followed by manganese. Now the zinc era is at hand. Others will follow, showing that no metal or mineral of economic importance will be allowed to go to waste, but must add its share to the permanent mineral wealth of the world.

Another illustration of the application of common sense. Our waterways are harnessed and converted into electric power, which is transferred over small copper wires to the individual mines and mills, there to pump water, compress air, hoist and transport ore and waste, which has been mined by modern pneumatic and electric machinery, and finally reduce the ores to the metals sought.

When we consider that these same waters are allowed to go on unsullied to the farmer to be used to irrigate his property, which in its turn, adds to the world's wealth, an illustration of the constructive policy, as applied by common sense to mining, is presented, which shows that we are moving onward and upward.

And the end is not yet, for we are on the threshold of electrometallurgy, which will find its highest development in our midst.

To select an upbuilding constructive organization, carefully to determine and adhere to ideals, constantly to survey every problem from a lofty instead of from a near point of view, to seek special knowledge and advice where they can be found, to maintain from top to bottom a noble discipline, to build on the rock of the Golden Rule, of the square deal—these are the problems which common sense must solve.

After all is said and done, we must conclude that the last sense (common sense) is paramount and implies a familiarity and knowledge of the other senses.

SOME LOCAL SIDELIGHTS

The City Commission a few days ago promulgated a new ordinance requiring storekeepers to have their sidewalks swept clean by 8 o'clock every morning. At the same time the Commission permits the street cleaning department to operate its flushing wagon in the business district during the most active hours of the business day. Intersections of the principal streets are flooded and pedestrians are compelled to either wade through rivers of water and filth or else seek safety indoors till the scavenger crews get through. Great system.

* * * *

Judge Charles S. Varian, recognized as one of the foremost lawyers in this city and a sterling, progressive citizen, resigned as corporation counsel for Salt Lake about the middle of the month. Judge Varian is the second individual to resign the same position since the first of the year. He simply declined to impair his self-respect by serving longer.

Those asserting a familiarity with the affairs of the Utah Copper company believe that one of the next most interesting announcements to be made will be that the officials have decided upon additional mill capacity. How long this will be delayed depends upon two principal factors, first, the ability of the mine to supply the ore, and second, the stability of the copper metal market.—Salt Lake Tribune, April 18.

BROWN AND BLUEPRINTS

Brown-prints are prints similar to blue-prints, except that they are made on brown-print paper instead of blue-print paper. If a print be made on brown-print paper from a tracing as a negative, the print will show white lines on a dark brown background. This paper requires a little longer exposure than rapid blue-print paper, and must be washed three times, first in clear water from three to five minutes, then in a solution of fixing salt and water for about the same time, and finally are rinsed thoroughly in clear running water. The fixing salt is hypo-sulphite of soda, and a can comes with every roll of paper. Use in the proportion of half an ounce to a quart of water.

From the brown prints made as above, showing white lines on a brown ground, other prints can be made by using the brown print instead of a tracing. If these other prints be made on the same kind of paper—brown-print paper—they will show brown lines on a white ground. If ordinary blue-print paper be used, there will be blue lines on a white ground. These secondary prints require a longer exposure and must be carefully made in insure clearness. The white ground is convenient, because additions can be made on the print in pencil or ink. Brown-prints are much used because of the fact that tracing can be made and kept at a central office and brown prints from them distributed to the various agencies or branch houses which are then enabled to make for themselves as many duplicates as are required.—Mining and Scientific Press.

Mr. Frank H. Probert announces that the firm of Weed and Probert has been dissolved by mutual consent and that hereafter he will practice as consulting engineer and mining geologist, with headquarters in the Central building, Los Angeles.

The College of Mines of the University of Washington made its spring excursion for the mine inspection to Texada Island, British Columbia, from March 28th to April 6th. The party consisted of twenty senior and junior students accompanied by Dean Milnor Roberts and Prof. Joseph Daniels. The objects of the trip were to study the deposits of iron, copper, gold and limestone, and to inspect the lime kilns, oil-burning smelter and mining equipment of the region. Headquarters camp was established at Van Anda, near the north end of the island.

The difference in temperature of the outside air during the changes in seasons often exercises an important influence upon the ventilation of mines, this being due to the fact that in winter the outside air is cooler than that within the mine and in the summer warmer. This change will often effect a change in the air currents and as the outside temperature approaches that of the mine, there will be no natural ventilation except as this may be caused by wind pressure.

An ordinary drill may be hardened in sulphuric acid, making an edge that will cut tempered steel and facilitate in cutting hard rock. The acid should be poured into a flat bottomed vessel to a depth of about one-eighth of an inch. The point of the drill is heated to a dull cherry red and dipped in the acid to that depth. This makes the point extremely hard, while the rest remains soft. If the point breaks, reharden but with a little less acid in the vessel. After hardening a drill in this manner, wipe off the acid, if any remains on the point of the drill, before it attacks the metal and destroys the cutting edge.

Gold may be freed from lead in smelting zinc-box precipitate by the use of a flux containing 60 percent borax, 19 percent niter, 11½ percent sand and 7 percent soda. Manganese dioxide is said to be more efficient than nitre in oxidizing the lead, and for fusing 100 parts of the slime as a flux composed of 20 to 35 parts of borax, 20 to 40 parts of manganese dioxide and 15 to 40 parts of sand, is highly recommended. Gold recovered from alluvial work is usually nearly free from base impurities and can be melted down with a little borax glass and nitre. Flourspar, when available, is a good flux as it is very liquid when molten.

The International Society of Mining Accountants was organized in March. The objects of this new society are to promote the science of accounting and allied subjects connected with the production of the useful minerals and metals on the American continents, by means of an annual meeting for social intercourse and the reading of practical papers on accounting, etc., and the publication of the proceedings in an annual volume. There are two classes of members, active and honorary. Membership is open to any person interested in the subjects of the society, provided they are actively engaged in mining or allied industries. The Secretary is W. H. Charlton, 46 Hooker Ave., Detroit, Mich.

LEACHING APPLIED TO COPPER ORE* (XVII)

ELECTROLYTIC DEPOSITION OF COPPER FROM SOLUTIONS

By W. L. AUSTIN.

That branch of hydrometallurgy which has for its objective the extraction of copper from its ore, must necessarily be affected by the cost of the lixiviants employed. Therefore, modern methods of preparing chemical reagents through electrolytic treatment of solutions containing common substances, (such as chloride of sodium), have become of great importance in this connection. This industry has made notable advances in recent years and it is now profitable to manufacture chemical compounds in large quantities in comparatively remote localities, for instance in the mountains of the Scandinavian peninsula where water-power is abundant. Furthermore, waste products, such as the obnoxious sulphur-dioxide present in gases emanating from smelting-works, can now be turned to useful purpose by aiding in the production of acid lixiviants suitable for application in leaching ore. By combining the products of electrolysis with sulphur-dioxide, strong lixiviants may be obtained from substances available almost anywhere, the necessary factors being cheap power, sulphide ore, and common salt—the latter in small quantity.

As an elementary knowledge of the basic principles of electrolysis is essential to intelligent application of this powerful auxiliary for modern hydrometallurgy, it is proposed to briefly treat of this matter. In the following an effore will be made to place before those interested in the subject some succinct facts regarding electrolysis, which it is hoped will be useful in advancing the art as applied to extraction of metals from ore. This is not written for those proficient in electrolytical matters, but for the many who from one cause or another have been prevented from keeping up with progress in this branch of science, and who are attempting to get results without adequate knowledge of the subject. The very technical terms employed by writers on electrolytical matters are often confusing to the practical man, and much of the information given in text-books is far from being clearly stated. Whereas the "cut and try" method of advancement may sometimes lead to satisfactory results, it is usually more economical both as to time and cash expenditure, to first obtain information with regard to what has already been accomplished in any line of industry, and as to the scientific facts upon which it rests, before embarking upon a campaign of what may in the end prove to be merely re-discovery of well-known facts. Lack of information is the cause of much useless experimentation, and the various branches of technology are so highly specialized that it has become very difficult for one unfamiliar with any particular industry to acquire a working knowledge of it in a short space of time.

When a direct electric current is made to pass through a solution containing copper-sulphate, the points of ingress and egress of the current being two separate sheets of copper (electrodes), metal is dissolved at the anode (electrode at which the current is said to enter the solution), and is redeposited on the cathode (electrode at which the current leaves). The quantity of metal going into solution at the anode, and which is redeposited on the cathode, is in direct proportion to the strength of the current employed. A measuring instrument called a voltameter has been devised, one type of which is based upon the deposition of copper from a copper-sulphate solution (using copper electrodes) during the passage of an electric current. It is used for determining the quantity of current flowing through a circuit in a given time—the weight of the copper deposited indicating the quantity of current transmitted. In experimental work where changes in the strength of current supplied are apt to occur, due to reactions taking place in the electrolyte (liquor containing the metal to be deposited), it is always well to have a voltameter in the circuit to serve as a check on the readings of the voltmeter and ammeter.

ELECTROLYZING WITH INSOLUBLE ANODES.

In electrolyzing a cupriferous liquor, if instead of a copper anode one is employed which is composed of some material not acted upon by the liquor, or by the products generated, and which therefore does not go into solution (insoluble anode), then copper is still deposited on the cathode, but it is taken out of the liquor, without an equivalent amount of metal being dissolved at the anode, as in the instance just cited. It is evident, therefore, that in the latter case the electrolyte is undergoing constant alteration as to its chemical composition and other properties, and hence as to its function as an electrolyte—an element of considerable importance when making theoretical estimates with regard to the amount of current required to deposit a specific quantity of copper from a cupriferous bath, using insoluble anodes.

When an ore has been roasted with a view to the production of copper sulphate, the roasted material may be leached with water, and the lixivium thus obtained may be used as an electrolyte. In the electrolysis of such a lixivium, if an insoluble anode is employed (carbon for instance), copper may be removed from the electrolyte and be deposited upon a copper cathode. The operation which consists in passing an electric current through a cupriferous liquor with the object of depositing the contained copper, is termed electrolysis. In refining copper electrolytically, which is now done upon a very large scale, plates cast from crude-copper at the smelting-works are employed as anodes, and metal is dissolved from them and deposited upon sheets of pure copper used as cathodes. However, refining crude-copper plates differs materially from depositing copper out of cupriferous solutions derived from ore-leaching operations. For such work insoluble anodes must necessarily be employed, and the amount of current consumed per pound of metal deposited is much greater in treating liquors obtained in leaching ore than in refining operations.

As a preliminary to considering the practical bearing of electrolysis upon the hydrometallurgy of copper, it is necessary to understand the nature of an electrolyte, and an explanation should be offered why some liquors afford a passage for the electric current while others do not. Liquid conductors of electricity are termed conductors of the second class, thereby distinguishing them from metallic conductors, or conductors of the first class. An electric current will flow through a metallic conductor without producing an appreciable alteration in the conductor—

† Mining Engineer and Metallurgist, Riverside, California.

it flows without transportation of matter: when an electric current passes through a conductor of the second class there is always a transportation of matter, and usually chemical transformations are brought about.

Formerly it was thought that the electric current in passing through a copper sulphate electrolyte broke up the copper salt into two parts—(1) copper, and (2) a combination of sulphur and oxygen (SO_4). Such an hypothesis was quite natural, because metallic copper made its appearance on the cathode, and sulphuric acid accumulated in the liquor. Still several phenomena were observed which this theory could not satisfactorily explain. A closer study of the subject resulted in the development of the modern theory of ionization, a knowledge of which is essential in trying to explain reactions taking place when cupriferous liquors are subjected to electrolysis.

IONIZATION THEORY.

In refining crude-copper, inasmuch as copper is deposited at the cathode in the metallic state, and the metal composing the anode gradually goes into solution as sulphate, thereby maintaining the copper-sulphate strength of the liquor, the observed facts appear to explain the phenomena in the manner stated above; but at the same time it would seem reasonable to suppose that in the beginning of the operation a considerable force would be required to separate the metal from its associated acid-radical. Such, however, was found not to be the case—at least as far as concerned the work done by the current. Experimentation disclosed the fact that the smallest observable difference of potential between the electrodes of a copper voltmeter sufficed for transmission of current with the accompanying phenomena. In other words, it was found that an electrolyte would transmit a current without the latter exerting an appropriate force, such as would be necessary to tear apart a strong chemical combination. This interesting fact introduces the question as to the manner in which an electrolyte transmits the electric current.

When sugar, salt, and many other substances are thrown into water, they disappear as such, and it is said they are dissolved. They can be readily recovered by evaporating the water, but it is evident that when in the dissolved state their prior conditon must have been temporarily altered. If it were known, therefore, what happens to salt (NaCl) when it dissolves, then an explanation might be forthcoming as to why pure water is an extremely bad electrolyte, yet water with salt in it is a fairly good conductor.

The above mentioned, and other observed facts, led Arrhenius to formulate the hypothesis that all solutions of salts which are conductors of the electric current no longer contain the said salts in their original status, but that these salts are broken up to a greater or lesser extent (electrically dissociated) by the act of solution. The extremely small particles into which such salts are resolved in an electrolyte are termed ions. They are considered to be smaller than the old chemical molecules and atoms which before their advent did service in explaining chemical and physical phenomena. In addition to being a separate entity, each ion is thought to be combined with a definite quantity of electricity. It is not proposed here to enter into a discussion of the modern theory of solvation; nor to consider the ultimate composition of matter: attention will be directed only to such observed facts, and theories, as have a direct bearing upon practical electrolysis.

It is, at first thought, a severe tax upon the imagination to accept the idea that in dissolving common table-salt in water the liquid no longer contains the said salt in the form in which it was known to exist the moment before solution: that the salt in dissolving splits up for the greater part into sodium ions and chlorine ions, two of the most energetic chemical elements known to exist. A further difficulty presents itself in trying to imagine these substances as existing side by side in solution without their entering into combination with the elements of the water or with each other, and it becomes necessary in explaining the phenomenon, to advance the additional hypothesis that each elementary ion is itself combined with something which temporarily neutralizes its affinity for other chemical bodies. It is therefore assumed in the case at point that each sodium ion is combined with a charge of positive electricity, and that each chlorine ion is similarly combined with a charge of negative electricity. The electric charge combined with any ion, of whatever element, is assumed to be equal to that combined with each of the other separate ions, and as the sum of the positive electric charges must be equal to that of the negative, this is offered as an explanation of the fact that the solution remains electrically neutral. In the case of copper sulphate, the copper ions (cathions) are combined with charges of positive electricity; the SO_4-ions (anions) with charges of negative electricity.

WHY AN ELECTROLYTE CONDUCTS CURRENT.

With the help of the above mentioned hypothesis, it is possible to suggest a tentative explanation of the manner in which an electric current obtains passage through an electrolyte. Granting the presence of small particles of elementary, or combined substances, in a solution, which particles are associated with charges of electricity of opposite sign and are free to move in any direction, it is easy to understand that if two electrodes are introduced into such a solution—the one connected with a source of positive electricity, and the other with negative—that then the negative ions will be attracted to the positive electrode, and the ions combined with positive charges will move towards the negative electrode. Naturally also all the ions present in the solution will be set in motion as soon as there is the least electrostatic attraction offered by the two electrodes, and this explains why a current can pass through an electrolyte even when the electromotive force would have been insufficient to disrupt the combination of elements present in the salt before solution—the current simply attracts or repels the particles already dissociated by the act of solution.

Upon the arrival of the ions at the electrodes to which they are attracted, their charges are neutralized, and the ions themselves, deprived of their associated electricity, are free to unite to form molecules. Such is the hypothesis advanced by the foremost physicists of the day in accounting for the fact that when a solution of copper sulphate is introduced into a circuit through which an electric current is passing, metallic copper appears on the cathode plate and sulphuric acid collects around the anode.

However, a current passing through an electrolyte not only acts on the ions into which any particular salt—copper sulphate for instance—has been resolved, but it affects the ions produced by solution of other salts which may be present. No distinction is made by the current between the SO_4-ions originating in the solution of copper sulphate, and the SO_4-ions derived from sodium sulphate, sulphuric acid, or any other source. The same with metallic cathions—copper, sodium, etc. It follows that in electrolyzing a liquid containing substances other than those which are the object of the operation, where insoluble anodes are used, much of the current may be uselessly applied to production of hydrogen through the decomposition of water by metallic sodium deposited on the cathode when sodium sulphate happens to be present. The sodium hydrate thus formed naturally recombines with sulphuric acid produced at the anode, and the cycle recommences, unless the anode liquor (anolyte) is prevented from mixing with cathode liquor (catholyte) by introducing a screen (diaphragm).

Furthermore, chemical compounds produced in an impure electrolyte by the passage of a current, combine among themselves, forming new bodies which sometimes vitally affect the operation. These can accumulate in a bath until present in such quantities as to reverse the predetermined course of the reactions. It is quite possible in attempting to electrolyze a cupriferous liquor containing iron salts without employing a diaphragm, that the energy of the current is wholly expended in producing a cycle of chemical reactions without deposition of copper.

Then the removal of copper from a bath, due to deposition on the cathode, is constantly altering the relative proportions of the substances in an electrolyte, which in turn affects the degree of ionization, and conductivity. The temperature of the bath also influences the operation: a certain set of chemical compounds may be produced at a given temperature, while another set forms at a different degree of heat. For instance, in the electrolysis of a chloride of sodium solution, hypochlorites are produced at one temperature of the bath, chlorates and perchlorates at another temperature. These different phenomena can best be illustrated when considering specific cases in which they occur. Beginning with some simple examples of galvanic action, others more complex will be taken up later.

ACTION OF AN IRON-COPPER COUPLE.

If a galvanic couple consisting of two metals such as iron and copper, (which are placed at some distance from each other in the electromotive series), be immersed in a dilute copper-sulphate solution, and are connected outside the solution by means of a conductor of low resistance, then a current will flow through the solution from the iron to the copper. Under electromotive series is understood such an arrangement of different metals in a series that each one becomes positively electrified when placed in contact in air with the metal next below in the series. The precipitation of copper from mine-water by means of scrap-iron, an operation which results in the formation of innumerable galvanic couples, is an illustration of this phenomenon which comes under frequent observation. If a piece of coke be attached to a tin can by an iron wire and the combination be allowed to float upon the surface of a stagnant pond containing ordinary mine-water, even though the copper content of the water may be so slight as not to affect the coloration, the quantity of the latter metal precipitated upon the couple is extraordinary. There is more copper deposited than would be expected from contact of the couple with the water in its immediate vicinity, and may be explained by electrostatic attraction of copper ions from the surrounding liquid for a considerable radius. Carbon occupies a position near the negative end of the electromotive series, but apparently changes its position considerably according to the form (coke, charcoal, and graphite) and the manner of preparation.

If an iron plate and one of copper be placed in a copper-sulphate solution, and the two be connected outside the liquor by means of a copper bar, the two metals constitute the elements of an electric battery, and the current flowing through the bar can be measured—it can also be calculated from thermochemical data. The two results may not always agree because theoretical estimates are based upon data obtained with pure solutions whereas in practice the liquors usually contain other salts than those under immediate consideration. However, an estimate of the quantity of current required to deposit a given amount of copper from cupriferous solutions, using either soluble or insoluble anodes, often yields information of value in considering the cost of different methods of precipitation in ore-leaching operations. For instance, with a given cost of current, by this means it is easy to ascertain which is the least expensive agent for precipitation—iron or electricity. The theoretical method of reaching such conclusions is less expensive than the erection of elaborate plants, which in the past have often served merely to demonstrate the limitations of electrochemical reactions. It is not uncommon to hear the statement made that the amount of current required to deposit copper from liquors derived from leaching ore is a "negligible quantity," and the promulgation of this erroneous idea may account for the fact that a number of plants built with this end in view have ceased to attract attention shortly after beginning operations.

THERMOCHEMICAL CALCULATIONS.

In thermal chemistry the quantity of heat set free by the union of two elements, (as illustrated by the combustion of charcoal in air), is considered equal to the amount of heat necessary for the separation of the same elements. By reference to thermochemical tables it will be found that when 55.9 grams metallic iron combine with oxygen and sulphuric acid to form the ferrous salt, and this salt is dissolved in an abundance of water, then there are liberated 93,200 calories: when 61.8 grams metallic copper combine with the same substances, under similar conditions, to form copper sulphate, then 55,960 calories are set free. A calorie is understood to be the quantity of heat required to raise the temperature of one gram of water one degree Celsius—that is, from 15° to 16° C. The difference, therefore, between the quantity of heat evolved by the corrosion of 55.9 grams iron in a battery such as referred to above, and the quantity of heat liberated through the deposition of an equivalent amount (61.8 grams) copper on the negative pole, is 93,200—55,960=37,240 calories. This represents an excess of anode-energy expressed in heatunits (calories) when the specified weight of iron is corroded in a battery using a solution of pure copper sulphate as electrolyte: with the deposition of 30.9 grams copper only half the amount of iron will be consumed and the excess anode-energy will be 18,620 calories.

Heat being a form of energy, it must be related to other forms—mechanical and electrical—and one form of energy must find expression in terms of either of the others. It has been determined by experiment that the energy represented by one calorie is equivalent to the force required to raise 42.6 kilograms one centimeter, and also equals 4.189 units of electrical energy (4.189 watt-seconds= 4.189 volt-coulombs). It has been further determined that one ampere of current, flowing for one second (one coulomb), will deposit 0.001118 gram silver from an argentiferous solution. As the atomic weight of silver is 107.93, to deposit 107.93 grams of this metal (one gram-equivalent) will require $\frac{107.93}{0.001118}$ =96540 coulombs of current. This fundamental electrochemical constant (96540 coulombs) is called a Faraday, and represents the quantity of electricity supposed to be associated with the ions contained in one gram-equivalent of any univalent element. To release a gram-equivalent of any such element from solution it is (theoretically) only necessary to pass 96540 coulombs of electricity through the said solution.

Silver is a univalent element: copper is both univalent and bivalent—univalent in cuprous salts; bivalent in cupric. The same amount of current which suffices to deposit one gram-equivalent of a univalent element from a solution, separates only half of a gram-equivalent from solutions of a bivalent element. As copper combined with sulphuric acid in the form of copper sulphate is bivalent, one Faraday will deposit only half a gram-equivalent ($\frac{61.8}{2}$=30.9 grams) of this metal. Now, as 4.189 amperes of current flowing for one second at one volt pressure (1 volt-ampere-second=1 volt-coulomb) is equivalent to one calorie, therefore $\frac{96540}{4.189}$ =23046 calories represent the heat energy necessary to deposit one-half gram-equivalent of bivalent copper. As it was shown above that one Faraday sufficed (theoretically) for the deposition of 30.9 grams bivalent copper, and as the corrosion of the iron in the case of the battery under consideration yielded an excess anode-energy of 18,620 calories, such a battery should be able to produce a difference of potential equal to $\frac{18620}{23046} = 0.87$ volt.

The result indicated would be the theoretical difference of potential for an iron-copper couple immersed in a dilute copper-sulphate solution, but the available voltage would be less than the figures given because the flow of current would meet with resistance. The electrolyte would interpose resistance proportional to the distance between the electrodes; the external conductor joining the electrodes through the air would offer further resistance dependent upon its length and cross-section; and additional resistance would be encountered at each point of contact between conductors. Tables are available showing the amount of resistance offered by various metallic conductors of different cross-section: if these conductors are sufficiently large this resistance does not vary materially during an operation. With conductors of the second class (electrolytes) the case is different, because the consistency of the liquor is constantly changing.

RESISTANCE OF AN ELECTROLYTE.

The resistance offered by an electrolyte to the passage of a current is usually given in ohms per cubic centimeter. A resistivity of 50 ohms, for instance, means that a resistanee of 50 ohms is interposed between electrodes of one square centimeter section for every centimeter that they are separated. A copper sulphate solution containing five per cent of the salt offers a resistance of about 53 ohms per cubic centimeter. Solutions which are more concentrated, or more dilute, differ very much in resistivity. Tables are prepared which give the resistivity of various salt solutions at different degrees of concentration. Increasing the area of the electrodes decreases the resistance offered by an electrolyte in the case of a specified current.

Richards, in "Metallurgical Calcula tions," Part III, page 524, gives an estimate of the amount of copper which would be deposited per diem in a vat containing fifteen anodes of cast-iron and sixteen sheets of copper of same size, which would be simply an enlarged battery of the type above described. It is assumed that the copper-sulphate solution (about 5 per cent) has a resistivity of 50 ohms, and that the electrodes are placed 5 centimeters apart. The electrodes are short-circuited by resting on a triangular copper distributing bar of negligible resistance.

As the iron anodes are supposed to be hung between the copper cathodes, each anode operates from both sides, and as each anode is 40 by 80 centimeters in size, the total anode-surface is 40x80x15x2 =96,000 sq. cm. The loss in voltage due to contacts between electrodes and conductors is assumed to be 0.1 volt, and as it was shown above that such an arrangement of elements would yield an electromotive force of 0.87 volt, the available voltage to overcome ohmic resistance will be 0.87—0.1=0.77 volt. A resistivity of 50 ohms per cu. cm., spread over 96,000 sq. cm. surface, gives an ohmic resistance for the whole apparatus of $\frac{50}{96000} \times \frac{5}{1} = 0.0026$ ohms.

Now, as current $= \frac{\text{voltage}}{\text{resistance}}$, the quantity of current which will flow through a vat of this description will be (theoretically) $\frac{0.77}{0.0026} = 296$ amperes. The quantity of current per square centimeter of anode surface (that is, the current density) will be the stated number of amperes divided by the total number of sq. cm.: this will correspond to 30.83 amperes per square meter.

The quantity of bivalent copper deposited by one ampere of current in one hour is 1.184 grams, therefore, in one day 296 amperes will deposit 1.184x24x296 =8,411 grams. As the relative atomic weights of iron and copper are as 55.9 to 61.8 and as an atom of iron is corroded for each atom of copper deposited, there will be an expenditure of 7,608 grams of iron in depositing 8,411 grams of copper. This is assuming the iron to be chemically pure: it will, of course, require more of the scrap-iron usually employed for precipitating purposes than the above results indicate.

The calculation just given shows that under favorable conditions iron can precipitate more than its weight of copper from a moderately weak cupriferous solution. The reason that in practice more iron than the theoretical quantity necessary is consumed for this purpose, is due to two causes: (1) the iron used is dirty, or impure; (2) the access of air to the liquors causes complications. With regard to the last mentioned fact, when iron is dissolved at the anode the ferrous salt is produced, and this is very quickly oxidized by contact with air to ferric sulphate. Ferric sulphate not only re-dissolves some of the copper already deposited on the cathode, but it also attacks metallic iron. Hence, to deposit copper economically from weak cupriferous liquors it is essential to exclude the air from the vats as far as possible.

(To be Continued.)

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To conduct successful reverberatory smelting operations with gas, it is necessary that the furnaces be regenerative and so must be large and necessarily expensive in construction. Such furnaces are widely used in the manufacture of open hearth steel. Oil and coal-dust fired furnaces are at present coming into favor in copper reverberatory furnace operations.

HOW TO MAINTAIN A GRADE

In driving and tunnel work the miners unconsciously tend to work on an upgrade toward the face at a steeper angle than is desirable for drainage or for favoring the tramming of loaded cars. Too much grade is disadvantageous because the grade favoring loads is so great that the cars tend to run faster than considerations of safety should permit; greater effort is required to move empty cars up the grade; natural ventilation is interfered with, the results being especially noticeable at the face; and, in some cases, the unnecessary loss of ore in the backs above the drift may be undesirable.

The grade of drifts in some of the older mines of Cornwall is as great as 5%, often 7%. At the present time a drift is rarely driven at a greater grade than 1%, which is twice the grade recommended by some authorities.

To avoid driving at too great a grade, a template should be provided which the miners can use as often as they desire and without losing much time. Such a template may be made by cutting a board of convenient width and thickness so that it is exactly 100 in. long. The edges should be planed true and parallel. A line is then drawn from the upper corner of one end to a point one inch below the upper corner of the opposite end and the board sawed along this line. The board is then turned over, and a level-tube let into the edge, which is so adjusted that the bubble will be in the center of the tube when the edge of the board is in a horizontal plane.

In use, the template is laid upon the floor of the drift with the narrower end toward the face. Then if the grade of the floor is 1%, the bubble will be in the center of the tube.

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A rough method for determining the flow of a stream is to select some portion that is as straight and uniform as possible, for, say 300 feet and then measure the width and depth in six or eight places, from which may be determined the average width and depth. This multiplied together will give the average cross-section in square feet. Put a float on the water and note how long it takes it to travel the distance measured, from this can be determined the velocity of the water in feet per second. Multiply this by the average cross-section in square feet and the product will be the cubic feet per second of flow. Reduce the result by one fifth, to allow for the change in velocity between the surface velocity and average velocity of the stream.

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For nearly one month, or since the first day of May, there has been a strike on at the Murray plant of the American Smelting & Refining Company and the difficulty has not yet been adjusted. It is claimed that the trouble arose over the men demanding a raise from $1.75 to $1.90 a day, to $2.25. The company has seen fit to ignore the demands of the men and, as a result the plant, which was only running five of its eight furnaces before the strike, is now able to keep only two or three of the furnaces in blast. While nothing of the kind, of course, is acknowledged it seems probable that the company has been reading the "hand-writing on the wall" and sees its finish, anyhow. One by one the old patrons of the concern have been transferring their business to the International Smelting Company's plant at Tooele and the prospects are that the American (Guggenheim) crowd is, with respect to its lead smelting operations in this state, beginning to realize that its "survival of the fittest" proclamation of about three years ago is not destined to work out as it expected. Maybe the company is preparing to take advantage of the demands of its employees as an excuse for closing down the works permanently. Not many of the lead-silver ore producers of Utah will shed any tears if such proves to be the case.

Sloughing Off Utah Copper

A Few Remarks Tending to Show the Great Faith (?) which Mgr. Jackling and Prest. MacNeill Have In the Value of their Reports and Share Holdings.

Those of our readers who have taken seriously the annual reports of Manager Jackling and President MacNeill of the Utah Copper Company for the years 1910 and 1911 will doubtless be surprised to learn that both of these gentlemen have been unloading Utah shares during the last twelve months at a rate which, if continued will, before the close of the present year, find them with an insufficient number of these gilded evidences of wealth to qualify them as members of the Steam Shovelers' Union, much less the executive and managing heads of the "greatest copper mine on earth."

The official list of principal shareholders given to the public at the meeting of stockholders, held during the latter part of April, 1911, for the year 1910, credited Manager Jackling with the ownership of 11,000 shares, whereas the corresponding list made public at THE RECENT ANNUAL MEETING, for the year 1911, gives him an ownership of only 5,868 shares, and that President MacNeill, at the same time, had succeeded in reducing his holdings from approximately 50,000 shares to 34,194 shares at the time of preparing the list of shareholders for the 1911 annual meeting, held on the twentieth of last month. Again, if we may indulge serious consideration of the substance of the reports of these gentlemen to the shareholders of the Utah company for the years 1910 and 1911, THE HASTE WITH WHICH THEY PROCEEDED TO DUMP THEIR HOLDINGS ON A DECLINING MARKET SEEMS ASTOUNDING.

It will be remembered that the report for 1910 showed that the developed ore reserves had been increased from about 92,000,000 tons to 202,000,000 tons, an increase for the year of about 110,000,000 tons. The average yield of copper per ton of ore for that year was given at 20.51 pounds per ton of ore treated. On the basis of alleged cost of production for the year 1911—7.865 cents per pound —this would yield, at the present price of the metal, 8c. net per pound of copper, or a little more than $1.70 per ton. The net value of this newly-found 110,000,000 tons of ore was therefore more than $187,000,000—a sum equal to about $123 per share upon the entire outstanding capital stock of the Utah company, BEING ABOUT TWO AND ONE-HALF TIMES THE PREVAILING MARKET PRICE during the time in which the president and manager unloaded their shares, as before mentioned.

It will also be remembered that for a couple of weeks prior to the giving out of the 1910 report (that is, about

April 28, 1911), quiet hints were industriously circulated from the local Utah office and by confidential brokers of the Utah company that A BIG SURPRISE was about to be sprung upon the investing public which would cause a rapid rise in the shares of the company; in fact, $150 a share was mentioned by the more zealous of the Utah company's subsidized press as likely to be reached when the impending disclosures should be made public. Many of the gullible ones dipped in for such number of shares as their resources would permit at prices ranging at or a little below $50 per share. But when the report came out it fell with a dull thud. Likewise the market price of the shares. Evidently the expectant public investor was greatly disappointed. Whether the quantity of newly-found ore was too small or whether its ponderous proportions rendered the fragile foundation insecure are matters for each loser to judge for himself. Certain it is that the price soon began to recede and floundered heavily between about $48 and $44 per share during the balance of the year.

Just what view Manager Jackling and President MacNeill took of the merits of their reports can best be inferred by the fact that they accepted the view of the general public and unloaded their shares, as before indicated.

An examination of the report of Manager Jackling in respect to the method or manner of discovery of the vast millions of tons of new ore discloses the fact that ONLY 1400 linear feet of DEVELOPMENT work had been done during 1910, and that the discovery was the result of THE CONSTRUCTION BY THE COMPANY'S DRAUGHTSMEN OF A SERIES OF NEW CROSS-SECTIONAL LINES upon the claim maps whereby simple mathematical calculations disclosed errors in previous calculations and provided a new constant which showed each previously known ton of ore to have EXPANDED sufficiently to cause it to occupy an area equal in capacity to a little more than two tons, as originally estimated.

This remarkable phenomena is doubtless due to the fact that all porphyries expand or "swell" on exposure to the atmosphere, a fact generally known but not always understood by the average mining engineer but which—owing to his long and diversified experience—was doubtless familiar to Manager Jackling, and which fact no doubt moved him to discredit the report and dispose of his shares, as before said.

Whatever may be the facts in respect to the process by which this vast tonnage was unconsciously made to appear to have been discovered, it is quite certain that the supposed discovery was a surprise to both Manager Jackling and President MacNeill, because a careful examination shows that neither of the four regular quarterly reports put out by these gentlemen to the stockholders of the company for the year under consideration DISCLOSED THE SLIGHTEST INTIMATION of the discovery or development OF ANY ADDITIONAL ORE during the entire period covered by the reports. And it can not be assumed that HAD such discoveries been made, the facts would have been kept concealed from the shareholders for the entire year and then an additional four months pending preparation of the report.

All that has been here said of the manner of discovery of additional ore and the probable cause that led thereto for the year 1910, applies with equal force TO THAT OTHER HUNDRED AND ODD MILLIONS OF TONS, the first appearance of any official knowledge of which occurs in the recent annual report of Manager Jackling, given to the public four months after the close of the year during which a discovery is alleged to have been made. In view of the characteristic swelling of these ores as suggested in respect to the enormous increase, due to that cause, during the year 1910, it is not surprising that the increase for 1911 should be as great as stated in the manager's report for 1911. In fact, it is a matter of surprise that the increase was not greater, as there was more known ore at the commencement of the year 1911 upon which this peculiar propensity could operate. Besides, THE SAME PROCESS OF RESECTIONIZING DIFFERENTIATION and ELIMINATION OF PREVIOUS ERRORS was applied as in the former case.

Now, in view of the greatly increased market price of and APPARENT demand for the shares of the Utah company, should Manager Jackling and President MacNeill take the same view of their report for 1911 as they did of that for 1910, they should be able—before the close of another quarter—to dispose of their remaining holdings at a very considerable advance in price over that which followed the promulgation of the story of the discovery of the first hundred million-ton increment. But, as the public is made to appear as having accepted the latest story in a more serious vein, possibly the manager and president of the Utah company may be influenced—even deceived—by public expressions, and in such case it will not be at all surprising to learn that they are reinvesting the proceeds of former sales in the same securities. Of course one can never be quite certain of the truth or falsity of reports of this character until they shall have become advised of the more deliberate judgment of the public, which just now appears to be on the bull side of the report.

WAYS OF FIGURING PROFITS

With isolated exceptions Mines and Methods has stood alone in its efforts to keep the public advised concerning the deceptions practiced by some of the big mining corporations—and particularly the greatest offender of them all, the Utah Copper Company—in dealing with their shareholders and the public. Elsewhere in this issue we reproduce an article on "Utah Copper Costs" that was written by Mr. Heath Steele, of New York, for the Engineering and Mining Journal. We commend it to the consideration of our readers because it deals with the subject in what is evidently an unbiased and unreproachful spirit and because it shows so plainly that, judged by the honest reports of corporations with which comparison is made, Mines and Methods has never been too severe in its criticisms of the methods of the management of the Utah company. We have contended all the time that Utah Copper has never earned the dividends it has paid. Mr. Steele, in his own way, makes it very plain that such is and has been the case. His argument should prove an inspiration to those who have been doubtful of the sincerity of the strictures of Mines and Methods, as it must prove a hard lump to swallow by those "financial" writers and market boosters who, either through blissful ignorance or personal gain, constantly employ dark lantern methods to discredit the utterances of Mines and Methods, but who lack the nerve to come out in the open and declare themselves.

Mr. Steele deals with only a few of the features of the recent annual report of the Utah Copper Company, which is the wickedest and most barefaced attempt yet made to bamboozle the public and create a broad market for its stock. There are a lot of things about it that will be discussed in coming issues of this magazine, but for the moment we shall content ourselves with giving our readers a chance to see that we are not alone in our opinions and estimates of those who control the destinies of the Utah company.

It is doubtful if any series of articles ever published on the subject of ore treatment has attracted as much attention as those by W. Lawrence Austin on leaching now running in Mines and Methods. Orders for issues containing these copyrighted articles come from all over the world.

FIGHT ON IN ARIZONA

According to reports brought up from Phoenix, the Kinney bill, recently introduced in the Arizona legislature, now in session, is causing some of the mine managements to say things which, if true, do not quite jibe with the statements given shareholders in "official reports" and brokerage market "dope." One of the chief objects of the Kinney bill, it seems, is to require mining companies not to employ men underground who do not speak and understand the English language. Early in the present month the mining companies asked to be heard on the subject and, among others who appeared before the committee to whom the bill had been referred was L. S. Cates for the Ray Consolidated, B. Britten Gottsberger for the Miami and Sherwood Aldrich for the Inspiration.

It is not the purpose here to discuss the merits and demerits of the measure referred to, but we do wish to call attention to the manner in which some of the companies play fast and loose with the public. Cates' testimony brought out the fact that the Ray Consolidated paid an average of $2.25 per day to approximately 2,000 employees. Judge Worsley, one of the inquisitors, asked Mr. Cates if he thought the proposed law would prove good or bad for the state. "Bad," said the witness. "Could you not afford to pay even $4 and still make a profit at the Ray?" Mr. Cates replied with an emphatic "NO."

Manager Gottsberger, of the Miami, testified that the average wage paid by his company was $3.50 per day and that 75% of the men employed underground could speak and understand the English language. His company could pay such a wage and make money because of the better class of men and the greater efficiency of the force. Asked if he did not think the Ray ought to do equally as well. the witness replied that he was not standing sponsor for the Ray.

Here is the point we wish to make, as it was pointed out by Judge Worsley, who said to Manager Cates: "The literature, prospectuses and reports concerning the earning value of your property do not bear out your statement. If what goes out to the world concerning your property is true, then your declaration that a $3.50 or $4 wage scale would prevent you from making a profit is untenable," or words to that effect, as related by the visitor from Phoenix to this city.

In other words, the Ray Consolidated tells, for market effect, that it is now earning, and preparing to earn, as each new month passes into history, dividends that would make the Count of Monte Cristo look like a pie-counter magnate, while its representatives declare—honestly, we believe—that if another six-bits a day was added to the wages of its men, making its scale the same as a neighbor's, it could not earn dividends. The real fault with Ray Con. seems to be that it has too much "probable ore" of as uncertain value as its "fully developed" churn-drill hole reserves.

Sherwood Aldrich, of the Inspiration, told the committee that the proposed bill would be bad for the state of Arizona, and he threatened that if it became law some $10,000,000 or $12,000,000 that was intended for invetment in Arizona would be diverted to Utah or Nevada. If that is the case, Utah ought to send a delegation down to Phoenix to work for the passage of the Kinney bill.

AS LIKE AS TWO PEAS

A London expert who was sent to report on a mine in Gilpin county, Colorado, tells the shareholders that "the positive ore developed amounts to 135,545 tons of an average assay value of $9.35 per ton. The probable ore amounts to 95,025 tons of an average assay value of $9.22 per ton. The ore expectant amounts to 220,082 tons of an average assay of $9.22 per ton." Note the 22c! It is a well known fact that a metallurgist and mining engineer in that state, estimated to within a few cents per ton what it would cost to mill an 800,000-ton dump, and within a few dollars of how much profit per month he could extract in two years—and subsequently did it. But the other totally eclipses this—on paper—and knocks into a cocked hat the old adage "you cannot see an inch ahead of your pick's point." It simply shows what marvelous advance science is making in the art of mining when the value of 315,107 tons of "probable and expectant ore" can be given within a cent to the shareholders expectant.—By the Way item in Engineering and Mining Journal, May 4, 1912.

The above item is reproduced in order that we might tack on a paragraph from General Manager Jackling's report to the "expectant" stockholders of the Utah Copper Company, wherein it deals so minutely with the value of the "partially developed" ore, as follows:

"After deducting all the ore that has been mined from the property previous to January 1, 1912, there yet remained 301,500,000 tons of fully developed and partially developed ore, of which amount 229,830,000 tons were fully developed and 71,670,000 tons partially developed. The above-mentioned developed ore includes about 26,970,000 tons of partially developed ore in the slopes of the steam shovel workings. Of the fully developed ore, the average assay of 62,040,000 tons is 2 per cent copper; the average assay of an additional 92,130,000 tons is 1.6 per cent copper, and the average assay of the remaining 75,660,000 tons is 1.3 per cent copper. The average assay of the 71,160,000 tons of PARTIALLY DEVELOPED ore is 1.28 per cent, making the average of 301,500,000 tons of developed and partially developed ore 1.532 per cent copper.

WOULD "JOLLY" INVESTORS

Mines and Methods has often stated that—notwithstanding all the declarations of the insiders and the subsidized prattle of the daily press and the "financial" and market publications of the east that copper metal was nearly all consumed and that a broad market had developed for "porphyry copper" shares as a result—THE PUBLIC was not loading up with these offerings to any appreciable extent. There is some measure of satisfaction in having the Herald-Republican of this city build a goodly portion of its articles dealing with the visit of the great Eastern banking interests and copper magnates by quoting "a man whose interests have kept him in close touch with the mining world of New York and Boston," and making him, among other things, say:

"The copper situation has been unsettled for years; the public has not been investing in the copper stocks offered by these great banking institutions, and on each advance in the market those holding copper stocks HAVE BEEN UNLOADING ON THESE BANKING INSTITUTIONS. It has been suggested that this trip was for the purpose of assuring these men who have been supporting the market and taking the stock off from the brokers' hands for several years, of the merits of the properties and the stability of the investments made; and that these men, through a 'gentlemen's agreement,' after seeing the properties, GIVE SUFFICIENT FINANCIAL SUPPORT TO MAINTAIN THE MARKETS and produce the money for the SUPPORTNG OF THE COPPER METAL PRICE, and the bringing about of a more prosperous condition in the stock market THAT THEY MIGHT RECEIVE RELIEF IN CARRYING THE STOCKS THEMSELVES, and DISTRIBUTING THEM AMONG THE INVESTING PUBLIC by ASSURING IT that the properties ARE meritorious and justify the investment. (Capitals are ours.) * * *

"It is believed that when these men report the situation as they found it, the entire investing public will not only have more confidence in the copper market, but will have more confidence in the general business institutions of the country. * * * It is significant, indeed, that the great Standard Oil and Guggenheim copper interests are meeting here in Utah * * * with the hopes of (making a) distribution of stocks to the public AND RELIEVING THEMSELVES OF THE VAST AMOUNT OF STOCK THAT THEY HAVE BEEN FORCED TO CARRY. * * *."

From this frank statement it might be also inferred that these great banking interests, while expiating on the merits and tremendous value of these copper stock investments, are standing in together with a well-defined purpose of doing the dear public a fine turn by trading to them reams of gilt-and-gold "securities" for real coin of the realm.

A COMPARISON OF UTAH COPPER COSTS

By HEATH STEELE.*

The Utah Copper Company in its annual report states that it produced copper for 8.07c. per lb. in 1910 and 7.87c. in 1911. In summing up the copper situation in his report to the state of Michigan in 1911, J. R. Finlay, in reference to the porphyry copper mines said: "So far as costs are concerned, the porphyry mines are in essentially the same condition as other mines. Some can produce copper cheaply and others cannot. It is highly doubtful if their average cost will even be as low as in the Lake Superior district." The average cost of production in the Lake district during the five-year period 1906-1910 was 10.1c. per lb. for all the profitable mines. The Utah Copper Company claims that the cost figures reported cover costs of every kind and description, but before it is fair to compare any two cost records it is only fair to see if the figures given to each represent the same costs. It is the custom in the Lake district to charge every expenditure to operations. Their reports are by far the most satisfactory statements issued by any of the American mining companies; the total receipts and expenditures are itemized so that one can see at a glance the profit or loss for the year. No attempt is made to defer charges. Let us take two of the mines in this district as examples, the Calumet & Hecla, a mature property; and the Ahmeek, a new one.

During the five years mentioned it cost the Calumet & Hecla 8.95c. per lb. to produce 410,614,189 pounds of copper from 13,185,376 tons of rock averaging 31.2 net pounds of copper per ton. The total cost was $36,662,696, made up as follows: Mining, transportation and milling, $26,850,772, $2.04 per ton or 6.54c. per pound of copper; construction, $2,889,570, or 0.74c. per pound; smelting, refining and commissions, $4,684,975, or 1.14c. per pound; and general expenses, $2,237,379, or 0.53c. per pound of copper. It must be borne in mind that these figures represent every expenditure during this period, so that the total cost as given, substracted from the gross receipts, $61,313,175, leaves the actual net profits, $24,650,479; therefore there is no disputing the reported cost of production, 8.95c. per pound.

The Ahmeek Mining Company produced 35,911,797 pounds of copper, during the same period, from 1,722,281 tons of rock, having a net yield of 20.9 pounds per ton at an average cost of 13.3c. per pound of copper. But like the Calumet & Hecla figures, this cost includes all expenditures, which were partly absorbed in equipping the property, as will be noticed by the construction item in the costs herewith: Mining, transportation and milling, $3,002,075, or $1.74 per ton of rock, or 8.36c. per pound pound of copper; smelting, refining and commissions, $411,804, or 1.15c. per pound; construction, $1,226,945, or 3.42c. per pound; and general expenses, $145,192, or 0.40c. per pound of copper. The total expenditures were $4,786,018, which, substracted from the gross receipts, $5,134,777, gives the actual profit, $348,758 for the five years. In the case of the Ahmeek the cost will be lower in the future owing to a reduction in construction at the property; in fact, the cost reported for 1911 was 7.17c. per pound but the amount spent during the year for construction was much below the average required for the Lake Superior mines 0.8c. per pound of copper. It seems safe to say in regard to the future costs, that if the yield is maintained at the present amount and construction figured at the average cost, Ahmeek will produce copper at a cost of 7.5 to 8c. per pound with a certainty of an increse if the yield falls below the present amount.

The Utah Copper reports are elaborate and give many figures, but it cannot be said that they are plain to the average layman who tries to figure out the net results. It is a large property and owing to various investments and holdings the accounts are necessarily numerous; however, let us see what its costs would be in the plain language of the Lake Superior copper-mine reports.

For 1910 the report gives the operating expenses as $7,819,477, for a production of 84,502,475 pounds of copper from 4,340,245 tons of ore yielding 19.5 pounds net of copper per ton. This indicates a cost of 9.25c. from which 1.18c. per pound is deducted for gold and silver, making 8.07c. per lb. as reported. But if this figure is to be compared with the Lake Superior costs let us look further into the figures reported. We find that the operating expenses as reported include $272,675 for "prepaid expense-ore stripping" but in addition to this item as charged to operation, there has been a further expenditure of $1,022,967.34 for stripping and an additional sum for improvements and equipment charged to property account of $822,170.58. Add these two amounts to the total operating expense as reported and we have a total of $9,664,614.82, which makes the total cost of copper 11.49c. per pound, and deducting 1.18c. for gold and silver leaves an actual cost of 10.31c. per pound instead of 8.07c. as reported.

The 1911 annual report, just published, states that 93,514,419 pounds of copper were returned by the smelters from 4,680,801 tons of ore yielding about 20 pounds net per ton at a cost of $8,324,053 or 7.87c. per pound after deducting 1.07c. for gold and silver credits. The operating cost reported includes $351,060 for stripping ore, but like 1910 there was an additional amount spent, $1,628,766, for the same item, but charged to deferred account. If we add this amount and $1,215,121, which was spent for improvements and equipment as charged to capital account, as well as $30,966 for interest paid but deducted from miscellaneous earnings, we have a total expenditure of $11,198,905.75 for the year. We then have a cost of 11.94c. per pound and after deducting gold and silver credits, 10.87c. per pound instead of 7.87c. as reported. It will be noticed in this report that $2,500,000 of the stripping expense which in the past had been charged to deferred accounts, was charged to profit and loss account this year. In this way this sum will never appear in the report as an operating cost where it belongs. It is plain to see that the claims of 8c. costs have not been actually realized at the Utah Copper and are nothing more than estimates of hopes for the future, and are obtained at present only by deferring to some future date charges that may or may not be charged off at present in the correct proportion to the tons of ore produced. The fact that such a sum has to be charged off through profit and loss certainly leads to the inference that it has been found necessary to allow more than has been charged through the operating cost statements.

In regard to construction and equipment expenses, it must be remembered that these charges are inevitable and will continue to be a large item as long as the property operates. For example, the Calumet & Hecla figures given above, show that it has cost this mine 0.74c. per pound of copper or 7.86 per cent of the total expenditures during the five-year period. In the case of the Utah Copper the amount charged to capital accounts for construction and equipment in 1910 was 8.5 per cent of

*In Engineering & Mining Journal, May 11, 1912.

the total expenditures or 0.97c. per pound of copper; and in 1911, 10.8 per cent of the total or 1.29c. per pound of copper. The Calumet & Hecla current-construction expense represents about the average of what it has cost all the Lake Superior mines for the same expense.

If we reconstruct the figures of the Utah Copper Company's report in this way the operating profits are materially different from those reported in the 1910 and 1911 annuals; $5,401,775 and $6,237,928 respectively. In 1910 the operating revenue was $11,710,389; deducting the total expenditures for mining, milling, transportation, construction, improvements and stripping as stated, $9,664,615, the net operating profits will be only $2,045,774. The revenue from investments, etc., amounted to $1,510,863, making a total net revenue of $3,556,637, out of which was paid a dividend of $4,648,676, a deficit of $1,092,038 for the year.

In 1911 the operating revenue was $12,825,953, from which deduct $11,198,906 for expenditures and the operating profit is $1,627,047. The income from investments, etc., amounted to $1,766,995, making a total net revenue of $3,394,042, out of which a dividend of $4,703,022 was paid, leaving a deficit of $1,308,980 for the year. This makes a total of $9,451,698 paid in dividends in the last two years out of a total net revenue of $6,950,679, or an excess of $2,501,018 over revenue. During 1911 the current assets were reduced $2,030,753. The figures stated do not include any investments made by the company in various enterprises. It should be perfectly plain to any one that these figures must be reconstructed in this way if they are to be compared with the copper mines of Lake Superior carrying no deferred charges. The stripping that has already been done will surely yield more ore than has been taken from the pits but it is a question whether the operation of the mine can be continued from year to year with a less amount of stripping. An important fact in connection with this question is, that to increase the tonnage production 7.84 per cent in 1911 over 1910 it was necessary to increase the underground proportion 8 per cent—from 18 to 26 per cent of the total tonnage. If this mens that any further increase in output will have to come largely from the underground workings it certainly does not argue that the cost of mining and stripping will be lowered.

Marcasite has the same composition as pyrite, but is distinguished by its crystallization and lighter color.

UTAH COPPERETTES

Governor Spry's Ryan banquet speech: "When Jackling runs for governor of Utah we'll all vote for him." Of course the governor only had reference to those at the banquet for whom he could vouch.

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It is not considered "good form" to joke about copper stock market conditions and for that reason one Thomas C. Shotwell, who daily discourses on the New York market for a local paper should be suppressed. His guff about the "fundamental" and "statistical" position of the market and the red metal would start the risibilities of a "houn' dawg.' The copper stock market is just as "strong" as the big banking interests, who at the present time are "holding the sack," care to make it—no more, no less.

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An evening or two before the arrival of the John D. Ryan party, which inspected the mines of the Utah Copper Company, blasting along the steam-shovel slopes was so heavy and lasted so long that hundreds of people in Salt Lake began to get nervous; they could not imagine what it all meant. It was done, of course, to properly impress the visiting easterners with the tremendous magnitude of the operations. This feature of the visit will be better understood by the Bingham Press-Bulletin's statement that "for the benefit of the visitors the shovels were CONCENTRATED so that the bigness of the undertaking could be better demonstrated."

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In its main story of the magnificent banquet given by Colonel D. C. Jackling to the John D. Ryan party at the Hotel Utah on the evening of May 1, the Herald-Republican says: "Every precaution was taken to prevent the party from being disturbed by intruders and at the entrance to the grill room Police Inspector Carl A. Carlson, Sergeant E. V. Johnson and Sergeant Thomas Simpson stood guard."

Wonder what sort of an intrusion Colonel Jackling feared? The dissipation of the awful suspense by the fall of the curtain without an unwelcome guest (ghost) of any kind having eluded the vigilance of the sleuths on guard must have lifted a great strain from the colonel's peace of mind.

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The Salt Lake Herald-Republican of the 20th editorially relates that "an enterprising western journal has uncovered some interesting answers to questions in a public school examination," the following among the rest: "King Henry VIII, mostly by his own efforts, increased the population of England 40,000." In its comment the local paper says: "Take the one about Henry VIII. The only trouble with it seems to be that the total is a little high."

While extolling the virtues and abilities of Colonel Jackling at the Ryan party reception Governor Spry said, according to the Herald-Republican: "He (Col. Jackling) came amongst us unknown, but in a short period made his personality felt, and he has since been directly responsible for adding at least 25,000 people to the population of Salt Lake county." Like the case quoted in the first paragraph of this item, it is urged that the only trouble with the governor's estimate "seems to be that the total is a little high."

SILVER KING DEAL ON

According to the news that has sifted through from inside sources and which has been a subject for discussion in well-posted mining circles for several days past, it seems that negotiations are well along in a deal which, if it is finally consummated, will involve the sale of the Silver King Coalition company's mines at Park City to one of the most powerful foreign exploration companies in the world. Details of the undertaking can not be announced at this time, because of their tentative character, and it is probable that the daily press will find time enough to leave its forlorn copper stock boosting campaign long enough to have covered this piece of real news before the appearance of the June issue of Mines and Methods, a month hence.

About three weeks ago Mr. O. O. Howard, representing the foreign corporation referred to came to Salt Lake for the purpose of meeting the chief interests of the Coalition company and having them place a price on the famous Park City mines. Dickering has been in progress ever since and it was stated Monday that negotiations had reached a stage where, on compliance with certain conditions, the examination and sampling of the mines might be commenced by Mr. Howard.

The price named has, of course, not been released, but it is safe to say that the property, which has paid nearly $12,500,000 in dividends already, and which is declared to be now in better physical condition than at any time in the past, will call for the dislodgement of several millions of dollars on the part of the purchasers if it is secured. The prospective sale is of intense local interest because practically all of the stock in the Coaliton company is owned in Salt Lake and Utah.

LEACHING APPLIED TO COPPER ORE* (XVIII)

ELECTROLYTIC DEPOSITION OF COPPER FROM SOLUTIONS (CONTINUED)

By W. L. AUSTIN.†

In the preceding article the deposition of metallic copper from a neutral sulphate solution by means of an electric current generated through dissolving metallic iron in the same bath, was considered wholly from a theoretical standpoint. Iron anodes and copper cathodes were assumed to be hung in a solution of copper sulphate, and these were short-circuited at the top out of reach of the liquor. This was simply an improved arrangement of the ordinary features of cementation, and it was demonstrated by thermo-chemical data that in this manner one pound of iron should theoretically deposit 1.1 lb. copper. However, a simple laboratory experiment will show that this process does not proceed in the manner indicated. Spongy copper separates out at the anode in large quantity and the voltmeter registers a very weak EMF (electromotive force=potential).

Richards in "Metallurgical Calculations," Part III, page 523, states: "If iron in plates or sheets, or bundles of scrap iron in a crate or holder are immersed in copper sulphate solution and simultaneously connected electrically with a copper plate to serve as cathode, no copper precipitates on the iron, but all is precipitated on the copper. The iron acts as a soluble anode, going into solution as ferrous sulphate, while the copper is deposited out passive, dense, and practically chemically pure on the cathode sheet." The writer has not succeeded in obtaining experimentally the result indicated, when using a neutral solution of commercial bluestone, equivalent to 5% $CuSO_4$. Employing electrodes such as described in the foregoing, the current produced is very weak and the voltmeter shows less than half a volt. The greater part of the copper deposits on the iron anode. When crystals of pure copper sulphate dissolved in distilled water constitute the electrolyte, much better results are obtained. The solution is wholly decoppered and most of the metal is deposited on the cathode, but some still adheres to the iron. There is a very marked difference between tests made with chemically pure reagents and those carried out when using commercial products. The latter, of course, more nearly approximate working conditions. When a very little free acid (one part acid to 300 parts water) is added to the commercial sulphate solutions, the action becomes much stronger, but hydrogen gas is evolved and much copper separates at the anode in a flocculent state.

An explanation of this phenomenon might be as follows. In all galvanic cells which produce electric current, the source of electric energy is chemical action. This is demonstrated by the fact that after such cells have been in operation a sufficient time for chemical exchange of elements to take place, the cells exhaust themselves and current ceases to flow. Among metals which decompose water in the presence of an acid, is iron. If metallic iron is placed in weak sulphuric acid the water is decomposed, iron going into solution and hydrogen gas being given off. If instead of acid a solution of copper sulphate is taken, then the iron also goes into solution but no hydrogen gas appears. At least this is the case when the experiment is made using wrought iron: when cast iron is substituted the result is different, because of the carbon contained in the cast iron which forms with Fe a strong galvanic couple. A piece of cast iron when joined by a conductor to a piece of copper will cause a voluminous evolution of gas from a copper sulphate solution in which wrought iron will corrode without any appearance of gas.

SOLUTION PRESSURE.

When a metal is brought in contact with water a force is developed which tends to drive the metal into solution. This so called solution-pressure varies with different metals. Iron and zinc have a greater tendency to dissolve in a copper-sulphate solution than is the case with copper, therefore these two metals when immersed in a copper-sulphate bath crowd out the copper and take its place. That copper is reduced from a neutral copper-sulphate solution through the greater solution-pressure of the iron, and does not owe its reduction to hydrogen gas, is shown by the fact that when wrought iron is used there is no hydrogen gas evolved; and by the further fact that hydrogen gas can be passed through another portion of the same solution indefinitely without copper being reduced to metallic form.

When a galvanic couple such as iron-copper is placed in a neutral solution of copper-sulphate, the reactions which occur indicate that two distinct operations are in progress. In the first place, because of superior solution-pressure, iron is dissolved, whereby an equivalent amount of copper is precipitated at the anode. This copper detaches itself and collects at the bottom of the vessel. Under certain conditions hydrogen gas is given off from the pile, indicating that the precipitate is not alone copper, but copper alloyed with hydrogen. As ferrous sulphate is formed through corrosion of the iron, and as this salt in dilute solutions is readily hydrolyzed, (separated into basic ferric salts and acid), there soon appears a cloudiness in the liquor and the anode is attacked. Chemical action of acid on metallic iron produces EMF, or difference of potential between two electrodes, resulting in deposition of copper on the cathode when the electrolyte is a solution of copper sulphate. The anode-copper is sometimes flocculent, sometimes firmly adherent, according to conditions under which the experiment is carried out. EMF is also developed through action of ferric sulphate on an iron anode. Ferric sulphate forms rapidly in the liquor through absorption of oxygen from the air, and this salt dissolves iron, so that an electric current would be set up between short-circuited electrodes even were no acid formed through hydrolytic dissociation.

Another way of accounting for deposition of copper on the iron is, that as all forms of commercial iron contain more or less carbon, there must be portions of the surface even of a wrought-iron anode where minute quantities of carbon are present. Between the small particles of carbon and the adjoining iron, galvanic currents will develop, which in turn precipitate particles of copper from the enveloping liquor. Once metallic copper appears in proximity to the anode, innumerable short-circuited galvanic couples are established and more copper comes down. As the resistance of the electrolyte between the electrodes of the battery

† Mining Engineer and Metallurgist, Riverside, California.

is very considerable, only a portion of the copper is deposited on the cathode, while action between the short-circuited couples at the anode is correspondingly vigorous. The outcome of the operation is, voluminous deposition of copper-hydrogen at the anode, a small quantity of electrolytic copper on the cathode, and a weak electric current through the outside circuit. In any event, whatever the explanation, when copper is precipitated from a sulphate solution by means of a short-circuited galvanic couple composed of iron and copper, the electrodes being spaced five centimeters apart, the metal is deposited at two points.

The fact that copper is deposited on both electrodes does not of itself nullify the result derived from thermo-chemical calculations. That portion of the copper which separates out at the anode should necessitate the corrosion of a lesser quantity of iron than would be the case were an equivalent amount of metal deposited as cathode-copper, because the EMF necessary to overcome the resistance of the 5 cm. of electrolyte which separate the electrodes is diverted instead to metal deposition. The main disadvantage of anode precipitation lies in the flocculent condition of the copper which is easily adulterated through admixture with basic ferric salts. It is in fact cement-copper and not pure cathode copper.

CALCULATED VS. WORKING RESULTS.

A point which should never be lost sight of in considering theoretical estimates of the amount of power required to carry out any electrolytical operation is, that there always exists a great difference between calculated results and those obtained in actual work. For instance, in copper refineries if 62 percent of the calculated energy required is profitably employed, the result is considered satisfactory—that is, in estimating the power requisite for a given electrolytic refinery, an allowance of 61% above the theoretical quantity must be made. There are many opportunities for current to go astray, and since the liquors invariably contain mixed salts the quantity of metal separated is not proportional to the quantity of electricity passed through the solution. Especially the last traces of metal in solution require large excess of current to effect complete precipitation.

Returning to consideration of the subject under discussion, (the precipitation of copper from liquors by means of a galvanic couple), even if metal is not wholly deposited on the cathodes by current set up through corrosion of iron, still there seems to be room for improvement over existing wasteful methods. As pig-iron is largely used in the cementation process, it would seem practicable to cast such material in the form of rough anodes, and to suspend these in suitable vats together with copper cathodes, at the same time short-circuiting the electrodes. A great economy could be affected by excluding air from the vats, for if that were done copper could be precipitated with the minimum production of ferric salts. The ferric salts corrode as much, or more, metallic iron than is used in precipitating the copper. The tower system of precipitation in use at Butte is particularly wasteful of iron because allowing the liquors to fall in a shower over scrap-iron placed in racks, affords the best opportunity for the formation of ferric salts.

The atmosphere can be excluded from precipitation vats by covering them, which would result in the oxygen of the enclosed air being soon exhausted, leaving only inert nitrogen. In experimental work a sheet of oil has been poured on the surface of the liquor, which expedient answered very well for the purpose of preventing excessive oxidation. Whichever method of air-exclusion be adopted, liquors can be made to circulate through a series of vats until practically all the copper is removed, yielding precipitate fairly free from basic ferric salts, together with some pure cathode metal, and in this way the efficiency of the cementation process can be materially augmented. However, some basic salts are sure to form owing to hydrolytic dissociation which takes place even when air is excluded by using oil. Should oil be employed to prevent oxidation, it would only be necessary to draw off the oil-covering from such vats after the anodes had been consumed, and this could be done through plug-holes placed in the sides of the vats. If unnecessary corrosion of anodes can be prevented by exclusion of air, then with cast-iron anodes costing one cent per pound it should be possible to deposit copper partly as cathode metal, partly as cement, for approximately one cent per pound also.

So far the electric current generated by corrosion of the iron of an iron-copper galvanic couple has been alone considered. It is obvious that this primary current can be supplemented with current generated by a dynamo, which can be made to pass through the vat in the same direction as that flowing from corrosion of the iron. Richards (loc. cit.) also supplies an illustration of a case of this kind. He assumes an arrangement of 100 vats, all similar to the one described in the foregoing. These vats are supposed to be arranged in series, the anodes of each vat connected as one large anode, and the cathodes similarly coupled up as one large cathode. The dynamo used is considered capable of maintaining a pressure of 110 volts across its terminals. The bus-bars for conducting current are one by four centimeters in cross-section, and have a total length of 280 meters.

Now the resistance offered to the passage of an electric current by a copper wire of one square millimeter cross-section, and one meter in length, at 18° C., is 0.0175 ohm, therefore the total resistance of the bus-bars referred to in the last paragraph will be 0.01225 ohm. For as resistance to a given current decreases with cross-section of conductor, and as one by four cm. = 400 sq. millimeters, therefore the resistance of one meter length of the bus-bars will be one four-hundredth of what it would be for 1 sq. mm., and for 280 meters length it will be 280 times as much = 0.01225 ohm.

It was shown in the previous example that the theoretical resistance offered by a single vat, with electrodes as described and using a pure copper-sulphate solution, would amount to 0.0026 ohm, therefore the resistance which the current would have to overcome in traversing 100 such vats under similar conditions would be 0.26 ohm. Similarly a loss of 0.1 volt per vat, due to connections, would amount to $\frac{0.1 \text{ volt}}{2.6 \text{ amp.}} = 0.000337$ ohm, or 0.0337 ohm for the series of 100 vats. Adding the resistances of the external conductor, the electrolyte, and the connections, gives a total resistance for the whole series of 100 vats amounting to 0.306 ohms. This would be the theoretical ohmic resistance at the start, when the bath holds five percent $CuSO_4$; but as copper is deposited on the cathode its place is taken by iron, and the ferrous sulphate formed has a greater resistance than copper sulphate. So, as a matter of fact, the resistivity of the liquor will be steadily increasing as deposition of copper proceeds, and in consequence flow of current will also decrease and less copper will be deposited in 24 hours than the estimate based upon quantity of copper sulphate originally contained in the solution would indicate.

The theoretical difference of potential between the electrodes of an iron-copper couple produced by corrosion of the iron was found in the former illustration to be 0.87 volt: therefore in 100 vats it should amount to 87 volts. Without admitting the correctness of these figures they will be taken in order to make the calculation comparable with the former example, and adding these 87 volts to the 110 generated by the dynamo would give a total operative electromotive force of 197 volts. As the quantity of copper deposited from a bath is determined by the number of amperes of current flowing through it, and as current equals voltage divided by resistance, therefore $\frac{197}{0.306}$ = 644 amperes multiplied by the number of grams of copper deposited by one ampere in twenty-four hours will give the productive capacity of a single vat. Assuming the theoretical amount of copper deposited in 24 hours by one ampere (28.416 grams), there would be deposited in the whole 100 vats 28.416 × 644 × 100 = 1,829,706 grams of copper.

COMPARATIVE COST OF IRON AND CURRENT.

It is interesting, with the help of the data derived from the above calculation, to ascertain the effect of current obtained from the dynamo upon the cost of depositing copper with the arrangement cited. In the first example it was found that 7608 grams of iron in corroding deposited in 24 hours 8411 grams copper in one vat. It was also determined from the second example that with the help of the dynamo 18297 grams were deposited in the same time. At the ratio of deposition as established in the first example, to deposit 18297 grams of copper without the dynamo would call for the corrosion of 16550 grams iron, therefore the work done by the dynamo is represented by 16550 — 7608 = 8942 grams iron. As the dynamo is assumed to give a pressure of 110 volts across its terminals, and as the resistance of the total circuit has been estimated at 0.306 ohms, the current derived from this source should be $\frac{110}{0.306}$ = 360 amperes. As the operation is assumed to continue for 24 hours, the quantity of current delivered by the dynamo should be 360 × 110 × 24 = 950 kilowatt-hours. At one cent per kilowatt-hour there would be an expense of $9.50 distributed over 100 vats, so that the work done by the dynamo in one vat would be represented by $0.095. On the other hand, 8942 grams iron correspond to 19.7 lb. avd., and this at one cent per pound would represent an expense of $0.197. If, therefore the dynamo current were replaced by one developed through corrosion of iron, at the prices quoted the expense would be slightly more than doubled. If iron cost half a cent per pound, and the kilowatt-hour two cents, then the relative expense would be reversed. There would be an advantage in using dynamo-current because by that means cathode-copper would be produced, and not so much cement as in employing iron. It is evident, therefore, that attaching a dynamo to cementation vats might under favorable circumstances have some advantage.

If an electric current from an external source is made to traverse an electrolyte, the electrodes used may be either soluble or insoluble in the solution. It has been shown in the foregoing calculations that when the anode consists of a metal which has superior electrolytic solution pressure to that of the metal contained in the salt to be electrolyzed, is, in other words, a soluble anode, and the anode metal is capable of replacing the one in solution, then the current flowing through the bath will be augmented. Heat units will be liberated at the anode when the metal forming that electrode corrodes, and heat units will be used at the cathode in freeing the metal deposited from the electrolyte. The ratio of heat units liberated to those consumed is a measure of the auxiliary current developed by corrosion of the anode.

If the metal composing a soluble anode is the same as that liberated at the cathode, as in electrolytic refining of converter-copper, then the energy generated by solution should be theoretically precisely the same as that consumed by deposition on the cathodes. The one should off-set the other. When, however, the anode is composed of a substance not affected by the components of the electrolyte, or by the products of electrolysis, then the current traversing the bath is called upon to do work without receiving compensation from corrosion of the anode, and the energy expended is correspondingly greater. It requires more power to electrolyze a copper-sulphate solution using insoluble anodes than when others soluble in the bath are employed.

In electrolyzing a copper sulphate solution using insoluble anodes copper will be removed from the bath and sulphuric acid will be produced. To form, therefore, an approximate estimate of the energy required to carry out such an operation, recourse must again be had to thermal chemistry. Liquors which might be used for electrolysis would probably be derived from ore-leaching, and therefore would contain other salts in addition to copper sulphate. These would bring about various complications, according to their chemical nature and relative concentration in the liquor. For instance, with iron salts present ferric sulphate would be produced at the anode, and this reagent would be carried by diffusion to the cathode where it would redissolve the deposited copper. Accordingly in such work it is necessary to keep the anolyte separated from the catholyte by means of a diaphragm, and diaphragms are difficult to maintain and also offer resistance to the passage of the current. It is not practical to deposit metal from a bath at one electrode, and at the same time to generate a solvent for that metal at the other electrode, without interposing a diaphragm. It has been attempted to treat mine-waters by electrolysis, but consumption of current was found to be so great that the operation presented no advantages over cementation with scrap-iron.

ELECTROLYSIS WITH INSOLUBLE ANODES.

In electrolyzing a bath of copper sulphate using insoluble anodes metallic copper is deposited on the cathode, sulphuric acid collects in the electrolyte, and oxygen is evolved at the anode. To estimate the EMF required it is therefore necessary to ascertain the number of heat-units involved in liberating copper at the negative electrode and oxygen at the positive. Also the energy developed through the formation of sulphuric acid. By reference to tables of thermo-chemical data it will be found in such a case that 124,320 calories are absorbed in freeing copper and oxygen. The notation adopted in thermal chemistry for representing reactions, is illustrated by the following:

$[Cu, O, SO^3aq] = 55,960$
$[H^2, O] \quad = 68,360$

124,230 calories consumed.

In a similar manner it can be shown that the formation of sulphuric acid in the transformations under consideration developes 68,360 calories. The difference between the two amounts represents heat-units which it is necessary to supply in carrying out the reaction. The result is 55,960, which number refers to one gram molecule of copper separated. Now one ampere of current, flowing for one second at one volt pressure, (one volt-coulomb), will develop 0.2387 calories and 96,540 volt-coulombs is the amount of current required to separate a gram-equivalent of a univalent element. Copper combined as sulphate is bivalent therefore only half the amount represented by the atomic weight will be separated by 96,540 volt-coulombs, and to get the number of calories theoretically necessary to deposit that quantity of bivalent copper it is necessary to multiply the stated number of volt-coulombs by 0.2387 which gives 24,046. In the above calculation it was shown that 55,960 calories had to be supplied to separate one gram molecule of cathode copper, or 27,980 cal. for half a gram molecule. As one volt corresponds to about 24,046 cal., it is only necessary to divide 27,980 by this number in order to find the minimum number of volts required to electrolyze a solution of copper sulphate, which is 1.214 volt.

In electrolytic refineries the baths sometimes become too rich in copper and too poor in acid. To rectify this condition the solution is drawn off and electrolyzed in special cells, using insoluble anodes (lead). This is practically the same operation as the one under consideration, only the liquor is much richer. The EMF necessary to electrolyze such a bath varies between 2.0 to 2.5 volts, but this includes all the resistance encountered by The current. These figures afford a means of comparing theory with practice.

As to the energy consumed in overcoming resistance of the bath when electrolyzing a weak solution of copper sulphate, let it be assumed that the liquor contains 0.08 percent $CuSO_4$. Such a content is said to be 0.01-normal. Under a normal solution is understood one in which the molecular weight of a salt, stated in grams, is dissolved in one litre of solution. For example, a normal solution of chloride of potassium (KCl) is one holding 74 6 grams KCl in one litre of solution. In comparing the conductivities of different electrolytes, solutions are taken which contain an equal number of gram-equivalents (not molecules). A gram-equivalent is the formula-weight in grams divided by the number of electro-chemical equivalents which are necessary for its complete decomposition. Under electro-chemical equivalent is understood the quantity of electricity associated with a gram-equivalent of a univalent element—that is, 96,540 coulombs = 1 Faraday. While a normal solution of chloride of silver is one containing $\frac{107.93}{1} = 107.93$ grams AgCl, because silver is a univalent metal, a normal solution of copper sulphate contains $\frac{158.47}{2} = 79.23$ grams of that salt—that is, it requires two Faradays to completely decompose a molecular weight of that substance represented in grams per litre of solution. A bath containing 0.08 per cent $CuSO_4$, or more exactly stated 0.0798%, would have one hundredth part of 79.23 grams, and is, therefore, 0.01-normal.

If now the resistance of one cubic centimeter of 0.01-normal copper sulphate solution at 18°C. be 1394 ohms, and the electrodes are placed three centimeters apart, the resistance of the electrolyte in one vate would be 4182 ohms. If the current density is 20 amperes per square meter, which is equivalent to $\frac{20}{10.000} = 0.002$ amps. per sq. cm., then the theoretical EMF necessary to overcome resistance under conditions specified would be (current= $\frac{EMF}{resistance}$) 4182 $\times$ 0.002=8.4 volts. The total voltage absorbed at the start in overcoming resistance of the electrolyte would be 8.4 volts. Adding this EMF to that determined above as requisite to deposit metallic copper on the cathode (1.214 volt for one vat), the voltage across the electrodes would be 8.4 +1.2=9.6 volts. Including 0.2 volt absorbed by connections and contacts at each vat, the total EMF necessary to drive current through one vat at the start would be 9.8 volts.

The result given applies to a 0.01-normal solution, that is, to the solution present in the vats when the operation commences. As electrolysis proceeds copper is removed and sulphuric acid accumulates, and the acid being a better conductor than the copper salt, the resistivity of the bath diminishes progressively. This is well illustrated by the tables given in Mines & Methods, Vol. II, pages 282-284. Finally the 0.01-normal $CuSO_4$ solution becomes 0.01-normal H_2SO_4. Taking the resistance of one cu. cm. of 0.01-normal H_2SO_4 solution at 325 ohms, the three centimeters between the electrodes would offer a resistance of 975 ohms, and the EMF necesssary to overcome the resistance of the electrolyte would be $9.75 \times 0.002 = 1.95$ volts. Therefore when depositing the last vestiges of copper from the bath the EMF required would be $1.95 + 1.21 = 3\,16$ volts.

The average resistance offered by the electrolyte to a given operation will not be the arithmetical mean between the two extremes, because the conductivities of solutions do not diminish in proportion to their strength. For instance, the resistance offered by one cu. cm. of fifteen per cent $CuSO_4$ solution is 23.8 ohms, whereas that of a five per cent solution is 52.9. At the same time that copper content of the bath decreases, that of the H_2SO_4 increases, rendering conductivity very much better. The resistance of one cu. cm. of 15% H_2SO_4 solution is 1.8 ohms; of a 5% solution, 4.8 ohms. In the case at point, if the average voltage absorbed in overcoming the ohmic resistance through the electrolyte be taken at 3.52 volts for the total circuit, the electromotive force absorbed would be:

In depositing copper	1.21
Resistance of electrolyte	3.52
Loss in contacts	0.20
Total, volts	4 93

Assuming that the current traversing the vats amounts to 300 amperes, there will be consumed $4.93 \times 300 = 1{,}479$ watts $= 1.479$ kilowatts. As one ampere-hour deposits 1,186 grams of bivalent copper, 300 will deposit 355.8 gram in each vat in one hour. The output per kilowatt-hour would then be $\frac{355.8}{1.479} = 241$ grams=0.53 lb. avd. copper. A pound of copper, therefore, calls for an expenditure of 2 kilowatt-hours.

(To be continued)

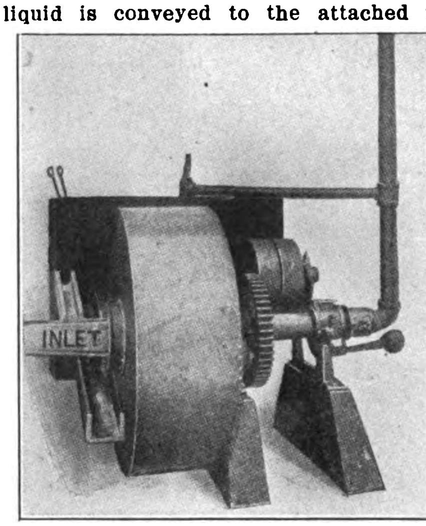
Halite is the scientific name for common rock salt.

ABBE-FRENIER SPIRAL PUMP

After considerable experiment by the Abbe Engineering Co. of New York and J. H. Frenier & Son, of Rutland, Vt., the makers of the Frenier pump, a new pump has been perfected, which is claimed to be simpler, more durable, requires less power and is better adapted to milling and concentrating mills than the Frenier or any other pump.

The stationary tank and all exposed bearings of the Frenier pump have been done away with, the tank is made round and of the same size as the spiral wheel and is fastened to one of its sides and revolving with it, as shown in illustration. The wheel and its hollow shaft sets in two bearings, the shaft next to the wheel is larger and sets and runs on two large friction wheels, which are fitted with large roller bearings, enabling the wheel to run with very little power.

On the opposite side of the wheel is a large central opening through which the liquid is conveyed to the attached re-



Abbe-Frenier Spiral Pump.

volving tank and at each revolution one-half of the spiral wheel is filled and advanced from spiral to spiral and up the delivery pipe as in the regular pump.

As all the sand and water are conveyed directly to the inside of the revolving tank the spiral wheel does not have to cut its way through thick settled sand at each revolution as in the regular pump, thus saving mucn power.

As all the sand and gritty waste are inside the wheel, no sand can possibly be spattered on the bearings and gearings as before, thus effecting a large saving in repairs and stoppage.

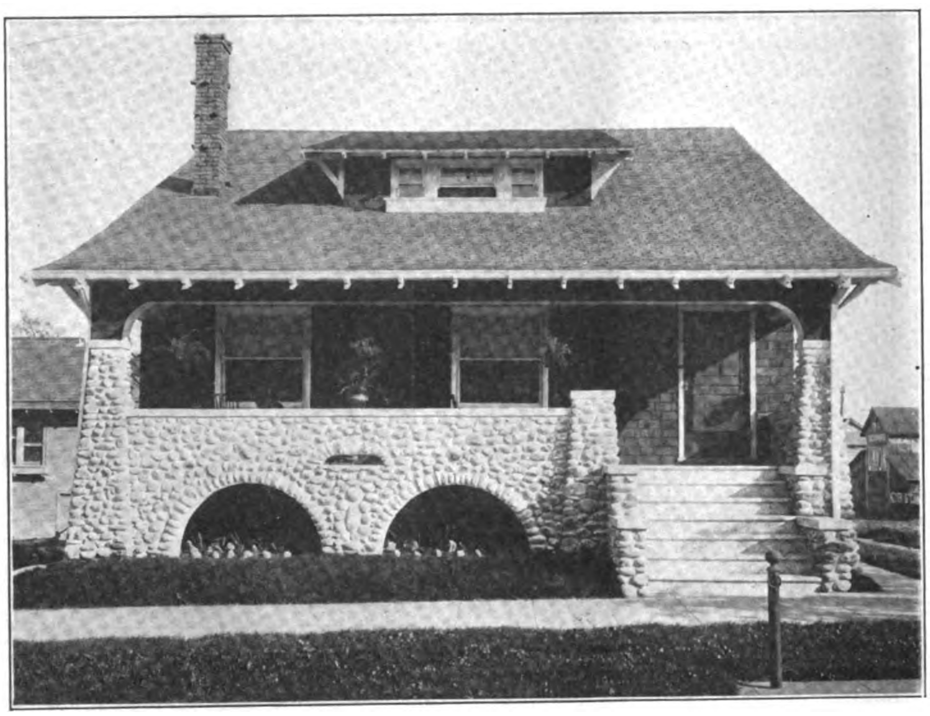
As the sand and water are kept in motion inside the wheel, much coarser sand or crushed materials can be elevated, and, as the scoop of the wheel does not have to cut its way at each revolution through thick and heavy settled materials and as most of the weight of the wheel is on large anti-friction wheels, very little power is required.

CONVERTING TAILINGS TO COMMERCIAL PRODUCTS

By AL. H. MARTIN.

The transformation of tailings into valuable products of commerce is of recent origin. Formerly the piles of waste rock lying around mines and dredgers was considered not only worthless, but of positive annoyance. No thought was paid to their possible use, and the material was freely given to any one desiring it. Of late years there has been a radical change and in the more favored localities companies are using the tailings to augment their earnings. The commercial use of waste rock has attracted paramount attention in California and Missouri, with other districts indicating growing interest. The tailings find their greatest use in road ballast and in the composition of concrete, with a growing demand for their employment in structural work.

The economic value of dredge and mine tailings depends principally upon their location. With adequate railroad transportation facilities and proximity to large markets, the disposal of tailings becomes a profitable business. When the mines or dredges are situated in remote sections, it naturally follows that the tailings lose commercial value, as costs of transportation render their use economically prohibitive. The dredging fields of California are admirably located for the profitable marketing of crushed rock, and it is in this state that the new industry has made greatest progress.



Cottage in Sacramento, Built of Natomas Cobbles and Rock.

FIRST PLANT IN CALIFORNIA.

The first attempt to turn dredge tailings to commercial purposes in California was recorded in 1907, when the Folsom Development Co. erected a rock crushing plant at Dredge. It had a rated capacity of 1,000 tons and was designed after about two years of comprehensive experiments. The tailings were excavated by a 45-ton steam shovel and loaded into dump cars, hauled by a dinky engine to the plant. A 30 horsepower electric hoist located at the head of the incline commanding the plant raised the loaded cars to an elevation of thirty feet. From here the cars discharged onto an inclined grizzly delivering to a 42x26-inch Farrel crusher. A bin placed underneath the grizzly collected the small gravel and sand, which subsequently went to the waste piles by means of a 20-inch belt conveyor 200 feet long. A 24-inch bucket-elevator received the crushed rock from the crusher and discharged into a sizing screen 24 feet long by 48 inches diameter. The sized product passed into bins located directly beneath the screen, and over the railroad tracks. This permitted the loading of the product directly into railroad cars. The oversize was delivered to a 36x10-inch Farrel crusher and again turned to the sizing screen.

This plant proved most effective and a good market for the crushed rock immediately developed. The management decided to increase the capacity to 1,500 tons, and to simplify operations. Accordingly the electric hoist, inclined car track and flat grizzly were discarded. A main receiving hopper, covered with timber grizzly bars, protected with steel lining ½-inch thick, was placed directly under the narrow guage tracks on which the dump cars operated. From the hopper the rock passed to a 36-inch Robins belt conveyor which discharged into a revolving screen 16 feet long by five feet in diameter. Here the gravel was separated into three sizes. Boulders over 4½ inches were received by a 42x26-inch Farrel crusher, and boulders over three inches to a 36x10-inch machine. Belt conveyors gathered the crushed rock and distributed it to the storage bins. The three-inch and smaller gravel passed to a screen 10 feet long by 42 inches diameter, where it was separated into two sizes of gravel and fine material. The larger gravels were fed to two sets of 30x20 inch corrugated rolls. A belt conveyor received the product and delivered to a 48x24-foot sizing screen located above the storage bins. The gravel was stored in six different piles. Below each pile was constructed tunnels of heavy timber. The product passed through these to an elevator which discharged into chutes commanding the railroad cars. The changes resulted in a reduction of operating costs, increases of capacity, and more rapid handling of material. Seventeen electric motors furnished power. This plant is still in commission and is now known as Natomas No. I, following its acquisition by the Natoma Consolidated of California.

$25,000,000 ROCK CRUSHING CO.

On January 1, 1909, the Natoma Consolidated of California, a $25,000,000 corporation, acquired the properties of the Folsom Development Co., the Natoma Development Co. and El Dorado Gold Dredging Co. The new interests at once recognized the possibilities of converting the waste rock into valuable products, and work on No. 2 plant was commenced. This was designed and erected by the Western Engineering & Construction Co., and particularly fashioned to meet the demands attendant upon the reduction of boulders. The plant went into commission July, 1909, and so favorable were the results that another plant was soon installed. No. 2 is located at Fair Oaks, about fifteen miles from the city of Sacramento.

The rock is excavated by a 40-ton oil-burning Bucyrus steam shovel, and loaded into Koppel cars. Each car has a capacity of four cubic yards and operates on a narrow-guage portable track, provided with a loop permitting loaded and empty cars to pass freely. The steam shovel is mounted on a broad-guage portable track paralleling the rock pile. The cars are operated by means of a 10x14-inch dinky oil-burning engine. The cars automatically discharge into the receiving hopper, located directly beneath the track.

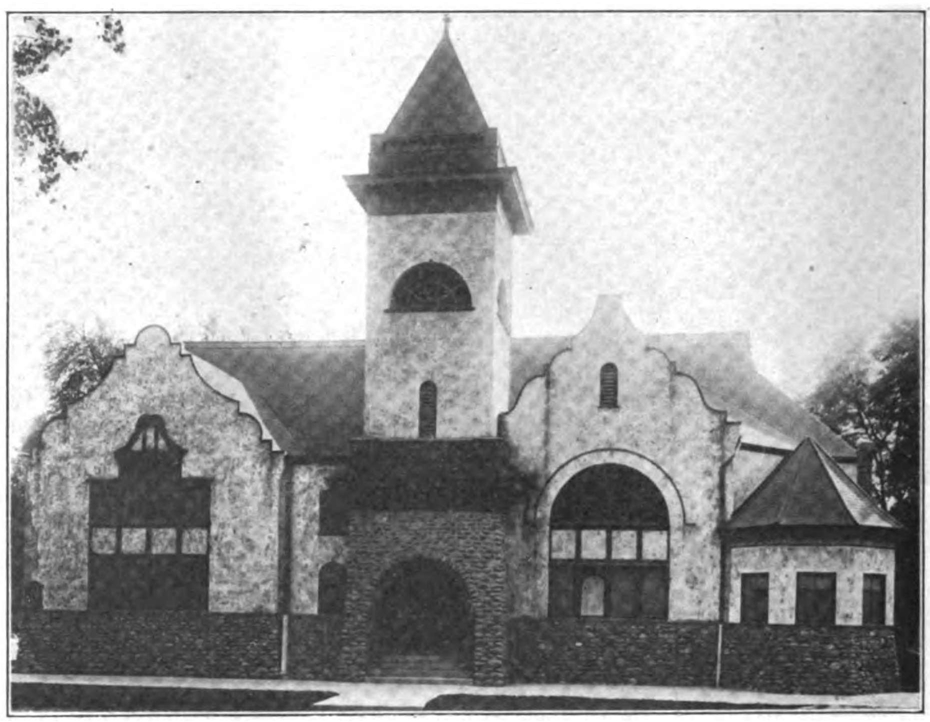
The hopper is composed of 4x12-inch plank lined with ⅜-inch steel plates. The mouth is 20 feet square and equippped with 6x8-inch timber grizzly bars, placed eight inches apart and guarded by steel wearing bars. A swinging gate, controlled by a chain, small drum and hand wheel, regulates the flow of the gravel in its passage from the hopper to a 36-inch Robins elevator operating at a speed of 125 feet per minute. From the elevator the rock passes to No. 1 screen which divides into 8, 4½, 3, 2½-inch and less sizes. The 2½-inch and smaller size is received by No. 2 screen which separates the ⅜-inch gravel and finer material from the larger pieces and discharges into two Allis-Chalmers 40x20-inch corrugated rolls. The small product from the screen passes to No. 3 screen which separates the sand from the ⅜-inch pebbles. The latter goes to the storage pile, and the sand to the waste dump. The gravel from the rolls is delivered to No. 4 screen which classifies into ¾ and 1½-inch sizes. The oversize goes to a 40x15-inch Allis-Chalmers smooth roll which reduces to ⅜ inch. The 3 and 4½-inch gravel from No. 1 screen is delivered to two 36x10-inch Bacon crushers, and the 8-inch to a 42-inch crusher. The combined product passes to screens No. 5 and 6, which divide the ⅜ and ¾-inch sizes from the larger gravel. The latter is next reduced in a 36x10-inch Bacon crusher and returned to No. 5 screen for redistribution. Recrushing continues until all the material has attained the desired size. Screen No. 1 has dimensions of 6x22 feet, 2 3, and 4 are 4x12 feet, and 5 and 65x24 feet in size. Thirty Robins conveyors serve the plant.

HANDLING CRUSHING PLANT PRODUCT.

The rock from the crushing plant is divided into seven piles, graded to the different sizes of crushed material. Each pile is 100 feet long, 40 feet wide and 40 feet high, with the center pierced by a reinforced concrete tunnel 110 feet long, 6 feet wide by 6 feet high. Each tunnel is provided with a 24-inch Robins elevator belt traveling at a speed of 250 feet per minute. The conveyor extends over the railroad tracks for 25 feet and discharges into a swinging chute, which directs the rock alternately into cars on two tracks. Four swinging gates are placed in each tunnel, facilitating their operation singly or combined. The gates are placed 20 feet apart and are connected with levers and rods to a hand-wheel at the tunnel mouth. An incline chute, connected with an auxiliary chute, extends from the heads of conveyors and permits the loading of cars on a third track, and either first or second car tracks may be loaded by this chute. This permits the loading of cars direct from the crushers, if so desired, instead of from the storage piles. The plant is so arranged that should a part become disabled the remaining units may continue as though nothing had happened.

The motor house is 24 feet wide by 60 feet long, with the 24 square foot pilot house located on the roof of the power house. All motors in the main plant are operated from the pilot house and the elevation gives the operator a clear view of the plant at all times. There are four 50 horse power motors; five of 100 horse power, two of 150 horse-power and one of 75 horse-power. Switchboard and controllers were especially designed to meet the requirements of the plant. A separate and different colored light is placed directly over each controlling switch, with duplicate lights and auxiliary switch close to each motor. Signals prevail whereby any disarrangement in any portion of the plant is immediately indicated to the operator. The wires from the pilot house to the motors pass through underground conduits, eliminating danger to employes. Electricity is delivered to the plant at 60,000 volts and transformed down to 2,300 volts for delivery to motors. Transformers are inclosed in a concrete tank placed underground, with drains provided to carry off all excess oil from the tank. Every precaution has been taken to lessen fire and electrical dangers.

The steam shovel loads seven cars in eight minutes, and the dinkey-engine hauls loaded cars to the hopper and returns empty cars to the shovel in seven minutes. Ten minutes is required to load a 40-ton railroad car from the storage piles. The steam shovel and engine are supplied with oil from two steel tanks 10 feet deep nad 11½ feet diameter. Oil is passed from railroad tank cars into the tanks by a pump located near the track. Water is received from tanks having the same dimensions as the ones carrying oil. Besides supplying the engine and shovel the water tanks contain sufficient water for the fire-fighting aparatus.



Church in Sacramento. Natomas Cobbles Used in Construction.

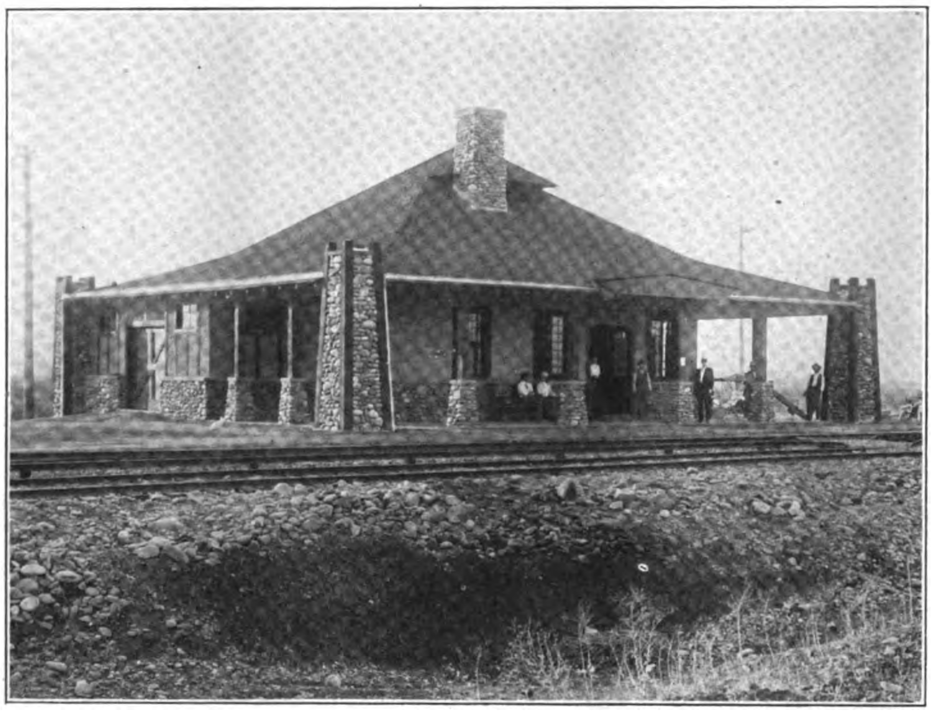
NOW IMPORTANT INDUSTRY.

The advent of the Natomas Consolidated into the rock crushing business elevated the industry from an uncertain by-product into the dignity of a co-product, the company deriving a large revenue from the hitherto neglected waste tailings. Other interests have emulated the example with satisfactory results.

The gravel is largely used in road building, and many of the finest thoroughfares in the north and central districts of California are paved with Natomas crushed rock. The finer material is in demand by manufacturers of concrete, while the cobbles and portions of the crushed gravel are largely employed in structural work. Some of the most pretentious business buildings and residences in Sacramento and nearby cities are largely constructed of the Natomas product. Besides supplying a demand for crushed rock that is steadily growing, the companies have been able to reclaim broad acres of land by the removal of the unsightly rock piles. The chief opposition to dredging in California has been due to charges that the industry ruined vast tracts of fertile farm and orchard lands by the storage of piles of rock on what was once productive ground. Consequently the operation of the rock-crushing companies is eliminating the objections of opponents of the dredging industry.

Crushed gravel from the mines in the Joplin, Missouri, district, is steadily growing in favor for road and structural work. The five railroads traversing the district use the product for ballast to a distance of 150 to 300 miles from the district. The product is also largely used in the building of concrete bridges, depots and viaducts by the railways. Cities in Missouri and Oklahoma are using the material largely, but the high transportation rate has restricted the employment of Joplin gravel in many instances, the railway companies apparently desiring to monopolize its use for their own work.

The mining companies of late have manifested a tendency to produce gravel that may be used wtihout further treatment. By the employment of sludge mills the objectionable sands are separated from the crushed rock and sent to distant piles, thus permitting the loading of the mill tailings directly into the railroad cars by means of incline flumes. In excavating the rock from waste piles steam shovels or cup-elevators are generally employed. The sale of gravel has yielded excellent revenues to many Joplin operators, and this branch of he mine industry has become almost a co-product. While the screening and crushing of rock has not been conducted at Joplin on the scale prevailing in California, results have been of a most satisfactory nature.



Northern Electric Depot, Nicoleus, Calif., Built Largely of Natomas Cobbles and Crushed Rock.

KINDS OF STONE MOST SOUGHT.

In the California dredging fields the rock consists largely of basalt, and the crushed material is adapted to practically any use. Flint, limestone and spar compose the Joplin tailings. The flint makes the best and longest-wearing road material, provided it is not oiled. Clean white or blue flint gravel is preferred in manufacturing concrete. Limestone is used to a considerable extent, but the spar is avoided because of its weathering tendencies. Pyritic tailings are undesirable for concrete work, owing to oxidations of pyrite and discoloring character of the resultant iron oxide. Practically any crushed mine or dredger rock will make good roads, but in structural work care must be taken to select material that will withstand the effects of the elements and maintain color.

In many of the small mining towns of California the streets are paved with rock from the waste dumps of the mines. The companies generally present the towns with all the gravel desired, and in some cases municipal rock-crushers are maintained to crush the rock to desired fineness. When transportation and carrying charges are favorable, much of this rock could be sent to more distant points and command profitable markets. The question is one that commands more attention from mine owners than has been accorded in the past.

DETECTING CARBON MONOXIDE

By GEORGE A. BURRELL.

In connection with its investigation of the causes of mine fires and explosions the Bureau of Mines is making a careful study of the methods that can be used with greatest efficiency for exploring mines containing smoke or suffocating or poisonous gases.

The presence of that poisonous gas, carbon monoxide (white damp), in the afterdamp of explosions and fires in mines has caused the death of a great many miners. An inspection of the reports of those explosions and mine fires in which men have been killed shows that this gas is often the cause of the majority of the fatalities. Haldane* makes the statement that carbon-monoxide poisoning is responsible for nearly all the fatalities. After a recent disaster at a mine in Pennsylvania in which twenty-one men were killed the bodies of seventeen men showed no such marks of violence as would be produced by the concussion of an explosion. Tests of blood from some of these bodies clearly showed the bright pink hue caused by carbon monoxide. Not only have men present in mines at the time of disasters succumbed to this gas, but rescuers endeavoring to save their unfortunate comrades have perished also.

Of the gases produced in mines, carbon monoxide is the most feared and the most difficult to detect. A miner's lamp gives warning of almost every dangerous condition of the atmosphere in a mine except the presence of this gas. Percentages of methane below these that form explosive mixtures can be detected by the appearance of the "cap" of the lamp flame, and a deficiency of oxygen is shown by the smothering of the flame in time for a retreat to be made before bodily harm can result. Carbon

* Foster, C. LeN., and Haldane, J. S. The investigation of mine air. 1905. p. 244.

monoxide, however, may be present in deadly quantities in an atmosphere without the safety lamp detecting it, because a proportion much below that required to give a cap on a lamp flame is extremely poisonous.

Other gases occasionally found in mines in harmful quantity, such as hydrogen sulphide, and oxide of nitrogen fumes can be detected even in great dilution by their odor, so that fatalities from the presence of these gases in mines are few.

The author tested the value of a wick flame as a detector of carbon monoxide in comparison with its value as a detector of methane. A Wolfe safety lamp, constructed so that prepared mixtures of air and carbon monoxide could be fed into it at the base, was used. The minimum percentage of carbon monoxide (about 2 per cent) required to produce a visible cap was found to be almost identical with the required proportion of methane. Two observers could detect no difference in the color or the height of the caps produced by this percentage of either gas. Neither could they when 3 per cent of either gas was used.

In a mine some observers, especially after becoming accustomed to the darkness ("getting eyesight," as it is termed), may detect a cap when the air contains less than 2 per cent of methane, and it is possible to detect less than 2 per cent of methane by the use of special testing lamps. But the point brought out by the author's experiments is that low percentages of either methane or carbon monoxide scarcely give caps that distinguish one gas from the other. Moreover, it has been the author's experience that when a given percentage of carbon monoxide is present in the air of a coal mine, a larger percentage of methane is usually present, so that this gas would interfere with the detection of carbon monoxide by a lamp even if carbon monoxide enough to give by itself a characteristic cap were present. It is also true that in the afterdamp of mines carbon monoxide in quantity sufficient to produce a cap usually accompanies a deficiency of oxygen and an excess of nitrogen, so that the lamp is extinguished before it can show a cap. One result of this last fact, however, is that the indications of a lamp may sometimes prevent a man from going into an atmosphere containing carbon monoxide enough to be rapidly poisonous.

The gases that come out of the crevices in the coal bed immediately after shots of explosives may contain much monoxide and hydrogen, besides methane, and when a lamp is held close to the crevices the carbon monoxide and hydrogen may cause the cap of the lamp flame to differ somewhat from the cap produced by methane alone. In exploring mines, however, the great danger to a rescue party is from small proportions of carbon monoxide—proportions so small that they have no visible effect upon the flame.

The author is aware that some mining men are of the opinion that a percentage of carbon monoxide below that which is immediately dangerous perceptibly brightens or lengthens the flame of a lamp, but he knows of no characteristic of carbon monoxide that would warrant such an opinion. A possible explanation of the brightening or lengthening, suggested by J. W. Paul, mining engineer of this bureau, lies in the fact that a party exploring a mine containing afterdamp sometimes enters a place in which the proportion of oxygen in the air is larger than it was in the place previously explored, and as a consequence the wick flame burns for a while with increased intensity. As the oxygen content of an atmosphere decreases, the flame of an oil lamp burns more dimly until, at 17 or 17.5 per cent of oxygen, the flame is extinguished.

CARBON MONOXIDE OCCURENCE.

Carbon monoxide has not been positively identified in the samples of what may be termed normal mine air collected by this bureau, except in samples collected at the working faces where the air was vitiated by powder smoke. Samples of mine air from the ventilating current, from the main returns, and from splits have been examined, also samples from inclosed areas in which the air had been still; but although the apparatus used was accurate to 0.02 per cent, the author can not state positively that carbon monoxide was present in any of the samples. A series of tests is now being conducted in which air from sealed bottles containing coal that was freshly mined at the time of bottling is being examined for minute quantities of combustible gases other than methane. Although about 12 examinations have been made on samples taken one week apart, the presence of carbon monoxide has not been positively determined.

It appears that carbon monoxide is produced in mines in harmful quantity only through the agency of heat or by the incomplete combustion of carbon that attends explosions, mine fires, the use of explosives, etc. The gas is produced by the imperfect combustion and dry distillation of coal dust in explosions, by the imperfect combustion of methane, by the burning of wood and coal with insufficient supply of oxygen, and by the contact of previously formed carbon dioxide with red-hot carbon, as when the flame of a blast or a gas explosion is projected into an atmosphere filled with the fine coal dust. The last-named cause operates toward the formation of carbon monoxide when those explosives that contain within themselves sufficient oxygen for the complete oxidization of their carbonaceous components are used in breaking down coal.

The carbon monoxide formed, with hydrogen and methane, collects in the open spaces and crevices behind a standing shot, and the miner is often burned by the flame that bursts forth when he carelessly puts his lamp close to a crevice or into an open space to examine the effect of a blast. Besides the danger that attends the burning of these crevice gases, trouble is often experienced from the gases that result from the use of improperly handled explosives in ill-ventilated parts of a mine. A series of experiments is being carried on by the Bureau of Mines to determine the gases that are produced by the firing of different explosives and the extent to which the use of the explosives vitiates the air of the working places.

PROPERTIES OF CARBON MONOXIDE

Carbon monoxide is a colorless and inodorous gas with a specific gravity of 0.967. A liter of it weighs 1.2506 grams at 0° C. and 760 mm. pressure.* It will not support combustion, but burns with a pale blue flame. The lambent flame above a grate in which anthracite or coke is burning is due to the combustion of this gas. Carbon monoxide is the main combustible ingredient of water gas, of producer gas, and of blast furnace gas, which contain approximately 15 to 40 per cent of it, and is present, but in smaller proportion, in illuminating gas made by the destructive distillation of coal. It has not been identified as a constituent of the samples of natural gas examined by the Bureau of Mines, a fact that accounts for natural gas being less poisonous than water gas, producer gas, or ordinary illuminating gas. Carbon monoxide in mixtures with air has a wide range of explosibility, from 16.5 per cent gas, lower limit, to 74.95 per cent gas, higher limit.** Methane has explosive limits that lie between about 6.1 per cent gas, lower limit, and 12.8 per cent gas, higher limit.† The lower limits cited above have reference to complete combustion and to the ignition of the gas by an electric spark. Other modes of ignition, changes in temperature, the shape of the containing vessel, differences in pressure, and the presence of more or less water vapor may change the range of explosibility somewhat. The addition of

* Rayleigh. Proc. Royal Soc. London. Vol. 62, 1897, p. 204.

** Jour. Soc. Chem. Ind. Vol. 21, 1902, p. 395.

† Idem.

a large quantity of carbon monoxide to explosive mixtures of methane and air would have the tendency to widen the upper limit of explosibility over that of methane alone.

PHYSIOLOGICAL EFFECT OF CARBON MONOXIDE.

The oxygen absorbed from the air in the lungs is normally taken up by the blood in the form of a loose chemical combination with the red coloring matter (haemoglobin) of the corpuscles, and in this form it is carried to the tissues where it is used. Haemoglobin not only combines with oxygen but also forms a far more stable compound with carbon monoxide and when saturated with the latter it can not take up oxygen. Hence, when the corpuscles in the blood of a living animal are saturated with carbon monoxide they can not carry oxygen from the lungs to the tissues, and death must result. According to Haldane,‡ carbon monoxide has no other effect than that resulting from its interference with the oxygen supply of the tissues, and apart from its property of combining with haemoglobin it is physiologically indifferent, like nitrogen.

The affinity of carbon monoxide for haemoglobin is about 250* times as great as the affinity of the latter for oxygen. However, if oxygen is administered to a person not too far overcome it will completely replace the carbon monoxide in the haemoglobin. In this respect pure oxygen acts about five times as rapidly as normal air, which contains approximately 21 per cent of oxygen. From air containing very small percentages of carbon monoxide, less than 0.1 per cent, the blood of a man does not take up enough of the gas to cause distress unless the man breathes air a long time. If the air contains larger proportions, the blood sooner reaches that stage of partial saturation with carbon monoxide that produces helplessness. Haldane** makes the following observation:

> The blood of a man will take up about two pints of CO or oxygen. A man at rest breathes about 10 or 12 pints of air per minute, and experiment shows that of the carbon monoxide inhaled about 60 per cent is absorbed by the blood. If a man would breathe air containing 0.1 per cent of carbon monoxide he would absorb 0.007 pint per minute. It would then take him nearly 2.25 hours to absorb a whole pint or produce one-half saturation of the blood, at which stage the limbs would become so weak as to cause them to give way when effort was made to walk. A man who is walking, however, breathes about three times as much air as a man who is at rest, hence he might absorb a pint within an hour. With 0.2 per cent of carbon monoxide the time would be one-half as long, with 0.3 per cent, one-third as long, etc.

If a man who has breathed mine air containing carbon monoxide and has retired to fresh air to recuperate, again enters workings containing this gas before the carbon monoxide has entirely been displaced from his blood, he feels the effects of the gas in less time than when he entered the workings before.

The experience of those who have been partly poisond by carbon monoxide seems to teach that usually much pain or distress does not precede collapse. One of the first symptoms is weakness of the limbs and dimnes of eyeight. For some time after resuscitation, however, there may be severe headache, or even epileptic seizures and other serious ailments.

Poisoning by carbon monoxide can take place very suddenly. For instance, a man in a mine may quickly pass from a place containing such a small quantity of the gas that he has experienced no distress into a place containing a larger quantity where, because of the already partially saturated condition of the blood, he will quickly succumb. Also, the action of the poison may be accelerated by increased exertion, such as climbing a steep incline or ladder, or lifting heavy weights.

CHEMICAL TESTS FOR CARBON MONOXIDE.

The author has by the aid of a portable gas-analysis apparatus made tests of the air in mines after explosions and fires and has thus ascertained on the spot the composition of the atmosphere in the workings. Because of the time required to make such tests and the need of the services of a person with some knowledge of gas-analysis apparatus, chemical tests of the atmosphere in a mine immediately after a disaster are not made as often as they should be. Another reason for omitting them is that quick chemical tests for small quantities of carbon monoxide are not made as successfully as are chemical tests for methane, carbon dioxide, and oxygen.

Perhaps the best chemical test for carbon monoxide, in that other gases do not interfere and very simple apparatus is required, is by the use of blood diluted with water to a buff-yellow tint. This test, in the author's experience, is capable of distinctly showing as little as 0.03 per cent of carbon monoxide in the atmosphere. The method of procedure is as follows:

One or two drops of blood drawn from the finger are diluted with water until equal portions of the solution placed in 100 c. c. test tubes have a buff-yellow color. One of the tubes is taken into the mine, and at the place where the air is to be tested about 50 c. c. of the blood solution is poured out, the mine air taking its place. The tube is then corked, taken to the surface, and gently shaken for 10 minutes. If the air contained carbon monoxide the pink color caused by the presence of carbon monoxide haemoglobin is detected by comparing the solution with the normal blood solution in the other tube.

A fresh active solution of cuprous chloride may be used instead of blood for examining air for carbon monoxide. According to the author's experience, the use of such a solution, if the apparatus is precise and is properly manipulated, will show proportions of carbon monoxide harmful to a rescue party.

THE USE OF MICE AND BIRDS.

Experiments With Mice.—In the author's opinion the use of birds and mice is superior to chemical tests for carbon monoxide in that the test is quickly made, requires no technical experience, and is sufficiently exact.

Two or three mice or small birds can be placed in a cage and carried into the mine with an exploring party. Because the rate at which chemical changes occur in them is enormously greater than it is in a man, they show symptoms of poisoning far sooner. Haldane states that a mouse weighing one-half an ounce consumes about 15 times as much oxygen as one-half ounce of the human body would consume in the same time. With 0.1 per cent of carbon monoxide in the air, Haldane found that about two hours elapsed before giddiness, etc., began to appear in a man at rest, and, according to an anlysis of the blood, exposure for another half hour would have sufficed to produce practical disablement. A mouse became giddy in ten minutes. With 0.6 per cent of carbon monoxide in the air, all of the animals tried became helpless in two minutes and rapidly became comatose or died, whereas a person breathing the mixture was entirely unaffected even after ten minutes. An examination of this person's blood showed that it was one-fourth saturated.

In experiments at the laboratory of the Pittsburgh station of the Bureau of Mines white mice were placed in air containing the following percentages of carbon monoxide: 0.16 per cent, 0.2 per cent, 0.33 per cent, 0.46 per cent, 0.37 per cent, and 0.77 per cent. The mice were placed under a tight glass bell jar having a capacity of 10 liters, into which carbon monoxide had previously been introduced. The atmosphere inside the jar was thoroughly mixed and sampled twice during the experiment, the samples being taken from different points in order to make sure that the content of carbon monoxide was uniformly distributed. The samples were analyzed by combustion of the carbon monoxide in an apparatus with which duplicate analyses agreeing within 0.01 per cent could be performed.

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‡ Jour. Physiology, Vol. 18, 1895, pp. 200, 430, 463.

* Haldane, J. S., Causes of death in colliery explosions and underground fires.

** Idem, p. 17.

An analysis of the air in the jar at the end of one hour showed that the oxygen content had been depleted 1 per cent, due to the breathing of the mouse, or not enough to affect the air. In air containing 0.16 per cent of carbon monoxide, a mouse showed signs of sluggishness in about six minutes, judged by outward manifestations, did not increase to any great extent up to the time the mouse was taken from the jar two hours later. The animal's rate of breathing had dropped from a normal of 160 respirations to about 120 respirations per minute. The mouse did not evince such signs of distress as would serve, if the mouse were carried into an atmosphere containing carbon monoxide, to indicate in one hour's time the presence of 0.1 per cent of the gas.

In air containing 0.2 per cent of carbon monoxide a mouse suffered partial collapse in 15 minutes and showed decided symptoms of distress in eight minutes. At the end of an hour it had not lost all muscular power. It died in two hours.

In air containing 0.31 per cent of carbon monoxide a mouse suffered partial collapse in seven and one-half minutes and showed decided symptoms in about four minutes; but 35 minutes had elapsed before it lost all muscular power and ability to turn over when placed on its back. After removal from the bell jar, the mouse was seemingly in normal condition again in about two hours.

In air containing 0.46 per cent of carbon monoxide a mouse gave decided signs of distress in two minutes; staggered around and showed partial collapse in four minutes; and in six minutes had lost all muscular power.

In air containing 0.57 per cent of carbon monoxide a mouse showed decided symptoms of distress in one minute, partly collapsed in two minutes, lost all muscular power in seven minutes, and died in 16 minutes.

In air containing 0.77 per cent of carbon monoxide a mouse showed distinct signs of distress in one minute. It lost all muscular power in five and one-half minutes and died in 12½ minutes.

The experiments showed that in air containing the smaller percentages of carbon monoxide the mice displayed varying degrees of activity up to the time they exhibited pronounced distress. Of course, the value of the tests in exploring mines depends upon the warning that the mice give while they are being affected by the carbon monoxide, and it is especially desirable that their actions should indicate the presence of extremely small proportions of carbon monoxide, so that men will have ample time to retire from an atmosphere that contains such proportions of the gas. In the experiments it was found that in small quantities of gas and under like conditions, one mouse might clearly exhibit signs of distress whereas another might become comatose without showing distress so distinctly. Consequently, in using the test, the mouse should be closely watched, and a man not wearing breathing apparatus should retire at once from any part of a mine where the atmosphere distresses a mouse. It is advisable to carry at least three mice at a time into a mine, and to prod them slightly if they remain too quiet, in order to observe them in action.

A man when he exerts himself by carrying heavy objects, climbing ladders, or running consumes in a given time more oxygen and also more carbon monoxide than when he rests. Consequently, a man at work might feel symptoms of carbon-monoxide poisoning that would not be clearly shown by a mouse confined in a cage in the same atmosphere. In an atmosphere containing the small quantities of carbon monoxide usually found in mines after explosions and mine fires, a person may be able to go a long distance without experiencing much inconvenience. On the return trip, however, the symptoms may become so aggravated that considerable difficulty may be experienced in getting to the base of operations or to the surface.

Experiments with Birds.—Because mice may be slow in responding to the presence, in the mine air, of such small percentages of carbon monoxide as would cause distress to a man at work, experiments similar to those performed with mice were tried with birds. Canaries were confined in a bell jar in atmospheres containing the following percentages of carbon monoxide: 0.09 per cent, 0.12 percent, 0.15 per cent, 0.2 per cent, and 0.29 per cent.

After an exposure of one hour to an atmosphere containing 0.09 per cent of carbon monoxide, a bird was not affected to such an extent that it would, if carried into a mine, indicate by its actions the presence of that proportion of carbon monoxide. Only by close observation could one detect that the bird at the end of an hour felt slightly distressed.

With 0.12 per cent of carbon monoxide in the atmosphere of the bell jar, a bird did not show clearly symptoms of being affected. In about 15 minutes it had lost its liveliness and thenceforth remained comparatively quiet. The bird did not fall from the perch, but close observation showed that it was decidedly weaker at the end of the hour than was the bird placed in air containing 0.09 per cent of carbon monoxide.

In air containing 0.15 per cent of carbon monoxide, a bird evinced symptoms of slight distress in three minutes. It gasped, gradually became weaker, swayed, and at the end of 18 minutes fluttered from the perch. At the end of an hour it had not lost all muscular power, but showed symptoms of extreme weakness.

In air containing 0.2 per cent of carbon monoxide, a bird showed pronounced signs of distress in one and one-half minutes; itbecame very unsteady in three minutes, and fell from the perch in five minutes. After it was taken from the jar, it regained its feet in two minutes and appeared to be in normal condition in five minutes.

In the air containing 0.29 per cent of carbon monoxide, a bird fell from the perch in two and one-half minutes. When placed in fresh air again, it had almost revived in five minutes.

SUMMARY.

The following table shows the relative susceptibilities of mice and canaries to carbon monoxide poisoning:

Per cent CO.	Mice—Effect.
0.16	Very slight distress at end of hour.
.2	Distress in 8 minutes; partial collapse in 15 minutes.
.31	Distress in 4 minutes; collapse in 7½ minutes; lost muscular power in 53 minutes.
.46	Distress in 2 minutes; collapse in 4 minutes.
.57	Distress in 1 minute; collapse in 2 minutes; muscular power lost in 7 minutes; death in 16 minutes.
.77	Distress in 1 minute; muscular power lost in 6½ minutes; death in 12½ minutes.

Per cent CO.	Canaries—Effect.
0.09	Very slight distress at end of hour.
.12	Weaker at end of hour than after exposure to 0.9 per cent
.15	Distress in 3 minutes; fell from perch in 18 minutes.
.20	Distress in 1½ minutes; fell from perch in 5 minutes.
.29	Fell from perch in 2½ minutes.

These tests show that canaries may be better than mice as indicators of the presence of noxious gases in the atmosphere of mines, since they more quickly show signs of distress in the presence of small quantities of carbon monoxide. In addition the symptoms of poisoning in birds are much more clearly defined. A bird sways noticeably on its perch before falling and its fall is a better indication of danger than is the squatting, extended posture that some mice assume without much struggling, attempts to walk, or other preliminary symptoms of poisoning. Consequently birds not only give more timely warning of the presence of small quantities of carbon monoxide, but exhibit symptoms that are more easily noticed by exploring parties.

RELATIVE SUSCEPTIBILITY OF MEN AND BIRDS.

In order to determine for himself the relative susceptibility of men and birds the action of carbon monoxide, the author performed the following experiment:

A gas-tight chamber, having a capacity of 80 cubic feet, was constructed. Into this chamber sufficient carbon monoxide was introduced to produce an atmosphere containing 0.25 per cent of the latter. The author entered this atmosphere, taking with him canary birds and pigeons. The canary birds evinced distress in one minute and fell from their perches in three minutes. The pigeons only showed slight signs of distress in 11 minutes. The author remained in the atmosphere for 20 minutes, and at the end of that time only suffered a slight headache, although later he became ill. The illness lasted several hours and was accompanied by nausea and headache.

The experiment shows that small birds are much more susceptible to the action of carbon monoxide than are men, and demonstrates the desirability of using small birds, such as canaries, rather than larger ones, such as pigeons.

In company with other persons the author has also witnessed practical demonstrations of the usefulness of canary birds in exploring mines after explosions had occurred therein. The following analysis shows the composition of the air about 200 feet beyond the point at which a canary bird collapsed. The bird was carried by an exploring party without breathing apparatus. A miner's lamp would burn in this atmosphere, which is typical of those that have caused many deaths in rescue parties, and would give no warning of the presence of the deadly white damp.

Composition of a mine atmosphere renedred dangerous by white damp:

Analysis of Atmosphere.

CO_2	1.49
O_2	18.25
CO	.60
CH_4	1.25
H_2	.29
N_2	78.12
	100.00

Analysis Differently Stated.

Air	Oxygen	18.25
	Nitrogen	69.07
	Carbon dioxide	.03
Black damp	Nitrogen	9.05
	Carbon dioxide	1.46
Methane		1.25
White damp		.60
Hydrogen		.29
		100.00

A sample of the atmosphere was not obtained at the exact place where the bird collapsed, but was taken at the face of a heading 200 feet beyond and close to what was supposed to have been the seat of the explosion. The exploring party was cautiously advancing along the heading when the bird collapsed; the members of the party immediately retreated without themselves feeling any distress. The bird quickly revived when placed in better air. About one hour later a helmeted party advanced to the face of the heading and collected the sample of air mentioned. The sample was obtained 18 hours after the explosion and before ventilation had been restored in this part of the heading. The carbon monoxide content of the air at the place where the bird collapsed is problematical, but certainly was less than 0.60 per cent, because the air was purer at places in the heading farther back from the face. As a rough guess, the carbon monoxide content may be placed at 0.20 or 0.30 per cent.

The following analysis shows the composition of the atmosphere in an entry that had been more or less traversed by exploring parties for several hours prior to the taking of the sample:

CO_2	0.31
O_2	20.51
CO	.04
CH_4	.20
H_2	.00
N_2	78.94
	100.00

One member complained of not feeling well at the time the sample was collected, but in prior exploration work he had probably breathed for several hours air containing small portions of carbon monoxide. Hence, his symptoms were to be attributed to the cumulative effect of the air previously breathed rather than to the immediate action of the small proportion of carbon monoxide shown in the sample.

Another advantage of the use of birds in exploring mines remains to be considered. A mine atmosphere may be so deficient in oxygen as to extinguish a lamp flame and yet may not contain so little oxygen, or so much carbon monoxide, as to cause distress to birds. In exploring a mine after an explosion a party including members of the Bureau of Mines encountered an atmosphere that, as shown by analysis of a sample, contained the following gases:

CO_2	4.10
O_2	13.64
CO	.00
H_2	.00
CH_4	1.20
N_2	81.06
	100.00

The party was not equipped with breathing apparatus but carried safety lamps and birds. When it entered this atmosphere the lamps were extinguished (an oil lamp goes out in air containing less than 17 per cent oxygen), but neither the men nor the birds showed signs of distress.

In regard to the oxygen deficiency required to cause distress in men, Haldane says:

> When the oxygen percentage of air is gradually reduced by absorption of the oxygen, or (what is exactly the same thing) by addition of nitrogen, very little may be felt before the occurrence of impairment of the senses and loss of power over the limbs. If reduction is gradual, and the symptoms be carefully watched, it will be noticed that at about 12 per cent of oxygen, i. e., with a reduction of 9 per cent, the respirations become just perceptibly deeper. At 10 per cent the respirations are distinctly deeper and more frequent, and the lips become slightly bluish. At 8 per cent the face begins to assume a leaden color, though the distress is still not great. With 5 or 6 per cent there is marked panting, and this is accompanied by clouding of the senses and loss of power over the limbs, which would probably end sooner or later in death. It is probable that any sudden exertion made in air markedly deficient in oxygen may lead to temporary loss of consciousness, so that sudden efforts should be avoided in all cases where, through accident or necessity, a man is in an atmosphere which will not support light, and in such a position that he might fall into worse air or otherwise injure himself. When air containing less than 1 or 2 per cent of oxygen is breathed, loss of consciousness, without any distinct warning symptoms, occurs within 40 or 50 seconds. Loss of consciousness in air deprived of oxygen is more rapid than in drowning or strangling, since in the former case not only is the supply of fresh oxygen cut off, but the oxygen previously in the lungs is rapidly washed out. Loss of consciousness is quickly succeeded by convulsions, which are followed by cessation of the respirations. The heart still continues to beat, in the case of cats and dogs, for from two to eight minutes; in man this period is probably longer, for it seems to be the general rule that the larger an animal is the longer it will resist asphyxiation. So long as the heart is beating, however feebly, animation may be restored by artificial respiration. This may require to be continued for a considerable period, as the after effects of deprivation of oxygen are very serious, and the respiratory center may not recover for some time.

The above statement shows why the atmosphere previously mentioned put out the lamps, but did not affect the men, and seemingly had little effect upon the birds. Of course men not wearing breathing apparatus should retreat at once from an atmosphere that extinguishes an oil-lamp and thus avoid the possibility of suddenly entering an atmosphere so deficient in oxygen that safe retreat would be difficult. For although birds would undoubtedly indicate in season a deficiency of oxygen sufficient to cause distress to men, if further advance were made, yet immediate retreat from an atmosphere in which a lamp does not burn assures a larger margin of safety.

In bringing these tests to the attention of miners and mine officials the author makes no claim to originality in the use of birds or mice for the purpose of detecting harmful quantities of carbon monoxide in the air of a mine. Dr. Haldane strongly recommends their use. In this country, however, small animals have been used for the purpose described in comparatively few cases. For that reason and because the test is so simple and practical the author has added his observations to the work of Dr. Haldane in order to urge the general adoption of the test in this country. The fact that no series of tests of the comparative merits of birds and mice in atmospheres containing the entire range of small quantities of carbon monoxide had been made is a sufficient reason for the experiments described in the preceding pages. Further, the author's observations indicate that mice are hardly as sensitive to carbon monoxide poisoning as Dr. Haldane's experiments would indicate, and that small birds are better indicators of poisonous atmospheres than are mice.

How Copper is Sold and Speculated In

By W. R. INGALLS.†

The interest of the miner and the metallurgist extends to the production and disposal of the refined metals. In their subsequent utilization by the drawers of wire, rollers of sheet, etc., he usually has no concern. The last step of interest to him, and this is of vital interest, is consequently the sale of the refined metals. The details of the selling, the methods and conditions thereof, and in short all that pertains to the marketing are not, however, well understood. There have been, in the Journal, many articles upon this subject, but even in such a matter as selling metals there are changes in practice and therefore this present series of articles will not be wholly a repetition of what has been said previously. It is not my intention to touch upon the selling of iron and steel, or of many of the minor metals, such as antimony, nickel, etc., but rather to confine myself to copper, lead, zinc and tin, with brief references to aluminum and quicksilver. I shall begin with copper as the metal of superior interest.

I shall not enter far into the subject of statistics. It will be sufficient to remark that at present the world's production of new copper is about 2,000 million pounds per annum, whereof about 1,450 million is the product of American refineries. The predominance of America in the world's market is therefore self-evident. This predominance is emphasized if it be further stated that of the remaining output a considerable portion is consumed in the respective countries of production, e. g., this is the case of Russia, and is not competitive.

Besides the new copper there is a considerable production from scrap and junk, which to all intents and purposes is equivalent to new copper. In the United States this production amounts to about 60 million pounds per annum.* It appears therefore that the total production of copper in the United States is fully 1,500 million pounds per annum, the disposal of which implies the selling of an average of five million pounds per day of business. It is evident from these figures that transactions in the copper market must go on all the time and that in the dealings of first hands they must be of high order of magnitude. In the business from this standpoint the carload is representative merely of retail trading; one hundred thousand pounds is a relatively trifling unit; a million-pound lot is only ordinary in periods of activity; and transfers of much larger blocks are common. Transactions to the amount of 30,000,000 pounds per week only dispose of the current production, without allowance for resales. When the market is classed as dull, a weekly business to the amount of many millions of pounds is likely to be done, but less than the average. Business has to be upward of 30,000,000 pounds per week to be pronounced brisk.

KINDS OF COPPER.

Copper is marketed in four principal kinds, viz.; 1, Lake; 2, electrolytic; 3, pig; 4, casting. Lake and electrolytic are marketed in three principal forms, viz.: cakes, wirebars and ingots. Pig copper, as its name implies, is sold in pigs, while casting, generally goes in the form of ingot. Cakes are commonly rectangular slabs of the metal; rarely discs. Cakes are used chiefly by the rollers and spinners. Wirebars are long bars, of square cross-section, tapering at one end to facilitate passage through the rolls of the wire mills. Ingots are the well known pigs that are partially divided into two or three sections, which is to facilitate the breaking of them for introduction into melting pots. Ingot copper is in fact used chiefly by the makers of castings and alloys, brass being the most important of the latter. Besides the ordinary ingots there are also what are called "ingot bars," weighing 60 to 90 pounds, which are divided by three to five notches.

Cakes and wirebars as furnished by the several refiners are generally of about the same size and shape, but there are some manufacturers who require special shapes and often pay a premium for them. Sales of copper at a fancy price are occasionally reported in the newspapers and heralded as marking an advance in the market, whereas in fact they represent merely some purchase of copper in a special shape and perhaps also of a special brand.

LAKE COPPER.

As its name indicates, Lake Copper is produced by the mines of Lake Superior, and indeed it is produced only by them. Formerly it was relatively of much more importance than it is now, but during the last 20 years electrolytic has displaced it as the kind of metal of superior importance although in certain ways it still retains the premier position. Electrolytic is, however, now conceded to be superior to Lake in conductivity and equally good in some other respects. Lake copper is superior in the combination of high conductivity with high toughness, but in the main it holds the esteem that wins for it a pre-

† Editor Engineering & Mining Journal in May issues.

* Statistics of the recovery of copper from scrap and junk are conflicting and confusing unless they be carefully defined. Most manufacturers of copper have scrap and trimmings, which they remelt or return to the refineries for remelting. Manifestly such copper should be excluded from statistics because it has never been used. The correct view of the secondary recovery of copper is, in my opinion, confined to what is obtained from the reworking of old material, i. e., material that has been used, collected, and restored to the market in the form of ingot, etc., thus becoming to all intents and purposes new copper, with which it is in fact competitive. Such recovery is practiced not only by smelters who make it their special business, but also by the refiners whose chief business is the treatment of virgin copper.

mium in the market to a hoary prejudice on the part of some manufacturers who continue to demand it because they always have, because it has proved good, and because they don't want to take chances in trying anything else. Given two lots of the same metal cast in different molds, one with an old, well-known name and the other with a new one and some melters will report different results. Such absurdity is gradually disappearing with the introduction of the chemist into the brass works and other factories.

Lake copper is marketed as three distinct kinds, viz., special brands (Calumet & Hecla and Quincy); prime Lake (Tamarack, Osceola, Wolverine, etc., including the electrolytic Lake refined by the Calumet & Hecla at Buffalo) and arsenical (Copper Range, Isle Royale, etc). These brands command different prices, the specials generally realizing a little higher and the arsenical a little lower price than the good, ordinary Lake copper. However, this is not always the case. At some times the arsenical copper sells on a par with first-class casting, but there have been times when a demand for copper high in arsenic has brought for it a price superior to prime Lake copper.* Similarly there have been times, especially during periods of decline in the market, when the best grades of Lake copper have been sold on the same terms as electrolytic. In general, however, prime Lake copper commands about 0.25c. per pound more than electrolytic, basis New York, but not so much on basis of delivery. Further on I shall dwell more in detail upon this subject. Lately the Calumet & Hecla has been making a differential of ⅛c. per pound between its Torch Lake and Buffalo copper.

ELECTROLYTIC COPPER

The production of electrolytic copper now amounts to about 80 per cent of the total American production, and 70 to 75 per cent of the world's production. Because of its excellence and the magnitude of its supply it occupies the leading place in the copper business. When the price for copper is referred to without qualification the common understanding nowadays is that the price for electrolytic copper is meant.

The electrolytic copper produced by the several refineries is substantially uniform in quality. Certain brands, e. g., B. E. R. and N. L. S., have at times enjoyed a little preference and indeed have commanded a small premium, but at present no material differences are recognized and the respective agencies compete upon an equal basis. The standard specifications, approved February 18, 1910, provide that all wirebar and cake copper shall have a purity of at least 99.9 per cent, silver being counted as copper, and an electrical resistivity not greater than 0.15535 international ohm per meter-gram at 20 degrees C. The specifications of the American Society for Testing Materials adopted in 1911 are as follows:

The copper in all shapes shall have a purity of at least 99.880% as determined by electrolytic assay, silver being counted as copper. All wirebars shall have a conductivity of at least 98.5% (annealed); all ingots and ingot bars shall have a conductivity of at least 97.5% (annealed), excepting only arsenical copper, which shall have a conductivity of not less than 90% (anneled). Cakes, slabs and billets shall come under the ingot classification, except when specified for electrical use at time of purchase, in which case wirebar classification shall apply. The annealed copper standard, or resistance of a meter-gram of standard annealed copper at 20° C., shall be considered as 0.15302 international ohm. The percentage conductivity for the purpose of this specification shall be calculated by dividing the resistivity of the annealed copper standard by the resistivity of the sample at 20° Centigrade.

Wirebars, cakes, slabs and billets shall be substantially free from shrink holes, cold sets, pits, sloppy edges, concave tops and similar defects in set or casting. This clause shall not apply to ingots or ingot bars, in which case physical defects are of no consequence.

Five per cent. variation in weight or ¼ in. variation in any dimension from the refiner's published list or purchaser's specified size shall be considered good delivery; provided, however, that wirebars may vary in length 1% from the listed or specified length, and cakes 3% from the listed or specified size in any dimension greater than 8 in. The weight of ingot and ingot-bar copper shall not exceed that specified by more than 10%, but otherwise its variation is not important.

These specifications do not take into consideration the so-called casing copper used for the purpose of alloying with other metals to produce cast shapes.

BRANDS OF COPPER.

A list of the important brands of copper in the American market is as follows:

American Smelting & Refining Co.	P A
American Smelters Securities Co.	BER, BCW,† Tacoma
Anaconda Copper Mining Co.	M A
Arizona Copper Co.	A C C†
Balbach Smelting & Refining Co.	Bb† N B C
Calumet & Hecla Mining Co.	C H M Co.
Copper Range	C R
Nichols Copper Co.	N L S, R M C
Phelps, Dodge & Co.	C*Q, P D C†
Quincy Mining Co.	Q M Co.
Raritan Copper Works	N E C
Tamarack & Osceola	T M Co.
Tennessee Copper Co.	T C C†
U. S. Metals Refining Co.	D R W

†Casting.

SMELTING AND REFINING.

The smelting of Lake copper is a relatively simple process as is also the refining which is done in the same works. These works are near the mines in Michigan, except the plant of the Calumet & Hecla at Buffalo, N. Y., and from them the copper goes directly to the manufacturers. The C. & H. works, at Buffalo comprise an electrolytic refinery in which some of the more argentiferous copper is refined. The copper so refined constinues to be classed as Lake copper. At the Dollar Bay smeltery a proportion of Montana cathodes used to be smelted with the Lake copper, the product going into the market as "Lake."

The refiners who rework scrap and junk, producing casting copper, employ reverberatory furnaces, the refining process being simple.

All of the other producers of copper turn out a first product known as pig or blister copper, this being the crude metal poured from the bessemer converters. Nearly all of the producers have converter plants, but a few ship their products as matte to other converters. The refiners receive a small proportion of their crude copper in the form of anodes, some of which is not strictly blister copper.

The bulk of blister copper goes to the electrolytic refiners, it being necessary both to eliminate impurities and to extract its gold and silver content. Some of it, however, is non-argentiferous and sufficiently pure as it comes from the converters to be used as casting copper after a simple furnace refining. Such copper is marketed as pig or bessemer copper and to a large extent is exported. The product of the Arizona Copper Company, Detroit Copper Company and Tennessee Copper Company is of this class. Some of it contains enough silver to be near the dividing line and goes directly into consumption or to electrolytic refining according to commercial conditions, sometimes one way, sometimes the other. At present only the ACC copper is sold as pig. The product of the Detroit Copper Company is marketed as PDC (casting) and that of the Tennessee Copper Company is either marketed as casting or is electrolytically refined.

The first marketable product of the electrolytic refiners is cathode copper, i. e., the refined metal in large, rough, electrolytically deposited plates coming from the tanks. The cathodes go generally to melting furnaces wherein the process of refining is completed and whence the copper is cast as cakes, wirebars, or ingots, but there are some buyers of cathodes who do the rest of the process in their own works. Much less cathode copper is sold now than formerly. The major part of what is disposed of in this form goes to Europe. The cathode allowance for export is variable, ranging from 5 to 10s. per 2,240 pounds (0.054 to 0.108 per pound). In shipping copper in this way heavy losses in weight (0.25 to 0.75 per cent) occur, owing to the brittleness of the

* The arsenical Lake copper constitutes a class by itself, having a distinct market. It cannot be used in place of prime lake, nor of electrolytic, but finds employment either as casting copper or rolling copper. For the latter purpose it is in good demand, owing to the high tensile strength of the sheet made from it.

plates and the rough handling in loading and unloading.

ELECTROLYTIC REFINERIES.

The following is a list of the electrolytic copper refineries of the United States, together with their situation and a statement of their capacity at the end of 1911:

Works.	Location.	Capacity, Pounds
Nichols.....	Laurel Hill, N. Y.	330,000,000
Raritan....	Perth Amboy, N.J.	330,000,000
Baltimore...	Canton, Md.	288,000,000
A. S. & R. Co........		180,000,000
U. S........	Chrome, N. J.	180,000,000
Balbach....	Newark, N. J.	48,000,000
Anaconda...	Great Falls, Mont.	65,000,000
Tacoma.....	Tacoma, Wash.	28,000,000
C. & H. Min. Co........	Buffalo, N. Y.	55,000,000
Total.....	....	1,494,000,000

THE SELLING AGENCIES.

A few of the producers sell directly their copper and handle no other copper. This is the practice of the Quincy, Miami, Mohawk and Wolverine companies. Other companies sell their own copper and also act as agents for other producers. Thus, the Calumet & Hecla sells the product of the other Lake companies in which it is a stockholder. The Anaconda Copper Mining Company, through the United Metals Selling Company, sells the Cananea, Copper Range and Highland Boy copper, Phelps, Dodge & Co. sells the Calumet & Arizona. The American Smelting and Refining Company sells the Utah, Nevada, Ray, Chino and Tennessee copper. These concerns sell their outside copper on commission, the rate now being commonly 1 per cent. The American Metal Company and L. Vogelstein & Co. act both as agents and as traders. The one large producer, Calumet & Hecla, and the five agencies that have been mentioned sell about 80 per cent of the total American copper product. Beer, Sodnheimer & Co., E. P. Earle, and one or two other concerns handle relatively small quantities.

These concerns constitute the "first hands." Besides them there are numerous dealers who conduct a speculative or distributive business, or a combination of both. Their supplies, barring what comes from the scrap and junk smelters, are of course obtained from the producers and agencies either by purchase or by representation. Virgin copper has been known to be delivered against sales through unusual channels.

INTERNATIONAL RELATIONS.

Approximately one-half of the production of American refineries is consumed in the United States; the other half is exported to Europe. Copper moves freely from one country to another, there being no import duties except into Russia and perhaps some minor countries. These conditions create an international market for copper, i. e., the American and European price is in general the same, allowing for freight differentials. The principal nominal markets are New York and London; the only other public market that comes into consideration is Hamburg. In importance Hamburg is decidedly inferior to London, to which in the main it conforms.

In New York the dealings are wholly in refined copper; in London they are both in refined sorts and in what is known as "standard" under a form of contract determined by the metal exchange which classifies and rates most of the commercial kinds of copper. Transactions upon the London Metal Exchange are conducted under systematized rules and the open market that is thus established is the focus of extensive speculation, which is no more confined to London itself than are the transactions on the New York stock exchange confined to Wall Street. Both of these places are simply the points of execution of orders emanating from all parts of the world. Thus, many of the speculative movements originate from orders cabled from New York and several American houses are prepared to conduct such business, in which public interest upon certain occasions has been openly invited, just as it might be invited to participate in speculation in cotton or wheat.

In view of these connections it is obvious that while the London and New York copper markets may temporarily exhibit a disparity, such a condition can not long exist, generally for not more than a few days, inasmuch as disparity immediately opens the way to profitable arbitrage business. If "standard" at London rises above the New York parity the American agencies may sell contracts and deliver their refined copper against them. On the other hand, if "standard" falls below the parity they may cause their refined copper to move at concessions and cover their sales by purchases of "standard" in London. There are frequently triangular and even quadrangular or more complicated transactions, such as occurred several years ago when China was playing an interesting part in the copper market. The details of these are often too abstruse to be understood by anyone except the traders who make it their business. The number of houses in a position to conduct arbitrage business is in fact small.

A consideration of the nature of this international business makes it manifest that the American and Europen markets must stand at the same level during most of the time. A movement may start in London or New York; if the start be in London it may be specifically inspired from New York; and a general change in level may be anticipated on one side or the other, which is why New York watches London so carefully, and vice-versa, but natural conditions prevent any disparity from being of anything but temporary character.

NEW YORK A BASING POINT.

While New York is the great market for copper and while the price for copper in New York is the commonly accepted basis, a great deal of the copper sold, perhaps the major part, never physically enters New York. The electrolytic refineries, with a few exceptions, are situated on branches of the bay of New York, four of them being in the State of New Jersey and only the Nichols works in New York. This, however, is merely a technical distinction, three of the large New Jersey refineries being separated from the municipality of New York only by a narrow body of water. At the refineries the copper is loaded on lighters by which the copper is taken to the steamship docks for export or to the railway docks for transhipment to interior domestic places. In a few cases direct delivery to manufacturers can be made by lighters and to some extent the copper is shipped directly from the refineries in railway cars. The greatest manufacture of copper is on the Naugatusk valley in Connecticut. There are important isolated centers, such as Trenton, N. J., Rome, N. Y. and Detroit, Mich. The copper that goes westward from New York has to stand a back freight through the longitude that it has already traversed in coming eastward as blister copper. Not so with the electrolytic copper coming from Tacoma and Great Falls or the Lake copper from Michigan. When copper is delivered from western manufacturing points it is a common practice of the Lake producers to settle on the basis of the New York price with freight allowance. In the case of the electrolytic producers conditions are more complicated because of the trade custom respecting delivery.

PRICE RATES.

The price for copper is quoted to buyers in a variety of ways, whereof the more important are as follows: New York, cash; delivered, 30 days time for payment; delivered, cash; delivered, cash, less 0.5 per cent discount; f. o. b. dock, New York (for export); delivered in Europe, c. i. f. (cost, insurance and freight). Formerly copper was sold on a strictly cash basis. At present the custom of granting time prevails in the domestic business, the larger part of the copper being sold on terms that include delivery at the buyer's works (the seller paying the freight), allowing 30 days (after arrival of the copper) for payment; and discounting the bill for cash. This is the meaning of the common, commercial phrase "delivered, 30 days." The custom of quoting copper in this way is now so general that the explanatory phrase is commonly omitted, which makes it necessary to employ an explanatory phrase when the basis be different. If it be said in the trade that the price of electrolytic copper is 14c. it is understood what that means, but outside of the trade such an understanding does not generally exist. The net, cash price, basis New York, is of course a very different thing from the price delivered, 30 days. In the foreign business the c. i. f. basis is also one of delivery, the seller landing the copper at some European port.

The practice of selling copper to domestic manufacturers* on the delivery and time basis was, I believe, inaugurated in the '90s. Lake copper was naturally delivered to them directly from the west and in introducing the then new kind of copper—electrolytic—coming from the west via New York it was reasonable to offer it to the manufacturer on terms that relieved him of a study of freight rates. The innovation of time allowance against the old cash basis was inspired doubtless by competitive reasons and coincided with the elimination of the middleman (broker), the rise of the great agencies possessing large financial resources, and the direct dealing with manufacturers whose credit was good and well known. Losses through bad accounts in the copper business as now conducted are almost an unknown occurrence.

The granting of time on copper bills is of course a concession to the buyer, because the latter gains and the seller loses interest on the money, although this is not figured by some producers in their accounts. They reckon a sale as a sale irrespective of when they receive their money, but the interest on the money involved in the transaction accrues to some one, nevertheless, and is recognized in the discounting of bills for cash.

The time allowance is not a commendable practice or to the best interest of the business. At certain times it has been abused. In shipping to Connecticut the refiner in New York figures upon financing the consignment for about 45 days, the time while the copper is in transit being about 15 days. The buyer may take advantage of the agreement by delaying the receipt, i, e., delaying weighing in or entry upon his books, from which he begins to count his 30 days, and the seller is impotent, being anxious to avoid giving offense, especially when competition is keen.

For the most part, Lake copper is sold directly by producer to manufacturer; however, some of it is distributed through the selling agencies and some through metal brokers. The several sellers of Lake copper do not adopt the same plan in making their quotations. Some sell on the basis of New York, net cash, adding or deducting difference in freight between shipping point and New York. Thus, in selling copper for delivery at Buffalo, some producers name their New York price and deduct the difference in freight between Michigan-New York and Michigan-Buffalo. Other producers sell at a price including delivery to the manufacturer's yard, allowing 30 days' time for payment, or not, as the case may be. Some producers selling to brokers allow them a commission of 0.5 per cent and in selling directly to manufacturers give them (the manufacturers) the same allowance, which of course is simply a trimming from the nominal price. When the bill is discounted for cash the total discount comes to 1 per cent. This allowance is not made by all of the Lake producers.

The agencies which sell the bulk of electrolytic copper differ slightly in their methods, but in the main they are obliged to accommodate themselves to each other in order to remain competitive. The transactions in electrolytic copper come under three heads, as follows: (A) Sales to manufacturers situated in the west. (B) Sales to manufacturers situated in eastern districts. (C) Sales for export.

WESTERN SALES

The manufacturers situated in the west are, as a rule, supplied by the western refiners, who have a double advantage, saving a part of the freight to the Atlantic Coast and obtaining a higher price for their product, eastern refiners being obliged to pay freight backward in order to compete. The western refiners in selling at interior points, are, however, limited by the competition of Lake copper. This will be made clear by the following example:

Assuming the price for electrolytic copper to be 12½c., net cash, New York, and the price of Lake copper to be 12¾c., same basis, if a western refiner sells at 12½c., Chicago, he saves about ⅛c. freight from Chicago to New York. In order to realize the equivalent of 12½c., cash, New York, the eastern refiners would have to quote 12.70c. at Chicago. The Lake producers can afford to sell at 12⅝c., Chicago, netting the equivalent of 12.75c., New York. Consequently, in times when there is a fair market for copper, the price in Chicago is likely to be just enough lower than the price for Lake copper to induce the buyer to take electrolytic instead of Lake and still sufficiently high to make it more profitable to the western electrolytic refiner to sell there than in New York. The result of this condition is that in ordinary times the eastern refiner does not compete in the western market. If business, however, is slack and it is difficult to sell copper, the eastern product will be offered competitively in the west, because then it is chiefly a question of finding a market and the equalization of freight becomes a secondary consideration.

DELIVERIES TO EASTERN POINTS.

Similarly copper may be delivered to some interior points more advantageously from Baltimore than from Perth Amboy. These conditions produce complications in the competitive selling of copper at points west of the Atlantic Coast and in connection with the prevailing custom of the trade affect materially the price quoted for any particular point and the amount that the seller will net. The producer of Lake copper often finds himself embarrassed by widely different freight rates, the rate from Michigan to Connecticut by rail being about 34c. and by water and rail only about 18c. This materially influences his attitude toward the market at the opening and closing of navigation and gives play to the operations of shrewd outside speculators at about those times.

In selling upon the basis of price delivered to domestic manufacturers, with time allowance, or discount for cash, the freight that is paid by the sellers differs naturally according to the respective situation of the refinery and the manufacturers' works. Thus, while the refiners at Perth Amboy have merely to pay a switching charge for delivery of copper to a Perth Amboy wire mill, a refinery situated on Long Island has to pay a lighterage charge or a freight charge. The freight from the principal refineries around New York to the principal mills varies from a switching charge of 1c. per 100 pounds to a rate of 18c. per 100 pounds. It has become the custom among the principal selling agencies to quote a uniform rate, disregarding differences in freight, the idea being to treat all consumers alike and the assumption being that in the long run the freight will equalize itself. A

* Throughout this article I refer to the "manufacturer' rather than the "consumer." The real consumer rarely enters directly into relations with the refiner. The latter sells to the manufacturer of wire, etc., who is simply a middleman one step further in advance. There are, however, some large users of wire, such as the General Electric Co. and Western Electric Co., which buy wire bars and have them drawn on toll or contract, but even they are not the ultimate consumers.

very large part of the shipment of copper goes to the Naugatuck valley in Connecticut, the freight rate to there being about 10c. per 100 pounds, which expense is generally assumed to be about the average. This rate, however, applies to only part of the shipments, a large part of the Western copper going through on milling in transit rates, which reduce the cost of delivery from New York 4½@7½c. per 100 lb. The producers who sell copper to domestic manufacturers in the east, are consequently subject to freight charges of from 4½ to 12½c. per 100 lb., or even a little more to some out-of-the-way places.

The terms, cash 30 days after arrival, are generally reckoned as corresponding to an average interest loss of 45 days, which amounts to a little more than 10¼c. when figured on a price of 14c. per pound and at 6 per cent interest. Several of the large agencies sell at the flat discount of 0.5 per cent for cash upon delivery, which is 7c. per 100 pounds when the price of copper is 14c. The net cash equivalent, New York, of a sale "delivered, 30 days," is consequently from 12½ to 20c. per 100 pounds less than the commonly quoted price. What the producer realizes comes back, of course, to the basis of New York, cash. The variation in terms is frequently a method of shading prices without jolting the nominal position of the market.

SALES TO EUROPE.

Sales to Europe are made by the several agencies through their European manufacturers. A custom similar to that in the domestic trade exists with respect to quoting a uniform price for delivery at various ports regardless of difference in freight. In times when business is brisk an exception is likely to be made in quoting for delivery to the so-called "outports," to which the freight rate is materially higher than to Liverpool, London, Rotterdam and Hamburg. However, in times of keen competition some of the sellers prefer to waive the differential for the so-called "outports" rather than to reduce their price.

The average freight rate to regular ports in Europe is about 11c. per 100 pounds,* the insurance amounts to about 1.3c., interest and banking expenses 3c., and brokerage (at 0.25 per cent) 3c., making the total of charges about 18.3.** The terms of payment for European sales vary; common conditions are three days' sight draft, or sight draft on consumers, or cash on arrival of steamer. In either case the seller suffers a certain loss of interest or a loss in the rate of exchange. Some sellers extend credits to European buyers and in consideration thereof sometimes receive higher prices, the credits ranging from two weeks to three months. It is a common custom when making sales to Europe on credit to sell the risk to a bank at an expense of ¼ to ½ per cent. The average cost to the seller of delivering copper to regular ports in Europe is about 17½c. on the average, some figuring it a little higher (20c.), some a little lower (15c.)

With respect to what is actually netted by the seller it appears, therefore, that there is no material difference between the selling for delivery in America and in Europe upon the usual terms in each case, i. e., when ocean freights are normal.

CASTING COPPER.

The market for casting copper is relatively narrow and erratic. In the market for this sort the smelters of scrap and junk figure prominently, their product being casting copper and trade customs are not so firmly established as they are in the market for other kinds of copper. This is to say, casting copper may be sold in almost any way that occurs to the imagination and may be agreed upon by the parties concerned. It is sold upon the basis of cash, New York, and upon the basis of delivery, with or without time allowance. Time allowance may run to considerably more than the 30 days commonly allowed on electrolytic bills. The credit of buyers and sellers is also a more important consideration in this market than in the others.

In general casting copper is worth from 12½ to 20 points less than electrolytic, but the ordinary disparity may not always appear in the records of actual transactions. Electrolytic copper is quoted upon the basis of a wholesale market in the broadest sense, while the business in casting copper is always relatively of a more or less retail character. Thus it may actually happen that transactions in casting copper may be made at a higher price than for electrolytic, which, of course, is in no way a true index of actual market conditions, but merely the difference between a retail and a wholesale market.

Neither casting copper nor cathode copper is a reliable basis for commercial calculations, except in so far as concerns transactions in those particular forms, which in fact are of minor importance. Lake copper is a more valuable index inasmuch as its sales represent upward of 200,000,000 pounds per annum, and the record of Lake prices is important because it goes back to the early years of copper production, while the record of electrolytic is still comparatively brief. The real index of the copper market is the price for electrolytic copper and that ought always to be the basis, both casting and cathode copper being subject to erratic and non-indicative varitaions.

CONTRACTS.

The expression of "the spot price for copper" is sometimes used, but it is substantially meaningless. There is no stock of copper in warehouse at New York that is capable of delivery on demand. There may be such a stock at the refineries, but even when the refiners have an ample supply of refined copper on hand, about 10 days after receipt of order is usually expected as an allowance of time in which to conform to specifications as to shape of bars, etc. Such a filing of an order would be called "prompt delivery." The bulk of the copper is not sold in that way but rather is sold on contracts for forward delivery. Few manufacturers conduct their business upon the basis of hand-to-mouth buying, although they may approach that condition in periods of great plethora of supply, such as existed in 1910 and 1911. A manufacturer receives orders for wire, brass and other goods to be delivered at a subsequent date or during a period beginning with some date. Knowing pretty nearly what his requirement for copper is going to be, he places contracts with the agencies for delivery on their part at corresponding periods. The agencis are generally desirous of providing for the disposal of their product as far ahead as possible, but neither buyer nor seller is commonly disposed to take chances on the market for more than two or three months ahead. This practice of contracting explains the alternating periods of dullness and activity in the copper market. Having during January, let us say, arranged for their February and March

* This refers, of course, to what may be considered normal conditions. Lately there has been a sharp rise in ocean freights, which has affected copper shipments as well as other commodities. Thus, the rate on copper from New York to Liverpool has gone from 7s. 6d. to 15s. (from 8.1 to 16.2c. per 100 lb.); the rate from New York to Hamburg has gone from 10c. to 16c. per 100 lb.; and the rates to other ports about the same way.

** The bank commission (1.5c) may be saved by drawing directly on customers, but such drafts are frequently subject to foreign stamp taxes, and moreover a draft on a commercial or industrial concern cannot be sold so well as a draft on a bank, wherefore the net result is likely to be about the same as if the drafts be sent to a bank for collection, with a commission to the bank, which is the practice of some of the selling agencies. The interest (1.5c.) is always a disputed item in these calculations. Some of the agencies figure it, some do not. Some concerns reckon the brokerage at upward of 0.25%, there being few, if any, of the sellers who are not subject to higher charges than that nominal rate. Some figure 5c. per 100-lb. with copper at about 14c. These points explain the differences of opinion respecting the charges upon European shipments that exist among the selling agencies.

copper, buyers may keep out of the market for a month or more before opening negotiations for their April requirements, especially if recession in the market is anticipated. On the other hand, if an advance is expected, they are likely to keep right on in their buying, keeping steadily booked up for two or three months ahead. Some manufacturers contract for their supplies upon the quotational basis, ordering their requirements from day to day, or from week to week, as wanted, and settling upon the basis of the monthly average. The manufacturers who do this escape the risk of speculative pinches (losing also, of course, the chances of speculative profit) but in the long run undoubtedly come out as well as the manufacturers who rely wholly upon their trading ability.

European manufacturers as a rule are compelled to cover their wants further ahead than the American because by far the larger portion of their supply must be brought over sea. A manufacturer who needs a certain shape of wire bars at his mill in Germany in March, for example, will have to buy it ordinarily in January for February shipment from the United States. The London standard market creates a complication for the selling agencies and no matter whether they like it or not, they have to graduate their quotations for forward delivery somewhat according to the premium that may be being paid for standard for forward delivery. If they should not do that their copper would ultimately find a market in London anyhow.

The custom for contracting for future requirements that prevails in the industry not infrequently leads to irregular conditions. Thus in periods of extraordinary demand, as in 1906, when stocks on hand had been substantially exhausted and refiners had become substantially sold out for one or two months ahead, a belated manufacturer requiring immediate delivery may be obliged to offer such a premium as will induce some holder to resell or to uncover some reserve supply. On the other hand, in periods when the condition of the market is the opposite a producer needing immediate cash may be unable to sell in such a way as to produce it except at a sacrifice, but may be able to sell for forward delivery and instead of waiting for his money may discount his contract. Transactions of either kind are small in relation to the great volume of business.

SPECULATION.

Speculation in the copper business in this country is severely discouraged, for the simple reason that the producers and agencies are primarily concerned with the merchandising of copper. They cannot regulate the European market in this way and are obliged to meet conditions over there as they find them, but in this country they can and do refuse to sell to any but manufacturing interests. The refusal does not necessarily take the form of an absolute declination, but may be conveyed by the quotation of a prohibitive price. All of the agencies do not, however, consistently follow this policy. Some of them at certain times have distinctly encouraged speculative participation even on the part of persons who are no more concerned in the copper industry than they are in cotton or coffee, undertaking to carry copper on margin in the refinery yards. The seller may later on be plagued by the competition of copper in his own yard. This kind of speculative business is by no means general.

It is impossible, of course, for speculation to be carried on in other ways, either regularly or only occasionally. Thus the representative of an European buyer who has purchased for export may turn around and resell in this country. Similarly a manufacturer who has contracted for copper not yet shipped from the refinery may offer it for sale on his own account.

In spite of the discouragement of speculators pure and simple and also of brokers, a few manage to do business under handicaps. Some of the Lake producers do not hesitate to sell to brokers and at certain times it is fancied that electrolytic copper may be put in their hands by some of the great agencies, which, while ostensibly out of the market, asking a price that they are unable to get, are not averse to cutting prices vicariously.

A consideration of all the conditions that have been discussed in the foregoing sections of this article will explain why business in copper on the metal exchange of New York practically disappeared and why it has been impossible to revive it. The producers and agencies, now few in number, are able and not "on 'change." The few trans- to merchandise their copper without the intermediary assistance of brokers and middlemen. The customs that have developed in the trade, moreover, do not conform to the customs of trading on in exchange. The American market for copper is in the offices of the agencies and not "on 'change." The few transactions that take place on the latter are insignificant and command no general attention.

MARKET INFORMATION.

The question may be asked, how do dealers in an unorganized market, a market in which there is no public exchange, truly speaking, obtain the information that is necessary for the conduct of sharp competition. In fact this is done in the same way as in the market for pig iron and many other substances. In this present era of the telephone, physical meeting between buyers and sellers is unnecessary. Inquiries are made and transactions involving large sums of money are consummated over the telephone.

The agencies manage to keep well posted through their elaborate organizations and continual intercourse with buyers. Offerings in Europe are promptly cabled back to New York. Domestic buyers generally do some "shopping," and frequently communicate information about what is offered to them. The would-be seller whose offer is rejected knows of course that his price has been cut by some one else. The invitations to manufacturers to make bids throws light upon the situation in a full market. These and similarly ordinary exchanges of bids and offers exhibit the nervous system of the copper market. Of course the London market is always a factor.

It happens occasionally in certain periods of excitement that an agency may buy copper at a certain price and immediately resell it at a difference of ten points, or vice-versa, just as on the stock exchange transactions sometimes occur contemporaneously in the same crowd at a material difference in price. However, such inequalities are soon smoothed out as conditions become calmer.

ABSOLUTE PRICE.

There is no way of determining the absolute price for copper from day to day or even from year to year, as must be evident from a consideration of the market conditions that have been outlined and discussed in this article. By "absolute price" I mean the average that might hypothetically be obtained by dividing the proceeds of all the copper sold by the number of pounds sold. An approximation is all that can be expected.

In the record of the Journal the daily quotation is essentially quantitative i. e., it is aimed to represent the bulk of the transactions, basis New York, cash. The small lots occasionally sold at premiums figure almost disappearingly small when averaged in the great volume of transactions. The monthly and annual averages are simple arithmetical means.

Many of the producers state in their official reports the amount actually received for their output; their averages are of course quantitative individually. It is impossible to arrive at a general quantitative average because many producers fail to report their figures and also because those that do report employ different methods of bookkeeping. Some report the net receipts on the basis of New York, but many state the gross receipts upon delivery and debit freight and other charges in another account. The matter of interest is generally disregarded.

In any given year there is a moderately wide difference among the averages reported by individual companies. This is explainable partly by the variation in methods of accounting referred to in the previous paragraph, and partly by differences in selling. All producers are no more likely to realize the same price for their copper than are all farmers for their wheat; some sell more judiciously and alertly than others. Some may sell but sparingly on a declining market and find themselves ultimately compelled to dispose of large blocks at the lowest price, while others may be successful in the policy of reserve in the opposite way.

TWO DISTINCT SELLING POLICIES.

There have been during recent years two distinct policies in selling on the part of agencies. Some have distinctly conformed to the system of reserved selling above indicated, remaining to a large extent out of the market for long periods, unable to realize the price asked by them. Other agencies have followed the policy of selling all the time, taking the price that could best be obtained. In periods of dull, declining markets this policy of constantly pressing sales has been quite irritating to other agencies desirous of starving manufacturers into paying their price asked. The copper market has, however, been always an open one, save for the brief attempts of the Secretan Syndicate and Amalgamated Copper Company to corner it (both of which were colossal failures) and has historically obeyed the law of supply and demand. Some of the agencies take in immense quantities of crude copper under contract and they are naturally bound ordinarily to sell it more or less in the ratio of its acquisition. On the other hand the producer who is selling through an agency on commission may be more disposed to carry his output awaiting a favorable time for its sale.

While the different policies in the market may lead to materially different averages in any single year, it seems from such evidence as is available that in the long run there is no great difference in the results. This refers to the comparative experince of individual companies. Considering the results of all companies year by year a summary of the figures of those reporting publicly affords a fair approximation to a true quantitative average. A study of these figures indicates that the producers generally fall a little short of attaining the quotational average. A consideration of the psychology of buying and selling affords an explanation of this. In a declining market, frequently started by large selling by one or two concerns more farseeing than the others, the time is soon reached when buyers themselves become frightened and but little of the commodity can be marketed until speculators become interested in taking over large quantities at or near the bottom, which usually marks the turn of the tide. Upon an upward movement sales usually become smaller as the culminating point is approached. Thus in 1907 the quantity of copper sold at 25c. and upward was relatively small. The decline started with some heavy selling, but upon the long descent business was comparatively light and did not become large until 12c. and under was reached. The quantitative average in that year was extraordinarily lower than the quotational.

The manufacturers of wirebars, sheet, brass, etc., purchase wirebars, cakes and ingots. The consumers obtain their copper upon the basis of those manufacturers, the prices of which do not fluctuate in so mobile a manner as does that of the raw material. During the last four years, the average difference between wirebars and wire was 1.7c. per pound; between cakes and sheets 5⅞c. per pound. The price for wire was quoted by a pooling agreement until about the beginning of 1911. Upon the disruption of the pool the wire business became strenuously competitive and prices were cut in some cases to the manufacturing margin, which is commonly reckoned at about 1c. per pound. In general the official price for wire has corresponded with the market price for wirebars, i. e., over long periods, although at many times it has been out of tune, the fluctuations in the price for the metal not always having been quickly reflected. This has given some large users of wire an opportunity to play both markets, buying either wire or wirebars to be drawn on total according to variations from the normal difference.

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When a belt has become oil soaked and will not stay on the machine, a good method of cleaning it is as follows: Coil the belt loosely in a tub of sufficient size, and cover with whiting. Be sure that the whiting gets in between the coils of the belt, and it will be only a short time before the whiting will absorb the oil from the leather. It will then only need to be wiped clean to be ready for further service.

VANADIUM

By JAMES O. CLIFFORD.*

The great importance of vanadium in the steel industry, other manufactures and the arts has stimulated the search for deposits of vanadiferous ores of commercial value. While the occurrence of vanadium is widespread and varied, it is rarely found in such quantities as to be profitably worked.

The ores most commonly met with are the vanadates, which are usually reddish or brownish in color, unless contaminated by considerable quantities of copper, iron or manganese—in which event they may be more or less greenish or black. The following is a brief list of the more important vanadium-bearing minerals:

Vanadinite, a chloro-vanadate of lead containing 19.4% vanadic acid, is the best known vanadium mineral. It occurs in prismatic hexagonal crystals, as globular aggregates, and as simple incrustations. In color it ranges from straw yellow to deep red. Endlichite is a variety of vanadinite occuring in long, slender needle-like crystals. It differs from vanadinite by its lesser percentage of vanadic acid and higher content of arsenic pentoxide; it is, therefore, intermediate in chemical composition between vanadinite and mimetite.

Descloizite is a hydrous vanadate of lead and zinc containing about 27% vanadic acid. It occurs in short prismatic, or pyrimidal crystals; also, as a psuedomorph after vanadinite. Its color is generally clove-brown to black. Dechenite does not differ essentially from descloizite. Cupro-descloizite is a variety containing from 5 to 12% copper oxide.

Mottramite and Psittacinite are nearly identical in chemical composition and structure. In color they are greyish-green to black, and contain 9 to 20% vanadic acid.

Volborthite is an olive-green vanadate of copper, containing 14 to 40% vanadic acid. Calcio-volborthite is of a calcium-grey color and is an alteration product of volborthite in view of the replacement of the copper by calcium and barium compounds.

Pucherite, a vanadate of bismuth containing 29% vanadic acid, occurs in small orthorhombic crystals of a reddish-brown color.

Vanadiolite, a vanadate of calcium containing 45% vanadic acid, occurs massive and has a characteristic greyish-green color.

Vanadium occurs as an original con-

* Mining and metallurgical engineer, Deming, N. M.

stituent in the rock-forming minerals mica, augite and hornblende. Roscoelite is essentially a vanadiferous muscovite of secondary origin and contains as high as 35% vanadic acid.

Carnotite, a uranyl-potassium vanadate (contaminated with calcium and barium compounds) contains as nigh as 38% vanadic acid. In color it is a canary yellow, and occurs in small pockets in sandstones. Carnotite derives its chief importance from its uranium content.

Patronite, a sulphide of vanadium from Peru, S. A., contains 60% vanadic acid. In color it ranges from dark green to black, and occurs massive. Its associated minerals are a natural red oxide and a vanadiferous asphaltite. Kentsmithite, an impure sulphate of vanadium from Colorado, occurs massive, is of steel-grey color and contains 15 to 22% vanadic acid.

QUALITATIVE AND QUANTITATIVE ANALYSES.

Qualitative Test—The borax bead dissolves vanadium pentoxide to a clear bead, colorless, or with large quantities of the anhydride, yellow in the outer flame, green in the inner flame. With large quantities of vanadic acid it appears brownish when white hot, and only turns green on cooling.

A sulphuric acid solution of vanadium pentoxide, when considerably diluted with water and treated with metallic zinc then heated, turns blue, then green, and finally from lavender to violate. Many organic substances, such as sugar, oxalic and tartaric acids, etc., reduce vanadic acid, especially in the presence of strong mineral acids, to the blue tetraoxide. The same reaction takes place when SO_2 or H_2S are added to the solution in acid. The addition of hydrogen peroxide to the blue tetraoxide occasions further oxidation, characterized by a brownish-red coloration. The hydrogen peroxide test is extremely delicate, as by its use less than 0.01% vanadium can be detected in solution.

Quantitative Analysis—Although numerous methods are given for the quantitative determination of vanadium in ores, the following—devised by J. Kent Smith, consulting metallurgist, International Vanadium Company—will be found satisfactory on nearly all vanadiferous ores

Weigh out .512 gram, or multiple thereof, of the pulverized ore. Fuse in an iron crucible with ten times sample's weight of sodium peroxide; cool and dissolve fusion in water in a 500cc. evaporating dish or casserole, using about 150cc. distilled water. Acidify with 50cc. to 75cc. to 1:3 sulphuric acid, and boil for fifteen minutes. Add until permanently pink an n-10th potassium permanganate solution, then cool. Discharge the permanganate color with a n-10th ferrous ammonium sulphate solution. By means of the potassium permanganate and ferrous ammonium sulphate solutions neutralize the solution. Then add a measured amount (excess, about 20cc) of the exactly n-10th ferrous ammonium sulphate solution. Titrate the excess of ferrous ammonium sulphate back, with an eaxctly n-10th potassium bichromate solution, using a freshly prepared solution of potassium ferricyanide on the spot plate as an indicator. The disappearance of the blue color denotes the end point. The number of ccs. of ferrous ammonium sulphate solution, less the number ccs. potassium bichromate solution, denotes the amount of sulphate used to oxidize the solution of vanadic acid; and where .512 gram sample was used, each cc. ferrous ammonium sulphate equals 1% vanadium.

METALLURGY AND ALLOYS.

The ores most commonly met with by the metallurgist are, patronite, carnotite, roscoelite and vanadinite. Numerous methods have been patented for the extraction of vanadium from the ores in which it occurs, but many of these are totally inoperative; for the reason, primarily, that vanadium has many laboratory peculiarities that are not apparent on a mill scale.

Smelting methods, with a view to subsequent recovery of the vanadium content from slag, does not offer much encouragement, especially in the treatment of ores containing less than 3% vanadium pentoxide.

Processes for the extraction of vanadium by fusion with various reagents, such as nitre, potassium bisulphate, etc., do not lend themselves to the economic treatment of low-grade ores in view of the excessive loss of reagents, additional heat required to effect fusion and the difficulty of dissolving the fused material and refining the primary solutions obtained from leaching.

While the sole method of economic extraction of vanadium from low-grade ores seems to be entirely by means of hydro-metallurgical and electro-chemical means, it must be borne in mind that expensive reagents cannot be used, nor can cheap ones be used in large excess unless a reasonably large recovery of used materials is thereafter made. Considerable progress has already been made in this connection, and we may look forward to more economical processes in the reduction of vanadium from ores and refining or vanadates of iron, calcium and copper.

The greatest difficulty encountered in the treatment of ores containing vanadium is to economically place the contained vanadium in solution, free from gangue. When this is done the vanadium will be in condition in which it can be readily handled.

The two leading methods of extracting vanadium from its ores is by leaching with mineral acids, and by alkalis. Better results are obtained from alkaline vanadates, which are more uniform than vanadyl compounds. Alkaline vanadates are more soluble in water, while vanadyl compounds in dilute solutions are more readily precipitated by the impurities present.

Patronite is treated first by roasting to reduce to oxide, followed by decomposition with sulphuric acid. Carnotite ores are generally decomposed by roasting with sodium chloride, or fixed alkalies. Roscoelite is best treated with a 1:1 mixture of sodium chloride and crude lye, the ore being roasted followed by leaching with water. Vanadinite is, to a limited degree, decomposed by sulphuric acid. Roasting with sodium chloride does not give good results. Few of the processes in use at this time effect a recovery in excess of 70% of the vanadium contained in ore treated.

It is as important to get vanadium out of solution completely as to obtain complete extraction from the ores. It is therefore necessary to precipitate all of the vanadium from solution in a chemical combination and physical state suitable for further refinement. Since the most important product is ferro-vanadium alloy, the method of preparing vanadate of iron—from which ferrovandaium is readily made—is briefly stated.

The method employed in producing vanadate of iron is to add ferrous sulphate to a neutral solution of sodium vanadate. Vanadate of iron is precipitated to the bottom of the tank holding the solution; this precipitate is then filter-pressed and dried. The vanadate of iron thus obtained usually contains appreciable quanties of the basic salts of the original solution, which, unless removed before further reduction, is detrimental to the electric furnace in which it is reduced direct to ferrovanadium.

The various vanadium alloys contain from 15 to 52% metallic vanadium. A price of $5.00 obtains per pound metallic vanadium contained in alloys.

The basis of settlement for vanadiferous ores varies greatly in different districts and with different companies. A very satisfactory quotation by one of the European buyers is: Ores containing a minimum content of 10% vanadic acid command an average price of 50 cents per pound V2 O5 contained, f. o. b. cars shipping point.

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CONTENTS:

Developments since the last issue of Mines and Methods makes it look as though the negotiations for purchase of a control of the Silver King Coalition company's mines at Park City would come to naught. From the information it has been possible to gather the collapse of the deal—if it does fail—can be charged to no other reason than a failure of the parties at interest to agree on a price. Mr. Howard and his engineer were permitted to make a cursory inspection of the mine about the middle of the month and, as the engineer left the city within a few hours after the trip to Park City was made, the impression gained currency that both sides threw up their hands and called it "all off." Of course there is a possibility that negotiations may be opened again in the near future, but indications, at this writing, are against it.

COPPER AND THE PUBLIC

The New York correspondent of the Mining and Scientific Press declares that, notwithstanding all the market reports tending to show the depletion of copper metal stocks, that investors in copper shares are not satisfied that the truth is being told. And then another bomb is hurled into the camp of the share market boosters by telling of John Hays Hammond's activities in the field of wireless telegraphy where the big feature of the business lies in its proclaimed tremendous economy through the practical elimination of the use of copper. These things, the correspondent says, are no small factors in the dullness of the copper share market. This is the way he puts it:

> The copper shares are still dull, in spite of much work by press agents. The investors are apparently studying the discrepancies that seem to exist between the reports from the mines and the refinery figures that are given out, and are asking "Where is all the blister copper that figures as mine output?" The market feature, both in New York and London, for some weeks past, has been a specialty that in its future depends almost wholly upon the elimination of copper as a conductor of electricity in telegraphy—the Marconi Wireless Telegraph issues. John Hays Hammond is about to attend the international wireless conference in London, and in the meantime is erecting two wireless telegraph towers on his estate in Connecticut to be used in experimental work in directing dirigible submarines in the waters of Long Island Sound. It seems odd that one of the world's famous mining engineers should act as a delegate to a conference to further a means of communication which will do away with one of the chief uses of copper when the system is fully perfected.

Another condition that is undoubtedly having its effect is the fact that, while this country and all other units of the industrial world are experiencing an era of foreboding unrest and political chaos, the copper metal and share market manipulators are insistent on "working up" prices. This they are doing in the belief tht the public will be stampeded, as it was some seven or eight years ago, when stocks went soaring in sympathy with the boost of copper metal to 26c. a pound. But the boosters are reckoning without their host. The "suckers" won't take the kind of bait that is now being offered; they got snubbed too hard before. It is all right to discourse on the absorption of copper, but the public wants to know—if it has been used—who has used it and for what purpose. And on that proposition, to the utter disgust of the boosters, the public is "standing pat," as it ought to.

The Engineering and Mining Journal of the 22, after discussing other features of the situation affecting the price of copper and copper stocks, declares that "the recent advance in copper that has been unsatisfactory to many persons, but otherwise to well-wishers for the industry, has been the NONDEVELOPMENT OF AN OLD FASHIONED COPPER STOCK BOOM. (The capitals are ours.) It is true that most of the standard copper shares have risen in about the same ratio as the metal, but there has been no public excitement carrying prices up to a basis of 5 per cent yield on 17c. copper AND THOSE WHO HAVE STOCKS TO SELL ARE DISAPPOINTED. No doubt the public will save money, because there is no probability that copper will average 17c. over a series of years, and besides the best of the copper stocks ought to yield more than 5 per cent on the purchase price.

The absence of public excitement is possibly due to an increase in wisdom, but anyway it may be attributed to SUSPICION RESPECTING THE PRESENT SITUATION. Most people are convinced that the last six months have witnessed a substantial improvement in general business, but while that has been slow and orderly, as reflected in the iron and steel markets, THE COPPER MARKET HAS BEEN CRAZY, which discrepancy has not easily been reconciled; and, moreover, the MYSTERIOUS DISAPPEARANCE of the new production of copper has had the effect of creating doubt rather than of inspiring confidence.

FRENCH VIEWS OF CHINO

French investors are not taking kindly to the attempts of American market boomers and promoters of some of our so-called "porphyry issues" to market their wares abroad. First the French sat down hard on Utah Copper for good and sufficient reason and now, according to the news that comes through Paris financial and mining publications, they are paying their respects to the manipulators of Chino. On April 26, and again on May 3, this year, L'Argent tells its readers what it thinks of Chino in no uncertain terms. The April 26 item, translated, reads as follows:

Chino Copper—In the number of exotic values that the last raise in copper has produced, we find the Chino Copper. Of the total of 700,000 shares forming the actual capital of the company, the promoters claim more than one-half—that is, 375,000—in remuneration of their services. But, as they have a very limited confidence in the value of their mines, they say to themselves that it would be much better to imitate the rat in the hold before the ship sinks and to land with someone else the shares in their possession. It is for this reason that they attempt to unload on the French capitalist, whose pocket-book is the ideal type of the inexhaustible mine, a first slice of 200,000 shares. These shares, which have a nominal or par value of 25 francs ($5) are offered at 168 france ($33.75). That represents for the number of shares referred to, a speculation (profit) of 28,600,000 francs, or $5,720,000. The pill is a very large one and the public will have some trouble in swallowing it.

This criticism of the game Chino promoters had ribbed up for the French market followers probably called forth some "market letter" response, for on May 3 L'Argent devoted considerable space to the proposition and expresses astonishment that Chino's sponsors had the hardihood to attempt and that the Bourse representatives would permit the presentation of Chino Copper to the French public. Translated, the May 3 article handles the subject as follows:

Chino Copper—This enterprise, called porphyritic, became its tenor in metal is greatly inferior to the percentage of the true copper mines, actually offers its shares at an assessment six times higher than nominal, thus leaving to the eventual purchaser only the risk of a loss.

When a person addresses the public, one of the conditions necessary to attract attention is to present under a new form the product that he wishes to exploit. It is thus from a medical point of view that we establish a perfect evolution; in the well-to-do class, which is that of our readers, it is good taste and even snobbish to speak of neurasthenia and appendicitis; twenty years ago these two affections were simply called faintness and phlegm. One would have been ashamed to actually use these expressions, whereas now one often meets women who tell you with an air of superiority, "I have had an operation for appendicitis." This malady is indeed a privilege of a good table. It is the same from a financier's point of view—one must follow the style and, if need be, provoke it. This is what the introducers of "porphyric" mines on the Paris market have been very well understood. This work has dazzled some clerk of the exchange whose habit it is to talk a great deal without understanding anything; but whatever they may say of it, the copper industry is not yet ready to be revolutionized.

The properly called copper mines are represented by the Rio Tinto, the Boleo or the Tharsis. These exploitations treat generally pyrites or double sulphures of iron and copper, a sort of friable mineral which appears in blankets, in leads or in pockets. The mineralization is important and contains a percentage of from 3 to 3½ of metal. For several years the Americans have tried to extract from the copper the rocky masses, sort of blankets of a granitic porphyry, extremely hard, where the copper mineral chalcocite or chalcopyrite, is found irregularly disseminated in the form of little grains. The "porphyries" exploitations, instead of obtaining mineral easy to crush, require extremely powerful steam shovels to carry the rock, the hardest that exists, under crushers and to reduce it to dust. The mixture obtained passes then over screens and shaking tables where the inert matter is separated from the mineral because of the difference in densities. The mineralization does not compensate the different operations that we have just indicated, for it is expressed by the figures 1.4 or 1.6 per cent, as against 3 and 3½ for the real copper mines, as we have indicated above.

The porphyries are then incapable of competing with the European coppers, because the former make use of deposits that the latter disdain; thus the Tharsis has completely put aside a concession whose mineral tenor is only 2% copper. The American mines remain inferior from a mineralization standpoint. Besides, as the preparatory operations are much more tedious, their exploitation can only produce defective conditions; the price of the net cost of copper reached, in fact, the figures $180 (900 francs) and $200 (1000 francs) a ton at the time that the Spassky, situated in the heart of Siberia, 800 kilometers from the nearest railway, a distance that had to be traversed by carts or camels, offered the same metals at the rate of $180 (800 francs) a ton.

Under the circumstances we are astonished that they could actually present to the French public the Chino Copper stock. This stock, the nominal price of which is $5 or 25 francs tries to get into our pocket-books at $33 (165 francs) and $33.60 (168 francs). On a capital of $4,000,000, or 20,600,000 francs the Bourse here permits for the 800,000 shares a speculation of $22,280,000 (111,400,000 francs). It really makes one think that the credulity of the parsimonious buyer is fathomless and as limitless as infinity for these people to have the audacity to propose to him a slice of this size. Independent of the capital stock, there exists a mortgage debt of 12,500,000 francs in bonds at 6% which do not appear in the balance sheet of December 31, 1190, the only one, up to now, that the promoters have dared to show us, for it must be singularly difficult to find a real counterpart of this new sum in the assets of the company; the accountant of the company is surely forced to increase enormously its supply and stock of mineral.
* * *

UTAH COPPER'S GYMNASTICS

Seeing that the addition of 100,000,000 tons of new ore to the reserves of Utah Copper during the year 1911—as recently confided to the world in the company's annual report—had no effect on the market price of the company's shares, it is respectfully suggested that the management tell to what extent its "porphyries" are swelling this year, in semi-annual installments. Why not state, during July, that 50,000,000 tons have been added so far this year. According to previous figuring that would add about $65 more to the value of each share and might advance the market price 25c. or 50c., particularly if copper continues to soar as it has been doing every minute since the last annual report was issued. And whether such a statement advanced the market price of the shares or not, see how much sounder the "fundamental" and "statistical" position of the company would be. After the proposed 50,000,000 tons was added to the "blocked out" reserves, there would still be, according to the estimates of George L. Walker, about 150,000,000 tons more, in the gambler's parlance, to "nigger" with.

Arguing along the modest and shy lines that characterize the daily press and brokerage "market letter" utterances, Utah Copper had developed ore representing approximately $100 a share previous to 1910, for its present capitalization; $250 a share was added to that during 1910-11; the development of another 100,000,000 tons of ore this year would tack on another $125 per share in value and there would still remain another 100,000,000 tons—another $125 a share—for next year, thus rounding out Walker's estimate and giving the shares a real, dyed-in-the-wool-intrinsic market value of $600 a share. SO THAT THE INSIDE INTERESTS WHO ARE NOW STRAINING EVERY NERVE TO MAKE A MARKET THAT WILL PERMIT THEM TO UNLOAD must be willing to sacrifice about $540 a share in order to grab $60 in REAL MONEY per share. Funny, isn't it.

COPPERETTES

"Neither Utah Copper nor Navada Consolidated have EVER been active traders," says the well posted New York correspondent of the Mining and Scientific Press. But we fear that he does not read the list of "sales" of Utah Copper sent out from the New York "laundry" every day.

* * * *

It is reported to us that no underground-mined ore was treated in the Arthur plant of the Utah Copper Company during May, the reason given being that it was too hard to treat. Now what do you think of that? This mill was reconstructed to make it conform to the high standard (?) of the Magna plant—and now it won't work!—that is, it won't chew up tonnage fast enough to suit the management. Tonnage is what exigencies demand at both the Arthur and Magna mills all the time; recoveries are of secondary moment, because "copper is the cheapest thing we've got."

* * * *

Enriched by the "underground tonnage" from the Boston Consolidated Barnsdall properties of the Utah Copper mines, the rock put through the Magna mill during the month of May is reported to have run between 1.4 and 1.5% copper. The mill's recovery, it is reported to Mines and Methods, amounted to 52%. All of the steam-shovel product of the Utah Copper mine is now probably coming from what is likely to be designated in some of the future reports as "near ore," because the "partially developed" ore goes 1.28% copper without any "sweetening" from underground workings, all of which must have been mixed with the Magna feed last month.

MINING THE MAINSPRING OF INDUSTRIAL SYSTEM

By JAMES RALPH FINDLAY.*

Scientific understanding of natural forces underlies a prodigious expansion of industry and wealth. What does that wealth consist of? In the main it consists of marvelously improved vehicles of communication and travel; telephones, telegraphs, railroads, automobiles, elevators, and steamships; of comfortable and safe abodes built very often of steel and concrete; of innumerable factories capable of supplying nearly every luxury or utility we can think of. Our wealth consists of our ability so to use the natural elements of light, heat, gravity and chemical reactions that each man no longer has at his service merely the muscular effort of his own body and of the bodies of horses and cattle, but such great energies that with their aid one man may do what formerly required 10 or 20 men to do.

I wish to draw your attention to the fact that practically all the means for these accomplishments are supplied by our mines. We dig out of the earth not only our materials but our energy. The modern ship is as good an example as any. She is wholly built of and propelled by the products of mines. The energy which makes possible the very process of building is supplied by mines for almost every lathe and riveter in the world is driven by steam which is furnished by coal.

How shallow then is the idea so often entertained, and so casually expressed that the business of mining is a kind of gambling from which the prudent business man should carefully shy away! On the contrary mining is the mainspring of our whole industrial system.

What I wish to inquire into, is how far has this particular effort of civilization been accomplished. Have we gone nearly as far as we shall ever go in finding uses for minerals? Or is there still a vast field for expansion ahead? It is too big a question to be answered more than partially. It is plain enough that the expansion is still in full progress and that it is too big a movement to be stopped suddenly. This can be easily ascertained by the most casual inquiry into the facts, but it is a different and more difficult question when we come to look at it in its larger aspects.

We must expect some limit to the increasing use of minerals. The main cause for increase is the rising consumption per capita in the great industrial nations. In 1850 each person in the United States used 1028 lbs. of coal and about 75 lbs. of iron; in 1910 each person used 11,000 lbs. of coal and 600 lbs. of iron. How this enormous increase of consumption has taken place since a date when the age of steam and iron was already well started. Even in 1860, steamships went regularly between the principal parts of the world, railroads already connected the principal cities and steam engines were driving the principal factories. Yet in the 50 following years the use of coal increased ten fold. We have added in that time electric lighting, electric railroads, steel buildings, cement pavements, power elevators, automobiles, power-driven machinery, ocean cables, wireless telegraphs, and innumerable other avenues for the consumption of metals and of power.

If such an expansion is to continue for another 50 years we shall be using minerals with a lavishness that staggers the imagination. If it does continue then each person will use 120,000 lbs. of coal and 5,000 lbs. of iron every year with other things in proportion. Allowing for the increase of population such figures would mean a consumption of ten thousand million tons of coal and four or five hundred million tons of iron annually in the United States alone. This seems incredible and utterly out of the question. In other words I believe that the enormous expansion in the use of minerals will soon begin to slacken.

I said a little while ago that there is no present evidence of slackening. My idea is that approximately the same causes which are producing the general increase of population and particularly the growth of enormous cities are behind the great expansion in the use of minerals. The cities grow because transportation is easy and quick; the largest cities grow especially because the perfection of communication allows certain forms of business which otherwise might be scattered all over the country to be carried on to best advantage in the largest city. New York for instance is growing on a multiplicity of small manufactures. Forty odd per cent in number of the new manufacturing enterprises of the country are located there, but the average number of employes is only 24. Undoubtedly this goes on because a great center of population supplies artisans for each specialty, and because the city itself is the greatest single market. The highly improved transportation facilities naturally act to better advantage in carrying articles from big markets to lesser ones, than from lesser markets to big ones for a variety of reasons that will occur to everyone.

The general increase of population is without doubt due to the same causes. This increase is taking place only in the great industrial nations or in regions controlled by them. The improvements in the means of getting a living, the stoppage of useless wars and disorders, the stoppage of plagues and famines have all been caused by improvements in transportation and production. These agents have afforded populations which had been brought to a standstill by restricted living conditions another chance to grow.

But in the center of the world's civilization we find a great nation where the population is not increasing. I mean in France. The census figures show a marked decline in the birth rate also in the United States, and I believe the same facts are beginning to appear in England. An enormous and continued increase of population is I think generally taken for granted. As a general fact it cannot be disputed; but its unlimited continuance is a manifest absurdity, for a few centuries of increase like that of the past 50 years would multiply the human race until there would not be standing room. A check is inevitable, and I believe it is already perceptible.

Similarly we can find reason to expect a check to the growth of cities. This will come from the working out of the present cycle of industrial development. Whenever the perfection of transportation shall have brought all the people to the great cities who can profitably go to them in the pursuit of business or pleasure the disproportions to growth of those cities will cease.

My idea is that the most highly civilized, or at least most active industrial nations may be already somewhere near their maximum productively, although they certainly have not reached it. There are forces in action now which are plainly still adding to the industrial activity of the average man. While I don't pretend to have any special knowledge of mechanical matters I take no risk in stating that not one of the great systems of power utilization has reached its full development. I mean that a given million people are not yet fully supplied with electric lights, telephones, automobiles and other comforts and luxuries. To illustrate this I will give one or two specific examples. A classmate of mine is connected with the Boston Edison Electric Co. He told me that in 1896 that company had a total of 200,000 lights on its circuit. In 1908 it was adding lights with-

* Abstract of annual commencement address, Missouri Schol of Mines, May 31, 1912.

in the same territory at the rate of 200,000 each year, and expected to continue doing so for many years to come.

The practical gas engine is barely 20 years old but in that short time it has revolutionized certain forms of industry and is rapidly revolutionizing, through the automobile, what we may conveniently call neighborhood transportation. It has also made real a dream of many ages—the navigation of the air. But it occurs to me that any specific thing accomplished by the gas engine is of minor consequence compared with the fact that through it high-class machinery has become a plaything. It seems to me this may indicate that with us at least the great cycle of industrial development may be approaching its culmination. Let us dwell on this idea for a moment.

Water wheels have supplied industrial power for thousands of years, but, because no means had been invented for transmitting that power, that form of machinery was chained down to certain localities. The invention of electric transmission removed that shortcoming and the power from water wheels is rapidly becoming more usable. But generally speaking the manipulation of electrical machinery remains in the hands of the specialist; and certainly up to the present the mass of the people have not been accustomed to use machines driven by water power. The steam engine has been in use for about 125 years. Its usefulness has been and is stupendous, but the necessity of providing with each unit a cumbersome boiler has always confined its use to trained specialties. To be sure the use of both steam and of electricity has been gaining ground ever since they were made practical, but after all it remained for the gas engine to bring high-class machinery into the hands of the average man. There is enormous significance in this fact. Heretofore industrial efficiency has been growing because the use of machinery has been spreading from one class of people to another and from one industry to another. It has been growing because it could spread. When the use becomes universal there will be no such chance to spread. I am inclined to think therefore that we are within striking distance of the time when the highly civilized and creative nations will have put as many power-using devices into the hands of their citizens as they can use. Now since the principal use of minerals is to provide the means of utilizing power I argue that the consumption of minerals will reach its maximum amount per capita at the same time.

I will state the case in concrete form. Every person in the United States uses 600 lbs. of iron each year, and uses more each year. I would not like to state a figure of how much each person will ultimately use, for that would be mere guesswork; but we may be very sure that the amount will increase at least as long as the percentage of people who run automobiles increases. Since that point ought to be reached in a decade or two I argue that each person will increase his consumption of iron for that long, but not much longer. Let us see what this will mean to the steel business. In 1900 each person used 400 lbs.; in 1910, 600 lbs. At this percentage rate by 1920 each person would be using 900 lbs.; but suppose that the present decade is the culmination of the great power-using cycle, that the percentage rate will not be maintained and that the amount of iron used by each person increases only by the same number of pounds as during the last decade. We should by this calculation allow 800 lbs. per person in 1920. The population of the country by that time should be 110,000,000. The amount of iron manufactured by that time should be about 44,000,000 tons, against 26,000,000 in 1910.

Allowing that during the following decade the consumption would increase only 100 lbs. further per capita and allowing for the increase of population, the output in 1930 would be 60,000,000 tons.

What I am driving at is to put before you some ideas about the prospects of the mining business. One question for a young man to consider is what hopes to entertain. There is no use going into a form of activity which you do not believe in. I have used the figures just stated because I believe that they give a fair idea of the growth which may be expected in the mining business in the immediate future. It is perfectly fair, even conservative, to expect that the consumption of all mining products will double inside of 20 years.

I have had in mind thus far the progress of our own country only; let us consider the rest of the world a little.

The active industrial nations constitute today only a fifth, or perhaps a quarter of the human race.

We may specify only Great Britain and her English speaking possessions, Germany, Austria, Italy, France, Norway, Sweden, the Netherlands, and the United States as the really active industrial nations. The rest of the world is not altogether without the knowledge of power-driven industry, but its knowledge as yet is only borrowed and its application sporadic. If the whole race used iron as fast as the people of this country the annual consumption of the world would be at least seven times what it actually is. Now I conceive that the industrial ideas of Europe and America are sure to be adopted in some form or other by all other peoples until they become universal, just as agriculture in earlier times must have spread from some source until it became universal. One would be bold indeed to say when all this will be accomplished, for nations and races have an obstinate way of working out their own destines in their own way, but the events of the last few years contain many striking signs of the stirring up of intellectual life in Asia. Turkey and India have shown in different ways a capacity and desire for advancement. In India for instance a large steel plant has been started with native capital.

When we come to that word capital we reach one of the stumbling blocks of those nations that are industrially backward. According to many of our advanced labor unionists, capital and capitalism are the source of grievous economic injustices. Perhaps that is true, but whatever evils lie in the existence and domination of capital are surely counterbalanced by benefits that cannot exist without capital. I have lived in countries where there was little or no capital. There was likewise little or no industry, little or no security, little or no labor and mighty low wages. Capital is the symptom and the product of good morals, good government and fair dealing, as well as of energy and natural resources. It cannot exist without a general confidence in the integrity and ability of other people. Modern industry is most emphatically co-operative. The business or the enterprise owned by an individual is now a rare thing. The industrial unit is now the corporation, and that is created only by joint action and joint capital. People who are afraid to trust each other cannot form corporations and cannot participate very much in the best efforts of modern civilization. The progress of industry therefore in some countries may have to wait until the people prepare themselves for owning capital.

But at any rate there is an immense field for the further development of industry throughout the world. It is a fair presumption that the nations that are ahead now will continue to be ahead for some time. Undoubtedly they will find considerable business in furnishing the backward nations the facilities for making a start.

The proposition of mining with reference to the development of civilization and of industry is plain enough. The importance of minerals as the materials for industry has been steadily growing and must continue to grow. In our own country we may be somewhere near the point where we have as much mineral wealth per capita as we can find use for, but in the world at large that point is still far off.

LEACHING APPLIED TO COPPER ORE* (XIX)

ELECTROLYTIC DEPOSITION OF COPPER FROM SOLUTIONS (CONTINUED)

By W. L. AUSTIN.†

It has been repeatedly observed that in the electrolytic precipitation of copper from solutions with the help of insoluble anodes, iron salts under certain conditions interfere with the operation. Ferric salts produced at the anode attack copper deposited on the cathode, unless some means is taken to prevent their formation, or else to obstruct diffusion, should they be formed. Furthermore, iron present in an electrolyte is deposited with the copper when the voltage unduly rises owing to polarization. It is also readily deposited from a bath containing ferric sulphate, because this is decomposed at a lower theoretical potenial (1.62 volt) than the ferrous salt (2.02 volts). This is particularly the case when basic salts are formed through lack of circulation in the vat. The theoretical potential necessary to electrolyze cupric sulphate is 1.20, it being understood, of course, that, as with the foregoing voltages given for iron compounds, reference is made to electrolysis using insoluble anodes. Owing to causes stated it is evident that iron salts can under the given circumstances not only materially reduce current efficiency but also contaminate the copper. Recognizing these difficulties, some inventors have devised means for eliminating ferruginous salts from the electrolyte as far as possible; but as iron is usually present in ore, more or less of that element always finds its way into the bath.

USE OF A DEPOLARIZER.

In electrolyzing a copper sulphate solution, using an insoluble anode, oxygen is evolved at the positive electrode. The sulphuric acid produced by combination of the acid radical with water at the anode is also electrolyzed with evolution of hydrogen at the cathode. These two gases, oxygen and hydrogen, bring about counter-EMF which can reach formidable proportions. Several inventors have sought to overcome this disadvantage by introducing a depolarizer into the bath. Sulphur dioxide contained in the gases from ore-roasting furnaces is a convenient depolarizer for the purpose, as it combines with oxygen liberated at the positive electrode producing sulphuric acid. Reinartz demonstrated in his experiments that from 60 to 65 percent of the oxygen liberated at the anode can in this manner be brought into reaction with sulphur dioxide. Besides depolarizing, the acid accumulating in the bath lessens its ohmic resistance when otherwise it would increase as copper is removed by deposition on the cathode.

Another advantage gained by increasing the acidity of a bath through the introduction of sulphur dioxide gas is, that iron and zinc are not readily precipitated from such solutions and therefore the cathode copper is purer. These matters were discussed in Mines & Methods, Vol II, pp. 281-284, and the experimental data furnished in the article referred to should be of assistance to any one engaged in electrolyzing copper sulphate solutions with insoluble anodes. Referring to the tables given by Reinartz it will be noted that a considerable voltage was employed in those experiments when the electrolyte contained but little free sulphuric acid. It is also apparent that in treating impure solutions (amperage remaining constant) the electromotive force necessary to maintain the desired current-strength fell steadily as copper was removed from the bath and free acid accumulated in it. This was not so marked when iron was absent, as is shown in Table II. This fact, taken in connection with other phenomena to which attention was called in the article referred to, indicates that the presence of iron salts is an advantage when sulphur dioxide is used as a depolarizer.

It was shown in the preceding article that the average EMF theoretically necessary to remove copper from the 0.01-normal copper-sulphate bath under the conditions stated, can be estimated at approximately 4.93 volts—with electrodes 3 cm. apart and assuming all the copper to be removed in course of the operation. In Reinartz' experiments the weakest solution employed contained 2.54 percent copper =6.38 percent $CuSO_4$, which would be 0.8-normal, and this strength of solution was found to require a pressure of 1.9 volts. The electrodes were, however, 7 cm. apart at nearest point, with probably an average distance of 10.4 cm. because of the circular cathodes. To compare the theoretical results obtained in the first case with the experimental figures given by Reinartz, both must be reduced as nearly as possible to a common basis. To do this the first step to be taken is to ascertain the respective resistances offered by the two solutions to passage of the current.

COMPARISON OF METHODS.

The resistivity of 1 cm. cube 0.01-normal solution is 1394 ohms, whereas that of normal solution is only 39 ohms, the ratio being as 36 to 1; but the respective distances between the electrodes in the two cases are as 3 to 10.4. Three times 1394=4182 ohms represents the resistance between electrodes in the case of the 0.01-normal solution, and 10.4 times 39=406 ohms would be approximately that encountered in the Reinartz experiment. Therefore the ohmic resistance of 0.01-normal bath would be approximately 10.3 times that of a normal bath for equal cathode surface, notwithstanding closer proximity of the electrodes. As a matter of fact the ratio would be less than 10.3 because the resistivity of 0.8-normal solution is greater than that of a normal one; but on the other hand there was a considerable amount (quantity not given in the original) of free sulphuric acid in the bath, which would greatly lessen the resistance. Taking the working surfaces of the revolving cathodes at 819 sq. cm., and the current at 5 amperes as stated, the current density would be $\frac{5}{819}$ = 0.0061 amperes per sq. cm. To obtain the EMF necessary to drive 0.0061 amperes through a resistance of 406 ohms, the first must be multiplited by the second—$0.0061 \times 406 = 2.48$ volts. This would have been the pressure necessary had the solution been normal; but conductivity was improved by the free sulphuric acid added to the solution, and this, taken in connection with the development of auxiliary EMF through oxidation of sulphur dioxide to sulphuric acid at the anodes, benefitted the operation to such an extent that actual work showed 1.9 volt sufficed, although ohmic resistance of the 0.8-normal solution should have been greater than of a normal one.

Taking the cathode surface in operation at 819 sq. cm., the resistance of one cm. cube of Reinartz' bath of mixed copper and iron sulphates with sulphuric acid must have been (assuming the average distance between electrodes to

† Mining Engineer and Metallurgist, Riverside, California.

have been 10.4 cm.): $\frac{1.9}{0.0061} \times \frac{1}{10.4} = 30$ ohms. It has been shown in the article previously mentioned that current efficiency (as represented by cathode copper deposited) was 90 percent. The amount of current consumed in depositing 75 grams (=0.165 lb. avd.) of copper was $1.9 \times 5 \times 15 = 142.5$ watt-hours, or 0.1425 kilowatt-hours, which is equivalent to 1.157 lb. copper per kw-hour. At a cost of one cent per kw-hour, the expense in depositing 1.157 lb. copper would be $0.0086 per lb. This sum is less than half that estimated as required in the previous example.

To sum up. In the first example a weak solution containing 0.03 percent of copper sulphate was used, which had a high resistivity, and the electrodes were placed 3 cm. apart. In the second example the solution contained 2.34 percent copper, but the electrodes were 10.4 cm. distant from each other. In the second case a depolarizer was used. In the first place under the conditions assumed the expense was two cents per pound copper deposited; in the second it was less than one cent, and at the same time a strong solvent liquor was prepared for use in extracting metal from new material. It follows, that in depositing copper electrolytically from sulphate solutions, employing insoluble anodes, there is manifest advantage in using fairly concentrated solutions, as also in introducing a depolarizer. The experimental data supplied by Reinartz' researches are of special value in illustrating the advantages of depolarization. It will be noted in the Reinartz experiments that use of a diaphragm was dispensed with because it was found that sulphur dioxide prevented formation of ferric salts at the anode. The iron in the bath was, therefore, beneficial in that it assisted in converting sulphur dioxide into sulphuric acid. It should be further noted that in many of the Reinartz experiments the current efficiency at the cathode amounted to 100 percent.

VALUE OF THERMAL CALCULATIONS.

The principal value of calculations such as those given in the foregoing lies in their affording a basis for estimating the comparative efficiency of different methods—for instance, the relative costs of deposition by electrolysis or cementation are readily calculated; also the approximate expense of electrolyzing solutions of varying copper content. Or the relative amenability to electrolysis of cupric and cuprous chloride solutions as compared with each other, or with cupric sulphate, can be approximately shown. A rough estimate of the amount of power required for a given purpose is also possible; but to the result reached through recourse to thermochemical data it is always necessary to add a surplus to provide for consumption or power from sources other than those calculated upon purely thermochemical lines. When the bath is fresh and the anodes are new, an operation may proceed approximately according to theoretical estimates; but after a while the consumption of energy in a bath creeps up, when solutions derived from ore leaching are electrolyzed without introducing some auxiliary.

Among the causes which conspire to increase consumption of electromotive force is the change in concentration of solution in proximity to the cathodes, unless good circulation is maintained. As copper is extracted from the bath the catholyte is correspondingly diluted, and weak solutions interpose greater resistance. Then films of gases which collect on both electrodes set up a current which flows in the opposite direction to that of the main one. Even the metal deposited on the cathode when not firmly adherent, interposes resistance. When solvents of copper, such as the ferric salts, are permitted to reach the cathode, the work of the current is partially nullified by the metal going again into solution. Then the contacts and conductors absorb energy. In estimating current absorption in electrolytic copper refining, where, of course, soluble anodes are used, loss in the dynamo has been given as 10 percent, and that in the conductors as 22 percent, so that with current efficiency 90 to 95 percent of the theoretical, only from 62 to 66 percent of the energy consumed finds useful application.

As to choice between salts of the metal to be subjected to electrolysis, there is not much difference from the point of view of EMF necessary for their decomposition. Taking the respective heats of formation of copper sulphate and chloride as represented by the following thermochemical formulae, and dividing each by the valency of copper when present as cupric salts, the following quantities of energy represented in calories are found necessary for their decomposition:

$[Cu, O, SO^3aq] = \frac{55,960}{2} = 27,980$ calories.

$[Cu, Cl^2] = \frac{62,710}{2} = 31,305$ Calories.

Now one volt-coulomb (= one joule = one watt-second) is the electrical unit of *energy*, and has been determined by experiment to be equivalent to 0.239 calories. To decompose the sulphate and chloride of copper requires the application of as many electrical units of *energy* as are respectively represented by the following equations: $\frac{27,980}{0.239} = 117,071$, and $\frac{31,305}{0.239} = 130,983$ volt- coulombs. An electrical unit of *energy* can be expressed as the product of two factors, one being of the nature of a *quantity* and the other of *pressure*. A coulomb (= one ampere flowing for one second) is the unit of *quantity* of electricity (not of energy), and by experiment it has been determined that 96,540 coulombs is the *quantity* of electricity associated with a gram-equivalent of any univalent element, or with half a gram-equivalent in the case of a bivalent. This quantity of electricity will suffice to separate half a gram-equivalent of copper from either of the bivalent salts above mentioned; but, as shown in the number of heat-units absorbed in their formation, it requires more energy to break up the combination of elements composing one of these salts than it does the other. Were the heat of formation of a given salt, as determined from thermochemical data, represented by exactly 96,540 volt-coulombs (=96,540 amperes flowing for one second at one volt pressure), then the voltage necessary to decompose this combination would be clearly one volt. It follows that if the energy as given in volt-coulombs is either more or less than 96,540, the voltage required to break up the combination will be proportional to the number of times 96,540 is contained in the figures representing the said energy. In the cases of the two copper salts under consideration, the theoretical voltages necessary for their decomposition are respectively $\frac{117,071}{96,540} = 1.21$ volt, and $\frac{130,983}{96,540} = 1.36$ volt.

VOLTAGE REQUIRED TO ELECTROLYZE CUPROUS CHLORIDE.

Where copper is univalent, as with cuprous chloride, the theoretical voltage required would be greater than in either of the foregoing instances, as is evident from the following. $[Cu, Cl] = \frac{32,875}{1} = 32,875$ calories = heat of formation. The energy necessary to break up this combination, expressed in units of electrical energy is $\frac{32,875}{0.239} = 137,552$ volt-coulombs. From which follows that the theoretical voltage necessary to carry out the operation is: $\frac{137,552}{96,540} = 1.42$ volt.

Although one ampere of current separates 1.1 gram of bivalent copper per hour, and double that amount of metal from a univalent copper combination, the energy required to separate equal amounts of metal from the two salts is evidently not also in the ratio of one to two. It was shown above that 96,540 coulombs at 1.36 volt pressure is the theoretical amount of energy necessary to deposit half a gram-equivalent of copper from a bivalent salt, while in the case of the univalent combination the same quantity of electricity at 1.42 volt will separate a whole gram-equivalent. Therefore, to separate equal amounts of metal from cupric and cuprous solutions will call for an expenditure of power in the proportions 2.72 to 1.42. Reduced to percentages, the energy theoretically necessary to deposit copper from a cuprous salt is only 54 percent of that required to deposit the same amount of metal from a cupric, assuming the heat of formation to be 32,875 calories: taking the calorific power at 35,400 calories, as given by some authorities, the voltage required for decomposition of this salt would be of energy would be 57 per cent. 1.54, and the corresponding expenditure of energy would be 57 per cent. It will be shown later that the operation of depositing copper from cupriferous solutions is more complicated than is indicated in the simple reaction 2CuCl + Electricity=Cu+$CuCl_2$, and that the results given require to be modified.

In the Hoepfner process, to which reference has been repeatedly made in these articles, copper is dissolved out of the ore by means of a solution of brine carrying cupric chloride, the cupric salt being the active leaching reagent. The resultant liquor is electrolyzed in vats, the anodes and cathodes being separated by diaphragms. Upon entering the vats the liquor is divided into two streams, one flowing through the cathode compartment, the other through the anode. The Hoepfner process was very carefully thought out, and was intelligently applied. It is essentially a chlorine process, and was thoroughly tested upon a working scale at several places. Its history, therefore, reflects much light upon the application of chlorine lixiviants to ore-leaching operations. In lixiviating any ordinary copper ore with a solution of electrolyzed cupriferous brine, naturally more or less iron will be taken up which cannot be profitably eliminated, so that the electrolyte must necessarily be ferruginous. Judging from the published accounts of the practical working of the Hoepfner process such was found to be the case, and means were devised for removing iron salts when they accumulated in too large quantities.

THE HOEPFNER PROCESS.

Cupric chloride ($CuCl_2$) in attacking mineralized copper is converted into cuprous chloride (CuCl) which is dissolved in the excess of brine present, and therefore the liquors flowing through the electrolytic vats carry the metal in the cuprous state. In the cathode compartment copper is deposited, while in the anode compartment an equivalent quantity of CuCl is raised at the same time to $CuCl_2$. Considered from the standpoint of thermal chemistry, and neglecting heats of solution, the energy absorbed in these reactions should be as follows:

[Cu^2, Cl^2]=65,750 calories absorbed.
[Cu, Cl^2]=51,630 calories liberated.

Difference 14,120 calories absorbed.

These figures represent, however, the energy required to decompose two gram-equivalents of the cuprous salt, and to form one gram-equivalent of the cupric chloride. Both, therefore, require two Faradays for their decomposition, or what amounts to the same thing, both must be halved before dividing by 96,540 volt-coulombs. It follows that the voltage necessary to carry out decomposition of CuCl in the cathode compartment, with formation of $CuCl_2$ in the anode compartment, will be theoretically: $\frac{14.120}{2} \times \frac{1}{0.239} \times \frac{1}{96.540} = 0.3059$ volt. In addition to the voltage necessary for chemical reactions, there will be required EMF to overcome omhic resistance of electrolyte, contacts, diaphragm, and conductors.

To compare the theoretical working of a Hoepfner cell with the results obtained by Reinartz previously mentioned, let it be assumed that the distance between electrodes is 10.4 centimeters, and that the active cathode surface is 819 square centimeters. One hundred cubic centimeters of a 15 percent NaCl solution at 14° Celsius will hold in solution 3.5 grams cuprous chloride, and such a solution at 18° C. has a resistivity (ohmic resistance of one cubic centimeter) of 6.1 ohms. Therefore the ohmic resistance of 819 sq. cm. cross-sectional area of the saline liquor (disregarding salts of copper, iron, and other metals) would be $\frac{6.1 \times 10.4}{819} = 0.0774$ ohm. Taking the current density at 0.0061 amperes per sq. cm., or 5 amperes for the 819 sq. cm., the voltage necessary to overcome ohmic resistance of the cell would be $0.077 \times 5.0 = 0.387$ volt. The theoretical voltage absorbed between electrodes in one cell would be therefore 0.3059+0.387 =0.6929 volt, and adding 0.2 volt for resistance at contacts would bring the total up to 0.9 volt.

To arrive at the theoretical amount of copper deposited in one day, it is necessary to multiply the quantity, (2.368 grams) deposited by one ampere in one hour from a univalent combination, by the number of amperes of current passing through the apparatus: 2.368×5 amperes×24 hours = 284 grams =0.62 lb. avd. per day. Five amperes flowing at 0.9 volt pressure for 24 hours=0.108 kilowatt-hour, and the quantity of copper deposited per kw-hour is: $\frac{0.62}{0.108} = 5.74$ lb. avd.

THEORY AND PRACTICE.

This result is merely an approximation, of course, because a statement of all the factors which enter into the equation is not available, but it is interesting to compare it with results said to have been attained in the practical working of the process. In one instance it was stated that in practice the actual EMF found to be required was from 0.6 to 0.8 volt, and that with a current (=0.0025 amperes per sq. cm.) of cathode surface, in 24 horse-power hours strength of 2.3 amperes per square foot (=17.9 kw-hours) deposited 133 lb. copper. This would be $\frac{133}{17.9} = 7.43$ lb. of copper per kw-hour. Now, 2.3 amperes flowing for 24 hours at 0.6 volt pressure equal 0.03312 kw-hour. But 2.3 amperes will deposit in that time 2.372×2.3×24= 131 grams (=0.29 lb.) copper. Therefore, theoretically 0.03312 kw-hour should have deposited $\frac{0.29}{0.03312} = 8.75$ lb. copper, so that the actual cathode efficiency as stated is 84.9 percent of the theoretical.

The result given compares very favorably with those obtained in electrolyzing sulphate solutions, and it is easy to understand why methods designed to extract copper from ore as cuprous chloride, with subsequent electrolysis of the cuprous solutions, should have received so much attention. The question naturally arises, why have none of these processes achieved lasting commercial success?

In the case of the Hoepfner process, the fact that the patentee found it desirable to take out several patents subsequent to the main process patent, having for their objective the removal of iron salts from the liquors, indicates that these interfered seriously with this method of ore reduction. That he also had difficulties with his anodes and diaphragms is shown by patent applications for improvements designed to meet such troubles. Furthermore, while cupric chloride will attack copper sulphides, it is nevertheless a weak reagent, and must in consequence work very slowly. To handle a large quantity of ore would necessarily require a plant of considerable proportions, so that the tardiness with which the solvent works, together with the cost of additional apparatus used in purifying liquors, would offset in a measure the theoretical advantage to be gained by electrolyzing the cuprous salt.

If the attempt is made to increase the solvent-power of the lixiviant by raising the voltage in order that chlorine shall be liberated at the anode, then a number of other reactions take place which complicate the situation. Taking the calorific power of [Na, Claq] =96,510 calories, the theoretical voltage necessary for its decomposition is. $\frac{96.540}{0.239} \times \frac{1}{96.540}$ =4.18 volts; but in solution, owing to formation of NaOH this is reduced to 2.29 volts. At this pressure, augmented by that necessary to overcome ohmic resistance, the brine of the bath will be decomposed, hydrogen appearing at the cathode and chlorine being liberated at the anode. But long before this point is reached, ferrous and ferric sulphates and chlorides will be subjected to electrolysis, as will also cupric chloride and sulphate. Ferrous chloride is electrolyzed at (theoretically) 2.16 volts, and cupric chloride at 1.36 volt (1.6 volt is given by one writer), if, therefore, the ohmic resistance of the circuit is increased in any manner whatever, so that it reaches the point at which ferrous chloride is decomposed, then ferric iron will appear in the anolyte and metallic iron will be deposited on the cathode with the copper. Even when the EMF is raised only a little above that required to decompose cuprous chloride, cupric chloride is attacked with evolution of chlorine.

COPPER REFINING DIFFERS FROM COPPER EXTRACTION.

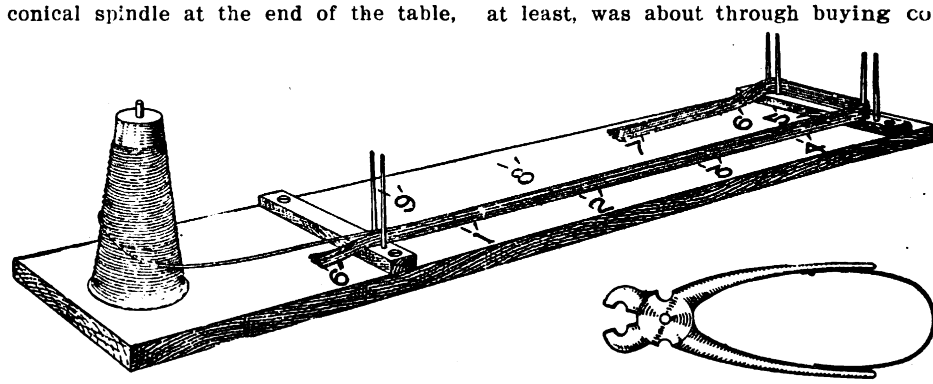
Working with insoluble anodes and a diaphragm, and a constantly changing electrolyte, is not such a simple operation as where soluble anodes are employed, for instance, in electrolytic copper refining. In the latter process the composition of the electrolyte is practically constant, and polarization is not to be feared. The probabilities are that the rocks upon which the Hoepfner process split were, weakness of lixiviant, uncontrollability of voltage, and shortcomings in the mechanics of the electrolytic cells themselves. A paper written by E. Jensch, and published in Chem. Zeitung for 1894, page 1906, goes into the difficulties which arose when attempts were made to put this process into commercial operation.

Attention has been repeatedly called in these articles to the unsatisfactory results obtained when depositing a metal electrolytically in the same apparatus in which a lixiviant for that metal is being generated. Any method of ore-reduction undertaking to carry out such a scheme is heavily handicapped, just as is the case with a smelting furnace designed to smelt ore in the upper part and bessemerize the resulting matte in the crucible. Both operations may be successfully carried out separately, but interfere with each other when performed in one and the same piece of apparatus. In the case of electrolysis, the problem confronting metallurgists would be greatly simplified if deposition of the metal, and preparation of the solvent, were considered from the standpoint of two separate operations. This statement may possibly have to be modified when applied to processes employing a depolarizer, but these methods have yet to be demonstrated upon a commercial scale.

The whole subject of electrochemistry was literally in its infancy some twenty-five years ago, and its applicability to ore-leaching operations has not yet received due attention on the part of men financially able to carry experiments from the laboratory through to commercial demonstration. Entirely new electrochemical methods have been discovered in late years for separating metals, not only from each other, but also from ore. Along some lines the art of electrometallurgy has met with encouragement, so that now many of the most valuable metals are obtained almost exclusively by electrical methods. Electrometallurgy of copper has been held back, however, through the failure of the old, purely chemical processes to meet modern conditions, as well as by the impractical methods advocated by some of its devotees.

TABLE FOR CUTTING FUSE

The accompanying drawing shows the design of a table for conveniently cutting fuse. It is used at the Blackberry and Montana mines, near Joplin, Mo. The coil of fuse is carried on a conical spindle at the end of the table, and from this spindle the fuse is unwound as it is measured. The fuse is held between a series of two 60-d. nails driven into two cleats of 1x2-in. wood that are screwed to the table. The cutting is done six inches ahead of the first pair of nails, so that there are no long, loose ends in the way. On the table are marks which are used in measuring the several lengths of fuse usually required.



In cutting the fuse, the loose end from the coil is run through the first pair of nails, taken around the turning nails, passed through the last pair of nails that hold the loose end when the fuse is being cut, and the end is pulled along to the mark indicating the length desired. Then with the fuse cutters the fuse is cut off at the other end, and another piece of fuse, measured until all the fuses have been cut, the different pieces being left securely held between the nails until the miner is ready to cap them. To aid in the cutting, the fuse cutters, which are ordinary crimpers, are made with a spring rivited to one of the handles, so as to keep the jaws apart. This increases the speed of cutting the fuse somewhat, and makes the use of the crimpers more convenient.

One of the local dailies on the morning of the 10th printed an Associated Press resume of market conditions in New York which, among other features mentioned: "The fresh advance was accompanied by a fair consensus of hopeful views of the business and financial prospects FROM VARIOUS AUTHORITIES, including THE REPUTED LEADER OF THE ORGANIZED MARKET MOVEMENT TO ADVANCE STOCK PRICES THIS YEAR. * * * The approach of July settlements abroad brings tightening money conditions. PUBLIC WARNINGS have been issued BY GERMAN FINANCIAL AUTHORITIES against undue extension of banking credits for speculation and THE DANGER OF COLLAPSE of a LONG-CONTINUED BOOM in industry." This would seem to indicate that Germany, at least, was about through buying copper. And it shows, also, that the APPARENT strength of the market is still entirely due to the manipulations of those big interests which are determined to unload on a gullible public.

Mica prices vary with the size of the sheet. According to D. B. Sterrett, of the U. S. Geological Survey, it is not possible to give absolute prices of manufactured sheet mica from the lists of dealers, since discounts allowed vary with the nature of the purchases. The prices of the sizes given in the table below are quoted from a standard list for 1911. Discounts ranging from 70 to 10% are allowed on stove mica and from 60 to 10% on electrical mica.

Prices per pound quoted for stove and electrical mica for 1911:

Stove Mica.		Electrical Mica.	
1½ by 2	$1.20	1 by 3	$ 1.75
2 by 2	2.00	1 by 6	5.50
2 by 3	3.50	1½ by 4	2.75
3 by 3	3.75	2 by 4	3.50
3 by 4	7.00	2 by 7	7.25
4 by 6	9.50	3 by 9	11.00

CALIFORNIA GOLD DREDGING INDUSTRY

IN FOURTEEN YEARS THESE FIELDS HAVE CONTRIBUTED $48,000,000 TO NATION'S WEALTH

By AL. H. MARTIN.

Successful gold dredging in California dates from March 1, 1898, when W. P. Hammon and Thomas Couch placed a crude single-lift bucket-elevator dredge in commission at Oroville. The growth of the industry since then has been one of the rapid, important developments in world gold mining. In the brief span of fourteen years California dredges have produced in excess of $48,000,000, with the last three years particularly productive. Practically all of this has been contributed by the Oroville, American River and Yuba River fields, but recently important dredge activities have commenced in smaller districts, notably in Trinity, Calaveras, Siskiyou and Shasta. The California dredging field has been proven from Siskiyou, in the extreme northern part of the state, to Merced, a south-central county, and numerous previously neglected districts are promising to become important producers. Not only are new districts claiming interest, but some of the older sections also, due largely to the great reduction in operation and extraction costs attending the construction of the modern 15-cubic foot boats. The advent of these mammoths has enabled operators to profitably work deposits formerly considered valueless.

Aside from extension of the fields and construction of dredges of steadily increasing capacity, the greatest advance has been the reduction of working costs. In the earlier installations eight to ten cents per cubic yard of gravel handled was considered a good working rate, but with larger boats this was cut down to six cents. Subsequent installations steadily decreased expenses, until the new 15-cubic foot boats are easily handling gravel at an approximate cost of two cents per cubic yard, with even lower rates attained under particularly favorable conditions. From the 3-cubic foot dredge handling about 1,250 cubic yards daily, the capacity of the gold boats has increased to 15,000 cubic yards daily with the 15-cubic foot craft in action. The amount of yardage handled and costs established naturally varies under changing conditions, yet some of the best extraction and low-cost records have been made in fields noted for the deep deposits and difficult ground. This is indicated by the low costs and high yardage handled in the American River, or Folsom, field where much of the gravel is compact and difficult to handle, compared with the easily worked Oroville material. The building of large dredges appears in its infancy, and there are many California engineers who anticipate the construction of dredges exceeding 20 cubic yards before many years have passed.

The larger dredges naturally can only be profitably employed where the deposits are sufficiently extensive to justify the high initial cost. At present their use is confined to the three main fields, but an 11-cubic foot boat has been recently erected in Trinity county, near Lewiston, and similar large boats are planned for other outside districts. When the gravel is of limited extent the employment of a small dredge is virtually compelled, and operating costs are correspondingly higher. But the increased gold saving efficiency and generally cheaper power now obtainable in practically all districts have enabled operators to profitably handle small deposits formerly considered of scant merit.

YUBA RIVER LEADING FIELD.

The leading productive field is the Yuba River, located in Yuba county. This field is maintaining an annual gold output exceeding $3,300,000, with ten dredges in commission. Dredging in this field commenced in 1904, six years after the first boat went into action at Oroville. Two California type dredges, Yuba No. 1 and No. 2, were installed by W. P. Hammon and R. D. Evans in August, after an expenditure of nearly $100,000 in prospecting. This work continued two years, during which time about 300 test holes were drilled to depths ranging from 60 to 70 ft. The proven field has been developed for an approximate length of five miles and has an average width of one mile, but at times widening out to four miles.

During the extensive hydraulic mining operations prevailing in the early days of California, enormous quantities of tailings were washed down the Yuba river and its tributaries and deposited over the placer bed underlying the Yuba Basin. It is estimated that half a billion cubic yards of hydraulic tailings were deposited yearly, burying the river channel gravel to a depth of ten to 40 ft. Some gold exists, but not in sufficient quantity to justify working. The gravel rests on a bedrock of volcanic ash, strongly resembling the Oroville deposit, and ranges 40 to 90 ft. deep, with drill holes in some instances locating gravel and gold to a depth of 110 ft. below water level. The deposit yields ten to 30 cents per cubic yard throughout, and in dredging a portion of the soft, sticky bedrock is excavated. The natural water level ranges from several feet above to four feet below surface.

It was early seen that to work the Yuba River deposit satisfactorily large and powerful dredges must be provided. The two first boats installed were the first of their kind to excavate to a depth of 60 feet below water level, and several improvements were made to reinforce the digging apparatus and other equipment. In 1905 the Yuba Consolidated Gold Fields was organized to acquire the Hammon and Evans interests, and the rapid progress of the district virtually dates from this time. The new company was incorporated with $12,500,000, and immediately proceeded to install a number of California type dredges of the most powerful design. The later boats are excavating to a depth of 65 ft. below the water line, and one of the best low-grade records in California dredging was established by the 15-cubic foot boat of this company early in 1912, when gravel was handled at a cost below two cents per cubic yard. The holdings of the Yuba Consolidated Gold Fields embrace 3,000 acres. The Marysville Dredging Co. is operating on 600 acres of dredge lands adjoining the Yuba Cons. estate on the west.

OROVILLE AND TRIBUTARY DISTRICTS.

Oroville and its tributary districts, Wyman's Ravine, Honcut Creek and Butte Creek, ranks after the Yuba River field in production. Here was incepted the modern California dredging industry in 1898, and the particularly favorable natural conditions have materially aided in keeping the field to the front in subsequent years.

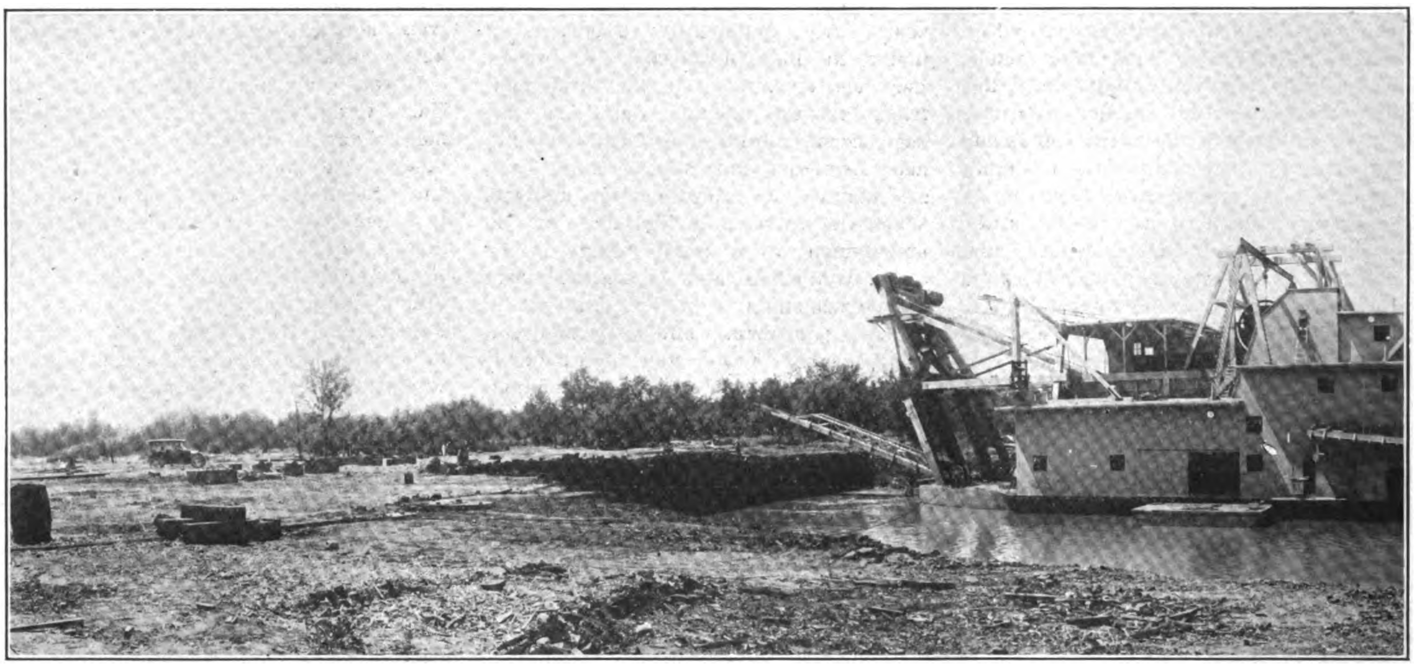
To date over $22,000,000 have been produced by the Oroville dredges, and although the major portion of the field has been dredged, a sufficient extent of proven ground remains to insure activity for several future years. The bedrock is volcanic ash with the gold-bearing deposits ranging generally from 25 to 40 feet in depth. Most of the gravel is easily worked, and the numerous dredges in commission have experienced little trouble in handling the deposits.

In the outlying districts the gravel and formation closely resembles the main field, with the gravel clean, loose washed and dredged with comparative ease. Twenty-seven dredges are in commission in the Oroville field and its tributaries, ranging from small 4 cubic foot boats to the 15-cubic foot mammoth of Natomas Consolidated of California. Most of the dredges have capacities ranging from 5 to 7 cubic feet, the ease with which operations are Oroville Dredging, Limited, Pacific Gold Dredging Company, Oro Water, Light & Power Company, and two or three smaller concerns. The Butte Creek Cons. Gold Dredging Company is operating a 13 cubic foot dredge in the Butte Creek division of the field.

AMERICAN RIVER SUCCESSES.

Closely pressing the Oroville district for second honors as a gold producer, with the likelihood of winning the race before the close of 1912, the American River, sometimes designated the Folsom, district in Sacramento county claims particular attention. Operations in this district have had a commanding influence on the evolution of the California dredge, and its operators have demonstrated their ability to handle ground previously considered too refractory for dredging. Activities were of six to eight feet partly cemented. The succeeding 25 to 30 feet is exceedingly compact, but below this the gravel is worked without difficulty. At first it was considered impossible to dredge this deposit without continuous blasting, which besides materially increasing costs, made work difficult and unsatisfactory. After repeated trials, it was found best to undermine and break down the upper 20 to 30 feet by employing hydraulic monitors, leaving the lower deposit readily accessible. Outside the Rebel Hill belt the deposits have a general depth of 20 to 30 feet.

The Folsom Development Co. in 1905 undertook the construction of Folsom No. 4 dredge, the pioneer of the modern California type of gold-dredge. Radical departures from accepted types was the order, and the entire craft was con-



This Illustration Gives a Perfect Idea of the Manner in Which Dredging for Gold in California is Now Being Carried On. The Left Page View Shows a Long Stretch of the American River Field Being Divested of Its Buried Wealth by One of the Great Dredges of the Natomas Company; the Right Page Half of the Picture Shows the Tailing's Dump.

conducted facilitating the profitable operation of the small boats.

In the early days of the field only the richest portions were worked, and several small tracts of good ground occur among the old dredged holdings. The gold-saving methods in the old days were far from efficient, and it is estimated that considerable sums were lost in this way. These factors have stimulated interest in plans to redredge the old workings, engineers believing the deposits still contain sufficient auriferous values to pay dredging with boats of the largest type. This may eventually result in the re dredging of the major portions of the old field. The principal operating companies are Natomas Consolidated of California, incepted in the spring of 1899, one year after the first California dredge went into action, with the Colorado-Pacific Gold Dredging Company the pioneer. This was composed of Colorado people, with R. G. Hanford, manager. From the first it was apparent new and untried problems must be conquered before the great gravel deposits could be successfully mined. The field contains two distinct belts, one exceedingly refractory, the other easily worked by ordinary methods. The refractory belt is known as the Rebel Hill deposit, and the difficulties experienced in handling this gravel developed a new era in California dredging.

The Rebel Hill belt ranges from 50 to 75 ft. in depth, with the upper strata structed along broadly progressive lines. The boat was partly designed and constructed by the company in its own machine shops, with the Bucyrus machinery employed. The bucket line supported 68 13-cubic foot buckets and the single-bank gold-saving tables were replaced by a double bank arrangement. The hull was massively constructed to withstand the strain of the heavy machinery, and shaking screens installed to facilitate the handling of large quantities of material. The boat was built along the original plans of General Manager R. G. Hanford, in face of adverse criticism of many prominent engineers. The first few weeks of operation were followed with keen interest, and when it became apparent that the new boat was a brilliant success, it was realized that a new era in California dredge-building had arrived. The dredge handled approximately 250,000 cubic yards of gravel per month, and established an average working cost of three cents per cubic yard, a figure that stirred the interest of the most conservative.

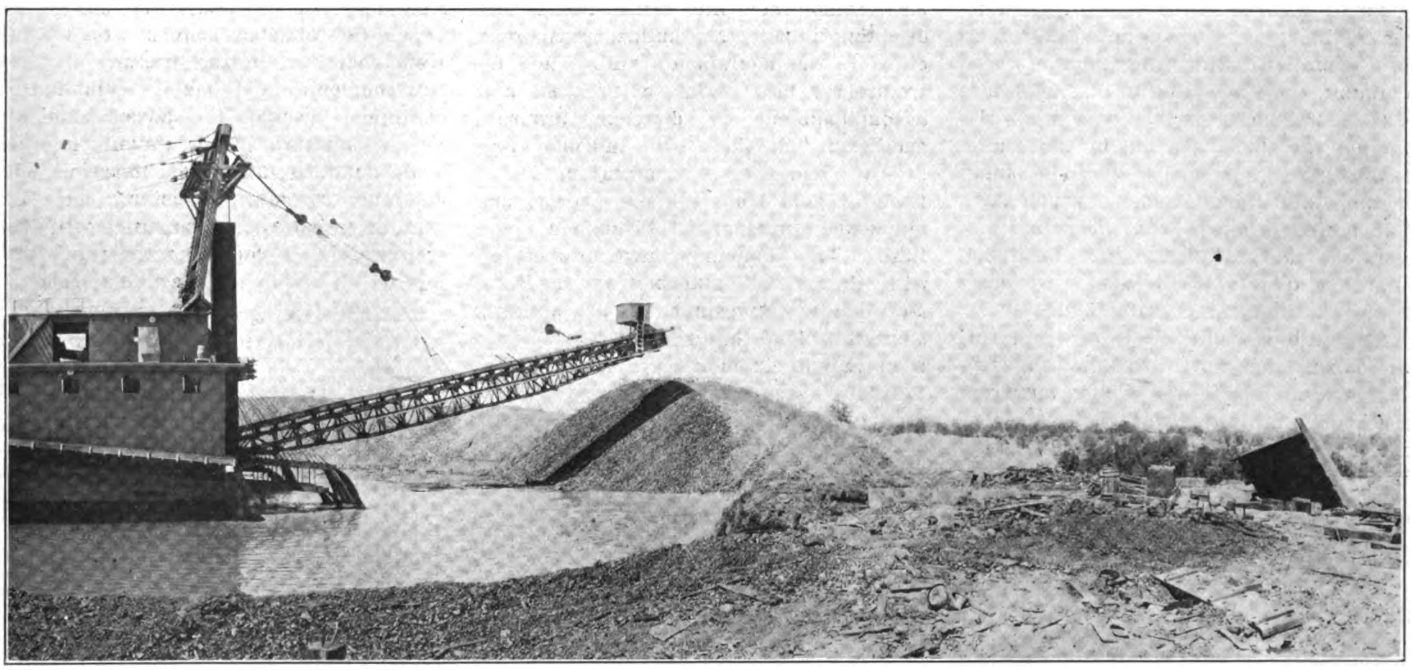
Flushed with the success attending its venture, the Folsom Development Company arranged to conquer Rebel Hill. Accordingly Folsom No. 5 was constructed. This was the first gold-boat ever equipped with hydraulic monitors and was constructed along heavy lines to withstand the terrific strain it was evident must be considered. The buckets were of 9 cubic feet capacity, and two monitors, with three-inch nozzles, were mounted in the bow. A high head centrifugal pump, driven by two 50-horsepower motors, supplied water. This dredge went into action December, 1905, and immediately demonstrated its ability to handle the most refractory material. Considerable difficulty was experienced in handling the immense quantity of material and it was apparent that the washing facilities must be augmented.

The work of altering the equipment was turned over to the Western Engineering & Construction Company, and numerous improvements made. The shaking screens were replaced by others of the revolving type, and upper bank of gold-tables and a longitudinal sluice placed on both sides of the dredge, and a gold-saving contrivance placed in the save-all. Other work was done to lessen the strain and increase digging efficiency. Bucyrus machinery continued to be used. The reconstructed boat proved remarkably efficient and most of the subsequent installations in the Folsom field have been modelled along the lines developed by the experience with No. 5.

GIANT DREDGE CONSTRUCTION.

With the acquisition of the Folsom Development and other companies by Natomas Consolidated of California, January 1, 1909, the era of giant dredge construction dawned. This company, capitalized at $25,000,000, immediately proceeded to build several boats of the largest type, with the climax attained in the recently commissioned No. 10. This boat, like its predecessors, No. 8 and No. 9, are of the 15-cubic foot single-lift bucket elevator type, and was designed especially to dredge the Rebel Hill deposit. It is also the first all-steel dredge ever built in Califronia, the hulls of earlier boats being composed of wood. The bucket line consists of 90 15-cubic foot, close-connected buckets, and the dredge has a theoretical capacity of 450,000 cubic yards per month. The plate-girder digging ladder has a length of 119 feet and excavates to a depth of 55 feet. The buckets are built in three sections, securely riveted. The hood is composed of ½-inch steel plate, and the bottom of high-carbon steel reinforced under the back eye by an inserted plate of manganese steel. The lip is manganese steel, with a cutting edge 13 inches wide and two and one-half inches thick. Each bucket weighs about 3,700 pounds, and total weight of digging ladder, rollers, bucket line and auxiliary equipment exceeds 700,700 pounds. The tumblers are fashioned from high-carbon steel and cushion plates from chrome nickel steel. The 90 bucket-pins are made of high-carbon steel, oil tempered and annealed. Manganese steel composes the 184 bucket bushings. Digging ladder and bucket-line are operated by a 400-horsepower 2,000 volt variable speed motor.

The total weight of equipment exceeds 2320 tons, or a greater tonnage than many vessels. The steel hull displaces 920,000 pounds, a reduction of nearly 300,000 pounds from wooden hulls of identical type and dimensions. The saving of weight by the employment of steel reduces depth of hull from 12½ feet to 10½ feet, permitting operation in more shallow ponds. The dimensions of the hull are: length 150 feet, width 56 feet, exclusive of the overhanging five-foot decks on each side. The steel hull is expected to outlast about two ordinary wooden hulls, and it is understood initial costs closely approached the figures involved in wooden hull construction. Besides insuring long life for the dredge, the steel hull forms an excellent protection against fire, an element that has ended the career of a number of California gold-boats. Ten dredges are operating in this field, nine owned by Natomas Consolidated, and one by the Ashburton Mining Company. The present annual yield of this field is about $1,500,000.



TRINITY FIELD IN LIMELIGHT.

The latest field to claim particular attention has been developed in Trinity county, in the extreme northwestern portion of California. The placer deposits of this region have long been noted for their prolific wealth, and operations have been largely conducted by hydraulic methods. This county is exempt from the generally unfavorable California laws regulating hydraulic mining, as the streams are unnavigable, drain directly into the Pacific, and the adjoining lands are higher than the rivers. As a result hydraulic mining has flourished since the earliest days, and the county has long led all other California sections in this respect. However, in some instances hydraulic mining has not proven completely satisfactory, absence of sufficient water and topographical conditions militating against long seasons and the desired low costs. The result has been the adoption of dredge mining. Three dredges are active in this field, of which the largest is the 11 cubic foot boat of the Trinity Dredging Company.

Small dredges are operfating in Calaveras, Siskiyou, Shasta and other foothill counties, with the suction type claiming some attention in Shasta, where one or two boats of this type are working on the upper portion of the Sacramento river. Exclusive of some small suction and dipper dredges, which have not figured to much extent in actual production, the California gold fleet embraces a total of 63 dredges. Of these 51 are in the three main fields.

The outlook is distinctly favorable for an expansion of the dredging industry for several years to come, improved methods and lower working costs permitting the handling of low grade material in the old fields, while auriferous belts in the newer regions offer much promise. The onward march of the goldboats in the lower Sacramento valley has been to some extent checked by the agitation of sentimentalists, who hysterically clamoring the dredges were ruining good farming land beyond redemption, have fought the operators viciously. But the wise policy adopted by Natomas Consolidated and other far-sighted companies is steadily overcoming the prejudice that has so long prevailed. By removing the rock and reducing it to road and structural material the unsightly tailings are being eliminated and the planting of the cleared land has strikingly demonstrated the fertility of the soil.

At Oroville and other centers trees, crops and vineyards flourish on reclaimed land, and numerous acres formerly worthless for agriculture have been transformed into fertile tracts. The dredging industry has builded prosperous cities in the Sacramento valley, and introduced a new regime of progress and accomplishment in districts formerly smothering in their own infirmity and dry-rot. Factories have sprung up, and a flood of gold from the old placers has quickened prosperity throughout the State. The companies have co-operated with the Debris Commission and the State and Federal Governments in building barriers to hold the turbulent Sacramento river and its tributaries in leash during the flood seasons, and otherwise contributed to the upbuilding and advancement of their particular fields.

REINFORCED CONCRETE IN MINE SHAFT WORK

By E. R. JONES.*

This evening, as at another time, I find that I am acting in the capacity of lieutenant of Mr. Uren. Mr. Uren has already gone into the subject of concrete construction, generally, and in some detail, and it has been left to me to furnish some information on reinforced concrete as applied to shaft construction.

I wish to thank Mr. S. R. Smith of the Ahmeek Mining Company, and Mr. Will Smith of the Mohawk Mining Company, for information furnished me.

That which follows deals principally with the making and installation of concrete, and most of the information which I may be able to furnish you has been acquired through personal experience and intimate contact with the work.

Since the cost of material for the making of concrete varies widely with the locality and the property, and there is also a discrepancy in the wage scales of the different mining companies, any detail of costs would not only prove tiresome but would be of little value, except where conditions were exactly similar to those below described, so that, where cost is mentioned, it will be for the purpose of comparison in a special case with timber which the concrete has supplanted.

For a number of years solid concrete and reinforced concrete shaft collars and shafts have been in vogue where the conditions warranted a shaft of any degree of permanence, but not until nineteen hundred and nine was reinforced concrete tried as a substitute to take the form and similar methods of installation as the long-used timber sets for shaft purposes; namely, at the No. 3 and 4 Shafts of the Ahmeek Mining Company.

In the beginning, two distinct kinds of material were used; a good grade of gravel and natural sand from a local pit; and the trap rock, through which the shafts were sinking, together with clean conglomerate sand from the C. & H. Mill. Sets were moulded from these two classes of material and installed with equal partiality and subsequent service has proven both to be equal to the demands made upon them. Pieces set aside for the purpose were allowed to season sufficiently that they might be given a fair competitive test, and it was found, on comparing the fractures in the two combinations of material, that the sand and cement filling the spaces between the rounded pebbles broke away from them, while the fracture in the trap-conglomerate same combination continued through the larger elements of the mixture. The gravel mixture could doubtless have been improved considerably by careful washing, but the cost of preparation, compared with the trap rock and conglomerate sand, prohibited its use in this particular case.

MATERIALS AND PROPORTIONS.

The materials finally used were as follows:

No. 1. Portland cement. Conglomerate sand. Trap rock trommeled over ¾-inch through screens.

The proportions used were 1-3-5 in wall plates, end plates, and dividings, and 1 2-4 in studdles. The reinforcement in wall and end plates consisted of three ¾-inch Monolith steel bars with ¼-inch webs, crimped onto them, together with two straight ¾-inch Monolith bars. The dividings were reinforced by four ½-inch Monolith steel bars wound spirally with ¼ inch steel wire, the whole presenting a column with square cross-section. Studdles were reinforced with two pieces of old wire rope 1¼-inch in diameter. Reinforced concrete slabs were moulded for the shaft lining, the material used being fines of trap rock under ¾-inch, conglomerate sand and Kahn expanded metal as reinforcement. The mixture used for slabs was 1 2-4. By way of experiment, the writer selected a piece of No. 1 hemlock plank of the same length, width and thickness of a concrete slab, which had seasoned for one year, supported them at either end, and placed them side by side, and then applied an equal pressure across the center of each. Three failure cracks appeared in the concrete slab just previous to the breaking of the hem-

* Read before the association of mining engineers of the copper country, the Michigan College of Mines Club at Houghton, Michigan.

lock plank, although total collapse of the concrete slab did not occur until the pressure was considerably increased. While the method of the test employed was crude, it proved to the satisfaction of the writer that the concrete slab was much superior in strength. Considering the rapid decay of timber used as shaft lining, no further comparison of the two is necessary.

In the moulding of the concrete sets, 2-inch No. 1 white pine was used in the construction of the forms. These were soaked in Delaney's wood preservative, and repainted with preservative on the interior each time before setting up, thus insuring them against warping and prolonging their lives indefinitely, as well as securing a smooth and easy parting from the concrete when removed. A Smith barrel type mixer was employed in preparing the charge for the forms. The amount of water used in the mix was such that, when the batch was piled, it settled rapidly without agitation. A dryer mix was attempted by way of experiment, but due to the amount of reinforcement employed, it was found impossible to ram the dryer mix into place.

The labor involved in the making consisted of two carpenters, setting up forms and keeping them in repair; one man wheeling forms onto skidways ready for filling, returning used forms to shop and cleaning the same; one man feeding mixer from stock piles of rock, sand and cement; one man delivering mix to forms and shoveling material into place; and one mason ramming charge into final position. With this combination of men as many as four complete sets, consisting of 64 separate pieces, have been moulded in one day of nine hours. In ordinary weather, the sides of the forms were allowed to remain in position over night, and then removed, while the bottoms were left in place another twenty-four hours. The bottoms were removed by turning the pieces on their sides, where they were left to harden one day longer before removal to the stock pile. All through the process of removal, the sets were handled with the greatest care in order to preserve the appearance of the set and prevent cracking, which might not develop to the eye until weathered. All skidways used in making and storing were brought to a level to prevent warping and bending while the sets were green, to insure a perfect fit underground, for unlike timber, the concrete set cannot be brought to place unless perfectly true. Sets should not have been used under sixty days after removing forms, although we, through the reduction of the stock piles, have been forced to install pieces of fourteen days set, but the greatest care was observed in handling and putting in place underground. Concrete sets one year old, which have been subjected to all manner of weather, can be abused somewhat and handled almost as carelessly as timber.

As before stated, the above mentioned sets were made for the No. 3 and 4 shafts of the Ahmeek Mining Company. The shafts are of the three compartment variety—two skidways and one manway, dipping at an angle of 80 degrees. The outside dimensions of the compartments are:

Shipways—7 feet 6 inches high; 6 feet 10 inches wide.

Manway—7 feet 6 inches high, 3 feet 0 inches wide, with the end plates and dividings, making the greatest span of 7 feet 6 inches. Offsets were moulded in all plates 5 inches from the inside face to accommodate lining slabs. Also, holes were cored for the use of hanging bolts and bracket bolts. The wall plates, end plates and studdles have a cross-section of 80 square inches —dividings 81 square inches. The percentages of reinforcement are approximately as follows:

Wall and end plates	5%
Dividings	5%
Studdles	3%

It was found advisable from the beginning, because of the great weight of the wall plates, to mould them in two sections, one section spanning the ladder way, and one skipway, and the other section spanning the remaining skip compartment. These two sections were connected when in place by two bolts passing through holes, cored for the purpose, and two straps of iron spanning the splice. Studdles were made for 4 feet 0 inches, 5 feet 0 inches, and 6 feet 0 inches sets to accommodate the ground passed through.

The weights of the different pieces comprising the set are as follows:

Long section of wall plate	1,035 lbs
Short section of wall plate	700 lbs
End plate	600 lbs.
Divider	645 lbs
3 feet 3-inch studdles	268 lbs.
Complete set of 16 pieces	8,104 lbs.

LINING THE SHAFT.

Taking the weight of No. 1 western fir, which has been exposed to the weather in stock piles, as 33 pounds per cubic foot, the above concrete set weighs almost three times that of a 12x 12-inch timber set which the concrete set is intended to replace. Because of this additional weight of the concrete set, it was found necessary to increase the usual five or six men on the timber gang to seven in number. In a vertical shaft, to which the concrete sets are especially adapted, the number of men per gang might again be reduced. The sets are hung or built as the ordinary timber sets, only requiring an additional rope and block to swing the pieces in place. After the sets are wedged to line, bottoms are put in between the plates and the surrounding shaft wall, and the set is then tied to the shaft wall by means of concrete, in the proportion of 1-3-5. The concrete slabs are then put in place, and loose rock thrown behind them, filling up what space still remains between the set and the wall of the shaft.

After the set is in place, it is extremely important that it be well protected from the blast, for, unlike the timber set, concrete will not stand the blast. For this purpose, the writer used flat timber and steel plates chained to the under side of the plates and dividings, and even this precaution was at times inadequate. Where the ground was breaking easily, the sets have been as near as twelve feet to the miners, and again, when the ground was especially refractory, sets forty feet from the blast have been cut out. It is obvious that it is well to keep as far behind the mining as the ground will permit. In dangerous ground, which required timbering close up to the sinking, timber sets were used, but, had not time played an important part in the sinking, no ground was met in which concrete sets could not have been installed. With a gang of seven men, one complete set can be installed in a nine-hour shift. This permits a sinking rate of better than one hundred feet per month, which was accomplished at the No. 3 and 4 shafts.

The comparative cost of the concrete set and timber set, delivered at the shaft collar, is striking. The concrete set was delivered for $22.50, the timber set for $37.60. These figures are based on:

Western fir @ $28 00 per M, f. o. f. car.
Crushed rock @ .35 per yard, f. o. b. shaft.
Conglomerate sand @ .60 per yard, f. o. b. shaft.
No. 1 Portland Cement @ 1.15 per bbl., f. o. b. works.
Reinforcement @ $12.00 per set, f. o. b. factory.

The Ahmeek Mining Company, I believe, was the first to adopt the concrete stringers, and the Mohawk Mining Company soon followed with their use. At the Ahmeek, these stringers have been in continuous use since the beginning of operations and have required no repairs. Supt. Smith of the Mohawk has informed me that soon after the stringers were installed, skip repairs increased about one hundred per cent.

The stringer being entirely rigid and the skip also of rigid construction, the axles of the skips were found to be crystallized and the rivets working loose. This feature was overcome by moulding 2-inch pine strips, after preserving them in Delaney's Wood Preservative to prevent decay, into the stringers at intervals of three feet, allowing them to project one half inch above the face of the stringer, and resting the rail thereon. The pine strips have been in place four years, and none have been replaced to date, and skip repairs have been reduced to normal. Possibly because of a differently constructed skip, Ahmeek repairs were not abnormally high but the same racking of the skip body occurred and the Ahmeek Company has adopted the Mohawk feature and expects to profit accordingly.

Concrete plats, or stations, have been in use at both the Ahmeek and the Mohawk for some time. They differ from the timber plat in outward design only in the cross-section of the members, which are 9x12 inches, and are reinforced with old rail and wire rope, and replace the 12x12 inch and 12x14 inch timber formerly used. Holes are cored to accommodate gates for skip and dump doors and tram rails are imbedded in the concrete, making the use of spikes unnecessary. When turn-tables are used on the back of the plat, the rigidness furnished by the concrete insures the trammers against derailed cars, resulting from a tilted table.

At the present time, our company is installing reinforced concrete dividings to replace the practice of putting in ten-inch flat timber. In cross-section they are 9x12 inches, and are reinforced by old rail. On the ladder road, they are placed six feet from center to center and between the skip compartments are put in as often as the hanging requires. Since the casing along the ladder road performs no other office than the protection of the men while on the ladder, or in case of a fall, plank is used for the purpose, and a 3 inch hemlock strip is moulded into the dividings to facilitate the fastening of this casing.

PAINSTAKING FOR GOOD WORK.

Quite often in the placing of concrete and reinforced concrete, both above and below ground, not enough attention is paid to the character of the men employed in charge of the mix and actual distribution of the material. It is not enough, that the work shall look finished and neat on the removal of the mould boards, which any gang of men can accomplish with only this end in view. The placing of concrete where strength is desired, as well as weight and finish, requires the greatest care and judgment. Men should be selected who will see that the fines are uniformly distributed with the coarser material, for, unless the rock of the mixture is made to well overlap, congregation of coarse material and fines will accumulate which will result in a weakness, which often cannot be detected after the work is completed. The ideal method of placing the mix is by hand with shovel, but in shaft work this method is slow and requires extra labor, where the work is situated some distance from the place of mixing. Where chutes are used to convey the mix to its destination, the larger material arrives in advance of the fines, making an even distribution difficult and at times impossible. The writer has eliminated this feature by placing traps at regular intervals in the conducting launders, for the purpose of retarding the larger particles, thus securing a more even mix at the end of the launders than at the beginning.

Concrete has long been used underground for bulkheads, forks, open gutters and casings for fire doors and cannot be surpassed for these purposes. As applied to shafts, the material is comparatively new, but each succeeding year marks its advance, and in the end, timber will have been entirely superseded. For much of the underground construction, timber is still the rival of concrete, but, due to the increasing scarcity of the timber suitable for mine use, it cannot long remain as such, and must soon make way for the more plentiful materials, concrete and steel.

PEN PICTURE OF NEW YORK

The New Yorker supposes the United States are so called because they are not separated from each other by the Hudson River. New York, although the metropolis of the western world, is located on a group of islands east of New Jersey. The archipelago is made up of Manhattan Island, Long Island, Staten Island, Governor's Island, Blackwell's Island, Bedloe's Island, the Emerald Isle, and Standard 'Ile. New York was discovered by persecuted Netherlands and named by the piratical English; it is owned by expatriated Americans, governed by evicted Irish, populated by wandering Jews and homeless Yankees. The resident of the metropolis is the original man without a country

The government of New York is hybrid, like its population. Its charter contains all the misfit paragraphs of the other thirty-three thousand charters of American cities. It is in some respects the most wonderful document ever produced by the hand of man (with the aid of scissors). It is fifty times as long as the United States Constitution and proportionately obscure. Its main function is to enable the tail (Manhattan) to wag the dog. The supremacy of the city hall is variously regarded. Long Island is stung by it, Staten Island is stung less by Manhattan's mastery than by Jersey's mosquitoes, the Emerald Isle is green with jealousy, Standard 'Ile makes light of it, while Harlem no longer has its goat.

The outlying parts of New York are inhabited by respectable but honest people, who cling to terra firma in spite of Bronx cocktails and the Brooklyn Eagle. Manhattan is the haunt of the high rollers, the submerged tenth, and the tourists, who are generally half-seas over. Hence, the generous naughtycal provisions, such as Raines Hotels, syndicate theatres, the 'L roads, Jersey fairies, and the Broad way which leadeth to number twenty-six.

Ever since the city was founded by moving "Vans," the population of New York has been restless and unstable, but the pace of today beats the Dutch. Three-fourths of the people are hunting for work, the other fourth for play, and neither group is happy when it finds it. This incessant activity results in fireproof skyscrapers and marble palaces, inflammable tenements and incendiary yellow journals, Fifth Avenue feathers and femininity, and Bowery boys and booze, luxurious hotels and prolific sweatshops, high bridges, high prices, and high life, (also Metropolitan life and New York life), the dead beat of Tammany and the antiquities of the Metropolitan Museum, the New Theatre and the new woman, the newest railway stations and the latest scandal, an amorphous public library and an embryonic cathedral. In Brooklyn, one may even find homes!

New York is unabashed by the heavens above, the earth beneath, or the waters under the earth; its towers pierce the heavens, its subways the earth, and its tunnels the sea. Despite subways and tunnels, subterranean restaurants and borough halls, the senior editor pointing to heaven and the contributing editor giving them hell, life is chiefly on the surface. The streets are full of hair-breadth escapes, beauty is skin-deep, books and milk are skimmed, and business is on edge. New York may be superficial but it is not unlettered! It is true it is unacquainted with the U. S., ignorant of the meaning of D. V., and scornful of T. R., but it honors the I. O. U. of John D., and is ruled by the O. K. of C. F. Murphy.—Twentieth Century Magazine.

It is reported that the Homestake Mining Company of South Dakota recently encountered a considerable body of high grade free gold ore in its lowest levels.

Edison's New Method Of Ore Separation

A few weeks ago the newspaper press of the country was flooded with accounts of a new process of extracting metals from ores by which Thomas A. Edison proposed to revolutionize the industry of mining and convert worthless masses of rock that might contain even infinitesimal quantities of gold, silver, lead, zinc or copper into bonanza mines. No one at all familiar with mining and milling paid serious attention to the flamboyant stuff thus paraded as "news," and which failed utterly in the presentation of descriptive detail realizing, in the first place, that a man like Edison—nor anyone with authority to speak for him—would father such "wild and wooly" publicity concerning any invention that might have as an object the simplification or improvement of methods now in vogue for the separation of mineral from the gangues or matrixes in which it may occur. The one prevailing impression that the articles referred to seemed to convey was that Mr. Edison had perfected a solvent of some mysterious character that would extract values from ores of very low grade with such ease and at such small cost that almost any kind of rock carrying mineral could be worked at a profit.

In a letter wherein he comments on what the newspapers have been saying, Mr. Henry B. Clifford, president of the Clifford Exploration Co., of New York, among other things, says:

Over a year ago we interested Mr. Edison in the question of an improvement in concentration, utilizing his fine grinding rolls as the basis for the prevention of sliming. During the past year we have made considerable progress in making higher savings from the finer meshes, and also in the general separation of the metal in complex ores, dividing the lead, zinc, iron and copper by a system of concentration. These experiments have been conducted in a large 100-ton unit in his laboratory at Orange, but there is yet considerable to be done before we will feel justified in erecting a practical plant.

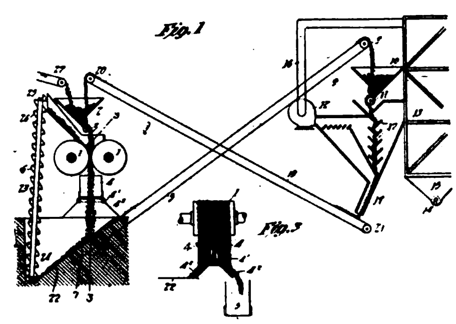
Mr. Edison does not anticipate entering mining or milling, but by his arrangement with ourselves, if this improvement works to his satisfaction, we are to attempt to commercialize it by erecting a large plant somewhere in the west, that a thorough demonstration of its practicability can be made before offering the improvement to the mining public. Mr. Edison has made no claims whatever, as we are still experimenting on the problem.

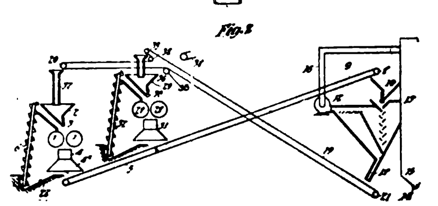
What I desire more to impress, is that he is not working upon a solvent; simply an improvement in concentration.

With this explanation by Mr. Clifford, it will be of interest to those who have been following the subject—and particularly the general reader—to learn just what Mr. Edison is attempting in the way of ore concentration. The following description of his latest patented ore-separating devices—granted March 12, 1912—was written by G. J. Rollandet and published in Mining Science, of Denver, on the 13th of the present month:

THE EDISON SEPARATORS.

The object of the invention here described is to increase the capacity of that class of appliances connected with crushing machinery, which comprises a crushing system and a blowing or other separating system whereby the fine ma-





terial sought, such as Portland cement, can be removed from the body of the pulp and the coarse returned to the crusher to be reground.

As an introduction to the description of his invention, Mr. Edison states that in a patent issued to him January 22, 1907, for apparatus for grinding and separating fine materials, a system is described in which the product from a plurality of rolls passes to one common belt conveyor system, whence it passes down through a number of blowers connected with dust chambers for settling the dust blown out; the tailings of the separator, that is the material from which the fine dust has been so separated, falling upon one common conveyor system to be returned to the several crushing rolls for regrinding. Where the material to be handled is very hard, the percentage of fines, that is of material sufficiently fine to be utilized as desired, is small for the amount of material handled, and it is very desirable to relieve the conveyor system of so large a non-effective bulk, and to increase the capacity of the blowers or other means which may be employed for separating out fine material. This result is attained in a very simple manner by connecting to each roll an elevator and an adjustable deflecting plate beneath the roll, whereby any desired portion of the ore, after passing through the rolls and which would in the system shown in the patent above referred to, go directly to the blowers, is deflected to the elevator and returned to the rolls locally and re-crushed, thus enriching the ore which is conveyed to the blowers.

In the following description of Mr. Edison's invention, reference is had to the cuts accompanying this article, in which Fig. 1 represents a diagrammatic view of the system embodying the invention, in which a single pair of rolls only is shown. Fig. 2 is a diagrammatic view showing the manner of carrying out the same method with a plurality of crushing rolls used in connection with a common conveyor system, and Fig. 3 is a sectional view taken on line 3 3 in Fig. 1, showing the deflecting plate below a pair of rolls.

Referring to Fig. 1 of the drawings, the crushing rolls 1 are provided with ore or other material to be crushed from the hopper 2, which is provided with a roller feed 3 for feeding the material to the rolls in a wide, thin stream. The material crushed falls from the rolls in a stream which may be intercepted by an adjustable deflecting gate or plate, which is indicated diagrammatically at 4. The deflecting plate 4 is shown in full lines as intercepting the stream of falling crushed material midway to divide it evenly in two parts. The plate is shown as pivoted at 4^1 and may be tilted transversely to the direction of rotation of the rolls to such a position as to divide the stream of material in some other proportion, such a position being shown in dotted lines. Stationary guide plates 4^2 are shown below the pivot 4^1 to guide the streams of ore divided by the plate 4 to the conveyor 5 and the inclined surface 22. The material so divided passes part to the endless, continuously operating conveyor belt 5 leading to the blowers, and part to the continuously operating elevator 6, which returns the same to the feed for the rolls. The gate 4 may be adjusted to effect any desired ratio of division of the crushed material.

BLOWER SYSTEM OF SEPARATION.

As indicated, the conveyor 5, which rotates over wheels 7 and 8 at either end thereof, carries the ore to a separator 9. While any suitable form of separator may be used, it is preferred to employ a blower system, as shown, wherein the material falling from the conveyor 5 into a hopper 10 is fed by a roller feed 11 into the path of a current of air blown by a fan or blower 12. The air blown by blower 12, and carrying with it the fine, dust-like particles contained in the falling stream of ore, passes into a series of settling chambers 13 in which the dust settles and from which it may be removed by means of a conveyor 14 passing through the hopper 15 in the bottom of the chamber. The supply of air for blower 12 is drawn through a tube or passageway 16 from the dust chamber itself, so that a closed circulating system is thereby provided in which the ill effects of changes in the condition of the outside atmospheric air are prevented. The stream of ore falling from the roller feed 11 in the path of air proceeding from the blower 12 is intercepted and delayed in order that the air currents may properly separate the fine particles therefrom by means of baffle plates 17, as shown.

The tailings from the separator pass through a spout 18 on to a continuously operating conveyor 19 carried by rollers 20 and 21, which return the said tailings to the hopper 2 to be again passed through the rolls 1. The portion of the ore passing through the rolls 1, which is deflected by the gate 4 into the local system, passes down the inclined surface 22 from the bottom of which it is removed, as stated, by the continuously operating elevator 6 and fed into the feed for the rolls as above stated. The elevator 6 is shown as consisting of an endless belt 23 passing over rolls 24 and 25 and provided with buckets 26, atlhough any other form of conveyor by which the ore deflected might be continuously conveyed to the hopper of the crushing rolls might be employed as well as the form indicated.

In Fig. 2 of the drawings the same system is represented with the addition of a second pair of crushing rolls to indicate the manner of proceeding when a plurality of such rolls are used in the system. Here, as in the case of Fig. 1, the ore fed to rolls 1 by roller feed 3 is separated by deflecting gate 4 into two divisions, one of which is carried by conveyor 5 to separator 9, and the other of which is guided by inclined surface 22 to elevator 6 to be conveyed back again to the feed for the rolls 1.

Ore for the rolls 28 is fed from hopper 29 by means of roller feed 30 and is deflected in a similar manner to that described in connection with the first named pair of rolls by means of deflecting gate 31 into two divisions, one of which falls upon the conveyor 5 and the other of which is elevated by the elevator 32 to be added to the feed for the rolls 28. The tailings of the separator 9 fall from spout 18 upon conveyor 19, whence they are conveyed back to the feeds of the several crushing rolls as indicated in the figure. The conveyor 19 passes over the rolls 20 and 21 at the ends thereof as in the case of Fig. 1, but it also is guided by rolls 33, 34 and 35, so that a portion of the ore carried thereby may be fed into hopper 29 for rolls 28, while the remainder of the ore is carried to hopper 2 for the rolls 1. This is arranged by having the conveyor provided with rolls 33 and 34 so positioned as to conduct the conveyor 19 past the hopper 29 with an upper and a lower run, whereby the conveyor in passing over roller 33 unloads ore through chute 36 into hopper 29 to an extent equal to the capacity of the rolls 28, while the remainder of the ore carried by the conveyor 19 is caught by the lower run of the conveyor and carried onward to chute 37 of hopper 2. Crude ore from the stock house may be added to the system at any convenient point as by the conveyor 38 indicated diametrically in the figure.

HOW THE SCHEME WORKS.

As an example of the use of the invention, if it be supposed that 300 tons of ore pass through a pair of rolls per hour with 10 per cent of fine material of the required size therein, 300 tons would have to be handled by the conveying system and blowers per hour to obtain 30 tons of fine material in a system of the type indicated by the letters patent above referred to, and before the addition of the invention described herein. If, however, say 150 tons of the 300 tons crushed per hour by the crushing rolls in this illustration be removed by the deflecting gate, passed to the elevator and thence again crushed by the rolls, the latter would still be crushing 300 tons of ore per hour and the blower or separator would be separating nearly 30 tons of fine material per hour as may be demonstrated mathematically, but the conveying system and the blowers would be carrying only 150 tons per hour.

It should be noted that when the deflecting gate is set in its middle position, a given amount of uncrushed material is fed into the rolls in a given short time interval from the belt 19 and from the stock house, and an equal amount of material partly crushed or fine and partly uncrushed is fed into the rolls from the continuously operating elevator system. A given percentage of the uncrushed portion of the material is crushed in passing through the rolls, and all the material is divided in half, one part going off on belt 5 to the blower and the other part being returned to the rolls by elevator 6. Each portion must average the same percentage of fine material. The portion of material, crushed or fine and uncrushed or coarse, returned locally to the rolls, meets in the hopper an equal amount of material, all coarse, from belt 19 and the stock house, and the operation of crushing and dividing is repeated, the same given percentage as before of the uncrushed part of the material being reduced to fineness in the passage of the whole through the rolls.

It will be seen that in continuous operation the percentage of fines in the material returned locally to the rolls increases rapidly at the start and approaches a maximum, which in the example given seems to be approximately 27.3 or not far from 30 tons of fines per hour, an equal amount of fines, of course, being carried off by the belt 5 to be blown. Therefore, if the capacity of the conveyor system was 300 tons per hour, two sets of crushing rolls could be used therewith in place of the one set previously used, in which case 300 tons of material would go over the conveying system per hour with approximately 55 tons of fine material removed per hour by the blowers. In the device illustrated in Fig. 2, for example, if the capacity of the conveyor 5 is conceived to be 300 tons per hour and the capacity of the sets of rolls 1 and 28 to be 300 tons per hour each, and the gates 4 and 31 to be so adjusted as to divide the stream of ore falling from the rolls 1 and 28 into equal parts, 150 tons per hour would then be deflected by the gates to the conveyor 5 from each set of rolls, and 150 tons per hour would be deflected from each set of rolls to the elevators 6 and 32. With the blower separating then approximately 55 tons of fine material per hour and the conveyor 38 from the stock house making up the deficiency thus occasioned, the conveyors 5 and 19 would be operated up to their capacity of 300 tons per hour and 150 tons of ore per hour would be fed into each of the hoppers 2 and 29 from the conveyor 19 and 150 tons per hour into each of the said hoppers from the elevators 6 and 32, whereby each set of rolls would be supplied with sufficient material to operate at its capacity of 300 tons per hour.

PRESERVATION AND DECAY OF MINE TIMBERS

By G. B. McDONALD.*

The subjects of decay and seasoning of timber are more or less closely associated with the matter of preservative treatment. Decay in wood is an organic process caused by low forms of plant life, either bacteria or fungi. The bacteria are microscopic in size but the fungi become quite conspicuous when the fruiting bodies appear on the surface of the wood. The fungi consists of small threads which penetrate the wood structure and these are the real cause of decay rather than the fruiting bodies commonly known as punks or brackets. Under proper conditions the spores produced by the fungi gain access to the wood structure and decay soon begins. The spores of the rot producing fungi may gain access to the timber either before or after the timber has been felled. However, it is generally the case with mine timbers that the disease is contracted after the timber has been placed in the mine, due to its close proximity to other decaying timbers. A rough wood furnishes excellent place for the lodgment of spores and also good conditions for holding moisture, thus hastening the process of decay. Although timbers may have been sufficiently treated externally with some good preservative, yet the spores often gain access to the interior of the stick through season checks or cracks which are not thoroughly protected by the preservative fluid. It is frequently the case that a fungus is growing in the timber before the tree is felled. If the fungus is subsisting on live wood and is not able to survive on dead tissue, the felling of the timber causes the death of the fungus and avoids further decay from that source. If the fungus is developing in the heart wood of the tree, which is practically dead tissue, the rot may continue to develop after the tree has been cut down and worked up into mine timbers.

Wood is composed of small cells which are made of cellulose; around these cells is a substance known as lignin. Some species of fungi attack only the cellulose of the woods, others only the lignin around the cells, and still others disintegrate both lignin and cellulose causing a complete breaking down of the wood structure. After the wood is first attacked by a fungus, discoloration takes place and later the wood fibers are changed to such an extent as to make the wood soft, brittle, and practically worthless for any purpose. Any fungus must have for its proper development, a supply of moisture, heat, air and food. Without any one of these the fungi can not develop. In places where the timbers are constantly dry there is no danger of rot producing fungi doing damage. The conditions which hasten the rotting of timber are those where the wood is constantly subjected to alternate wetting and drying. A good circulation of air is also an important factor in preserving timber in a mine, in that it tends to reduce the amount of moisture present. Shafts where ventilation is poor, where there is an abundance of moisture and heat, are the most favorable for the development of fungus diseases. Although the loss of timbers can never be wholly prevented, yet the life of the timbers can be very materially increased through proper methods of seasoning and preservative treatment.

INCREASING LIFE OF WOOD.

For all classes of round timber, either posts, piles or mine props, it is thoroughly understood that the removal of the bark prevents decay to a certain extent. This is due to the fact that while the bark is on, the wood adjoining the inner bark is kept constantly moist and the conditions are ideal for the development of fungus. The peeling is effective inasmuch as it hastens the seasoning process. The cost of peeling is an item which must necessarily be considered, however, as we are told by the Forest Service that it costs only from twenty to fifty cents per ton to peel mine timbers. It is no doubt true that many times this amount is saved by the increased length of life of the timbers. The simplest means of materially increasing the life of wood is by proper seasoning. It is well known that the amount of moisture in any piece of green timber depends upon the part of the tree from which the timber has been cut. The outer zone of a tree, or the sap wood, contains a much greater amount of moisture than the heartwood. On this account, and for the reason that the outer zone is more exposed to fungus spores, the sap wood is more subject to decay than the heart wood. On the other hand the sap wood portion of a tree will season more rapidly than the heart wood portion. By piling the timber in such a manner as to permit a free circulation of air, the seasoning process can be accomplished quite rapidly. However, the time required for the seasoning depends to a large extent on the climate. By kiln drying the moisture content of the timbers can be reduced to a smaller per cent than by the mere process of seasoning, however, this will add a considerable item of expense. It is well known that by reducing the moisture content the strength of the wood is materially increased, provided that an excessive amount of moisture is not driven off so that the wood structure is effected. A piece of timber well saturated with moisture is generally considered about one-half as strong as a properly seasoned stick.

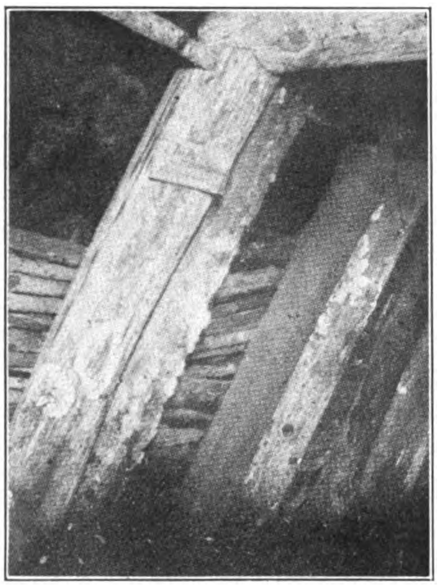
Seasoning will prevent the work of rot producing fungi so long as the timber remains comparatively dry. When the timber is to remain in a moist situation, another method may be employed, that of poisoning the food supply of the fungi. This is brought about by injecting a poisonous fluid into the structure of the wood or by merely applying a coating of some antiseptic to the surface of the timber. A great variety of preservatives have been tried out in the United States and also in other countries; however, there are only four which need to receive serious attention. These are creosot, zinc chloride, corrosive sublimate and copper sulphate. At the present time in the United States the last two have been almost discontinued. There are a large number of patent preservatives for sale, all of which have as a basis either zinc chloride or creosote. Creosote as used for the preservation of timber is a bi-product of coke oven plants. Unlike zinc chloride, creosote is a very complex substance, being composed of a great number of compounds. Both zinc chloride and creosote are exceptionally good preservatives, yet creosote has the advantage in that it is not soluble in water; this fact making it superior for preservation of mine timbers, especially those subjected to moist situations. When once injected into the structure of the wood, creosote will not wash out. Zinc chloride is cheaper but timbers preserved with this fluid are only serviceable in comparatively dry situations.

METHODS OF PRESERVATION.

The methods of preservation of mine timbers may be covered under three heads: First, surface treatment; second, open tank treatment, and, third, high pressure treatment. The surface method has been used to some extent in the treatment of mine timbers. This method in its simplest form consists in applying a thin coating, preferably of hot preservative, to the timber by means of a paint brush. The objection to the method consists primarily in the

* In Iowa Engineer.

fact that it is difficult to get the preservative well into the season checks, knot holes, etc. The preservative in this case only penetrates a very thin zone; however, as long as this zone of preservative remains unbroken there is little danger of decay. In this method it is especially important that the timber be thoroughly air dried before the preservative is applied, otherwise the evaporation of the moisture from the interior of the stick will cause checks and expose some of the unprotected



Fungus Growth on Untreated Mine Timber. Third from Left Was Treated.

wood to the fungi. This method is often used where only a small amount of timber is to be treated, an amount which would not justify the installation of the apparatus required for the use of other methods. It is often the case that the brush method of treatment is a more expensive means of preserving the timbers than by dipping them in a tank. If the proper apparatus is available, it is a much simpler and quicker method to immerse the timber for a short time in the preservative. The dipping process is not only more economical of labor but by its use season checks, cracks, etc., are covered more satisfactorily than if the brush is used. The preservative will penetrate the surface of the wood better if it is warmed before immersing the timber. In some cases, the timber may be allowed to remain in the fluid for a few minutes before being removed; however, this method is entirely different from the one to be described under the heading of "open tank treatment."

In the Open Tank treatment the penetration is secured by an entirely different process. This method compares more nearly with the "high pressure" method than to the dipping or surface treatments just described. After the wood is thoroughly seasoned and a greater part of the moisture in the cells and cellular spaces is replaced by air, the timber is immersed in a hot bath of creosote or zinc chloride as the case may be. The hot bath is continued from five to six hours, depending upon the kind and condition of the timber. In the hot bath the air and moisture in the wood expands and a portion of them pass off. At the conclusion of the hot bath, as quickly as possible a change is made to a preservative having a low temperature. This causes a contraction of the air and moisture still remaining in the wood, thus creating a partial vacuum which draws the preservative into the wood. In this method, through atmospheric pressure, is accomplished the same results as with artificial pressure under the "high pressure process." Green timber is very unsatisfactory to treat by this method since it requires a much longer time to make the treatment and there is an unnecessary loss of preservatives through volatilization. The penetration of the wood may be secured by any one of the following schemes; first, after the timber has remained in the hot preservative for some time the heat may be withdrawn and the preservative allowed to cool without changing the timbers from the tank or without changing the preservative; second, the timbers may be transferred from the hot tank to another containing a cool preservative; third, after the heating process, the preservative may be drawn

Fungus Growth on Untreated Portion of Mine Timbers. Upper Portion of Timber Treated, Lower Portion Untreated.

off and replaced by a cool solution without removing the timbers.

OPERATING OUTFITS.

For a small operation a convenient outfit might consist of an old iron boiler ten feet in length placed vertically in the ground and set to a depth of about five feet. For a small job it would not be necessary to have the tank fitted up with steam coils for heating the preservative. It would only be necessary to construct a fire place beneath the tank and heat the preservative by direct heat. This outfit is very commonly used in the preservative treatment of fence posts. It is desirable to make the treatment as short as possible, not losing sight of the fact, however, that a certain amount of time is required to secure the object desired by this method, namely, a good penetration. The process is in reality a pressure process and differs radically from the mere dipping of the timber. The time necessary to secure the desired penetration will vary with the species and the moisture content of the timber and also with other factors. Many species of timber have a heartwood that is difficult to penetrate. With these it is generally useless to continue the treatment after the sap-wood or outer portion of the stick is thoroughly penetrated. The absorbing process takes place generally during the cooling of the liquid. It is not desirable in treating, to allow the temperature of the hot fluid to go above 215°-230° F., since the strength of the timber may be decreased. With most species of wood, especially those having a wide sap wood, a complete treatment of this outer portion of the wood will afford a good protection for the entire stick. The open tank method is not adapted to species which resist the penetration of the preservative fluid.

Under the High Pressure method, the two processes most commonly used are the "Bethel" and "Burnettizing." These processes are the same except that in the former cresote is the preservative used and in case of the latter zinc chloride. The method of injecting the preservative is practically the same in both cases. The timber to be treated is placed on iron trucks which are rolled into large horizontal iron cylinders, some of which are 8 or 9 feet in diameter and 150 feet in length. These cylinders are constructed so as to withstand high pressure and the doors fitted up so that they can be tightly sealed. After the cars of timber are placed in the cylinders, steam is admitted at a pressure of about 20 pounds to the square inch and this pressure is maintained for several hours. The steam is then blown off and vacuum pumps are started, which remove a large portion of the air and moisture from the wood structure. This process is continued several hours also, after which the preservative is run into the cylinder at a temperature of 160°, the pressure pumps are started and a pressure maintained until a sufficient quantity of the preservative is forced into the wood. The preservative is then drawn off and in a few minutes the timber is ready to be withdrawn.

SOME OTHER PROCESSES.

The "Boiling" process is very frequently used for treating green timber. The equipment is practically the same as for the above processes except that the hot bath may be continued from a few hours to a couple of days, depending upon the size and condition of the timbers being treated. During this prolonged hot bath much of the sap and moisture of the wood is driven off by being forced out of the wood through expansion. After the hot oil is drawn back into the receiving tank, cooler oil is pumped in and put nuder a pressure of 100 to 125 pounds per square inch, thus causing a very good penetration in as much as the method takes advantage of high pressure along with a certain amount of penetration which is obtained due to the treatment with a colder liquid following a hot bath.

In the "Reuping" process the method is entirely different. The preliminary steaming is omitted. Before being placed in the cylinder, the timber is thoroughly air dried. Air is then pressed into the timber at a pressure of about 75 pounds until the wood structure is partly filled with compressed air, then, still keeping up this pressure, creosote is admitted into the cylinder at a somewhat stronger pressure. After the timber is entirely covered, the pressure is increased to 225 pounds per square inch, which causes a penetration of the oil into the wood structure. The creosote is then removed, thus relieving the pressure on the wood, which permits a part of the preservative to be pressed out of the wood by the compressed air within. This method has an advantage in using only a small amount of preservative.

Another method which is unique is the "Wellhouse." The preservative fluid which is used is zinc chloride. As we have said before, this preservative has the disadvantage of being leached out in moist situations. However, this process overcomes that difficulty. Before the zinc chloride solution is pressed into the timber, it is mixed with one-half per cent solution of glue. Later a tannin solution is forced in by a separate treatment. The effectiveness of this process depends upon the formation of a "leatheroid" substance in the cell openings which prevents the leaching out of the zinc chloride.

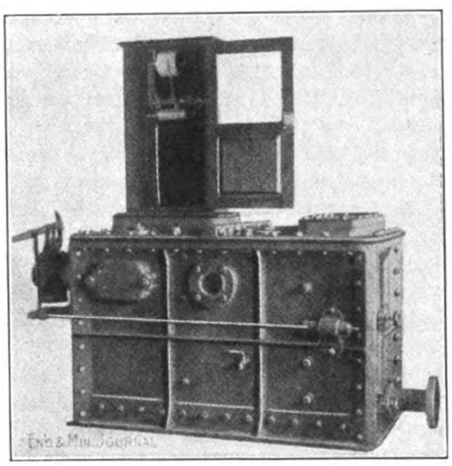
There are various other processes which may be described, each of which has its good points; however, most of them are quite similar to those already described.

In the treatment of mine timbers, a saving is not only afforded the consumer but the supply of timber is also conserved for the country in general. As the mere valuable species of timber become scarce, there is a constant tendency to substitute the inferior species of wood. This is being made possible by wood preservation which not only increases the length of life of the timber but also gives the consumer a much wider field to select from. Many woods which without treatment are almost worthless can be made serviceable by proper preservative treatment.

According to the Forest Service, the life of a mine prop has been estimated at approximately three years. It has been found that by treating, these props can be increased in length of life to thirteen years. From these figures it is easily seen how much of a saving may be effected through the use of preservative methods. As yet actual experiments in treating mine timbers have not been conducted with a large variety of species; however, there is an unquestionable saving for mine operators if they season their props before using and a great saving if in addition to that they treat the timbers with a preservative, preferably creosote.

LEA WATER FLOW RECORDER

In these days of scientific management, when so much depends on getting at the root of the evil in order to correct



Lea Water Flow Recorder.

abuses, the Lea water-flow recorder is an aid in keeping an accurate record of happenings in the boiler room. It shows all irregularities in the boiler feed, records the quantity of water evaporated per pound of coal, and thus shows the number of heat units in the coal.

The apparatus works on the V notch weir principle and is described as follows: A float spindle passes through the bottom of the instrument case, gearing into a small pinion upon the axis of a drum revolving between centers. Upon the body of the drum is a screw thread, the contour of which is the curve of flow for the V-notch, in connection with which the recorder is used. The spiral drum thread rectifies the motion of the recording pen, so that it moves equal distances for equal increments in the rate of flow; it provides a magnified scale for making an accurate observation of the rate of flow at any moment.

The actual depth of water in the notch can always be observed, and the instantaneous rate of flow in pounds or gallons can be seen with a high degree of accuracy. The recording pen which moves in direct proportion to the rate of flow produces a diagram, the area of which is a measure of the total quantity, and this can easily be deduced by means of a standard planimeter.

Heretofore, the Lea recorder was made on the open or atmospheric principle, but recently the manufacturers added a new type. The notched tank is made of cast iron, similar to the standard open-heater construction. The tank is entirely closed and is suitable for withstanding any pressure or vacuum up to 10 lb. The operating head of the Lea recorder is only about 18 in. Hence it can be installed without extensive changes in piping. It is made in sizes from 200 to 10,000 boiler-horsepower.

Besides being used for the measurement of boiler-feed water, steam consumption, etc., the Lea recorder can also be used for measuring pump discharges, flow of streams, acids, etc. For measuring the flow of acids the apparatus is provided with wooden tanks lined with lead, and the V-notch plate is similarly made. Hard lead or glass, however, can be used.

The apparatus is guaranteed to produce records which shall be within 1½% of absolute accuracy by weight; also that the average error due to variations of temperature over a range of 50° F. (i.e., 25° F. on either side of the normal) shall not exceed 0.5%. A feature claimed for the Lea recorder is that it is equally accurate at large or small rates of flow. Moreover, accuracy can be checked at any moment by observing the head flowing over the V-notch and computing the flow by Thompson's formula, and then seeing whether the record on the chart is being made accurately.

The U. S. Steel Corporation is improving sanitary conditions at its Marquette Range mines by the installation of drinking fountains.

The mineral output of Rhodesia, 1911, was as follows: Gold, 628,521 ozs.; silver, 18,7641 ozs.; lead, 638.78 tons; chrome ore, 52,363 tons; coal, 212,529 tons; antimony, 13.75 tons; asbestos, 1,120 tons, diamonds, 6,889 carats; other gems, 90,070 carats; tungsten ore, two tons.

LAW OF THE PAY-STREAK IN KLONDIKE PLACERS

By J. B. TYRRELL.*

Twelve years ago I had the pleasure of reading a paper before this Institution** on "The Gold-bearing Alluvial Deposits of the Klondike District," in which the topographical features of the country were briefly outlined, and the general character of the gravels and the underlying rocks were indicated. At the same time it was pointed out that the two sources from which to obtain an adequate water supply for the efficient mining of Bonanza Creek were the Rocky Mountains to the north and the conservation of the water of the creek itself. It is interesting to record that both these projects, first laid before the public through ths Institution, have now been completed by the building of a great ditch and flume from the Twelve Mile River, at the foot of the Rocky Mountains, and by the building of a dam across the upper part of Bonanza Creek.

This evening it is my intention to present to you, very briefly, some of the results of a study of the placer deposits of that northern country, especially with regard to any light that they may throw on the laws governing the deposition of placers and the formation of the run of coarse gold which is usually found in the bottoms of the larger valleys, and which is known as the "pay-streak" or "pay-lead." It is believed that the laws or principles here enunciated not only explain the occurrence and characteristics of "pay-streaks" in the Klondike district, but that they have general application to the concentration of heavy metals or minerals in alluvial deposits.

Placer deposits may be defined as "detrital deposits of heavy metals or minerals mechanically concentrated by natural agencies."

Prof. James Geikie defines a placer as "an alluvial deposit derived from the disintegration of metalliferous rocks and orebodies of various origin."

Richard Beck says:

"By detrital deposits we understand accumulations of ore formed by the destruction and re-deposition of primary deposits. These two results have been accomplished, in the main, in a mechanical, but in part, also, in a chemical way. In both cases water was the main agent used by nature for the purpose. Such a destruction and re-deposition of primary deposits may have taken place in remote geoligic periods, but only in comparatively rare cases have the products of such periods been transmitted to us in a recognizable condition. On the other hand, the Tertiary and Pleistocene formations of the earth's surface contain a great number of such detrital deposits, as they are commonly called. It is customary to use the term placer gravels for the Pleistocene and Tertiary alluvial gravel depoisits."

And again:

"Placer gravels are deposits of loose, more or less rolled, material derived from the destruction of older deposits, lying on the earth's surface, or at least very close to it, and containing paying amounts of ore or precious stones.

"As the material composing placer gravels has been exposed to all the influences of the atmospheric air and of the water seeping through the upper stratas of the soil, placers will be found to contain, in the main, only relatively insoluble, and, in general refractory metallic compounds, which, moreover, are protected by their great specific gravity against easy removal by water.

"These placer gravels are usually grouped into two classes according to their position with reference to the deposit from which they àre derived, and in part, also, according to the manner of the original process in which they are derived from the primary ore deposit:

1. Residual gravels, i. e., of local origin (eluvial gravels).
2. Alluvial gravels, i. e., formed by washing. These may again be subdivided, according to age, into recent, Pleistocene and Tertiary gravels.

"Residual gravels, the rarer of the two groups and certainly the less extensive, are found in the immediate vicinity of the original ore deposits, and quite independent of water-courses, viz., on mountain slopes, plateaus, and sometimes even on mountain summits.

"On the contrary, the gravels formed by the transporting and washing action of water are found only in the channels of brooks and rivers, in fresh-water lakes or along the sea-coast. They lie for the most part within the present valleys or along the present shore, but are also often found in stretches of fluviatile sediments, sometimes intersecting the present direction of the valley on old river terraces, or in sheets covering plateaus (California, Ohlapian in Transylvania), and, finally, in old shore terraces above the present level of the sea. Their material is always much rolled, and for the most part is assorted, according to the size of the ingredients, into shingle, gravel, sand, clay, mud, etc."

Residual gravels occur on many of the higher slopes in the Klondike, but only in few cases do they form workable placers. The best illustration of such placers which came to my notice was on the upper portion of Victoria Gulch, one of the tributaries of Bonanza Creek, where some beautiful sharp "spinel twins" of gold were found, just in the condition in which they had been washed out of a vein that outcropped higher up towards the summit of the ridge.

Most of the placers in the country are such as are designated above "alluvial gravels" and belong to the class of alluvial gravels found "in the channels of brooks and rivers."

PAY STREAK ECCENTRICITIES.

In many of these alluvial gravels that occur throughout the Klondike some gold can be found, but in the gravel deposits in the bottoms of most of the wider valleys, whenever gold is present, it is not evenly distributed, for most of the coarser particles are found in a band of restricted width which lies on or close to bedrock, and wherever the bedrock is fissured these particles descend into it for varying distances. This band or run of coarse gold is known as the "pay-streak," and the discovery of it beneath the gravel of the alluvial plain is the constant desire of the prospêctor.

The existence of this pay-streak has been recognized by placer miners from time immemorial.

A. G. Locke refers to it as the "gutter," which he defines as the lowest portion of a lead, which contains the most highly auriferous dirt."

Posepny states: "The gold occurs concentrated in the deepest portion of the weather-detritus, that is to say, on the contact with bedrock, and has penetrated all the open, loosely-filled fissures in the latter."

Beck states: "It would, however, be an error to assume that in a cross-section of a river valley the lowest layers of shingle, gravel or sand are throughout the richest. On the contrary, the values in this horizon are variable and pay gravel is ordinarily limited to streaks of greater or less width, which are found in one place in the centre of the valley, in another along one side, now nearer, now further away, from the present water course."

W. Lindgren writes of the pay-streak as follows: "It is well known to all drift miners, however, that the gold is not equally distributed on the bedrock in the channels. The richest part forms a streak of irregular width referred to in the English colonies as the 'run of gold' and in the United States as the 'pay-

* Paper read before the Institution of Mining and Metallurgy.
** Trans., viii, 217-229.

streak' or 'pay-lead.' This does not always occupy the deepest depression in the channel and sometimes winds irregularly from one side to the other. It often happens that the values rapidly diminish at the outside of the pay lead, but again the transition to poorer gravel may be very gradual. An exact explanation of the eccentricities of the pay-lead may be very difficult to furnish."

It is true that the pay-streak very often seems to be one of the most elusive of phenomena, and time and again the prospector is inclined to say that there has been no advance in the knowledge of the laws which govern the deposition of placer gold since the days of Job, 35 centuries ago, and that all that can be said now, as then, is that "There is a vein for silver and a place for gold."

But the pay streak is a feature in the structure and growth of the valley in which it occurs, its formation is governed by certain geological laws, and those laws should be recognizable without great difficulty if the growth of the valley can be traced with reasonable accuracy.

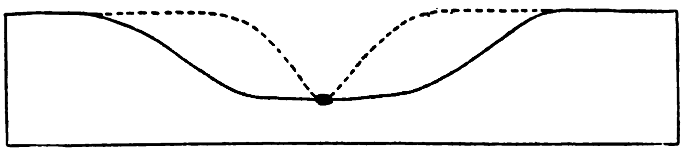


FIG. 1.—Diagrammatic representation of Pay-streak in the bottom of a simple valley.

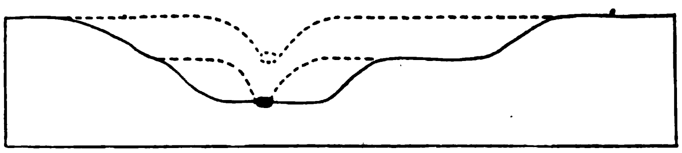


FIG. 2.—Diagrammatic representation of second Pay-streak directly below the first.

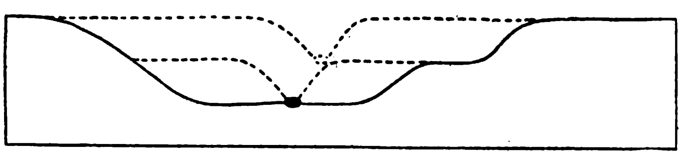


FIG. 3.—Diagrammatic representation of second Pay-streak obliquely below the first.

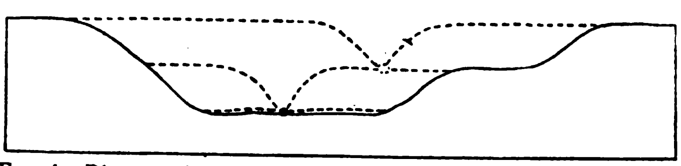


FIG. 4.—Diagram showing how first Pay-streak may be distributed in second valley.

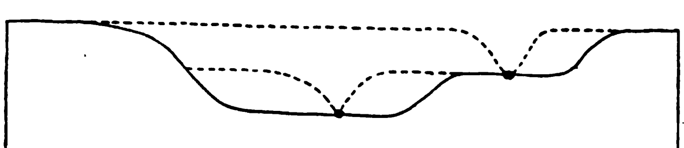


FIG. 5.—Diagram showing first Pay-streak as terrace and second lighter Pay-streak in second valley.

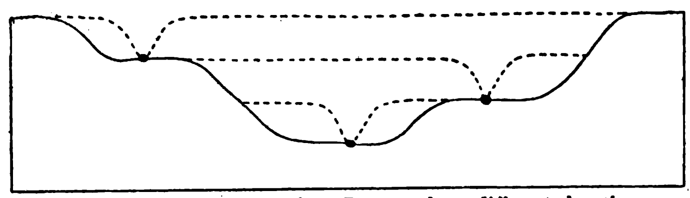


FIG. 6.—Diagram showing three Pay-streaks at different elevations.

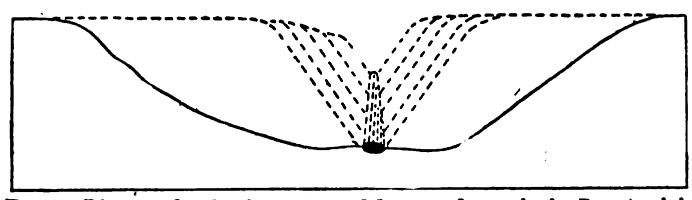


FIG. 7.—Diagram showing formation and downward growth of a Pay-streak in a wide valley.

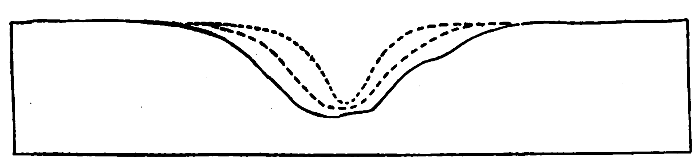


FIG. 8.—Diagram illustrating the transformation of a V-shaped valley into a U-shaped valley. (After Chamberlin and Salisbury.)

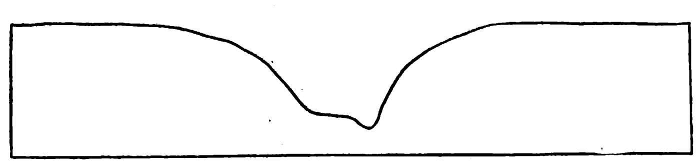


FIG. 9.—Diagram to illustrate the widening of a valley flat by erosion. (After Chamberlin and Salisbury.)

In what we now know as the Klondike district, marine sediments were laid down at various periods up to the beginning of Tertiary times, and after their deposition they were raised, crushed and bent into their present form and position.

The country was then worn down to base level, and a peneplain, the remains of which can now be seen at an elevation of about 3,300 feet above the sea, was formed. This peneplain may be called the "dome peneplain," as portions of it are distinctly recognizable in the vicinity of the mountain known as "The Dome." For our purpose the period of its formation may be designated as the "first cycle of erosion," since the history of the gold-bearing gravels would appear to begin with it and no gravel deposits have yet been recognized on it.

After the dome peneplain was formed the "first period of elevation" began, and the country was raised to a considerable height above the sea. The Yukon river which had probably been outlined at an earlier period, immediately began to erode its channel, while the water, which fell as rain on the elevated Klondike land, carved out smaller valleys to carry the drainage from it to the larger river. As the Yukon river was a powerful eroding agent it deepened its valley rapidly, and at the same time the smaller streams radiating from The Dome, such as Bonanza, Hunker, Dominion, Sulphur Creeks, etc., kept excavating their channels to keep pace with the lowering of the bottom of the valley of the Yukon river, which was the master-stream into which they flowed.

During all this time the valleys of these smaller streams maintained the general character of gulches or young valleys, with V-shaped cross sections. But little gravel or loose material remained on the rock which formed the bottoms of their channels, for it was being constantly moved downward by the current towards the Yukon river, and, on the way, was helping to cut deeper and deeper into the rock over which it traveled.

While this process of deepening the valleys was in progress, detrital material was being constantly brought into them by wash from their sides and by smaller streams from the ridges between them, and, as the rocks from whch this material was derived were gold-bearing, the detritus contained a small quantity of gold. Thus gold and particles or masses of rock were fed gently into the main streams.

Now, a stream with a certain velocity is able to carry pebbles of a certain size and specific gravity. If the specific gravity is constant the diameter of the pebbles which it can carry will vary according to the square of the velocity, and if the velocity remains constant, the size of the pebbles will vary according to the specific weight of the substance composing them weighed in water. For instance, if the velocity of a stream is doubled it is able to carry pebbles of quartz four times the diameter, or 64 times the weight, of those which it could carry before. If, on the other hand, one pebble is of quartz and the other is of gold, which is 11 times as heavy as quartz weighed in water, the volume of a pebble of quartz which can be carried by the current will be 121 times (11.2) as great as that of a pebble of gold, or, in other words, the diameter of the pebble of quartz will be about five times the diameter of the pebble of gold.

Again, if particles of quartz and gold of equal size are dropped into water the gold will sink to the bottom with more than three times the velocity of the quartz.

FORMATION OF PAY-STREAKS.

Where the fragments of rock, consisting of quartz, schist, granite, etc., and gold, are fed into the stream, they are caught by it and carried along the bottom until they lodge in some crevice or opening, from which they cannot be dislodged except by upward currents, and these upward currents will lift any pebbles of quartz or similar rock which are less than five times the diameter of nuggets, or grains of gold occurring with them, before they will lift the gold, even if the quartz and gold are equally accessible. This makes the removal of the gold exceedingly difficult as long as the crevice remains, for the upward currents will constantly carry away the finer and lighter rock, and undermine the grains of gold and allow them to sink. When the finer and lighter material is carried away, the coarser and lighter pebbles are exposed to the force of the current, and the smaller and heavier grains of gold are able to obtain lodgment beneath and between them so as to be almost inaccessible. In fact, under normal conditions, the spaces between the lighter pebbles are large enough to hold any grains of gold which could be carried by the current flowing over them.

It is thus shown that gold will remain permanently in a fissure of the rock in the bottom of a stream as long as that fissure remains in existence, and also that it will remain between or beneath larger pebbles and boulders as long as these remain unmoved.

Now, the small streams of the first period of elevation, which developed into, or was succeeded by, the second cycle of erosion, continued to cut down their channels as long as the Yukon River continued to deepen its valley. During all this the bottoms of their valleys continued to act as sluices, which were more or less efficient agents in collecting and retaining gold according to the character of rock of which they were formed. If the rock where the gold was discharged into the stream was a fissile schist standing on edge the gold would be caught at once, while, if it was a massive granite or other similar rock, without joints or fissures, or a smooth horizontal schist, the gold would be carried down-stream over it until it would be caught by some more favorable rock. In this way there would be rich places, and blanks in the streak of gold deposited in the bottom of the valley.

As the stream would continue to deepen its valley very gradually, almost imperceptibly, by downward erosion, those places which were underlain by schists standing in a vertical or highly inclined attitude would continue to hold the gold which they had already caught, and to accumulate more, for fissures would open as fast as the surface was worn away, and the gold would sink into them as they opened. On the other hand, those places which were underlain by a harder bedrock, and which had probably also a steeper grade, would remain barren. If, again, the character of the bedrock should change from "open" to "tight," the gold which it had held might be undermined by the continual downward erosion, and so be brought again within the influence of the transporting power of the running water, by which it would be carried along to find some new resting place farther down the stream.

When the Yukon River had eroded its valley down to base-level, the smaller inflowing streams were no longer obliged to continue to deepen their respective valleys to keep pace with it, but were able to cut them down to grade, and then to widen and form flood plains in them, thus changing the V-shaped valleys into U-shaped ones, floored by alluvial plains through which the rivers and brooks meandered from side to side.

FLOOD OR ALLUVIAL PLAINS.

A normal stream decreases in velocity and gradient as it descends its valley and reaches grade near its mouth before it has cut down the rest of its valley to grade. So, when each of these streams had cut down the lower portion of its valley to correspond with the base-level established by the Yukon River, it would begin to meander and extend the width of its floor. At the same time, with the decrease in gradient the velocity of the current would decrease, and its transporting power would be diminished. Consequently, part of the detrital material which would be brought down by the upper and swifter portion of the stream would be dropped where the current was retarded by the decreased gradient, and would lodge in the bottom of the valley and form a "flood plain" or "alluvial plain." This alluvial plain would be first formed where the V-shaped valley changed into a U-shaped one.

Most of the gold which had previously been discharged into the stream with the detritus from the adjoining hills and ridges would have already lodged in the bottom of the V shaped valley, and would have settled down almost vertically as the bottom was lowered by the downward erosion of the stream. If any gold was carried down to the mouth of the V it would have a very strong tendency to settle just where the velocity of the current was diminished, or at the head of the flood plain, and the weaker current would have no power to pick it up again, or to release that gold which was already present beneath it on account of having been previously caught in the bottom of the V-shaped valley. Thus the pay-streak would be formed. Afterwards the gravel, sand, and alluvium of the flood plain would be deposited over and beyond it, but it would continue to mark the position of the bottom of the old V-shaped valley, no matter how wide the bottom of the mature valley might afterwards be extended.

After a flood plain had been formed at the mouth of a valley the river farther up stream would still continue the downward erosion of its channel until it reached the grade of that below it, when lateral plantation and the formation of the flood plain would begin. Thus the plain was formed gradually up the valley from its mouth, and always, where the old V-shaped valley changed into a U shaped valley, there was left a trail of gold beneath it.

The gold which was collected and stored in the bottom of the V-shaped valley had been derived from the rocks of the adjoining country. At the same time the lighter material derived from the disintegration of these rocks had been carried through the valley and out beyond its limits, for the stream was then cutting down and enlarging it, and not filling it up, and there was very little room beside the stream for the accommodation of loose rock material. At the head of the flood plain this gold, which had been concentrated from the rocks of the surrounding country through previous ages, was gradually covered, and hemmed in on both sides, by gravel and alluvial material brought down by the stream at a later date. Therefore the gold in the pay streak was derived from its home in rocks at a date which preceded that of the formation and deposition of the gravel which overlies and surrounds it.

The gravel of the flood plain may itself contain some gold which had been washed down the stream with it, or which had been washed into the valley from the sides, but this gold is usually very fine, such as might be carried readily by the stream for long distances.

If, after the flood plain was once formed, the stream should continue to deposit gravel to considerable thickness in the bottom of the valley through which it meanders, the source of supply for the gold would, on account of the general wearing down of the country, become more and more remote, and the average gold contents of the gravel would gradually decrease from below upwards.

The laws governing the formation and position of the pay-streak in an alluvial plain in the bottom of a valley may therefore be stated as follows:

1. It was formed in the bottom and at the mouth of the V shaped valley, which was the young representative of the present valley.

2. It marks the position formerly occupied by the bottom of that V-shaped valley.

3. The gold contained in it was washed out of the surrounding country and collected into approximately its present position before the gravel of the flood plain (or terrace) was deposited over and around it.

It has been assumed, for purposes of illustration, that the growth of the valleys in the Klondike district, which empty into the Yukon River, was continuous and regular throughout the second cycle of erosion, and in view of their symmetrical character, and the regularity of the pay-streak, which has been shown to have existed in them, it is probable that this assumption is not very far from correct; but nevertheless there were doubtless interruptions and cessations, both in the regular course of erosion and sedimentation.

After the Yukon river had cut its valley down to base level in this White Channel period, or second cycle of erosion, the tributary streams flowing from the Klondike district also widened their valleys and formed flood plains, as has just been described.

Then there was a long period of

GROWTH AND CHANGE OF VALLEYS

quiescence, during which the base-level of the country was raised, permitting heavy accumulation of gravel in the valleys, while at the same time the hills and ridges were worn down to mature forms. At the mouth of the valley of Bonanza Creek the local gravels, derived from the watershed of the creek itself, accumulated to a thickness of more than 200 feet. These gravels can still be recognized forming terraces at many places on the hills several hundred feet above the bottom of the valley, and Mr. McConnel, who has carefully measured them, has shown on a map accompanying his report a pay-streak running in a very straight line through and beneath them. According to the laws here formulated, this pay-streak was formed in the bottom of the old V-shaped valley, which represented the valley of Bonanza Creek at the White Channel period in its youthful stages, and it now tells us the original position of the bottom of that V-shaped valley.

Just before, or at the termination of, the second cycle of erosion, the Klondike River brought a heavy load of sediment down from the mountains to the east, and covered the bottom of its own valley, and the mouths of its tributary valleys, with a bed of gravel, which, opposite the mouth of Bonanza Creek, has a thickness of 150 feet. The influx of this gravel caused the lower portion of the latter stream to move westward, almost to the limit of its own flood plain, and to be ready to begin a new rock valley with the advent of the next erosion cycle.

After the deposition of this upper gravel in the valley of the Klondike River a period of elevation set in and the third cycle of erosion was inaugurated, which has continued down to the present time.

With the advent of this cycle of erosion the Yukon River was rejuvenated and again began to actively deepen its channel, and at the same time the tributary streams also began to deepen their old channels, or to cut out new ones, in order to keep pace with the master-stream. The Klondike River, the largest affluent of the Yukon in this district, probably did not lag very far behind it in the work of downward erosion, but its tributaries, such as Bonanza and Hunker Creeks, undoubtedly continued to flow in narrow, V-shaped valleys as long as the main stream was actively engaged in deepening its channel.

Opposite the mouth of Indian River the Yukon River has not deepened its channel as far below the level of the channel of the second cycle of erosion as it has at the mouth of the Klondike River, and the Indian River itself, being a smaller stream, has not cut back its valley as fast as the Klondike River, so that Dominion, Gold Run, Sulphur, and the other tributaries of Indian River, have not had the same opportunity to deepen their channels as the tributaries of the Klondike River.

During the third cylce of erosion the smaller streams, and especially those flowing into the Klondike River, have cut down their channels to grade in narrow valleys, and have widened the bottom of those valleys by lateral planation and the formation of flood plains, giving them a U-shaped profile. Terraces have been formed on the sides of the valleys, indicating halts in the progress of downward erosion, and narrow V-shaped gulches still carry small, or intermittent, streams into the sides of the main valleys.

Pay-streaks, which have now been almost entirely mined out, ran beneath the flood plains down the bottoms of these valleys, or crossed the terraces on their sides, and other pay streaks were in process of formation in the gulches until that process was arrested by the work of the miner.

ECCENTRICITIES OF PAY-STREAKS.

It is not necessary for our present purpose to follow the growth of these younger valleys in detail, or to trace the formation of the pay-streak in them, for that was clearly governed by the laws which we have already enunciated, but it will be interesting to indicate a few of the eccentricities which may have been introduced in the pay-streak by irregularities in the growth of the valleys in which they were formed.

We have already seen that difference in the character of the bed-rock will produce a marked difference in the quantity of the gold in the pay-streak.

A variation in the supply will also influence the richness of the deposit, as may be clearly seen in many of the small lateral streams which flow into the main creeks. Some of these cut across the old pay-streak of the second cycle erosion, and where this occurs the gravels in the bottoms of these streams is enormously enriched.

Temporary cessation of downward erosion, with the corresponding formation of flood plains at successive levels, would appear, however, to exert the most powerful influence in affecting the nature of the pay-streak and introducing irregularities into it.

Let us suppose that a valley has been eroded down to the first level, and that a flood plain has been formed at that level. The pay-streak will occupy its normal position in this flood plain on the line of the bottom of the old V-shaped valley, as shrown in Fig. 1.

If the stream is rejuvenated and again begins to deepen its valley a number of other conditions may occur.

1st. It may cut down its channel directly beneath Pay-streak No. 1, in which the pay-streak will simply be lowered, and will contain practically all the gold from the older pay-streak, as well as any gold that may have been collected into the channel since the time of its formation, as shown on Fig. 2.

2nd. It may cut down its channel to one side of Pay-streak No. 1, and while still actively engaged in downward erosion may undercut the pay streak, and allow the gold to slide down the side of the valley into the stream, where it will be carried downwards until it finds a new resting-place. In this case, too, the second pay-streak will contain most of the gold that was in the first, but it will have undergone a decided movement down the stream. See Fig. 3.

3rd. The stream may cut out its second V-shaped valley entirely to one side of the first pay-streak, but when it again begins the process of lateral planation, and forms its second flood plain, it may undercut the pay streak, where part of it may quickly sink and form a pocket off the line of the true second pay-streak altogether (though it will give an indication of the former position of the first pay-streak) while part of it may be carried down by the stream and distributed in its winding channel. The true second pay-streak itself will, in this case, probably be very weak. See Fig. 4.

4th. The second channel may be formed altogether to one side of the first pay-streak, in which case the first pay-streak will be on a terrace and the second pay-streak will probably be weak. See Fig. 5.

Any of these conditions may occur in different parts of the same valley, and their relative intensity, or rapid changes from one to another, may cause great variations in the character of the pay-streak.

A greater number of stages in the deepening of a valley would allow for a still greater complexity in the character of the one or more pay-streaks which might be found in it, and these might be still further added to by a filling of the valley with detritus and partial re-excavation at one or more different times. But, for the period in which it was formed, the pay-streak represents the bottom of the young V-shaped valley, which formerly occupied part of the present valley.

MINE ACCIDENT WORK

The work transferred from the United States geological Survey to the Bureau of Mines related almost entirely to the mining and utilization of coal and the accidents connected therewith. The appropriation given to the Bureau of Mines for its work during the first year following its establishment were so worded as to be necessarily applicable to coal mining inquiries. Therefore it has not been possible as yet to extend the investigations of the bureau witn a view to their aiding in the upbuilding of the metal-mining industries. Meanwhile, however, the ratio of accidents to the number of men employed has been in many cases as large or larger in the metal mines of the country than it has been in many of the coal mines. The need for the extension of the mine-accident work into the metal mining field is a serious one.

However, the loss of life in connection with metallurgical operations in different parts of the country is worthy of serious consideration. A limited inquiry indicated that eleven deaths have been caused from posionous gases at a single metallurgical plant during one year. The serious need of inquires and investigations looking to the improvement of such conditions has become more and more apparent as inquiries have been made in connection with a number of the larger plants.

Furthermore, during the past several years the mining industries, in the Western States have fallen far short of the agricultural development. In some of the States there has been a retreat rather than an advance in mining development. It is believed that thorough inquiries and investigations concerning the metal-mining conditions in the Western States would do much toward improving the safety and health conditions, as well as toward generally advancing and upbuilding these industries. —From forthcoming annual report of United States Bureau of Mines, for the fiscal year ending June 30, 1911.

ELECTRICITY AND ITS DANGERS

The United States Bureau of Mines has just issued Technical Paper No. 19, written by H. H. Clark, the bureau's electrical engineer, on the subject: "The Factor of Safety in Mine Electrical Installation." The author acknowledges the many advantages that are known to attend the use of electrical machinery in mines, but urges that the requirements of safety as well as those of efficiency be considered when installing electrical mining equipment.

The paper calls attention to the fact that wherever the service conditons are indeterminate or variable, engineers are accustomed to use factors of safety in their designs, especially in those cases where the protection of human life is a consideration. The author believes that a similar factor of safety should be used in connection with the electrical equipment of mines.

To quote from the paper: "The safe operation of electrical mining equipment is an engineering problem that involves the element of human life and that is influenced by conditions and events that can not always be foreseen. The successful solution of the problem will, therefore, depend largely upon the factor of safety that is considered in the selection, installation, and maintenance of such equipment."

The paper proceeds to classify the electrical accidents that may occur in mines and states the principal sources of danger incident to the use of electricity underground. The conditions surrounding electrical equipment in mines are compared to similar conditions above ground and the paper shows that the requirements of mining work present certain difficulties in the way of maintaining electrical apparatus in perfect condition. The effect of roof falls, dampness, dust, and acid water are mentioned, and the observation is made that the temporary character of underground work limits the economical investment in electrical equipment and its installation.

The author does not regard the safeguarding of mine electrical equipment as a simple problem and states that there is no general formula for its solution. It is suggested, however, that a logical first step would be to remove contributory causes by placing lights and erecting guards at particularly dangerous points, and by selecting apparatus especially designed to offset the effect of dampness and dust.

A concrete view of the problem is presented as follows: "The problem of safeguarding may be divested of some of its vagueness and put in concrete form by considering that if the electric current can be kept where it belongs—in the conductors designed to carry it—it can not give shocks, set fires, or ignite gas, dust, or explosives. Electricity becomes actively dangerous only when it breaks away from its proper channels in stray currents or as sparks and arcs."

The paper lays stress upon the importance of first-class installation at the outset and frequent inspection of equipment after it is in place. The author considers that a competent electrician is needed to insure the safest and most efficient operation of mine electrical equipment and dwells upon the responsibilities and requirements of such a position.

Saturation is important but difficult to determine in any oilfield. Some lands yield 2000 to 3000 bbl. per acre and others as much as 100,000 bbl. At times, as one operator phrases it, "more oil comes out of a well than there is space in the rock below." Such anomalies are probably to be explained on the basis of fractures tributary to the well.

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CONTENTS:

Last month it was suggested that the Utah Copper management issue a statement this month showing how much new ore had been blocked out during the first half of the year, rather than wait until next spring and then tell us that another 100,000,000 tons had been added to the reserves. Our suggestion has been ignored, so the bankers and brokers who are still holding the sack may not be made to feel the effects of their folly by witnessing the addition of another $100 or more a share being developed in the mine and the stock going down as a result of the report, for some time to come. The announcement of an "extra" dividend may be the means of turning the trick the next time.

"REMODELING" MANIA OF UTAH COPPER

During the month of June one of the "remodeled" sections of the Arthur mill of the Utah Copper Company was closed down for ten days so that it might undergo another "remodeling." That the entire plant would have to undergo an additional "remodeling" sooner or later has been evident to everybody familiar with the record being made, but it was not expected that the second "remodeling" of the mill would begin until all of the thirteen sections had been brought up(?) to the standard of the company's famous Magna works, where they seem to have no great amount of trouble in saving just about as much copper as they lose. Wonder if they are going to give the "big drum" a try-out at the Arthur?

It is almost impossible to be serious when dealing with the subject of the Utah Copper's mining and milling practices, so broadly comical nave they become in the eyes of the mining and metallurgical profession everywhere. But it seems pertinent just now to call attention to the fact that this "remodeling" business has developed into what might justly be termed a perfect mania on the part of the engineers who have been shaping the destinies of Utah Copper, Ray Consolidated and Chino for the past several years without a protest on the part of those who now appear to be in urgent need of a Moses of some kind.

The Magna mill had barely gone through the smoothing-out stage of its career when its "remodeling" was undertaken. Equipment was discarded as being not the thing; other devices were tried and then some of the previously discarded traps were reinstalled; and so it has been going year in and year out, and this is the plant after which the Arthur mill, the Ray Consolidated and the Chino have been paterned, together with such modifications as were from time to time developed by the parent mill. The tinkering going at the Arthur is not to be wondered at, for the Ray Consolidated mill had only three units in commission when the "remodeling" of the first one was undertaken in order to keep pace with the head institution and, while detailed information concerning what is doing down there now is hard to get, there is no reason to believe other than that "remodeling" is still in progress, in order to catch up to what is now being done at the Arthur—and what is true of conditions at the Ray is most likely the case at the Chino, as well.

And it may as well be stated now that what is true of the mills also applies to the handling of the mines. There has been a system of "remodeling" or something of the kind constantly going on at the Utah Copper mine and if anything has been accomplished by it other than to hasten the "day of reckoning," there is nothing in the reports of the company to indicate it. The Utah Copper mine is now generally referred to by engineers and laymen, alike, as "a most wonderful SIGHT," and the company's Bingham & Garfield railroad is being exploited almost exclusively as a grand "scenic line." And in this respect it may be mentioned that it is now reported that the line is to be connected up with the Saltair bathing train road so that trains can run from this city to both "resorts"—Saltair and Utah Copper's "Mountain View," at Bingham. Just think of "a self-contained manufacturing enterprise" of the boasted magnitude of Utah Copper playing for the nickels and dimes to be made through the 25c. ando $1 fares that the operation of this "scenic line" may provide. Then compare the cost of mining, which we have shown from their reports to be not less than 75c. a ton, with the 24c. a ton cost of their little neighbor, the Ohio Copper, which possesses no steam railroad or spectacular steam shovel operations, and you have a picture which should furnish food for the serious consideration of the investor.

"IT IS TO LAUGH"

Shortly after the first of the month Daniel Guggenheim sailed for Europe. According to the interview he gave out before his departure he was not in his usual good humor. He very evidently is piqued and disgruntled and altogether disgusted with his adopted country, so he has pulled out for the "Faderland" and other portions of the European continent, according to the Boston News Bureau, for the purpose of "looking after European financial interests of his companies." In other words, the family has not been able to hoodwink the investing public of America to any appreciable extent for the past few years, so the gentleman decided to toss a few boquets at England, Germany and France, pack his grip with Guggenheim Exploration stock certificates and other gilded evidences of long "deferred" wealth and sail away determined to bring back the coin.

When a man gets "down on his luck," it is not considered good form in him to curse the land and smite the hand which has given him refuge and made it possible for him and his kin to bask in the sunlight of prosperity such as the Guggenheims have enjoyed for lo these many years, and under conditions and the employment of methods which, had they been attempted in Germany, for instance, would have resulted in their banishment from the country, bag and baggage. And to think that the head of the house of Geggenheim is now in Europe explaining that American investors have declined to buy their "securities" and that he is there for the purpose of presenting them with the good things which the investing public of the United States failed to appreciate, is to draw the curtain aside and obtain a glimpse of a scene which, stripped of its grotesque setting, borders on the pathetic.

We must quote from the utterances of Mr. Guggenheim to show how bad he feels over the failure of the American public's refusal to be parted from its money and how he unwittingly, perhaps, discloses his anguish at not being able to make his copper and gold schemes work out as he would have them do:

> We have at our doors the empire of Alaska. I am wondering what Germany, France or England would do in case they owned it. I am confident that within five or ten years after a thousand miles of railroad are constructed in Alaska, that territory will reproduce from two to three hundred millions of dollars annually.

A great many people in this country are wondering what Mr. Guggenheim and those associated with him would have done in case their schemes to control the coal, copper and gold resources of that rich country had prevailed. What was "Brother Simon" sent to the Senate of the United States for and what happened after it was found out what the game was. The Guggenheim failures in Alaska and the refusal of the government to come to their relief is one of the sorest spots on the Guggenheim business anatomy. We don't know what Germany, England or France would do with Alaska, but we have a lingering notion that it will not be controlled by and made to pay any particular tribute to the Guggenheim family. Nor is it likely that the Government will buy that 300 miles of railroad that was constructed for the purpose of selling shares in a copper mine that was touted as the biggest thing in the world, but which they knew all the time was of indifferent worth.

> We have had four years of bitter and unreasoning hostility to capital, and the result is painfully apparent, while the great countries of England, Germany and France have had enormous prosperity. We have greater natural resources than those three countries combined but we have been driving our capital away and it has been utilized in building up other countries, instead of being employed in the development of our own.

Of course Mr. Guggenheim guages our lack of prosperity by the failure of the American public to absorb stock at tremenduously inflated prices in the schemes with which he is so prominently identified. He is irritated to think that Utah Copper, Braden, Copper River, Yukon Gold and other propositions have not been converted into real money. This must be so, because it is conceded by every authority that this country has been enjoying usual and substantial prosperity for the four years he complains of. The only particular in which there has been a halt has been in a stock-market sense. Mr. Guggenheim has probably had as much to do with that as any one individual in this country and his recent attempt to get from under by reducing the par value and correspondingly increasing the number of shares in the Guggenheim Exploration Company and then listing the new stock, shows how keenly he feels the lack of confidence the public has shown in the stocks owned by his Exploration company. His idea has been that because of the standing and past earning ability of the Exploration company he could make a market for those shares and thus indirectly accomplish the same object that the marketing of Braden, Yukon Gold, Copper River, Utah Copper and other holdings of the Guggenheim Exploration Company which the public have refused to buy under their own titles, would have done. But it is said the public are not taking kindly to this newly prepared offering, either, and hence the departure of Mr. Guggenheim as above indicated for foreign shores.

In New York, even, Mr. Guggenheim's interview commanded anything but respect, and the Evening Post treated one his profoundest utterances in a most unbecoming and flippant manner, as follows:

> But for the distractions of politics, the obstetrical observations of Daniel Guggenheim, on sailing for Europe, would doubtless have received the attention they deserve. "We have now, as I see it, prenatal prosperity," he said, in his annual interview, "which, if allowed to be born, will, I believe, grow into the greatest this country has ever experienced." Alas! he fears it will not get born (mark the consequences), and that, if born, it will never grow to regular size, owing to the manner in which capital, which is the sire of prosperity, is continually antagonized. However, there are now four shares of Guggenheim Exploration Company stock where there was but one before, and the four shares of $25 each are selling in the aggregate for more than the one of $100 par value **ever was believed to be worth.** That is doubtless the strongest possible tribute to the importance of pre-natal influences upon even such things as securities.

In closing let us suggest to Mr. Guggenheim that the American public has simply come to the conclusion that when it makes investments there must be something behind the claims of prospectuses other than reckless pretenses of worth, manipulated reports and inexcusable bad management in the handling of properties.

HAMMOND—AND HAMMOND

Discussing the copper share market last month Mines and Methods took occasion to quote from a New York correspondent's letter to Mining and Scientific Press in which, it develops, the correspondent blundered in using the name of Mr. John Hays Hammond instead of John Hays Hammond, Jr., as a delegate to the International Wireless Congress in London and also as experimenting with a device for the control of torpedoes by wireless. This explanation would not have been necessary on our part had it not been for the fact that someone—probably connected with the senior Hammond's offices in New York—must have mailed to Mr. Hammond. at Lookout Hill, Gloucester, Mass., a clipping of the paragraph taken by us from and duly credited to the Mining and Scientific Press, omitting the accompanying comment. This seems evident because Mr. Hammond, in a note to the editor of Mines and Methods says:

> In the June issue of Mines and Methods I am referred to as a delegate to the International Wireless Conference in London. You pay me an honor I do not deserve; it is my son, John Hays Hammond, Jr., who is the delegate in question. Do you think I ought to call him to task for his endeavors indirectly to curtail the use of copper in the production of which my friends and I are so largely interested? Curiously enough, he is also experimenting with a mechanism for the control of torpedoes by wireless; while I am advocating universal peace and disarmament!

Concerning Mr. Hammond's query as to whether we think he ought to take his son to task for indirectly working to curtail the use of copper and for experimenting with contrivances that will have a tendency to make war more terrible, our answer, it seems ought to be: "Yes; take him across your knee and use the family slipper unsparingly. We cannot afford to see anything done that will interfere with the extended use of copper metal or in any way cripple the copper mining industry."

TRYING TO BOOST UTAH OVER BACK OF OHIO

About three weeks ago the mining department of the Salt Lake Tribune contained an article on the subject of "Copper Ores and Their Real Value" which, at first glance, seemed to have no other purpose than to show that mining values rarely came up to the sampling estimates of the best engineers. To illustrate the points sought to be gained by the writer the Ohio Copper property and the Nevada Consolidated were selected. The article attempts to show that while a number of eminent experts and engineers sampled the Ohio with results so uniform, that it seemed impossible a mistake had been made, yet the results of mining ore were not at all up to the grade which the sampling indicated should be obtained. Then it is shown that the early estimates of values in the Nevada Consolidated were fully verified by the grade of the tonnage mined up to the beginning of the present year. The article was rather cunningly constructed, and the fact did not appear conclusive that it had been promulgated with a purpose of not only injuring Ohio but as a means of boosting Utah Copper, until the appearance of chapter two, five days later, in the issue of July 17.

When this second article appeared it was plain that the first one had simply been designed as a prologue to the main play: that of making an apology for the fall in grade of the ores of Utah Copper, but at the same time to show that, because of the enormous tonnage handled, it did not much matter whether the rock treated was ore or only "probable ore."

The first article indicated that the engineers were on trial; the second article gives them a splendid coat cf whitewash and declares, in effect, that it cannot be expected that a mine will produce up to the average of the sampling; but, as is the case with Utah Copper, Nevada Consolidated and some of the others, the superior methods of mining and milling employed, it is contended, will make them win.

By all who have been following the history of Ohio Copper it will be remembered that the samplings were conducted and the stated values found by the eminent engineers referred to at a time when the sale of property or bonds were under consideration. Of course these facts did not, in any way, influence the reports submitted, which were made as any other reports might be—such, for instance, as those made for the Utah Copper company and others.

This second article unmistakably discloses the source of inspiration supplying the text for both and it illustrates to what extremes the Utah Copper-Ray-Chino crowd will go in an effort to stem the tide of public distrust and disgust with which they are being met in the mining share markets at home and abroad.

These comments are not designed to belittle the value of the low-grade copper mines. Properly managed and handled, with intelligent methods employed in the separation and collection of the values the ores may contain, Mines and Methods believes they are destined to make and become important factors in the world's supply of copper. When a propetry like Ohio Copper can be made to show handsome profits on ore the copper contents of which is barely one per cent—when treating a comparatively insignificant tonnage—the possibilities of this class of mining becomes apparent; provided, however, that as sane methods as are employed by the Ohio Copper—as evidenced by its reports—are put into practice. It is supremely unjust, and unfair, therefore, for a paper to hold a crippled and struggling enterprise like Ohio up to ridicule in order to boost the game of such a recklessly extravagant and overplayed proposition as that presented in the form and name of Utah Copper.

In the meantime we are reliably informed that the grade of the ore treated by the Utah Copper Company for the past three months has been nearly or quiet as low as that of the Ohio Copper, whilst its recoveries, at the same time, have persistently fallen considerably below 55% and frequently under 50%, as compared with 55 to 60% as credited to the Ohio Copper in the articles referred to. And that, because of such falling off, it became necessary to begin the remodeling of the remodeled Arthur plant during the past month.

FALLACIES OF MARKET REPORTS

Reviewing market conditions a little more than two weeks ago a New York correspondent of the Salt Lake Tribune said:

> Banks are discriminating against copper securities. The are refusing in many instances to make loans at all unless other securities accompanying the copper. This has given strength to the persistent rumors of a secret surplus of copper that is not being reported by the producers.

These market prognosticators have a hard time of it and most of their troubles arise from the fact that they seldom know what they are talking about. In a letter sent out a few days previous to the one from which the above extract wast taken it was declared that "all the facts and arguments on the constructive side of the market are fully disclosed and there is not another word that can be said in favor of higher prices."

Now, let us see. In the first place we have it on unquestionable authority that eastern banks are not discriminating against copper SECURITIES. It is the copper issues which, through misrepresentation concerning their worth and the partially successful efforts of their sponsors to make them appear respectable, that the bankers are fighting shy of. The bankers of New York and Boston are not discriminating against Amalgamated Copper, Anaconda, the Lake mines, the Phelps-Dodge mines, Miami, nor any other proposition that has the goods and is doing a legitimate business. The bankers apparently are simply protecting themselves by making distinctions; they are shaking but the chaff from the wheat. Neither are the banks becoming discriminators because of the supposed hidden hordes of the red metal; but there is abundant evidence to indicate that the banks of the east are steering away from those propositions the integrity of which the great investing public has come to doubt. Bankers are only human, and when they find that a discriminating public refuses to buy certain offerings they naturally protect themselves and their clients by withdrawing their support from such offerings.

Nor is our friend, the New York correspondent, right when he says that there is not another word to be said for the constructive side of the market. He has become so blinded through viewing everything from the fake boosting side of the game and his vision has become so narrowed thereby, that he has failed to see that the real trouble has been caused by the fraudulent tactics of a few combinations bent on going to any extreme to make their wares marketable. For many, many months this journal has been pointing out to the world what the real difficulty with the copper share market has been and still is. The investing public has not been slow to see that we were standing on firm ground, and now the bankers of the country are finding out.

We do not believe that the rumored hidden surplus of copper metal has anything at all to do with the present dullness and softness of the copper share market. In fact, we are not prepared to believe that there is a surplus that is more than sufficient to sustain a stable and healthy influence on the price of copper metal. That certain interests have been praying for a run-away copper metal market in order to create a stampede for their shares which they would have as widely "disseminated" as the ores in their mines, there is little doubt; but these prayers have not come from men behind the companies and mines enumerated above. The latter have been and are content to see the metal maintain a fair profit-making level, anywhere between 15c. and 20c., and they are not bothering about the market price of their mining stocks. Neither are the banks.

NOW FOR SOMETHING NEW

Well, what's the matter with introducing the public to something new? It is now quite evident that market followers have become sufficiently acquainted with the officially promulgated preorts on Utah Copper, Ray Consolidated and Chino to distrust their accuracy and to question the methods employed by the management to make the various properties meet expectations, so why not now give the public a taste of "disseminated" zinc and move the stock-market manipulating steam shovels on to the "deposits" flanking the holdings of the Butte and Superior properties in Montana? D. C. Jackling has been interviewed at Butte, where he stated that zinc was THE metal at present and that there seemed to be immeasurable quantities of it in the Butte-Superior section of the Montana copper camp. Almost immediately following this expression of opinion came the report that J. M. Hayes, cashier of the Utah Copper Company and President Colvin of the Butte and Superior company, had been taking options on all obtainable properties flanking the Butte and Superior. It was also naively stated that much of this property might eventually go to the Butte and Superior company, unless it should be finally decided to organize new companies to exploit it. This movement may be also suggestive of an application of the methods applied in Arizona, where the Ray Central and other property was taken over greatly to the advantage of the managing or inside forces of the corporations involved.

"Supposing" said the examiner, "you had renewed the manhole gaskets, had tightened up the nuts on the manhole dogs and had got 125 lb. of steam, what would you do if a dog came off and the handhole plate fell in?" "I'd go in after it," answered the candidate. "Any plate that could fall in against a pressure of 125 lb. would be worth going after."—Exchange.

D. C. Jackling, general manager of the Utah Copper Company, left Wednesday night for Butte, Mont., where he will spend two days inspecting the Butte and Superior mine. On Monday he will sail from Seattle for Alaska, his objective point being Juneau. His trip is purely of a business nature and he will be gone about a month.—Bingham Review, July 5. This sounds as though Manager Jackling had decided to take a few lessons in REAL methods of mining and milling at the Treadwell properties, where dividends are EARNED and paid out of legitimate profits, with pleasing regularity.

A new agreement has been entered into between the Butte miners' union and the mine operators that is to remain in force for three years. The new agreement, it is said, stipulates that, irrespective of the price of copper, the minimum wage of underground workers shall be $3.50 per day, and of surface men $3 per day; that when copper is 15 cents and under 17 cents a pound, underground workers shall receive $3.75 a day and surface men $3.25 a day; that when copper is 17 cents and under 18 cents, underground men shall receive $4 per day, and surface men $3.25 per day; and that with copper selling at 18 cents a pound or better, surface men shall receive $3.50 per day.

According to the annual report of the Anaconda Copper Company the development work carried on during the past year has not been as extensive as usual, due to the fact that some of the mines were closed down for repairs and various improvements and to the fact that some shafts were put out of commission, but notwithstanding this there were 30.7 miles of drifts, crosscuts, upraises, winzes and shafts added to the work of the year. In spite of the fact, however, that the development was not as extensive as in previous years, the ore reserves were maintained for the reason that the ore was not extracted. The mines of the company produced 184,070.20 tons of ore and 4,602.61 tons of concentrates during the year, making a total of 388,672.81 tons.

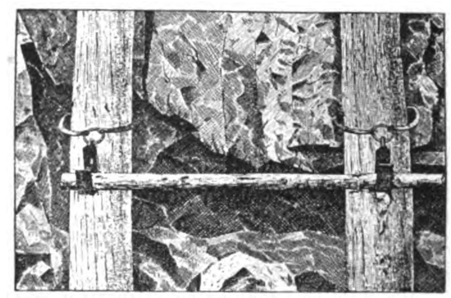
Accidents are more common on night shift than on day shift, and it has been proposed that the midnight shift, in particular, be forbidden. The Royal Commission on Mines in New Zealand, which investigated the matter, came to the conclusion that night work in mines, as elsewhere, "may be more detrimental to men than the day shift, but not so as to warrant us in making any recommendation thereon."

TEMPORARY STAGING HANGERS

By L. D. DAVENPORT.*

The hangers or suspensions illustrated in the accompanying sketch are used for supporting temporary staging in the Chisholm mine on the Mesabi range in Minnesota. The hangers are used in pairs to support a pole or beam, across two of which planks are laid to make the staging.

Clamps or large staples or boards spiked to the timbers in the drifts were formerly used for this purpose, but are open to the objection that they cannot be used on frozen timber.



The first hangers of the type illustrated were made with a pin or bar connecting the two hooks instead of a ring as shown. The hooks act in the manner of cant hooks, the greater the weight, the more firmly do they take hold of the timber. A spur on the heel of the hook prevents swinging.

These hangers are now used in the "slice" rooms at the Chisholm mine. They can be used on timbers ranging from 6 to 24 in. diameter. One of the hangers in each set is made with detachable tongs in order that they may be used with a yoke or handle as timber carriers. They may be also caught into a cap or post and used to hold a snatch block for lifting heavy timber.

The rapid spread of the use of concrete for varied purposes above and below ground indicate that in it an important structual material has been found. The use of concrete, has, however, spread faster than the knowledge of its properties, and of the requirements for its mixing and placing has spread. As a result much defective concrete work has been and is being imposed upon the public. The use of concrete is so simple that many people think that no special knowledge is necessary in order to have success with it. This is not the case. Concrete that is not mixed and placed according to correct methods cannot be relied on to give good service.

* Night foreman, Leonard Mine, Chisholm, Mont., in Eng. and Mining Journal.

Faults of Mining Laws and Remedial Suggestions

By HORACE V. WINCHELL.*

The question of national mining laws is of special interest just now in both Canada and the United States. Attention has been widely called to the many defects and general insufficiency of existing statutes, and wherever the matter has been discussed, the need for revision has been admitted. In the United States during the past decade there has been frequent agitation of the subject. Public officials connected with the administration of our land and mining laws have urged legislation along certain lines; the Director of the Geological Survey and the Secretary of the Interior has engaged the attention of Presidents, Mr. Roosevelt and Mr. Taft discussing it in messages to the Congress. Associations and societies of various descriptions, after due consideration, have passed resolutions demanding this or that measure of relief, and in some cases committees have been appointed for the purpose of making recommendations as to the principles to be followed in new legislation. Thus, a few years ago a committee of prominent mining engineers, among whom were John Hays Hammond, and James Douglas, united in a report upon this subject to the Government at Washington; but nothing came of it, and so far as I can learn, the report was never even published. More recently the matter has again been agitated and committees for its consideration have been appointed by the American Mining Congress and the Mining and Metallurgical Society of America.

The United States might well profit in this matter by the very sensible and systematic method which has been adopted in Canada to facilitate the proper settlement of this most important question. Here, as I am informed, a committee of engineers and attorneys has been selected by the Canadian Mining Institute to draft a bill for a Canada Mines Act, and to present the same for consideration and adoption by the Dominion Parliament. In other words, you Canadians are proceeding in the best way to procure laws framed by experts; and no one can doubt that statutes thus prepared are in every way superior to enactments whose subject matter is prepared by theoretical political economists on the one hand or by agitators and professional politicians on the other. I wish, therefore, at the outset to commend the Canadian Mining Institute for its very wise procedure in this matter and admonish you not to weary in well-doing, not to be disheartened at slow progress. When you have accomplished what you have set out to do, you will not only have that pleasant sense of satisfaction which succeeds the consciousness of duty worthily performed, but you will have made an investment of time and labor which will return a thousand-fold in actual wealth and prosperity. For that country which is willing to be guided as to the handling and development of its mineral resources by the crystallized policies of its mining engineers is the country whose mining industry will be at once best managed and the most productive of material blessings for all the people.

DIFFERENT SYSTEMS OF MINING LAW.

The mining laws of a country are those legislative enactments or customs established by precedent which control the acquisition and tenure of "mining regulations" which have to do with the methods and appliances used in operating mines. The principles underlying the mining laws of various countries have been found susceptible of classification into two groups: "(1) The concession system under which the state or a private owner of mining property has the right to grant concessions or leases of such mining property to individuals or corporations at discretion, or under certain general restrictions. (2) The claim system, under which any individual, under certain general specified restrictions, generally as to nationality and color, has the right to locate on discovery or otherwise certain limited areas of ground, and under certain conditions to hold, work, and dispose of the same."

Under the concession system the right to grant lies with the owner, and it is said that five-sixths of all the mining areas of the world are held under it; under the claim system the right to claim mining ground lies with the locator or discoverer. The latter is the system underlying the laws of Canada and the United States, as well as South Africa and Australia; but there are fundamental differences in these countries as to the nature of the possessory right and the character of title finally obtained.

Originating in the ancient proprietary rights of kings and fuedal lords to the minerals in the ground, the concession system still prevails in more or less modified form under all the ancient civilizations of the world. Its chief advantage is in the retention by the state of the right to select and control the operations of its concessionaires, thus assuring proper capitalization and development, good management, economical use of raw material, and the payment of rental or royalty. To this system there have been objections as follows: (1) that it places unduly large property control in the hands of a few men, and takes from the poor working man the chance of sudden wealth; (2) that by destroying competition in the sale of mines it places in the hands of the holders of large concessions the power of unlimited capitalization and speculation; (3) that it leads to the tying up of large areas of mining ground and thus restricts the employment of labor and the mineral production of the country. To these objections it may be answered that a relatively small number of men will always have control of the money with which to buy and develop mining property, no matter how it be granted; that the Government may easily regulate the capitalization of its lessees; and that a large, strong corporation is usually better prepared to thoroughly prospect its territory than the unaided though far more numerous prospector. If diligent prospecting is required as a condition in the concession, the system of preference rights to explore large areas with the further right to take out leases of limited area would seem to present many practical advantages for new and unexplored countries.

The claim system grew out of conditions in early mining days in the United States and Australia. The Argonaut horde who invaded California in 1849 and a few years later rushed to Australia were in many cases allowed to make their own local rules as to size of claim, method of discovery, staking, recording, and obtaining title. In the United States the usages thus established were later sanctioned by Congressional enactment which grew into our present system of

* Presented to the Canadian Mining Institute at the Toronto meeting, March the 6th.

mining law, and also served to greater or less extent as a model for Australia and other nations. This system, "however necessary in the peculiar circumstances of its inception, should have been altered as soon as changing circumstances permitted," but instead it has been patched and interpreted by judicial decision until the United States has today the most wretchedly inadequate and antiquated law with which a great country is anywhere afflicted. Instead of fostering the mining industry the law as it stands today and as interpreted by the judicial and executive branches of the Government creates confusion, entails unnecessary expense, causes waste, and retards development.

Two fundamental principles are common to the mining laws of all countries: (1) The right of the mineholder to a perfectly secure and indefeasible title to his property so long as he fulfills certain specified conditions entirely within his own control, and (2) the right of the state or other landlord to certain rents, royalties, or taxes on the property or its output, and to the reasonably constant operation of the mine.

In the power of the Government to fix the rate of royalty or taxes lies also the ability to promote or to discourage prospecting and mining. If the chief aim of the Government is the development of national resources and the increase of general prosperity and business, its policy for the disposition and holding of its mineral lands will be most liberal. If there is a desire to enrich the public treasury directly by means of revenues from taxes upon mines, the result may be a rapid decline of the mining business, and a shifting of the population to more favored communities. It is frequently stated, and truly, as I believe, that the principal factor in the growth and development of the United States and Canada has been the liberality of their policy for the distribution of their public domain. Freely, or at a nominal consideration, homesteads and mines have been offered to all who chose to come and settle, to develop and use. If during the past fifty or seventy-five years the policy of conservation as now advocated by its most ardent proponents had been expressed in our statutes North America would be for the most part as little developed as Alaska. There would be a line of settlements along the Atlantic and a few fishing hamlets on the Pacific. The interior of the country would still be to a very large extent bottled up and conserved; and the country would perhaps be still importing the bulk of its copper and iron as it is its supply of tin, platinum, potash, and nitre.

MINERAL WEALTH OF UNITED STATES.

To speak to an audience of mining men of the importance of a liberal mining law is like carrying silver to Cobalt or copper to Butte, but since these remarks may find a wider audience a few words upon the extent of our mining industry may not be out of place. First, with reference to the United States. The annual product of the mines of the United States now exceed $2,000,000,000 in value. They contribute 65 per cent of the freight traffic of the country. The industry employs over a million men at the mines and twice that number in handling, transporting and manufacturing the products. The total value of our metallic products during 1907 was $900,000,000; of mineral fuels, $788,000,000; and of non-metallic mineral products other than fuels, more than $378,000,000. During the year we imported mineral products to the value of $250,000,000, and exported mineral products to the value of $340,000,000. From the beginning of coal mining in this country in 1814 to the close of 1907, there were mined nearly seven billion (6,865,000,000) tons. Adding to this the one-half additional supposed to have been wasted in mining, gives a total of more than ten billion tons taken from the supplies originally available. The amount of easily accessible and available coal in the United States exclusive of Alaska, is estimated as 1,400,000,000,000, while the total, including Alaskan reserves of 150,000,000,000 tons and the coal not easily accessible, is perhaps double this amount and the country is as yet but partly explored. It may be remarked in passing that since the United States is now mining about 500,000,000 tons of coal annually we would appear to have a coal supply sufficient for about 6,000 years at the present rate of consumption, even without borrowing or buying from the enormous coal bins of Canada. Can anyone doubt that the provisions of the laws governing the disposition of the fifty million acres of coal land still remaining in the hands of the Government is a matter of importance to a nation with an annual coal consumption of five tons per capita?

AREA OF PUBLIC LANDS.

Figures are wanting as to the quantity and value of other mineral products estimated to remain within the unappropriated public domain. The land area of the United States, excluding Alaska and the insular possessions, is about 3,000,000 square miles, or 1,920,000,000 acres. Of this area over half is arable, and a little less than half is occupied as farm land. About two-thirds of the land has passed into private holdings. Of the original acreage there remained on July 1, 1908, 387,000,000 acres, or about one-fifth open to entry. Nearly all of this is arid or otherwise unsuitable for settlement by families. There are also about 235,000,000 acres in national forests, national parks, and other lands reserved for public use. Of the entire area of 1,920,000,000 acres there remain unalienated about 622,000,000 acres, or nearly one-third within which valuable minerals may still be discovered. Is it not a matter of vast importance to provide most carefully for the exploration, disposition, and development of this vast empire? In what direction can the fostering care of government be more profitably and properly extended? And when Alaska, with its undeveloped area of about 360,000,000 acres and the island possessions with 90,000,000 more acres, are taken into account, is it not clearly one of the largest questions before the public today?

CANADIAN CONDITIONS.

In Canada the percentage of unappropriated public domain is larger than in the older country lying along its southern border, and there is yet ample time to avoid the mistakes of omission and commission of the United States. With a total area of 2,118,814,000 acres, you have still in the hands of your Provincial and Dominion Governments the larger part of your acreage. Your annual production of minerals is valued at about one hundred million dollars. At its present rate of increase it may easily amount to $500,000,000 by 1950. Can your engineers find any more truly national work than to aid in the framing and adoption of the best possible laws for the protection and encouragement of the mining industry? Is it not apparent that there is a very close connection between mining laws and that conservation idea so dear to the imagination of the majority of our people today? If the true aim of conservation be "maximum use with minimum waste," is it not evident that to be consistent with this theory, mining laws must be liberal as to opportunity and inducement for the individual or corporation, and at the same time as scrupulous and exact in supervision and scientific regulation as the conditions of industry and the laws of political economy will permit? If the terms and conditions for acquiring mining property be so difficult as to materially restrict the number of prospectors or development companies. there will be far less than "maximum use"; and if no right of supervisory control is retained by the Government there will seldom be "minimum waste." The best code of mining laws will inevitably aid in the development of natural mineral resources, and at the same time have a tendency toward the right species of conservation, as contradistinguished from that variety of it which seems to aim at disuse, stagnation, and paralysis.

FAILURE OF AMERICAN MINING LAW.

In many particulars the present mining law of the United States is admittedly a failure, and in other respects it has both its critics and defenders. I propose to mention briefly some of its defects, and some possible amendments, not because there seems to be any danger that our worst faults will be copied by others, but in the way of general illumination of a question which is not always clearly understood even by our own people.

Briefly stated, the United States mining law, known as the Act of 1872, provides for location by discovery; possession perpetuated by annual assessment work; and title in fee simple to the surface and minerals obtained after the expenditure of a certain amount of money by the payment of $5 per acre, and the observance of certain formalities as to survey, etc. The metal-mining laws do not apply to all of the states. They are made applicable to the western states and territories with the exception of Michigan, Wisconsin, Minnesota, Missouri, Kansas, and Texas. Mining locations are not recognized in the states east of the Missippi River, nor is there in any state legal authority permitting one man to prospect or mine beneath the surface of ground owned by another without consent of the latter. To this statement there is one important exception, and that lies in what is called the "apex law" under which the owner of the outcrop of a vein in mining claims has the right to follow and mine the vein on its downward course beneath the surface of a claim owned by another. This law has proved more productive of expensive litigation than of economical mining, and in many of the more recently established and more progressive mining districts has been made inoperative either by common agreement or by compromise between adjoining owners. Placer mines are likewise located by discovery and held by annual work and acquired by purchase in fee-simple forever. Known veins within placer locations must be declared and paid for separately or else they are excepted from the placer patent and can be located by others as "lode claims." All veins on placer ground not known to exist at the time of application for patent belong to the grantee, but without extra-lateral or apex rights. If an applicant for a placer patent can be shown to have had knowledge of a valuable lode within his lines prior to the making of his patent application, his title as to that vein may be cancelled for fraud at any time upon application of a contesting locator. There is no limit to the time for such contests and they are still being brought in some cases twenty years after placer patent. The law is very defective on this point; for it frequently happens that veins discovered to-day have a value by reason of improved transportation facilities or metallurgical processes, although these same veins were of no value whatever when the placer claim was located and patented. The owner of such a claim is sometimes put to the expense and annoyance of defending such contests repeatedly, since there is no limit to the number of contestants. The law should be amended so as to make it impossibel to attack a placer patent on such charges after a reasonable term of years. Another absurd feature of the placer act is that providing for the location of oil, gas, iron ore, and other deposits in the same manner as auriferous gravel. Coal lands are sold by the Government upon an appraised valuation, and the amount of land that may be legally acquired is limited for an individual to 160 acres and for an association to 640 acres. Tracts of such limited area do not often justify the installation of the most efficient equipment, and economical operation is therefore impossible under the terms of the very law which was expressly designed to promote economy and prevent monopoly.

ABSENCE OF LEASING.

Under the present United States law there is no general system of separation of surface from mineral rights, no leasing of mines from the Government, no payment of royalty, and no Federal supervision or control after location and patent. Taxes are paid to the state and county, and mining regulation is attempted by many states. Unfortunately there is no uniformity of principle and practice as to these matters, nor any stability, nor assurance of permanence in any state either as to methods of operation required or basis of taxation.

Although it has been successful elsewhere and has much to recommend it, the Government leasing system has never met with much favor in the United States. There is not at present strong opposition to grants in perpetuity by the Government, although the leasing system has been recommended by some organizations and public officials. There is a hesitancy to create more bureaus; for bureaucratic administration is not popular with those who have tried to transact business with many of them.

Aside from the generally condemned apex law, there are two or three features of our present system which should be speedily remedied. The first is that provision of the law requiring a discovery of valuable mineral before location. There is really no sense in such a requirement. What seems valuable to one man is often worthless to another; and what is of no value to-day may be worth a million in a year or two. Moreover, it sometimes requires a year's work and a shaft of several hundred feet deep before the actual discovery of ore, even though the surface indications give ample promise of its existence below. Every mining engineer and geologist knows that many ore deposits have no value whatever immediately upon the surface of the ground. Why not allow a prospector to stake out his mining claim wherever he chooses on the public domain, and hold it so long as he performs the required amount of development work?

Another defect in our present law is that permitting a prospector to locate an indefinite number of mining claims and to hold them without doing his assessment work. Many promising districts are kept from becoming hives of industry and producers of mineral wealth by the tying up of their territory in this way. The prospector should be restricted in the number of his locations, and real development work should be exacted.

The last important defect in the United States and Alaska mining and land law to which I wish to call attention is the lack of any provision for appeal to the courts from the decisions of administrative officers. It is contrary to the general spirit of our institutions and an anomaly in constitutional government to take away from any citizen property rights to which he considers himself justly entitled under the law, by the mere fiat of an appointed government official who is here to-day and gone to-morrow. To place in the hands of such officials the final dicta in matters involving property valued at hundreds of thousands of dollars, and to provide no method of appeal to any duly constituted non-political judicial tribunal is not only to subject the said officials to great and unnecessary tests of moral courage and fidelity, but to require in them the qualifications of superior judges and experience in the interpretation of the law which many of them cannot be expected to possess. Serious injustice may be done without any remedy at law to the defeated applicant. In the interests of justice, provision should be made for appeals in important cases, and perhaps in all cases, from decisions of the Commissioner of the General Land Office or the Secretary of the Interior to some court of competent standing and jurisdiction, whose decisions could and would be accepted by the public and the interested parties as justified by the law and evidence. I am gratified to notice that this point has been carefully covered in the recommendations of the Canadian committee on this subject.

ENGLISH AND AMERICAN SYSTEMS.

A comparison of the mining laws of the United States with those of other English speaking countries will disclose a fundamental difference in the underlying theory of the proprietorship minerals, and hence the attitude of the courts upon the subject as reflected in their decisions. Recent publication of a report upon the "Mining Laws of Australia and New Zealand," has caused considerable discussion because of the fact that its recommendations have been to a certain extent adopted by other government officials in their annual reports and public addresses. This report apparently assumes a similarity between British laws and those of the United States in certain respects where actually a wide difference exists.

"Neither regalian right, nor anything similar, has ever existed in or been asserted by the United States. While it has sovereign authority, and the power to enact such statutes as Congress in its wisdom sees fit, within the limits of the Constitution, its right is dependent upon and controlled entirely by statute." Furthermore: "A distinction exists, and should be observed between ultimate ownership and right to govern on the one hand, and the exercise of regalian right after possession and title is parted with, on the other. The former exists in the United States, the latter does not. The ownership, as well as the manner of exercising control, of mineral lands is regulated in the United States by statute."

"The fundamental principles of the common law of England were to a certain extent ingrafted into our legal system when we separated from the mother country and were and still are the rule of action in the absence of legislation. As a general rule, under the common law minerals were the property of the owner of the land, the property in the surface carrying with it the ownership of everything beneath it. Wherefore the ownership of the surface was the best prima facie title to the ownership also of the mines. This prima facie ownership continued until rebutted by showing either: (1) that the land contained 'royal mines'; or (2) that it was subject to some particular custom that defeated the prima facie ownership, as in the case of the tin mines of Cornwall and Devon and the lead mines and minerals had become in fact, from divers causes several and distinct from the ownership of the soil and surface."

By the term "royal mines" was meant mines of gold and silver. These belonged exclusively to the Crown, by prerogative, although in lands of subjects. In this respect the rule was the same as under civil law. It was at one time contended that mines or mineral deposits containing the baser metals in combination with either gold or silver were royal mines. This contention, however, was set at rest by statutes enacted during the reign of William and Mary, wherein it was declared that no mine should be deemed royal by reason of its containing tin, copper, iron, or lead in association with gold or silver. Thus, those mines only came to be classed as royal in which were found the precious metals in the pure state. Briefly stated, the regalian right to mines, as recognized in England, was confined to those of the precious metals, gold and silver. The base substances belonged to the owner of the soil, except in certain localities where immemorial custom had modified the rule.

At the present time "England has no general mining laws. Legal questions governing the ownership of mines and minerals have been determined on the general principles of the common law."

As distinguished from the common law the theory of the civil law is thus clearly stated by H. W. Halleck:

"All continental publicists who have written upon the subject lay down the rule, that mines, from their very nature, are not a dependence of the ownership of the soil; that they ought not to become private property in the same sense as the soil is private property; but that they should be held and worked with the understanding that they are by nature public and they are to be used and regulated in such a way as to conduce most to the general interest of society."

C. H. Lindley has presented concisely the theory of our leading mining lawyers as to governmental control after patent, as follows:

"The Government of the United States does not concern itself with mining lands or the mining industry after it parts with the title. This title vests in the patentee absolutely to the extent of the property granted. No royalties are reserved; nor is any governmental supervision (except perhaps in the isolated case of hydraulic mines in California) attempted. Upon the issuance of the deed of the Government the mineral land becomes private property, subject to the same rules as other property in the state with reference to the transfer, devolution by descent, and all other incidents of private ownership prescribed by the laws of the state. Briefly stated, property in mines, once vested absolutely in the individual, becomes subject to the same rules of law as other real property within the state."

DID UNITED STATES WAIVE RIGHT?

But lately we are told that the United States "has never waived its right to the precious metals," and that "in all states where the Federal Government has never owned the land, and there are nineteen such states, the ownership of the precious metals lies with the state government," and "that in states where the ownership of the land has been vested in the Federal Government the ownership of the precious metals in like manner, lies with the nation, and that as against the Government no person has a right to gold and silver in any lands in the United States unless this right has been specifically granted to him in the deed of conveyance."

Here is a most radical difference of theory. Mr. Veatch would have the Government dominion and control of gold and silver and by implication of other metals beneath the surface of all lands except those in which minerals were specifically conveyed. He thinks the Government has the right to grant prospecting permits beneath private property and the power to collect royalties on minerals produced as a result of such explorations. In other words he insists upon it that the United States is in possession of a regalian right, but does not know it or has forgotten it. He would have the people wake up and seize what is theirs from all mine operators who are thus wrongfully removing from the ground valuable minerals never specifically granted to them by the Government. It can readily be seen that it is a matter of no small moment to ascertain whether such a thing is possible. Here is proposed mining law revision with a vengeance. I have not at hand the figures to show the relative proportion of lands patented as mineral lands and in all other classes; but have no doubt that the lands granted under the homestead, pre-emption, desert land act, private entry, townsite, timber and stone, railroad grants, and all other laws exceed in the aggregate the lands under the mining laws four to one. Now, if the minerals under three fourths of the privately owned land west of the Mississippi, and practically all the lands east of it, really belong to the Government, it is high time for the Government to assert its right and to exercise some sort of control over its vast possessions. This is either a nebulous and iridescent dream or a very important discovery. If the former the bubbles should be punctured, and the mist dispelled, before arousing too many false hopes; if the latter the work of mining law revision at once assumes paramount importance. Fortunately, we have some illuminating opinions of the United States Supreme Court, as a guide and cloud dispeller.

OPINIONS OF SUPREME COURT.

In the case of Deffeback v. Hawke, 115 U. S., p. 400, Mr. Justice Field, after reviewing at length the various acts of Congress relating to the public lands of the United States, concludes as follows:

It is plain from this brief statement of the legislation of Congress, that no title from the United States to land known at the time of sale to be valuable for its minerals of gold, silver, cinnabar, or copper, can be obtained under the pre-emption or homestead laws or the townsite laws, or in any other way than as prescribed by the laws specially authorizing the sale of such lands, except in the states of Michigan, Wisconsin, Minnesota, Missouri, Kansas. We say "land known at the time to be valuable for its minerals," as there are vast tracts of public land in which minerals of various kinds are found, but not in such quantity as to justify expenditures in the effort to extract them. It is to such lands that the term "mineral" in the sense of the statute is applicable. In the first section of the act of 1866 no designation is given the character of mineral lands which are free and open to exploration. But in the act of 1872, which repealed that section and reenacted one of broader import, it is "valuable mineral deposits" which are declared to be free and open to exploration and purchase. The same term is carried into the Revised Statutes. It is there enacted that "lands valuable for minerals" shall be reserved from the sale except as otherwise expressly directed, and that "valuable mineral deposits" in lands belonging to the United States shall be free and open to exploration and purchase. We may also say lands known at the time of their sale to be thus valuable, in order to avoid any possible conclusion against the validity of title which may be issued for other kinds of land, in which years afterward, rich deposits of mineral may be discovered. It is quite possible that lands settled upon as suitable only for agricultural purposes, entered by the settler and patented by the Government under the pre-emption laws, may be found, years after patent has been issued, to contain valuable minerals. Indeed this has often happened. We, therefore, use the term known to be valuable at the time of sale, to prevent any doubt being cast upon titles to lands afterward found to be different in their mineral character from what was supposed when the entry of them was made and the patent issued.

And in the case of the Colorado Coal Company v. the United States, 123, U. S., p. 528, Mr. Justice Matthews uses the following language:

"A change in the conditions occurring subsequently to the sale, whereby new discoveries are made or by means whereof it may be profitable to work the veins as mines, cannot affect the title as it passed at the time of the sale. The question must be determined according to the facts in existence at the time of the sale. If upon the premises at the time there were not actual 'known' mines capable og being profitably worked for their profit, so as to make the land more valuable for mining than for agriculture, a title to them acquired under the pre-emption act cannot be successfully assailed."

Since these are the opinions of the highest court in our land it is probable that although advocates of radical revision of our mining law may be able to change the form of its superstructure they will hardly be able to mine deep enough to disrupt its solid rock foundations. It will continue to present fundamental differences from the mining law of Canada on the north, and from that of Mexico on the south, but rights already granted will not easily be set aside.

GENERAL CONCLUSIONS.

Summarizing these somewhat disjointed remarks, it appears in general that:

1. The development and prosperity of all countries it vitally affected by the provisions of their laws relating to mines.

2. Greater inducements and more liberal rewards should be offered in unsettled countries than in districts of denser population.

3. Continuous development work should be required and rigidly enforced, but

4. No narrow limit should be placed on the amount of property held by an individual or corporation so long as the aggregate amount of work equals the product of the net units of area held multiplied by the amount of development required for each unit area.

5. In case of any contest either between rival claimants or between a locator and the Government full privilege should be given of appeal to the courts as in other matters wherein the title to property is involved.

In addition to the above, and with particular reference to the United States, taking into account the system of mining law there already established by long years of precedent and custom, the following recommendations are tentatively presented:

(a) The apex law should be abolished.

(b) Mining claims should be located regardless of a "discovery" and held only so long as the specified development work is performed in good faith.

(c) Placer locations should be limited to deposits of loose materials above solid bedrock.

(d) A statute of limitations should establish a reasonable term of years beyond which placer patents shall be immune from attack on the ground of misrepresenatation in the patent application.

(e) Special statutes should be enacted providing for the location and working of oil, phosphates, rare earths, haloids, and other mineral substances not specifically mentioned in the present laws.

(f) Existing titles should be fully recognized and confirmed and no effort should be made to create retroactive legislation.

I have purposely avoided any discussion of the relative advantages or disadvantages of permanent alienation of title as opposed to the government leasing system. For Canada, I am confident the latter system is to be preferred, and am pleased to find myself upon this point in accord with the majority of Canadian mining men.

An English chemical house is building a chemical works in Russia for the production of iodide of potassium and of sodium, also camphor. The raw material for the production of these products will be the marine growths on the eastern Siberian shore. This will be the first production of such chemical goods in Russia.

The scheme for tunneling the Bering straits and thus linking up the railway systems of Siberia and North America is again being revived, representatives of an American syndicate being at present in Europe for the purpose. The scheme involves the construction of a 40-mile tunnel beneath the straits and the building of new railways both in Siberia and northwest America to reach the approach stations on each side, and would enable passengers from any European capital to travel to New York and the principal cities of the United States and Canada by train journey throughout. It is proposed to sink shafts from islands situated midway in the Behring straits, thus enabling construction to be begin simultaneously from various points, and these shafts would subsequently be employed for ventilating the tunnel.—Exchange.

Copper smelting equipment is in course of erection at the Kalatinsky mines in the upper Isset district, Russia. The ore is a cupriferous pyrite containing as high as 3% copper.

New Wet Centrifugal Separating Process

By WILLIAM J. GEE.*

The new process here discovered is a mechanical method of separating the solid matter from the water and, in the same operation, grading it. The process consists in passing the liquid containing the solid matter in suspension through a rapidly rotating drum, whereby the solids are caused by centrifugal force to be deposited on a removable lining on the inner surface of the drum, while the water or other liquid passes away clear of suspended matter.

The apparatus is seen in sectional elevation in Fig 1, and in cross section in Fig 2. The drum (A) fitted with a base (B) is mounted on a shaft or spindle (C) the whole being suspended from a ball bearing of special design at (D) supported between girders at (E). Rotation is imparted by the pulley (F) to which a band-brake is fitted at (G). The upper end of the drum is closed by a cap (H) which makes a water-tight joint with the drum at (I) when clamped by the locking-ring (J). This forms a species of bayonet joint. The cap (H) has a hole in the middle and is held central on the spindle by means of the casting (K) which is a sliding fit on the spindle, and is connected with the cap by the upper end of the six rods (L). At the bottom of th drum at (M) is fitted a weir plate or diaphragm.

Depending from the cap into the drum is a kind of cage, or "container," seen best in the section, consisting of six vertical square rods (LL) to which are attached radial vanes or blades (NN). These blades extend the whole length of the drum, being connected to the cap at the top end, and to a circular plate (O) at their lower end.

The container slides easily in the drum, which is divided into six longitudinal compartments. Each compartment is provided with a curved plate (P). It will be understood that the container is, in effect, a removable lining to the drum, on which the recovered solids are received, as shown in the horizontal section (Fig. 2) at (Q). The operation of the machine is as follows:

The requiste speed (usually between 100 and 200 ft. per second peripheral velocity) being attained, the water containing in suspension the solid matter to be separated and graded is fed in a steady stream through the hole in the middle of the cap on to the casting, (K) (Fig. 1), which also serves the purpose of a distributing plate. The centrifugal force generated by the rapid rotation causes the water to fly to the wall of the drum and distribute itself thereon, so that an inner wall of water is soon formed which, when a given thickness is attained, overflows as indicated by the arrow at (R) and passes out of the drum through the holes in the bottom, under the weir plate, (M) at S.

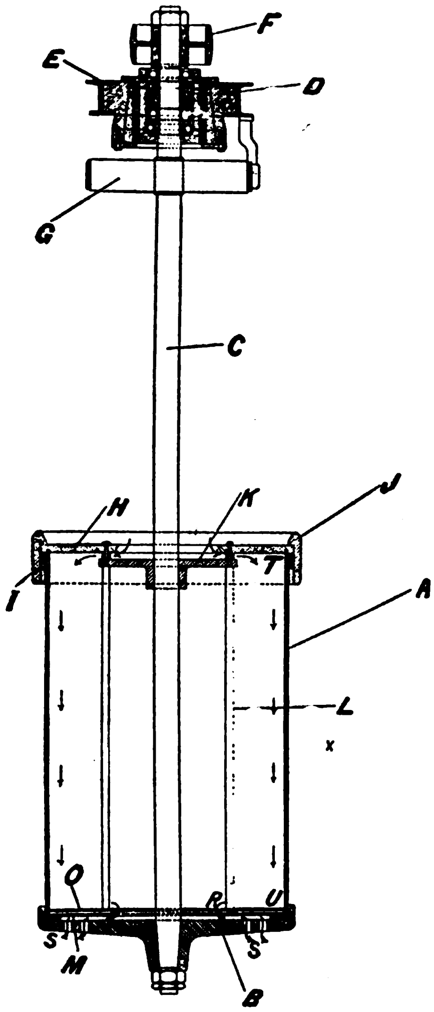


Fig. 1. Simultaneous Separating-Grading

It will be understood that a slow, steady current of water is thus set up in the drum, in the direction of the arrows, and in passing down the drum, the solids in suspension are gradually deposited on the plates which line the drum. The coarse or heavy particles are very quickly separated, and these are found near the inlet at (T). The finer particules are carried farther along before they become separated, until the finest are deposited at (U), near the outlet.

Consequently, the slab of recovered material ranges from the coarsest at one end to the finest at the other, with every possible degree of quality in between. The effluent water is quite clear.

When a sufficient charge of material has been recovered, the machine is stopped, the cap is unlocked, and the container drawn up by lifting gear (not shown) until the bottom plate (O) is within a few inches of the top end of the drum. The container is raised ready for discharging. The curved plates can readily be removed, with the slabs of recovered material adhering to them, fresh plates are inserted, the container is lowered into the drum and locked, and the operation repeated. Four to five "journeys" per hour are made, and each operation in the usual-sized drum (3 ft. diameter by 4½ ft. long) recovers about a quarter of a ton of graded material.

INDUSTRIAL APPLICATIONS.

The industrial applications of the process are very numerous. A large number of commodities, such as whiting, fuller's earth, China clay and other clays, ochres, umbers, and other earthly pigments, Tripoli powder, pumice powder, emery and other polishing substances, and so on, are at present treated by first grinding or puddling them with water, and afterwards settling them out of the water in the various grades, in the manner already indicated.

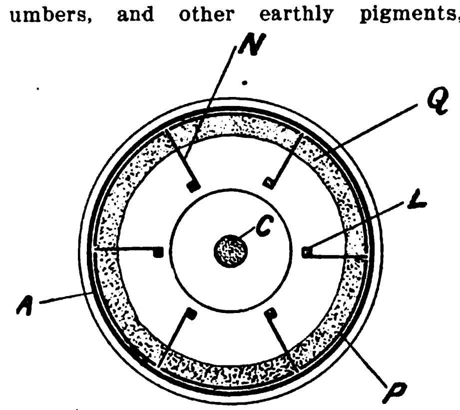


Fig 2. Cross-Section.

The machine is also applicable to the separation of solid matter from liquid where grading is of no importance, but where the object is mainly to get the suspended matter out of the water as quickly and cheaply as possible.

A sample of coal was sent to me, containing about 16% of siliceous ash. The object sought was the removal of the silica from the coal. I had the coal crushed to fine powder, and was able to get a very satisfactory result.

APPLICATION TO ORE DRESSING.

I now propose to deal with a new departure made in the direction of apply-

*Journal of the Royal Society of Arts.

ing the process to ore separation. A separator of a new type is illustrated in Fig 3 in sectional elevation, and in cross section in Fig. 4. In this machine we have the drum (A) mounted on the base (B) and closed at the top by the cap (C). Ball bearings (DD) at the top and the bottom of the drum are placed so that the drum may rotate on, but independently of, the shaft or spindle (E). As this ore machine runs at lower speed than the grading-machine, there is no objection to putting bearings at both ends of the drum. The weir plate at the bottom, inside the drum at (F) serves, as in the other machine, to provide an inner wall of water of the desired thickness within the drum. The shaft (E) is fitted with bearings at each end, and attached to the shaft, within the drum, but clear of it, are a number of radial vanes or blades, extending the whole length of the drum, and so arranged that the distance for which they dip into the wall of water may be varied, so that the grip of these blades on the water may be adjusted.

The principle of the apparatus is that the drum is caused to rotate at a given speed, and the wall of water is caused by the vanes to rotate within the drum at a greater speed, but in the same direction. These speeds, and their ratio to one another, may be adjusted within very wide limits. The result is that the particles of greater specific gravity—for instance, tin oxide, with a specific gravity of 6.7—are, by reason of their greater inertia, caused to deposit on the drum and remain there, while the particles of lesser specific gravity—let us say, quartz, with a specific gravity of 2.65—are carried along with the water and discharged with the effluent. Centrifugal force acts, in these centrifugal machines, in precisely the same way as gravity does on a conecentrating table. The only difference, so far as the effect is concerned, is in the intensity which, in this machine, is about 100 times as great as on the concentrating table. It is easy to adjust the speed at which the water travels relatively to the drum, so as to effect practically a perfect result.

The method of operating the separator is as follows: The drum and the vanes are set rotating at the required speeds, and clean water is fed into the drum until an effluent is observed at the outlet. This indicates that the wall of water in the drum has been obtained The inflow is now changed to water-suspended ore, whereupon the separation of the metallic particles is effected, as described, during the passage of the material through the drum, and the effluent will consist of water-suspended gangue only. The inflow of ore is continued until a sufficient deposit of concentrates is obtained, and it becomes necessary to discharge the metallic material. The discharge is effected in the following manner: The inflow is changed over from ore water to clean water, and in a short time all the gangue still in the drum will have been carried away and

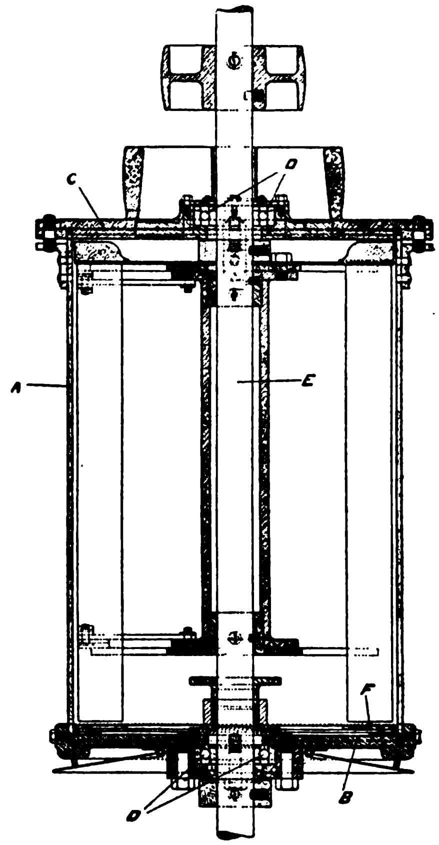


Fig. 3. Special Bearings.

the effluent will be clear. There will now be in the drum only a wall of clean water, with a thin layer of concentrates adhering to the inner surface of the drum. The effluent is now changed over to the waste, and put into communica-

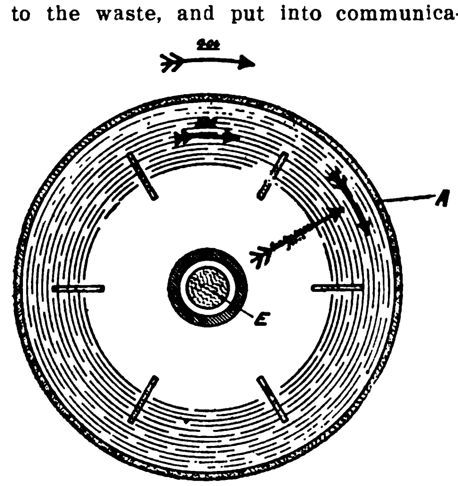
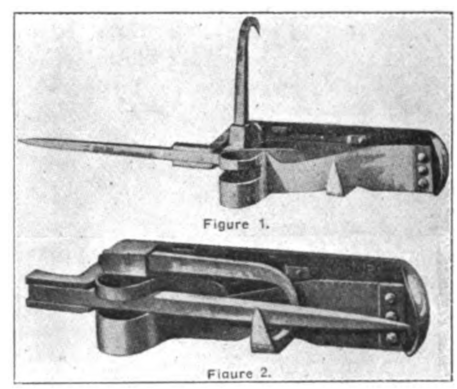


Fig. 4. Special Machine for Metallic-Ore Separation. Vertical Section

tion with the reservoir for concentrates. The drum is then retarded or stopped while the vanes still rotate. The stirring action of the vanes is thereby increased to such an extent that the concentrates are washed off the drum, and the continued inflow of clean water carries them away to the reservoir. In a few seconds the drum is quite clean. The effluent is now reconnected to the waste, the speed of the drum is restored to its proper ratio, the inflow of ore water recommenced, and the cycle of operations repeated. Gearing will be provided whereby these operations are periodically performed mechanically, and the apparatus rendered wholly automatic.

FOLDING POCKET CANDLESTICK

Miners and engineers frequently feel the need of a candlestick for underground work which can be conveniently folded and placed in the pocket. The owner of a pocket candlestick always knows where to find it. Nathan E. Varney of Denver, who has been engaged for some years in the manufacture of candlesticks for miners, has recently procured a patent upon a new device of this kind which he is just now placing upon the market.



Two views of the Varney stick are presented herewith, Fig 1 showing it open and ready for use, while Fig. 2 shows it folded and locked and in condition for the pocket. The essential feature is the means of engaging the base of the hook with the base of the spike, when the two are open, so as to secure absolute rigidity, to which also is added the convenient means by which both hook and spike are properly sheathed when folded. The stick is provided with most satisfactory locking systems when open and when closed. Finally, the closing of the spike compresses within narrow space a spring plate, which at its free end constitutes the thimble or candleholder proper. The compression of this spring when closed gives a certain tension which holds the folded parts tightly in position.

To find the capacity of a cylindrical tank, square the diameter in inches, multiply by the length in inches and multiply this result by .0034. This gives the capacity in United States gallons.

Company Promotion Methods in London

By WILLIAM HILLMAN*

In spite of the great and growing importance of New York as a money center and ever admitting that the "Money Trust" is there developed to its greatest extent, London is still pre-eminent in finance and it is to her financiers that the eyes of all who desire capital are turned. Although many Americans are thoroughly familiar with London financial methods, I believe those who are contemplating financing their enterprises in London will find the following notes of interest.

It is my object in this article to give an account of the usual method of raising money in London for public companies of moderate capitalization, say up to £500,000, and to point out some of the difficulties that an American vendor is likely to encounter. I also wish to show that in spite of its high reputation English company law does not afford adequate protection to the investor, and to indicate how some of these defects might be remedied.

WHERE THE PROMOTER IS ESSENTIAL.

About the first fact that strikes an American who attempts to sell properties in London is that as a rule there is no chance to sell to a group of private investors and that he must depend upon having his property handled by means of a public company; i.e., a joint stock company formed in accordance with a special body of laws, and offering its shares to the general public, usually by medium of a prospectus that is published as an advertisement in the leading newspapers, and is also distributed to individual investors through the mails.

These public companies are formed and their initial expenses are borne by promoters, and hence the chief requisite for doing business is "first catch your promoter." This is an extremely difficult task, for strange as it may seem, the promoter is a shy bird, and his name does not often appear in connection with the companies that he promotes. Though there are directories of directors, and all sorts of classified lists of investors and shareholders, there is no list or directory of London promoters. This retiring disposition of prominent men is quite a feature of London life and is carried to such an extent that some prominent bankers and capitalists do not have their names appear in the directory or in the telephone book.

It is probable that any American visiting London will have letters of introduction to leading engineers and capitalists, and it is equally probable that he will be disappointed when he attempts to do business with any of these people. He will find them so occupied with their own affairs and his interviews so full of depressing interruptions that he will not have a fair chance of stating his own case; the most that he can hope for is to be allowed to leave his maps and reports and to accept a promise that they will be carefully examined. Sometimes the reports are opened and read, but not always.

THE GLAD HAND IS NOT EXTENDED.

A typical interview might be somewhat as follows: A long delay in a gloomy cupboard is ended by an invitation into an innner sanctuary by a stolid commissionaire, whose breast shines with medals won in Africa or Oriental campaigns. Hardly do you state your business when your host tells you that he has already had your proposal placed before him, or at any rate a similar one. He regrets that he cannot entertain it at present. You scarcely get a chance to utter three consecutive sentences before he is interrupted by the telephone, and you soon learn that you are talking with a man whose mind is too full of absorbing business to contain any new ideas. He is sure to have a deal of some sort on in the part of the world which is financially fashionable, whether it be West Africa, the Malay states, or, as recently, Nigeria. To him all other parts of the earth are non-existent. "Now if you only had a tin concession in Nigeria I could handle it in a minute. It is so difficult to get anything good there. I am just promoting a property with a capital of £1,000,000 and I cannot handle anything else until this is out of the way." Brr! Brr! goes the 'phone. "Yes, you must get on to him at once, for if he gets away I don't believe we can handle the deal." Then follows a long 'phone conversation, probably touching on gold before it ends. Eventually he turns to you and says in a confidential manner: "You heard this deal I was just talking about on the 'phone. It is practically all settled, and the shares are certain to be oversubscribed. Possibly I could get some underwriting for you if you feel like taking some." And before you know where you are, you will find yourself listening to the details of the promoter's scheme, and all chances of discussing your own proposal vanish. This effective method of getting rid of a visitor who seems likely to prove unprofitable, by leading the conversation to the promoter's own affairs, is so common that I have sometimes thought that it must be laid down somewhere in a "Manual for Promoters."

An intimate acquaintance with busy promoters has convinced me that it is practically useless to try to sell a mine or other property through them, and it is the busy promoter that the American coming to London is likely to meet. It seems, therefore, that his best chance is to get in touch with promoters who are not so busy. These men are equally hard to find, and are usually only to be reached through intermediaries who expect a large slice of profits for their introductions.

PITFALLS FOR THE UNWARY.

Here it seems appropriate to caution the American who is unfamiliar with London methods against giving commission notes or writing letters that can in any way be interpreted as giving anyone a claim on his property. The spirit of Dick Turpin is still stirring, and it is marvelous on what a slender basis of fact the commission hunter works. A stranger to London wiles should at once put himself in charge of an experienced solicitor as soon as he begins serious negotiations.

When a promoter is found who will undertake your business he is sure to want nearly all the rest of your profits—there are, of course, exceptions—and the more successful the promoter, the bigger the slice he takes. I know of one case where the promoter made about £60,000 on a deal and gave the unfortunate optionholder nothing except a call on some ordinary shares; a call which soon became worhtless. In this particular deal a property for which about £1800 was paid in cash was sold to the public on a basis of £130,000. No set rule can be given as to the amount of profits that a promoter requires, but a common formula among them closely resembles the problem set for Alice by the White Queen: "What's one and one and one and one and one and one?" The promoter's formula is: "One and one and one." This expression translated is: one part for purchase price, one part for working capital and one part for promoter's profits. I do not know of any deal that has been put through exactly on this basis, but it is an ideal toward which a number of promoters work.

After the promoter has been found and an agreement reached with him the busi-

* In Engineering and Mining Journal, July 6, 1912.

ness of the American is ended, for he can be of little use in the turmoil of a promotion. However, it seems worth while to give some details of the actual promotion for there is as far as I know but little written on the subject.

AN EXAMPLE OF COMPANY PROMOTION.

As I have remarked before, the promoter raises the money needed for his schemes by selling shares to the general public; his methods can probably be best understood by a concrete example. I give here, with some modification, the details of a promotion with which I am familiar. The property in question, call it the Marianne mine, was first offered for £100,000, but long negotiation convinced the owner that all cash was not to be had and he finally sold for £40,000 cash, and £60,000 in shares. As soon as negotiations were well under way the promoter formed the Maryan Syndicate, Ltd., capital £200 in 4000 one-shiling shares. This syndicate was formed to facilitate the handling of the promotion and also to protect the promoter from any claims that might in future be raised by irate shareholders in case the promises of the prospectus were not fulfilled. The promoter's name did not appear in connection with the formation of the syndicate, the orginal subscribers being three of his solicitor's clerks, whose average pay was £3 per week, and whose total belongings would not aggregate £100—yet the law considered these men of straw good enough to become responsible to the public for transactions involving about £200,000. Men who are anxious to find out who are the promoters in any particular case can best do so by investigating the original subscribers of the promotion syndicate, full details will be given by Somerset House, the record office for London companies.

All the contracts with the vendors, brokers and underwriters were made by the Maryan Syndicate, and the syndicate transferred the property to the Marianne Mining Co., Ltd., which had been formed with a capital of £200,000. Owing to the well drawn porspectus, based on the reports of a prominent expert, and to well chosen chairman and directors, backed by the efforts of strong underwriters, aided by a good press, and, most important of all, owing to the region where the mine was situated being in fashion at the moment, the promotion went off swimmingly and the shares were oversubscribed. The final résults of the promotion, omitting details, were £110,000 in cash received from sale of shares, which was distributed as follows: Cost of property, £40,000; working capital, £30,000; promotion expenses, £15,000; promoter's profits, £25,000; or a total of £110,000 cash received, and shares to owner of property, £60,000; shares in reserve, £30,000, so that the total capital of the Marianne Mining Co., Ltd., is £200,000. The promotion expenses in detail were: Legal fees and expenses of formation of company, £1000; printing and postage of 30,000 prospectuses, £500; advertising prospectus, £3200; expert's fee and cables, £1000; broker's fee for allowing use of name on front page, £500; underwriting £110,000 at 8%, £8800; or a total of £15,000 for promotion expenses.

MAILING PROSPECTUSES A BUSINESS.

The 30,000 prospectuses were mailed to possible investors by a firm that makes a speciality of this work and has a large staff of clerks and classified lists of shareholders covering all Great Britain. The advertising was the publishing of the prospectus in about fifty prominent newspapers, the price ranging from £125 for a single issue in the Daily Mail down to £10 for a provincial paper. At the foot of each advertisement was printed a form for application for shares, and it was on these forms that most of the applications were made; few subscriptions resulted from the prospectuses that were sent out by post.

The underwriting, 8% on the cash received or £8800, was a heavy expense, and in this case it was extremely profitable to the underwriters, for as they had, in accordance with their underwriting contracts, to pay in but 10% of the amount underwritten, and as they received this amount together with their underwriting commission within 10 days, they made a profit on the money employed at the rate of 8% per day or over 2500% per annum. It is almost needless to remark that underwriting is not always so profitable. The great utility of the underwriter is as an advertiser and boomer of shares. It is for this reason that nearly all companies have their shares underwritten, though in many cases the expense is probably unnecessary.

THE HAZARDS OF BEING A PROMOTER.

The promoter's profit, in this case £25,000, seems excessive to the outsider, but it is usually divided among a number of people and to one who is familiar with the proceedings of the London bankruptcy courts the profits do not seem so attractive, for the way of the promoter often leads to failure. While the promoter can cover himself for most of his risks, he is bound to advance several thousand pounds for legal costs, expert's fees, cables and printing, on every business that he takes up and if he goes so far as to advertise his outlay will not be less than £5000 on any company that he forms. In case the public does not subscribe for his shares much of his loss is paid by the underwriters, but after his underwriters have been "stuck" once he finds it most difficult to get any new company underwritten. As a result he takes more chances and does his own underwriting, and often lands in bankruptcy. I know of several cases where the promotion expenses have run into thousands of pounds and the amount of shares subscribed for has been merely nominal; in case of a Rhodesian mine the promotion expenses were £5000, and £23 the amount of the shares subscribed.

It will be seen from the foregoing that this cumbersome method of raising money inevitably overcapitalizes the enterprise. Take the case of the Marianne mine, above mentioned; the mine worth £100,000 needed £30,000 working capital and would pay a profit on this, but now being saddled with £200,000 capital and an expensive and incompetent organization, has but a poor chance of success.

Not all companies are failures, and it is to be remembered that the promoter does much useful work in gathering capital from thousands of persons and enabling profitable enterprises to be established. Under the present constitution of society there seems to be no way by which the promoter's services can be dispensed with, and accordingly he will be able to levy his heavy tax on industry for a long time to come. However, the promoter does not set out to serve the public; his chief aim is to make profits, and an almost equally prominent aim is to avoid getting entangled in the meshes of the law. This is at times an expensive proceeding and promoters and vendors have been obliged to refund large sums. One of the most recent cases is that of the Kern River Oil Co., where a large sum of money was repaid by the vendors, and I know of another case where a promoter had to pay £176,000 in damages.

IRRESPONSIBILITY OF THE FLOTATION SYNDICATE.

It was to avoid such consequences that the irresponsible Maryan Syndicate was formed. By working through these irresponsible syndicates the promoter is insured against any claims of shareholders from irregularities in the purchase and transfer of the property, and for any mis-statements in the prospectus the promoter protects himself by his expert's reports in the first instance, and then throws the onus of the prospectus on the directors of the public company, in this case the Marianne Mining Co., Ltd. The directors shelter themselves behind the expert's report under the advice of solicitors and counsel.

The Maryan Syndicate, Ltd., was a private company, for it did not ask the public to subscribe to its shares, and had a capital of only £200, and this was the maximum amount that could be recovered from its shareholders. But, as a matter of fact, this £200 was never paid into the treasury of the syndicate, and its shareholders were not worth even that small amount. Therefore, the loss that could come to the promoter through the operations of the syndicate would be nominal.

PROSPECTUS CAUTIOUSLY PREPARED.

The greatest risk run by the promoter is in the preparation of the prospectus, for should any shareholder be able to prove that he had been misled by it he would have a good chance to recover his money from the directors, and they in turn would look to the promoter, so there is a possibility of heavy loss should any glaring mis-statements be found in the prospectus. Hence, the preparation of a prospectus is a delicate piece of work and only those on the "inside" have any conception of the vast amount of thought and consultation expended on a well written prospectus. It is first drawn up in a general way by an experienced prospectus writer, who well knows the safe path between glowing fancy and dull fact. His draft passes the scrutiny of the promoter's solicitor and finally a counsellor of note is called on to revise the finished work.

After all it is not the writing of the prospectus that gives the promoter the most trouble, but it is the selection of the men whose names are to adorn the "front page" in bold-face type. These important names are those of the chairman, directors, brokers, bankers, solicitors, auditors and secretaries; the names of the engineers are usually not considered of enough importance to mention.

NOTABLES AND NOBLES DESIRED AS DIRECTORS.

It is in the selection of the chairman and the directors that the promoter shows his capabilities, and the task requires a wide acquaintance, tact, influence and liberality. These are the men to whom the investor looks for a "square deal;" their names are what he first sees, and they have more weight with him than all the rest of the prospectus. Accordingly they must be men in whom the public has confidence, and yet they must not pry too deeply into the mysteries of the promoter's profits and the origin of the reports on which the prospectus is based. The chairman should have a title, for in spite of the failure of many members of the nobility to protect the interests of their shareholders "Sirs" and "Lords" are still of value in the city of London. From the promoter's standpoint, an ex-army officer, or a retired government official is an excellent chairman. Some of the directors should have a practical knowledge of the business that is being promoted.

The anxiety of the promoter to guard against consequences is easily accounted for by the well known high death rate among public companies. It does not seem worth while to prove this mortality, but the result of the West African boom are interesting. In 1901, 260 companies were formed and only 20 were alive in 1911, and of these only five or six have paid dividends and only one has done really well. The records of the West Australian boom are even worse.

In view of the great risk of a failure and of the subsequent attacks by angry shareholders, it is a mystery why so many men of high social position and large fortunes are induced to lend their names to support a business of which they know little or nothing and which is foredoomed to failure from the start. A startling instance was the acceptance by Earl Dufferin of chairmanship of Whitaker Wright's companies. A more modern instance is shown by the appearance of the names of Cornelius Vandervilt and Robert Goelet as directors of the United Malaysian Rubber Co., floated in London in April, 1910. In the opinion of prominent rubber experts, as stated at the time, the company never had the slightest chance of success, and the fact that instead of an estimated profit of £160,000 a loss of over £40,000 was incurred up to May 31, 1911, seems to show that the experts were correct. This case seems even more mysterious than usual for it is admitted that neither of the above gentlemen made any money from the promotion.

Now it is unquestionably the case that when a man buys shares on the strength of a publicly advertised prospectus backed by well known men, he expects to have a fair run for his money, and it is equally unquestionable than in 90% of the companies promoted during a boom he never has a chance of seeing his money again. The companies are formed and the shares issued under the protection of the law, and I hold that if the law was properly drawn up and administered a large proportion of the failures could be avoided. There would still be large sums of money spent unprofitably, but the risks run would be incurred knowingly, and investors would not be hoodwinked as at present.

INVESTOR HAS NO CHANCE TO JUDGE EXPERT'S REPORT.

It is not within the scope of this article to criticize the English company law in detail, but there are two points that seem important enough to discuss, and which should be of as much importance in America as in London. One of the great defects of the present methods of issuing prospectuses is that no chance is given to the investor to properly judge of the expert's report. A requirement that every prospectus should contain a description of the expert's qualifications, the amount of his fee and how it was paid and the name of the payer, the date and duration of his examination would materially aid an investor in judging of the value of the report. These requirements would certainly interfere with the present practice of having reports made by men who know nothing of the business on which they report, or who report on properties that they have not seen for years, or possibly have never visited.

IRRESPONSIBLE PROMOTION SYNDICATES.

Another defect in the present methods is the lack of control over the promoting syndicates. The intent of the law is that the promotion of public stock companies should be carried on in such a way that the private investor should have full notice of all contracts made and of the prices paid for the property that he is buying, and also that these statements should be made by some responsible authority so that the shareholder should have redress in case of mis-statements. But the invention of the irresponsible syndicate has taken away all chance of recovery of damages suffered by the investor. It would seem as if the interests of the shareholders would be much better served if every promotion of a public company were required to be carried on by men of substance instead of men of straw, and if carried on by a syndicate the actual paid-in capital of the syndicate should bear some reasonable proportion to the capital of the company which is being promoted.

When, through carelessness or shortage of water supply, a wooden-stave tank has been allowed to dry until openings appear between the staves, extending downward for some distance, strips of cardboard can be put into the cracks between the staves. The moment the cardboard is reached by the water it swells, stopping the leak. It will also give way to the wood as soon as it begins to swell, and finally decomposes, leaving the tank tight with the staves in their original position.

LEACHING APPLIED TO COPPER ORE* (XX)

COST OF ELECTROLYTIC EXTRACTION OF COPPER FROM ITS ORE

By W. L. AUSTIN.†

It has been shown in previous articles that there is no lack of solvents by means of which copper can be brought into solution out of its various mineralized forms. Furthermore, it is evident to any one who has investigated the subject that from the solutions thus obtained the metals may be deposited in different ways and applied to commercial uses. It is therefore clear, that what is wanted is not so much new processes as efficient application of some of those already in existence so as to produce practical results—the perfection of some one method so that it will stand up under continuous use.

It has been repeatedly pointed out that the efficiency of any process cannot be considered as demonstrated until the said process has been placed in competition with others the values of which have been proven through long usage. Before a method can be commercially applied it must be thoroughly tested experimentally. This can be accomplished upon a small scale as well as upon a large one. The criterion of a leaching process is not that it will treat a car-load of ore at one time, but rather that it will act continuously. With expert supervision a car-load of ore may be successfully handled, although at the end of the run the apparatus may be incapable of repeating the performance without extensive repairs. On the other hand, a process continuously working upon smaller quantities of material—say 200-pound lots—demonstrating that the apparatus employed responds to the calls made upon it, and that the essential qualities of the liquors are preserved after repeated usage, is far more satisfactory to the practical man. The car-load lot experimental works, operating intermittently, may resolve itself into a pit-fall for the unwary: it demonstrates nothing not already known that cannot be better illustrated by a continuously working small plant, and leaves vital issues still undecided.

PERTINENT QUESTIONS ANSWERED.

The question is often asked, Why are leaching methods not more generally applied in the reduction of copper ore? In the first place, some of the old-time processes depended upon the use of chemical reagents which were either difficult to obtain, or when procurable, entailed a heavy tax upon the operation because of the expense. Such methods were those making use of hydrochloric acid, sulphuric acid, ammonia, and other even more costly reagents. Chemical compounds of that nature, when they must be purchased, can manifestly only be profitably employed by works situated close to commercial centers, where chemicals can be cheaply obtained; but this usually involves heavy transportation charges, for copper mines are seldom found adjacent to manufacturing communities. Transportation of acids involves difficulties, and when freight charges have been added to the original price, their cost is prohibitive in remote mining districts. Hence leaching operations dependent upon chemicals brought in from a distance have had an ephemeral existence.

Secondly, when salts such as chlorides and sulphates are employed as lixiviants in lieu of strong acids, the action is much slower, and a considerable period elapses between the time that the metal is taken out of the ground, and disposal of the finished product. This implies a large plant—much expense applied to limited output—and an indifferent attack upon the ore by the weaker solvents. This was the case with processes based upon the use of ferrous and ferric chlorides (chemically prepared), ferric sulphate, cupric chloride, etc. With the exception of Rio Tinto, none of the methods relying upon the use of chemically prepared salts have survived the test of commercial usage.

Thirdly, where electrolytic processes have been tried, often too much has been attempted in one and the same apparatus simultaneously. For instance, it has been essayed to deposit copper, and to prepare a lixiviant in one operation. This entails a fine adjustment of electrodes, current strength, concentration of solution, diaphrams, electromotive force, chemical action, temperature, resistance of electrolyte, etc., which has proven difficult to secure without assistance of depolarizers. All such methods have failed to obtain commercial recognition up to the present time, although in laboratories they give apparently satisfactory results with limited quantities of material over short periods of time. Usually in considering such processes sufficient importance is not attached to the fouling of solutions through continued use, the break-down or anodes, and to wear and tear on the apparatus through attrition and chemical action. The inevitable destruction of mechanical contrivances designed to agitate sharp grains of material in hot, mordant liquors, has been a serious handicap upon all processes employing such means of bringing lixiviant and ore together. Apparatus of this kind can be kept going in laboratories for short periods, but naturally fail to respond to working conditions upon an extended scale. They remind one of some of the older types of pulverizers which could be kept upon exhibition during the day only by using the night for repairs.

Fourthly, correct roasting of an ore to assist in rendering the copper more susceptible to lixiviation has been the stumbling block in some operations. Too much heat produces complications: too little, as well. When possible, it is best to leach an ore in the raw state, because roasting for leaching operations is a delicate undertaking. Nor is roasting necessary in many cases, for there are lixiviants which exert a strong oxidizing action—sufficient to separate copper from sulphur—but it is expected to make oxidation of raw sulphides the subject of a separate chapter.

However, all these adverse conditions may be overcome—will be overcome in fact—by application of practical common sense to the problem, and it will be helpful to the accomplishment of this result when it is not attempted to force conditions to meet the requirements of some patented process. It is not to be expected that all ore should be found suitable for leaching; but such ore as can be leached will yield greater profit per ton when intelligently manipulated, then when treated in other ways.

COSTS OF HANDLING ORES.

As to cost in handling ore, the beneficiation of any ore includes the following items: mining; mechanical preparation of the ore for metallurgical treatment—crushing, concentration, etc.; procuring the medium of reduction—fuel, chemicals, fluxes, etc.; reduction—smelting or leaching; separation of the metals from intermediate products—matte, liquors;

† Mining Engineer and Metallurgist, Riverside, California.

disposal of waste material—slag, tailings; marketing the products.

As concerns the first of these divisions—mining—the expense entailed in excavating an ore and in transporting it to a metallurgical works, is apt to be the same regardless of method of reduction applied; but of course the advantage will be with a plant situated close to the mine, as against one placed at a distance. Freight charges often consume a large part of the values in an ore, and naturally these will be reduced in proportion to the lessening of cost of transportation Therefore, it is evident that the expense of treating an ore in a suitable metallurgical plant at or close to a given mine, will be less than when the same ore is carried long distances This perfectly obvious fact is illustrated by the establishment of numerous gold and silver leaching plants at mines, the ore of which would not stand expense of marketing as such. Lixiviating is a means of ore-reduction peculiarly adapted to local treatment The necessity of railroads is obviated, which is an essential in the case of smelting operations unless water transportation is available

Most ore requires some sort of preparation before it is ready for treatment by either dry or wet methods. Only a small proportion of the copper ore smelted goes to the furnaces direct from the mine. The common practice is to pass the ore through concentrators, and concentration generally entails very considerable losses. The extent of this waste is hardly realized, but the statistics published by some of the large companies furnish illuminating data. For instance, according to the report of the Nevada Consolidated Copper Company for fifteen months ending December 31, 1911, there were treated by that company by wet concentration 3,338,242 dry tons of ore, assaying 1.8 percent copper. The extraction was 67.59 percent. This indicates a direct loss in the tailings of 38,949,272 pounds of copper for the fifteen months, or 31,259,418 lb. per annum.

WASTE IN CONCENTRATION.

According to the report of the Utah Copper Company for the year ending December 31, 1911, that company treated 4,680,801 tons of ore averaging 1.51 percent copper. The total content of the ore handled was, therefore, 141,360,190 lb. copper. The average recovery in the mills was said to be 69.53 percent, making the loss in the tailings 43,072,450 lb. copper. Hence the reported losses in the wet concentration mills of these two companies alone amounts to 74,231,868 lb. copper per annum. Add to this the losses at the mills at Ray, Chino, Miami, Clifton, Cananea, etc., and the total waste of national copper resources due to use of extravagant methods of reduction, is seen to be enormous. It is useless to compound these tailings for future treatment. A ton of this material contains very little copper to begin with, and when it has been exposed to the weather for some time, (as an inspection of the dumps will disclose), the copper minerals oxidize and the resultant salts are removed by rain.

Examples of the cost of treating large quantities of ore by lixiviation may be obtained from reports of companies which make use of cyanidation in reducing their ore. Whether an ore is crushed to a suitable size in order that the particles of mineral enclosed in the matrix may be liberated and subjected to concentration, or whether it is comminuted for leaching purposes, the expense will not differ materially. In many cases it will be found that very fine comminution will be necessary to liberate fine particles of mineral for mechanical concentration, whereas strong lixiviants will penetrate and remove the same mineral from much coarser material.

As an illustration of the expense incurred in concentrating a copper ore, (which might be taken as comparable to the cost of lixiviation,) reference is made to the report of the Greene Cananea Copper Company for year ending December 31, 1910. During the year named this company milled 670,153 wet tons of ore at a total expense of $0.854 per ton. The recovery was about 75 percent of the copper in the ore, and the horsepower-year cost $78.48. The expense of putting the same amount of similar material through a leaching plant of the same capacity should not be any greater, barring possibly cost of lixiviant —but this latter item will be considered further down.

ADVANTAGES OF LEACHING.

At the works of the Guanajuato Reduction and Mines Company, (a leaching operation being conducted at Guanajuato in central Mexico), according to the company's report for the year 1910 the cost of milling was $1.21 (taking the Mexican peso at 50 cents), and the number of tons milled were 253,357 (2000 lb.) tons. The cost of power was not over $65 per horsepower-year. All ore was stamped through 26-mesh rolled slot wire screens, and the pulp, after passing over concentrating tables, was tube-milled. The average recovery was 81.35 percent of total silver content, and 83.71 percent of total gold. The figures at Guanajuato ($1.21) are higher than those at Cananea ($0.854), but then the cost of chemicals is included in the former, and the quantity of ore handled at Guanajuato was less than half that at Cananea.

It is evident, therefore, that the relative costs of handling an ore in a properly designed lixivation works, or in a wet concentration mill, are about the same, and the existence of numerous leaching plants the world over is proof that there are no serious mechanical difficulties in the way of treating large quantities of material by leaching processes. The main obstacle opposed to replacing cyanide solutions with lixiviants capable of dissolving copper instead of gold is the mordant action of the liquors employed in the latter case. The problem is to find materials out of which vessels may be constructed capable of withstanding prolonged contact with strong acid solutions. Such vessels must necessarily be of large dimensions, and they must be capable of withstanding rough usage, but the problem should not be one difficult of solution.

As to mining, whether an ore is to be lixiviated, or treated by wet concentration, the cost may be assumed to be identical, and as the cost of mechanical, treatment in a leaching plant, or concentrator, will also be practically the same, the next item for consideration is cost of lixiviant. Incidently it might be mentioned that mining expense varies greatly even when the same company is working a number of mines in the same district. For instance, the Cananea Consolidated Copper Company is operating nine mines in the Cananea district, and the cost per ton of ore extracted from these different properties runs from $1.761 at the "Oversight" to $9.702 at "Capote," with an average of $2.751 for the total tonnage.

If the cost of the lixiviant, and the expense for electrolytic deposition of the metals, be added to the cost of mechanical treatment by cyanidation, or by wet concentration, the total may be used for basis of comparison with the cost of producing crude copper bars by the combined concentration and smelting method. Referring again to cost of leaching ore (cyanidation), in South Africa, where leaching is practiced upon a very large scale, "the average value of the ore mined is about $.80 per ton," and "it costs $4.30 per ton to produce the gold." The total expense is therefore $4.30 per ton, including mining at great depth, and power, at about $70 per horsepower year.

DISCUSSION OF METHODS.

For the purposes of this discussion, preparation of lixiviant, and electrolytic deposition of metal, will be taken as two independent operations—if they can be combined in one, the value of the method is thereby enhanced; but, as was explained in a former article, chemical reaction between the elements forming a lixiviant can sometimes be effected at current densities which are inappropriate for deposition of the metal.

Formerly hydrochloric solutions were

prepared for leaching purposes by roasting crushed ore mixed with chloride of sodium. At the works of Gibbs, Jackson & Company, in England, muffle furnaces were employed for this roasting. The muffles were 59 feet in length and 12 in breadth (internal measurements). The flames passed over the muffle, then back underneath through four canals, returning through four parallel canals and then out to the chimney. The gases from the furnaces were conducted to towers filled with coke, down which water trickled. In this way the hydrochloric acid gases were absorbed, and a lixiviant prepared strong enough for leaching roasted ore.

At Alderly Edge, the residual liquors resulting from precipitation of copper from chloride solutions by means of iron, contained much ferrous and ferric chlorides, a small quantity of chloride of cobalt, and much manganese chloride. These liquors were evaporated in iron pans to about 1.4 specific gravity, and then sprayed into a reverberatory furnace. The bottom of the reverberatory was covered with red-hot sand, and the ferric chloride was decomposed, yielding ferric oxide and hydrochloric acid. The gases and steam were conducted to a tower filled with moist coke, where they condensed to a solution suitable for leaching purposes.

The instances cited above might be termed chemical methods of preparing solutions containing hydrochloric acid, as distinguished from electrolytical means of accomplishing this result. It has been stated that electrolysis of a solution of sodium chloride in the presence of sulphur dioxide yields hydrochloric acid, according to the formula: $2Cl + SO_2 + 2H_2O = H_2SO_4 + 2HCl$ (see U. S. Patent No. 973,776, page 1, line 3). It is also claimed that hydrochloric acid may be formed through direct combination of the hydrogen liberated at the cathode with chlorine set free at the anode. Now it is known that electrolysis of a sodium chloride solution at ordinary temperature yields hypochlorites, and that this compound is converted into chlorate by heating the solution. It is also known that hypochlorous acid and hydrochloric acid instantly react with each other, liberating chlorine, and also that hydrochlorine acid decomposes chlorates. It is therefore difficult to understand how hydrochloric acid can be produced electroylytically in appreciable quantity under the conditions specified.

On the other hand, as sulphuric acid is formed through oxidation of the sulphur dioxide introduced into the anolyte, whatever free hydrochloric acid is found in the liquor may be more readily explained through the assumption made in the following formula: $2NaCl + H_2SO_4 = 2HCl + Na_2SO_4$. That hydrochloric acid is formed in quantity in the electrolytic vat through the meeting of diffused hydrogen and chlorine ions, especially when a diaphragm is used, requires further substantiation.

To arrive at the approximate cost of electrolytically producing hydrochloric acid for purposes of lixiviation, let it be assumed that the reaction indicated in the formula last given is the one which probably takes place under the circumstances. It is then evident that the interchange of elements had best take place outside the electrolytic vats after the oxidation of the hypochlorites. The cost of the dydrochloric acid will therefore depend upon the expense incurred in producing sulphuric acid from sulphur dioxide.

It has been shown in a former article (Mines & Methods, Vol. II, page 283) that 65 percent of the oxygen liberated at the anode in electrolysis of a copper sulphate solution can be converted into sulphuric acid by the introduction of dilute sulphur dioxide gas (roast-furnace gas) into the anolyte. A simple calculation will show that a cubic meter of oxygen gas at 18° C. (ordinary average temperature) and 769mm barometer, will weigh about 2.95 lb. avd. In Germany, with power costing $0.0125 per kilowatt-hour, it costs to produce oxygen electrolytically approximately $0.156 per cubic meter. Hydrogen is produced simultaneously with the oxygen, and as there are two cubic meters of the latter gas liberated to each cubic meter of oxygen, and as the hydrogen is figured as costing $0.078 per cu. meter (weight 0.1851 lb. per cu. meter), if the oxygen alone is made use of it is assumed that the cost of the hydrogen will have to be charged against the oxygen, bringing the cost of a pound of oxygen up to $0.11.

ECONOMICS OF SULPHURIC ACID.

Theoretically, one pound of oxygen, combining with four pounds sulphur dioxide, will produce 6.125 lb. sulphuric acid. At 65 percent anode efficiency the cost of electrolytically produced sulphuric acid would therefore be $\frac{0.11}{6.125} \times \frac{100}{65} =$ $0.0276 per pound. To produce hydrochloric acid by the action of sulphuric acid upon sodium chloride 0.745 lb. hydrochloric acid will be generated for every pound of sulphuric acid consumed, and about three pounds of sodium chloride is required for every pound of hydrochloric acid generated. With rock salt costing one cent per pound it would be necessary to add three cents to the cost of hydrochloric acid ($0.037) stated in terms of sulphuric acid, making the approximate theoretical cost of hydrochloric acid generated in the manner indicated about $0.067 per pound.

Based on the above calculation, and assuming the ore to be roasted, it is evident from the following formulae that one and one-third pounds of sulphuric acid will dissolve as much copper in the oxide form as one pound hydrochloric acid:

$$CuO + H_2SO_4 = CuSO_4 + H_2O$$
$$CuO + 2HCl = CuCl_2 + H_2O$$

As the theoretical cost of producing sulphuric acid has been shown to be less than half that of hydrochloric, the advantage appears to lie with sulphuric acid as the more economical lixiviant, at least when prepared by action of sulphuric acid on sodium chloride.

If, therefore, it is necessary to roast an ore, it might be found advisable to leach with sulphuric acid prepared electrolytically in the manner indicated by Reinartz (Mines & Methods, Vol. II, pages 281-284), or by Laszczynski (Mines & Methods, Vol. III, pages 368-372). The Reinartz experiments proved that the free sulphuric acid content of a solution could be raised from 0.95 to 5.90 percent, and there is no reason why this percentage would not be further increased. The theoretical quantity of sulphuric acid required to dissolve forty pounds copper contained in a ton of oxidized material is sixty-two pounds, and at $0.03 per pound the expense for lixiviant would amount to $1.86 per ton. Some acid would be unavoidably consumed in other ways than in dissolving copper; but, on the other hand, the total expense of producing this lixiviant might be transferred and charged to the expense of separating the metal, as shown by Reinartz and Laszczynski: that is, in cases where sulphuric acid is employed to leach a roasted ore, the cost of lixiviant might be stricken out under certain conditions.

Sulphuric acid cannot be used as a solvent on some varieties of ore unless they have been roasted, and as it is advantageous to apply the lixiviant direct to raw ore where possible, recourse must be had to some other compound. A solvent that does its own oxidizing may be prepared by electrolysis of a solution containing sodium chloride; but the product varies greatly according to conditions under which the operation is carried out. It is possible in this manner to obtain a very efficient lixiviant, one which both breaks up the copper sulphide and dissolves the copper. The reactions which take place in the electrolytic vat when producing this solvent, are obscure, and it would be difficult to express them by means of formulae. Some experimental tests made with a solution prepared in this way upon raw mineral ground to eighty-mesh, showed an extraction of 65 percent of the copper in fifteen minutes; 73 percent in one hour; and 97.75 percent in three hours. However, there was something more than simple electrolysis involved in these results, although the expense was not materially increased. The cost of preparing the lixiviant is said to be one cent per pound of the copper brought into solution. The inventor of the process is seeking patent protection, so that the method of preparing this solvent cannot be disclosed at present.

CHLORINE GAS ADVANTAGES.

Sometimes chlorine gas may be used to advantage in leaching cupriferous ore. A method of preparing this gas for metallurgical purposes was described in Mines & Methods, Vol. II, page 121. Today the chlorine of commerce is wholly prepared by employing electrolytic methods. At Niagara Falls, it is stated, chlorine is produced for one cent per pound, and it is claimed that this reagent may be made available in the average western mining camp for two cents per pound. In Mining & Scientific Press of May 15, 1909, the following estimated cost of producing electrolytic chlorine is given. With power at three-quarters of a cent per horsepower, and salt at $10 per ton, the expense in generating one pound of the gas will be:

Power	$0.018
Salt	0.010
Attendance and repairs	0.012
Total	$0.040

No allowance is made in this estimate for caustic soda produced as a twin product. The cell used in generating this chlorine is constructed mainly of cement concrete, and is sold for $575 f.o.b. New York.

Data concerning the Hargreaves-Bird electrolytic cell, of which sixteen were in use at Piedmont, West Virginia, in 1906, can be found in Mining & Scientific Press for January 19, 1907, page 90. The McDonald electrolytic cell is illustrated, and described in full in Engineering & Mining Journal for June 6, 1903, pages 857-858. This cell was used at a chlorination works in Colorado, where it was expected to produce chlorine at $0.0225 per pound.

To bring one pound of copper into solution in the form of cupric cloride theoretically 1.1 lb. chlorine is required. The amount of chlorine necessary to leach a given ore can only be determined experimentally because there are usually other substances in addition to the copper which will be dissolved. Chlorine generated electrolytically may be so applied to the ore in several ways. It can be converted into hypochlorous salts—bleaching powder. Hypochlorites expert a powerful oxidizing action, and may be obtained either by bringing the gas into contact with caustic lime (or caustic alkali), or by electrolysis of a sodium chloride solution at a temperature below 60° F. Another way of applying chlorine is to use ferric chloride as a conveyor. Ferric chloride is a very strong chloridizing agent, readily parting with its third atom of chlorine to mineralized copper, and is then in a form to absorb more of the gas. Once chlorine has been obtained through electrolysis at a cost of, say $0.025 per lb., the additional expense of converting it into a convenient and effective form for application to an ore, is nominal.

(To be Continued).

Copper Deposits of Eastern Quebec

By JOHN E. HARDMAN.*

Half a century ago, or to speak precisely, between the years 1859 and 1865, there existed in that portion of Quebec Province which is known as the Eastern Townships, a very respectable and profitable copper mining industry. The capital invested was almost entirely American and came chiefly from the New England states. Today there are but two properties working in this section which are mining copper, and both of these are owned and controlled by United States capital. The balance of the district is non-productive and idle. It is hoped that the present article may make known a number of facts which will show some reasons for this decline of an industry once so promising, and may indicate that, with modern methods and appliances, a profitable industry can now be inaugurated and maintained successfully.

At the time when copper ore began to be worked and marketed commercially in 1858 the entire production of metallic copper in the United States was about 4,000 tons, and the very high prices which obtained for metallic copper during the American Civil War continued until the highest figure (59¾c) was reached in July, 1864. During the next twelve months, or in June, 1865, this price fell to 29½c, a drop of 30c in twelve months. It must also be remembered that during the decade from 1858 to 1868 the Lake Superior mines first began their commercial production, the Franklin and Pewabic each reaching an output of a million and a half pounds of metallic copper between 1863 and 1865. In consequence of the discovery of the Lake Superior mines, and also by reason of the extreme drop in prices, the American capital interested in the Eastern Townships found a more profitable field in the newly discovered deposits of the Keweenaw Peninsula in Michigan and capital was withdrawn from the Quebec field.

The occurrence of copper in this portion of Quebec, at Brompton Lake, was noted as early as 1841 by Sir William Logan, but before any authoritative printed account was available active mining had begun, and the year 1858 saw the first shipments of sorted ore sent to Swansea. During this year (1858) and those immediately following several Cornish mine captains came out to Canada for the purpose of exploiting these deposits and the names of Captain William Bennett and Captain John Wearne are still remembered in many of the localities where copper ore was formerly mined.

The geology of this section of Quebec has been particularly described in papers by Mr. John A. Dresser, originally communicated to the "Journal of the Canadian Mining Institute" and also published in Volume I of "Economic Geology," 1906. Briefly described the rocks of this eastern portion of Quebec are pre-Cambrian in age and are composed of altered sediments, tuffs and true igneous rocks, the latter being porphyries, andesites and diabases. These rocks have been folded, squeezed, and contorted, forming ridges or anticlines whose general direction is northeast and southwest. In consequence of this folding "lines of least resistance" occur which have afforded passage ways, or channels, for mineral bearing solutions which, by deposition or through replacements, have impregnated the rocks with metallic sulphides of copper and iron, thus forming deposits which vary in thickness from the fraction of an inch to masses occasionally reaching 60 ft. in width. This mineralization of the crystalline rocks appears to have been confined to three ridges or belts running in a northeasterly direction. The first and most westerly of these begins near the southwestern corner of Brome county and runs northeasterly through Arthabaska county; the second ridge commences at Lake Memphramagog and runs northeasterly through the City of Sherbrooke up to and beyond Lake St. Francis, this is the most important of the ridges; the third ridge extends along the international boundary between Maine and Quebec, but has only been prospected in a small

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section near the southern end of Lake Megantic.

These depositions or segregations of metallic mineral usually take the form of elongated ellipses or lenses which sometimes are connected together by a thin stringer of ore, but oftener are entirely disconnected. These lenses are arranged en echelon, and in one of the deepest shafts in the Province, that of the Eustis mine, these lenses have followed one another, and are still existing, to a total depth on the incline of the shaft of 3,300 ft.; in the Albert mine of the Nichols' Chemical company the total depth reached by the incline shaft is between 3,600 and 3,700 feet.

The ores found are divided by their metallurgical characterists into three distinct groups:

(1) Acid, or siliceous, ores occuring in acid rocks, sometimes with a quartzose gangue.

(2) Basic ores of which the base is chiefly iron, occurring usually in contact deposits having diabase for one wall, and typified best by the Memphramagog mine near Knowlton's Landing.

(3) Basic ores of which the base is chiefly lime, and typified by the Acton, Upton, and Ascot mines.

The principal ore bodies hitherto worked have been those belonging to the first class and found in the porphyry-andesite schists, the oldest rocks of the region. Ores of the second class are not so common, but usually occur in large bodies; the basic ores of the third class are quite infrequent. Secondary copper minerals such as bornite and chalcocite occur sparingly and the evidence of secondary action is fragmentary and quite insufficient to permit of generalization The evidence afforded by the older mines which have been worked continuously is to the effect that the ores continue to considerable depth with undiminished values in copper, silver, and gold.

The townships adjacent to and surrounding the city of Sherbrooke contain fifty or more properties which either have produced a respectable tonnage, or have shown bodies of ore which have been prospected in part, but have not yet been developed. The best known of the mines in this class are the Capelton, Eustis, King, Howard, Suffield, Huntingdon, Clarke, etc. Farthest to the northeast is the old Harvey Hill mine, and in the southwest is the ounce famous Huntingdon mine which has been worked to a depth of about 700 feet.

The values contained in these three different classes of ore do not vary greatly; probably the highest copper values are in the lime-basis ores and the higher silver values with the acid ores. The general average composition obtained from a very large number of samplings gives, for the acid ore, about 60% uncombined silica with from 20 to 25% alumina and iron, and 10% sulphur; the copper averaging 3%. The iron basic ores carry from 45 to 48% metallic iron and from 2½ to 7% copper. In Mr. Presser's article on this subject (previously referred to in this article) he gives the average of the Capelton Hill as from 4 to 5% in copper, 38 to 40% in sulphur, for the properties on the southern slope of the hill; for the properties on the northern side of the hill he gives a smaller average in sulphur and about the same percentage in copper.

Taking into review the general average of all the copper deposits in the townships, and averaging all classes of ore, the percentage of copper may be taken at not less than 3% and the precious metal (silver and gold) contents at from two to three dollars; the average percentage of sulphur lies between 25 and 30%, of silica between 40 and 45%, and of iron from 15 to 20%. To the metallurgist this average analysis indicates a composition that is readily fusible in the furnace.

During the period of activity in the early sixties, several small furnaces and smelting works were built of which only fragments and ruins now exist. All values in these ores, other than sulphur, have been religiously concealed by the companies which have been in existence for over 30 years, and the general public knows of these mines only as containing ores of sulphur and having value only for sulphuric acid making. Undoubtedly this view has been helped largelv by the fact that the cinder, after the sulphur has been burned off, has been shipped out of the country to the United States and there smelted, the copper and silver contents being credited to the production* of the United States and not to the Province of Quebec.

It must also be noted that during the forty years which have elapsed since the cessation of active work in the townships much railroad building has been done there, and the facilities for shipping ore have been very much increased. Sherbrooke is an important railroad center, having four different lines of railways entering the town, yet renewed interest in the copper resources of the district is still lacking. Investigation has shown that, with the exception of one or two particularly rich deposits, such as the recent discovery at Weedon, the mining of ore to ship and sell abroad is not profitable, and that the hope of a new industry in these ores is dependent upon the advent of smelting facilities which shall be able to treat the ore within a reasonable distance of the mine. The ores offer, if carefully selected, an almost ideal assortment for smelting without the use of barren fluxes. In addition to transportation facilities labor in the townships is cheaper than almost anywhere else in Canada and a large supply of electric power is available for all requirements of mining and smeling.

If the reader will take into consideration a few facts it should seem evident that there is the basis here for a permanent industry; the annual importations of copper into the Dominion are about 28,000,000 lbs. All the crude copper shipped from the large mines in British Columbia and those near Sudbury, Ontario, is sent to the United States to be refined; no refined copper is made in Canada. As to the importations, whether in bars, billets, rods, tubes, sheets, or any other form, 90% comes from the United States and 10% from Great Britain. These facts point to the desirability of the Dominion refining its own production of copper, which in crude form totals nearly 100,000,000 lbs. a year.

The small ventures in copper mining will not be successful, and it is admitted at once that a large capital is required to make the deposits of Eastern Quebec profitable. The deposits are large enough and extensive enough ot justify the investment of large capital and such investment would have a long period of life and a satisfactory profit. Probably the reason why these fields have so long lain dormant is that they are practically at the doorstep of Montreal and too near to enjoy the benefit of that old Cornish saying which declares that "Far away fields look green."

GOLD DEPOSIT OF WILSON MESA

By J. M. HILL.*

Two classes of deposits are worked in the vicinity of Basin and Mesa, Utah. In the mountains there are several quartz mining prospects and at least one locality where placer gold has been recovered. In 1907 it was first noted that the gravels on Wilson mesa carried gold. For two years these gravels were washed by crude methods and in 1910 a little excitement was created in Salt Lake and Grand Junction over the richness of the deposits. That their nature was not understood is clearly shown by placer and lode locations which cover the ground. There has been practically no production from the quartz mines, and it is probable that $5,000 would cover the entire output from both quartz and placer mining in the region.

The flat mesas south of Castle valley are covered by a coating of gold-bearing gravel. This deposit is usually very thin, being indicated by scattered bould-

*Extract from Bulletin 530-M. "Contributions to Economic Geology," U. S. Geol. Sur., 1912.

ers and pebbles or by small, flattened mounds of like material here and there on the standstone bedrock. In a few places it attains greater thickness. Some of the larger deposits stand as low, rounded knobs, but most of them seem to occupy re-entrants in cliffs. The latter was apparently the position at the Point Lookout placer. A combination of the two forms is seen at the Black Cap workings. A third and much rarer occurrence is along what appears to be an old channel which runs northwestward from the Black Cap.

The gravels are the same throughout, consisting of subangular cobbles of igneous material similar to that seen in the La Sal mountains to the east, with a relatively small proportion of sandstone fragments. They range in size from one-fourth of an inch to 2½ ft., with an average size of about 10 to 12 in. Fragments of monzonite porphyry cut by quartz stringers are fairly abundant and magnetite cobbles up to 4 or 5 in. in diameter are not at all rare. There seems to be a slight decrease in size of the boulders at the western edge of the deposits, but it is not everywhere the same and is rather doubtful. There is practically no stratification of these gravels except along the present drainage lines in reworked material.

The gold, said to be worth from $19 to $20 an ounce, occurs in small wires or flakes, and none of that seen appeared to be much water worn. It is distributed throughout the thickness of the deposits, which are said to be of about the same from the surface to bedrock. Besides the gold that can be recovered by washing it has been found that the "ribbon rock" (the monozonite porpnyry cut by quartz stringers) contains a fairly large portion of the gold value of the gravels. Some of the miners assert that for every ounce saved by sluicing 10 ozs. are lost in the ribbon rock which goes over the dump.

There is no natural water supply on Wilson mesa. A ditch originally built for irrigation is said to supply about 12 cu. ft. a second from the beginning of the thaw in April to the last of July, when the greater part of the snow has disappeared from the mountains. From then until October the supply is about 8 cu. ft. a second, and it is further diminished during the winter. The water is all taken from Mill creek, and considerable trouble has been experienced in obtaining enough for sluicing, as the town of Moab also takes its supply from this source and has a prior right to the water.

The Black Cap placer is locater in the cliff between the middle and upper mesas. The gravels here form a low knoll, and are also found below the general rim-rock level in what appears to be a cleft or re-entrant from the face of the cliff. The maximum thickness above the true rim rock is about 50 ft., with possibly as much more below at one place.

Hydraulicking into sluice boxes located in the re-entrant has opened a pear-shaped cut about 40 ft. in maximum width by 60 ft. long, with a face 40 ft. high. The location is ideal for this sort of work, as there is plenty of ground for a dump much below the level of the gravels. It is said that some difficulty was experienced with the larger boulders and that considerable gold was lost in the ribbon rock.

At the Point Lookout placer the gravels clearly occur in a re-entrant at the rim of a conyon leading into Mill creek. This locality is also in the rim of the middle mesa, just above the lower mesa. A very thin veneer of grayels covers an area of two or three acres, with one deeper deposit just at the rim.

A shaft sunk in the deep deposit has gone down about 20 ft. through gravel that contains a large amount of magnetite, usually as small pebbles, though some cobbles as large as 8 in. in diameter were noted. Very little water can be had here. The surface has been partly sluiced into a vibrating screen which allows only the finest material to pass. The fines were put through riffles and finally over a small amalgamation plate. Practically all the free gold was saved, but it was found that the tailings carried gold in the quartz ribbon rock.

At the Butterfly placer a low ridge running from the middle to the lower mesa is covered with gravel to varying depths, a knoll at the lower west end showing the greatest thickness. The main irrigating ditch referred to above passes this place and the gravels were handled by road scrapers, being carried upon a platform through which they fell into sluice boxes. The method was very cheap and it is said that with a team and scraper two men could make $16 a day.

At another locality two shafts about 100 ft. apart have been sunk; one to a depth of 40 ft. is all in gravel and the other, 10 ft. deep, entirely in sandstone bedrock. This is on the relatively flat middle mesa, but in a depression that at present is a water course and seems to have been a channel at the time of the deposition of the gravels. A prospect southwest of Mesa postoffice is also a low knoll of gravel with bedrock outcropping just east of it. This is apparently a remnant behind a ledge of sandstone. A prospect just east of Mesa is a continuation of the Black Cap deposit. It is a relatively thin layer of gravels except in a few shallow re-entrants.

The material composing the gravels of Wilson mesa is at least nine-tenths igneous. It occurs on flat-lying undisturbed sandstones which nowhere show any igneous rock in place. All the porphyry types represented in the main laccolithic mass of the La Sal mountains are represented by pebbles or boulders in these gravels. Pebbles of monzonite porphyry cut by stringers of glassy quartz containing limonite, which resemble the ore of the Tornado mine and other places, are frequently seen. These, owing no doubt to their original altered condition, are softer and more weathered than the previously unaltered rocks. It can hardly be questioned that the gravels were very likely derived from the La Sal mountains. Their present distribution is probably due largely to erosion since their deposition. In sheltered places such as re-entrants the gravels have not been removed, but they have been largely eroded from the flat-topped mesas except for the remnants left in old channels or between the present drainage lines.

The method of deposition of the gravel on the mesa is open to question. That its deposition is not related to the most recent glaciation is clearly shown by the fact that the last glaciers were very small, rarely reaching below an elevation of 10,000 ft. and never issuing beyond the high mountain valley. The material is subangular, no rounded pebbles being noted; it is fairly coarse for the most part, with only a little sand, and it is as far as seen unstratified. Two hypotheses are suggested by its character. Both torrential floods and glaciers form such deposits that one or the other of these agencies brought the material to its present resting place is fairly sure. In either event it is quite certain that the gravels were deposited at a time when the La Sal mountains were higher than they now are, and either explanation presupposes a very much greater precipitation than there is at present in this region. It seems probable that the gravels were deposited prior to the establishment of the present drainage system for deposits of this class are found only on flat-topped mesas, and if ever present have been entirely removed from the places now occupied by canyons. Similar gravels that were not visited are reported on the mesas north of the mountains.

If these gravels are glacier-borne deposits they must surely afford some evidence of this mode of transportation. The writer at the time of his visit did not fully realize the difficulty of proving this point, so did not spend sufficient time to collect conclusive evidence. One boulder of sandstone 10 ft. in diameter on the upper mesa about half a mile east of Mesa postoffice showed marks that were thought to be striae.

TREATMENT OF GOLD CONCENTRATES

By AL H. MARTIN.

Recovery of major values from concentrates has long claimed the attention of the mine managers. Numerous companies have preferred to ship the product to smelters, but various objections have developed, and the more progressive managements favor the maintenance of refining plants on the ground. When the concentrate is of a character to be handled without particular difficulty, and the property is remote from a smelting plant, the manager is virtually compelled to provide his own plant to recover the high values. Within recent years the larger and more powerful corporations have shown a disposition to refine their own concentrates, and the trend is admittedly in this direction. The practical mining man naturally is not interested in mere theories —he wants something more tangible—something that may be practically applied, something that enables him to earn maximum profits on an economic basis. By the experiments and experience of others he gathers knowledge, and on the results obtained by successful operators he fashions his course. Consequently accounts of successful practice must ever hold paramount interest for the modern gold mine and mill executive.

Prior to the development of the cyanide industry the chlorination process was extensively employed by companies refining their own concentrates, and this method continues to be effectively utilized in favored districts. Generally, however, cyanidation has superseded chlorination, and the more recently installed plants are advanced types of cyanide efficiency. Where the chlorine gas is still used natural conditions are generally propitious, and results excellent. In the earlier days of California quartz-gold mining this process claimed particular favor, and in many of the Mother Lode districts ruins of old plants are fairly numerous. The Mears process, wherein chlorine gas was forced into barrels, was first employed principally, and was later improved by Adolph Thies. By the latter's method the gas was generated in the barrel by charging sulphuric acid and bleaching powder with the ore, and adding necessary chemicals seperately—as is now done in the barrel process. The most important of the chlorination works now operated in California is employed by the Kennedy Mining company near Jackson. The Plattner process is used, modified and improved by experience garnered in long years of activity, with alterations made to suit varying ore conditions. The plant consists of two reverberatory furnaces, leaching and precipitating vats, and lead generators. The furnaces have inside dimensions of 80x12 ft. The plant is exceedingly simple and easy to operate, and its efficiency is demonstrated by the fact that the company has used it for years and continues to perfer it to more modern arrangements. It lies about one-half mile from the mill, the product being transported by a mule-team.

SUCCESSFUL CHLORINATION PLANT.

The material treated comes from the Frue vanners of the 100-stamp mill and the canvas concentrators. Sulphides of iron are the principal composition, with small percentages of copper, lead and zinc sulphides. The product is charged to the furnace through a hopper, only one furnace being operated at a time. The ore contains 7 to 10 per cent of moisture to avoid loss by dusting. Each furnace has a capacity of 7½ tons per twenty-four hours, and sixteen hours represents the period from charging to the discharge. As the charge is moved forward to within about twenty feet of the forward section of furnace, and while a small percentage of sulphur still remains, salt is added to the amount of three-fourths of 1 per cent of the dry weight of ore. This forms chlorides in the furnace with the lime and magnesia occuring in the ore, greatly lessening subsequent consumption of chlorine gas and resulting in lower operating costs. While the addition of salt to the furnace charge is generally condemned, because of loss of gold by volatization of values, in this instance oxidation is nearly completed, and the objection eliminated. While it is probable that some gold is lost, the percentage is so minute that it is deemed of scant consequence.

After the ore has been desulphurized it is removed into a steel car and discharged upon a checker-work floor paved with old mill dies turned reverse side up. The material is stirred at intervals to assist its cooling and later dampened by a jet of water. It is then charged into one of the four leaching vats. These are of cylindrical form, four feet deep by nine feet diameter. Cobbles are laid at the bottom, followed by successive layers of gravel and sand, forming an effective filter. Over this is placed a layer of six-inch boards as a shoveling floor. The damp ore is sifted into the vat through a shaking screen and as soon as the vat is filled within six inches of the top, a cover is lowered into place and sealed with a composition of sand and clay. A folded burlap bag seperates the charge from the cover.

The chlorine gas is introduced into the vat through the filter bottom and the process continues from six to eight hours. In the cover a small auger hole is bored. The circulation of the gas through the vat is determined by removing the plug from the auger hole and holding a bottle of amonia over the vent. The arrival of the gas is immediately signaled by a dense white vapor of amonium chloride. After the charge has remained in the vat a sufficient period, the cover-plug is removed and water introduced. When about four inches of this covers the charge the cover is raised by chain-blocks and the discharge-cock at bottom of vat is opened. Clear water is kept continuously running into the tank, the amount corresponding with the outflow of gold solution. The latter is received by a pipe and conveyed to the precipitating department. The running of solution is carried on until the addition of a ferrous sulphate solution indicates no gold value remaining. When this stage is reached the water is shut off and the tank permitted to drain, a matter of a few hours. Samples are taken of the pulp and should high values still show, the product is removed, dried and regassed. It is seldom that the pulp carries sufficient values at this plant to justify the second treatment.

The gold in the precipitation tank is precipitated by adding ferrous sulphate. The addition of this compound detects the presence of minute quantities of gold, and its employment has been found remarkably efficacious. Precipitation is accelerated by sprinkling surface of tank with a solution of barium chloride, only a small quantity being added by means of a whisk broom. This rapidly clarifies the water, and the gold settles to the bottom. When the water has sufficiently cleared it is removed by a floating syphon to a safe point and the remainder discharged into a smaller tank, where the gold is collected, filtered and dried. It is subsequently mixed with fluxes, melted in crucibles and moulded into a bar for shipment to the mint. The concentrates from the Frue vanners average $80 to $85 per ton, and the product from the canvas concentrators $40 to $45 per ton. In the chlorination plant 92% of total assay values are recovered. Costs average about $5.50 per ton.

SIMPLE CYANIDE METHOD.

An effective method of treating gold concentrates by a simple cyanide method is utilized by the North Star Mines company, operating the North Star properties at Grass Valley, Cal. The ores of this property carry little refractory matter, and for years practically all values were secured by amalgamation and simple concentration on canvas tables. The concentrates from two 40-stamp mills are loaded into a circular wooden tank, having a diameter of eight feet with an eight-foot depth, until ready for treatment. Contents are discharged into a 4½x20 ft. Abbe tube-mill and three pounds of cyanide added to each ton of pulp, the solution being united with pulp before admission to tube mill. The mill preforms twenty revolutions per minute, under sixteen horsepower. From the mill the pulp passes to a set of amalgamating plates and on to cone classifiers. From these the overflow passes to agitation tanks where it is kept in constant activity for six hours. It is decanted twice and the remaining product delivered to an Oliver continuous vacuum filter. Classifier underflow is returned to the mill circulation, and the product of the Oliver filter is precipitated by the usual zinc dust method. Concentrates average $30 to $40 per ton and approximately 93 per cent of values are recovered. Costs average $3 per ton.

This method commends itself to operators of properties where the ore is free-milling, and no particular difficulties are experienced in effecting a fair rate of concentration. At the North Star mill 77% of total values are recovered by amalgamation.

GOLDFIELD CON. METHODS.

The concentrate treatment plant of the Goldfield Consolidated Mines Company of Goldfield, Nev., followed a series of interesting and comprehensive experiments, and is probably one of the most satisfactory and effective ever erected. It was at first considered that roasting would be necessary to recover gold from the concentrates, but subsequent tests proved the feasibility of cyaniding the raw concentrates with extremely satisfactory results. The heavy freight and treatment costs attending the shipment of concentrates to smelters early convinced the Goldfield Consolidated management that the product should be treated at home, and with the coming of J. H. Mackenzie, the shipment of concentrates ceased. At first the concentrates were given an acid wash and agitated for eight hours in Pachuca vats. The pulp then passed to Dorr continuous thickeners. The overflow went to the precipitating tanks and the thickened pulp to a second Pachuca tank and a regenerated solution added. As this meant the pumping of the concentrates each time, with an attendant expense, the method was later superseded by a new arrangement. At present the product is agitated for eight hours and settled and decanted in Pachuca tanks—a method that has proven markedly satisfactory.

From the mill the concentrates pass by wooden launders to four amalgamating tables, having dimensions of four by sixteen feet. The final section of tables is provided with a carpet covering which gathers the gold escaping amalgamation. From the plates the product continues to three 10x20 foot redwood collecting and agitating tanks, equipped with a specially designed mechanical stirring device. Each vat has a capacity of fifty tons of dry concentrate and after the collection of charge it is decanted until the pulp contains about 50% moisture. The mechanical stirring arrangement is placed in action and gradually works its way through the charge until the whole mass is active. About twenty pounds of sulphuric acid are added to each ton of pulp and agitation continued for eight hours. Water is then admitted, the agitator raised and the pulp allowed to settle. After the clear solution has been decanted the pulp is washed twice lime added and agitation resumed. Lead acetate is dissolved in water and added to the charge at the rate of one pound of the compound per ton of concentrate. The agitation continues until the pulp is ready for pumping into the Pachuca vats.

Cyanide solution of a strength of 4½ pounds per ton of pulp is fed into the Pachucas before admitting concentrates. After dewatering and settling the product is delivered to a Kelly filter-press, containing 400 square feet of filter surface. It disposes of 50 tons per eight hours, total capacity equalizing 750 pounds of concentrates and 1,200 pounds of solution per square foot of filter every twenty four hours. The high-grade solution is clarified in a 36x36-inch 60-frame Perrin press and precipitated by the ordinary zinc dust practice. The precipitating department, treating all solutions, includes four 30-frame Merrill triangular presses in its equipment. Precipitates are subsequently placed in a 24-mould Boyd press, blanket concentrates and litharge added, and the whole briquetted. Briquets are completed in eight hours and after being dried are melted on a lead basis in blast furnaces. These are cylindrical in form, with 20-inch diameters, and have a capacity of 15,000 pounds of briquette per twenty-four hours. The lead is cupellated in an English double cupelling furnace and after oxidation is complete the gold is granulated by discharge into water-filled metal tubs. The resultant product is collected, dried, melted with borax and nitre in a No. 60 Steele-Harvey tilting furnace, and shipped to the Selby smelter, at Selby, California. The total extraction of values from concentrates averages 95.23%, at a cost of $5.85 per ton. Of this labor represents $0.93 and power $0.48 per ton. In districts where labor and power costs less than at Goldfield, the total cost would be correspondingly reduced.

ALASKA-TREADWELL CHANGES PLAN.

A radical departure from time-honored customs marked the comparatively recent change of treatment at the Alaska-Treadwell mines. The amalgamated plates are entirely dispensed with at this plant, and the concentrates treated direct by cyanidation. The result has been pronounced exceptionally pleasing, and the innovation has attracted wide interest throughout the mining world. Experiments were conducted under the supervision of F. W. Bradley, consulting engineer of the company, and Robert A. Kinnie, general superintendent. The plant has a capacity of 100 tons per day and is located 200 feet above the stamp mills. The Alaska-Treadwell company operates five mills, comprising 900 stamps, crushing 5,000 tons of ore per day. The concentrates are gathered by 360 Frue vanners, and about ninety tons are produced daily.

From the vanners the product is shoveled into flat-bottomed steel cars having an individual capacity of two tons. Locomotives haul the car-train to the foot of an incline at the cyanide plant building and the product is elevated to a switch above the main cyanide plant building by a Union Iron Works geared hoist actuated by a seventy-five horsepower motor. Most of the water has been removed from the concentrates before being taken from vanners, consequently the amount of moisture carried is small. From the cars the product drops into 100-ton steel storage bins. These have a diameter of fifteen feet and are provided with conical bottoms. The concentrates are kept covered with water and a strong lime solution maintained. The product is sluiced to three Dorr classifiers, which command three Abbe 5x22 tube-mills equipped with spiral feeders. Each mill makes twenty-seven revolutions per minute, and three-inch Danish flint pebbles are employed in grinding. When concentrates are amalgamated previous to cyanidation, the product from the tubes passes over ten copper amalgam plates, plated with two ounces of silver per square foot of surface. Each plate is ten feet long by four feet eight inches wide. From the plates the pulp flows directly into launders terminating and built into the floor, and from the pump the product is elevated by an air-lift to a spitzlutte, which delivers the coarse material to a Dorr classifier. From this machine it passes to a 4x12-foot Abbe tube mill. The mill's discharge unites with the overflow from spitzlutte and the combined product is elevated by air-lifts to two settling cones. The overflow of the Dorr classifiers pass through 200-mesh screens into two Callow dewatering cones. The spigot discharge of cones is received by ten amalgan plates. From these the pulp passes by launders into a distributing box commanding two Pierce amalgamators. From these the product continues into four eight-foot Callow cones. The spigot discharge passes to four more cones and thence to a Pachuca tank for agitation, decanting and settling. The thickened pulp is subsequently delivered to another Pachuca tank and given cyanide treatment. Two cyanide treatments are given, after which the settled pulp is delivered to a Kelly filter press. Two of these machines are employed and after the gold solution is mixed with zinc dust the whole passes to two 36-inch, 16-frame triangular Merrill presses. It is stated the rate of extraction exceeds 97% at an approximate cost of slightly over $2.87 per ton.

MANY TESTS PRECEDE CHANGE.

Th new method of concentrate treatment was decided on after over two years' investigation and the expenditure of over $27,000. Abandonment of amalgamation in favor of direct cyaniding was decided on after careful tests and numerous runs, and the results have been more satisfactory than even the engineers estimated. The practice has met with considerable approval from other metallurgical experts, and it seems reasonably certain that similar installations will be provided by other companies treating ore containing the Alaska-Treadwell characteristics.

Numerous special features are included in the equipment, and the special method of feeding zinc dust to the precipitating boxes is worthy special mention. The zinc is discharged directly into a small tube-mill by the zinc belt, and the tube is filled with a series of zinc rods two inches in diameter. These rods not only reduce the zinc dust to a finer state, but themselves yield zinc particles, thus aiding precipitation to some extent. The tube mill is composed of 10-inch pipe and has a length of six feet.

By similar changes and improvements in other portions of the plant the cyanide department has been gradually brought to its present high stage of efficiency. A comprehensive and interesting sketch of this plant was presented by Cyanide Superintendent W. P. Lass at a late meeting of the American Institute of Mining Engineers. The paper appeared in Bulletin No. 62 of the transactions of the society, and to this interested engineers are referred for more complete details. The departure from amalgamation to direct-cyanidation marks a distinctly progressive step—and is a principle likely to receive increasing attention in other gold mining fields.

While cyanidation has displaced chlorination in most fields as the best mode of recovering values of concentrates, the fact that chlorination is still employed by progressive and wealthy companies proves it has many good features. The simplicity of the treatment, and low costs of plants are points in its favor and have incontestibly influenced its use in many instances. But generally speaking the day of the chlorination works nears the unset—and the cyanide process is steadily driving the old process into oblivion. The chlorine gas made gold mining history in past decades, but metallurgical progress is steadily forcing the old to make way for newer and more effective principles.

Way to Success in Engineering Profession

During an address to the graduating class of the Montana School of Mines, last month, E. P. Mathewson, general manager of the Washoe smelting works at Anaconda, kept out of the rut of conventionality and imparted some wholesome advice, illustrated by personal experience, to the students, in the following interesting and entertaining manner:

I want to avoid the pedantic style of oratory and talk to you men, as one who has had a little experience in your chosen profession, to those just entering the arena. It has been suggested to me by your worthy president that I give you some account of my own personal experiences and those of friends of mine who have become prominent in the mining and metallurgical world. If you will pardon my speaking of myself, I will give you a brief account of my career.

After graduating from college, I was fortunate in securing a position as assistant topographer on the geological suvvey of Canada. I had several months experience in that line, returning home at the expiration of the survey.

STARTS IN THE WEST.

I found nothing in my chosen line of work and so I temporarily took a position as clerk in a wholesale establishment, all the time looking out for something in the profession. Nothing turned up that winter, so I made up my mind, after consulting with some friends, to try my fortune in the western United States.

I obtained a letter of introduction from the late Dr. T. Sterry Hunt to a man who was engaged in lead, silver and copper smelting in Colorado. This man had been a pupil of Dr. Hunt and had gone west shortly after graduation and amassed a considerable fortune. I did not know a soul in Colorado, but I met some people in Denver, who gave me the following advice: "Go to the gentleman to whom you have the letter of introduction and present the letter, and if he tells you he has no position vacant, ask him if he will allow you to push a slag pot away from the furnaces." I went to Pueblo, the following day and presented my letter. It so happened that the night assayer had just resigned, so I was offered the position as night assayer of slags and refinery products at the magnificent sum of $50 per month, the work being 13 hours night shift for two weeks and 11 hours day shift for two weeks. I liked the work and it seemed to agree with me.

At the time of my entering the employ of the company known as the Pueblo Smelting and Refining Company there were 13 technical graduates ahead of me. Shortly afterward the manager who had given me work resigned and a new man was put in charge. A little later the metallugist was offered a good position in Australia, and he left. He was followed by the assistant metallurgist, and within a short time so many changes occurred in the technical force that I found myself assistant superintendent in the plant before I had been two years in the employ of the company.

Mine was rather an exceptional case. I was assistant superintendent only one year when the superintendent resigned and I was appointed superintendent of the lead department there being another superintendent of the copper department. Shortly afterward, the superintendent of the copper department resigned and the manager asked me to take charge of both departments; at the same time telling me that the wages of the men in the copper department would have to be cut in half. This was a very pleasant opening, as you can imagine. I went to the foreman of the copper department, explaining my new position and the decision of the management regarding wages. The foreman told me politely that he and his men would quit, which they did.

RUNNING FURNACES BY A BOOK.

I thereupon took some men from the lead department and put them in charge of the copper furnaces. I had never seen a charge of copper refined, but there was an article published in the "Transactions of the American Institute of Mining Engineers" by Dr. Eggleston, which described fully the operation of refining copper in the Lake country. I got this article and camped at the works without sleep for 56 hours, directing the men I had put in charge of the copper furnaces in every step of the process. Whenever I got stuck I would retire to the office and consult the article, the result being that we ladled the biggest charge of copper that had ever been taken out of the furnace, and that charge was of the best quality every taken from that furnace.

After that things went smoothly enough in the copper department, as the men I had broken in took up their work readily, and as they were accustomed to funrace work it was not difficult to train them to handle copper.

I want to say, for the benefit of you young men, that the salaries paid in those days were not what are paid nowadays for similar services. My salary, as assistant superintendent, was $135 per month, and that large sum was only obtained after strenuous efforts on my part to have the management recognize my ability. That was the only time in my life that I ever asked for an increase in wages; but the manager, I knew, had no knowledge of the value of the services of a technical man; and I was aware that in other establishments in the vicinity men in my position were paid considerably more than I was.

I remained with the Pueblo Smelting and Refining Company until 1897. At that time the Guggenheim family had a number of smelting establishments, one of which was in Pueblo. The late Benjamin Guggenheim (one of the Titanic heroes) asked me to enter the employ of M. Guggenheim's Sons and take charge, as manager, of their Philadelphia smelter at Pueblo—the idea being that as soon as I found a man to take my place I should be transferred East. The transfer was made about three motnhs after entering the employ of these gentlemen, and I was placed in charge of the refineries at Perth Amboy, N. J.

During the next five years I was sent out to various parts of the country, including Mexico, and was for two years in South America, at Antofagasta, Chile, representing the interests of my employers.

After two years in South America, I returned to New York and shortly afterward my association with M. Guggenheim's Sons (who had, in the meantime, joined interests with the American Smelting & Refining Company) was served.

A few months later I was offered a position in Montana as superintendent of blast furnaces at the Washoe smelters, then just constructed. This position I took and a few months later, owing to the resignation of the manager, I was placed in charge of the plant and have remained there ever since.

UP FROM THE RANKS.

I will now give you, briefly, accounts of the lives of several men who are or have been prominent in the mining world. First, I recall a friend who was, at one time, employed by the Pueblo Smelting & Refining Company in Colorado. This man was a graduate of Freiberg. He dropped into Pueblo one day without any acquaintance in the town; he applied for work at the smelter; was given a wheelbarrow and shovel and a position as laborer in the sampling mill. He did not mention the fact that he was a graduate of Freiburg, but it so happened that the furnaces were out of order and he dropped a hint to the foreman in charge as to a good way to bring the furnaces around. The foreman reported the matter to the manager and the manager asked him if he knew anything about furnaces. He said he did "know a little," so the manager gave him a trial as an assistant about the furnaces. He proved that he did know his work and gradually he was advanced until he was placed in charge of the plant. Leaving that plant, later on, he took charge of a smelting plant in another part of Colorado, and he was then offered a position as metallurgist to the Broken Hill company, in Australia. This position he accepted with many misgivings, but it proved that it was the beginning of the making of his fortune. He built up the smelting industry for the Broken Hill company and then interested himself in other companies in Australia, finally retiring with a large fortune a few years ago. He still retains an interest in the work.

Another man took a small, humble position with a placer-mining company in California, showed himself to be a good assayer; then later was put in charge of some small quartz properties; from there he was called to South Africa, at the time the Rand was coming into prominence; showed his ability as an organizer in organizing some of the big properties there and managing them, and is today one of the most highly paid consulting engineers in the world.

Anothers man, nearer home, worked for years as assayer in Anaconda then in a similar position on the Pacific Coast, rising to the position of chief assayer at a large plant; then was offered a position as assistant to one of the managers in South Africa on the Rand, which he accepted. He filled that position satisfactorily and was advanced to the managership, and after several years' service in that capacity, returned to America to take up the work of consulting engineer, representing the capitalists who had been his employers on the Rand.

Another man, who began with pick and shovel around a smelter, gradually worked his way up to the superintendency of one of the large Colorado plants, was transferred to Butte, where he conducted some of the earliest experiments in the use of magnesite brick for the lining of converters; from there drifted into the mining end of the business, and is today one of the leading consulting mining and metallurgical engineers of the country.

Another man began as a field assistant to the geological survey of the United States; was afterward state geologist of Wyoming and from there drifted to Arizona, where he became connected with the Copper Queen Mining Co. His ability soon placed him at the head of the technical force of that company, and from that he was transferred to other larger concerns and given more authority, and today is the general manager of one of the largest companies in Mexico.

Another case: A young man sought employment at the Washoe smelter a few years ago as a laborer, said nothing about his technical knowledge, but put in a formal application for a position when a vacancy occurred in the tchnical staff. He was offered a position and we were surprised to find that he had been working for us for months as a laborer. He proved his ability in the technical line and when the opportunity was offered of a transfer to another company, at an increase of salary, he accepted, and today is the assistant superintendent of one of the largest companies in the country.

We have had many young men in Anaconda and in Butte who have worked their way up and today there are dozens of technical men employed about the mines and smelteries who are on the road to advancement.

The main things to be remembered by you are: To be not afraid to tackle any job that turns up. Never be above your position. Be sober and diligent. Faithful in business. True to your friends and to your employers. Learn to treat your associates and the men under you as men, and as soon as you can find the right girl (provided you have enough money to pay for the license), I advise you to get married. Do not wait to make your fortune before choosing your wife; if you do, the chances are 99 in 100 that you will never have one.

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CONTENTS:

It is now currently reported that the Utah Copper crowd has secured control of the Telluride Power Company's Utah and Colorado plants. This move on their part, if true, is commendable. According to report, the Utah Copper Company's power plant cost in the neighborhood of $4,000,000, and it has been able easily to supply power to the company's mines and mills at about double the cost that the Telluride company would have furnished it for. Now, if the Utah crowd gets control of the Telluride company, there seems nothing in the way of securing cheaper power for Utah Copper mines and mills and an eventual unloading of the Utah Copper's power plant on the Telluride company as an "auxiliary."

From Copper To "Gold Mines"

This space is reserved for the picture of A. F. Holden, the other eminent engineer who lent his name and gave his endorsement to the electrifying report on Alaska properties submitted herewith and which will be reproduced from month to month.

NOTED ENGINEERS JOIN BROKERAGE HOUSE IN A REMARKABLY PECULIAR PRESENTATION OF AN ALASKA GOLD MIRAGE.

As one of the most remarkable, alluring, and at the same time most deceptive bids for public support of a new mining venture ever made, Mines and Methods herewith presents the offer of Hayden, Stone & Co., with the endorsement of Daniel C. Jackling and Albert F. Holden, engineers of world-wide reputation, to finance the recently-organized Alaska Gold Mines Company. The statements made are remarkable for the care which has evidently been exercised to make them non-commital; they are made alluring to the unthinking and uninformed through the spread-eagle use of figures which, once thoughtfully dissected, will uncover a sufficient number of "little jokers" to convince the searcher after truth that "things are seldom what they seem." Deception is found in nearly every expression from the beginning of Hayden, Stone & Co.'s presentation of the matter, to the last lines of the "report" carrying the signatures of D. C. Jackling and A. F. Holden. This "report" is such a MASTERLY document, measured from a mining engineering standpoint, that we have made an effort to produce the photographs of Messrs. Jackling and Holden, so that the younger generation of engineers might gather inspiration from their beaming countenances while steadying their brains for the supreme task of making engineering worth while to themselves. We have been unsuccessful in securing the picture of Mr. Holden for this issue, but space alongside of Mr. Jackling's picture, it will be observed, has been reserved for him; and it is the purpose to reprint the report of these gentlemen from month to month until the picture is secured. Readers, we are sure, will be interested to know what a man looks like who is willing to lend his name to such a profound document as the "report" referred to.

HAYDEN-STONE LETTER.

Hayden, Stone & Co., present the matter in the following manner, the capitals in the "report" of Messrs. Jackling and Holden being ours, of course:

TO OUR CUSTOMERS:—We are organizing the Alaska Gold Mines Company, to have an authorized capital of $7,500,000, divided into 750,000 shares, par value $10.

This company is being formed to acquire a controlling interest, as praticularized below, in the Alaska Gastineau

Mining Company, which owns a large, low-grade, free milling gold deposit near Juneau, Alaska, to construct a mill for the property with an initial daily capacity of 6,000 tons, and to finance the development of the property for extensive operation. It is estimated that $4,500,000 will be required for this purpose.

There will be issued at the present time 614,700 shares and the company will hold in its treasury $1,790,000 Alaska Gastineau bonds out of a total issue of $3,500,000, being a majority, and $9,801,000, par value, Alaska Gastineau Mining Company stock, being about eighty per cent of the total capital of $12,000,000. There will be placed in the treasury of the Alaska Gastineau Company $1,250,000, and, in addition, in the treasury of the Alaska Gold Mines Company (the holding company) the further sum of $3,250,000, or a total of $4,500,000 in all.

Construction, equipment and development in an active manner has already been begun.

The balance of the authorized capital of 750,000 shares of the Alaska Gold Mines Company unissued, amounting to 135,300 shares, will be reserved for the general purposes of the company and to acquire, if it can be done on reasonable terms, the outstanding $1,710,000 of bonds of the Alaska Gastineau Mining Company, and the $2,199,000 of the capital stock of the Alaska Gastineau Mining Company.

The shares of Alaska Gold Mines Company will be payable, $5.00 per share at the time of allotment, and the balance of $5.00 will be called on or about July 1, 1913. Certificates of stock marked "$5.00 paid" will be issued as soon as the same can be prepared, and application will be made to list the stock upon the Boston Stock Exchange.

A large majority of these shares has been allotted to the group of gentlemen who will constitute the board of directors who have already been interested in the acquiring of these properties. The balance we propose to allot to our clientele.

We extend to you, subject to prompt acceptance according to the terms hereof, the right to subscribe to these shares at the price of $10.00 per share.

Subscriptions will be received up to the close of business August 28th, and allotments will be made immediately thereafter.

We reserve the right to accept any part of such subscriptions and to reject the whole or any part of any subscriptions. But in accordance with our methods we shall make as near a pro rata allotment as possible.

The character of these properties is, generally speaking, analagous to the low-grade "porphyry" copper mines, in that they contain vast deposits of low grade gold-bearing rock, susceptible to very economical milling. Physical conditions are very favorable for most efficient operation.

The organization of the company will be in part as follows:

MR. CHARLES HAYDEN, President.

MR .DANIEL C. JACKLING, Vice-President, in charge of operations.

MR. ALBERT F. HOLDEN, with the two officers named, and two others, will constitute an executive committee.

We have undertaken this business only after a most thorough investigation by qualified experts, whose reports have been submitted to Messrs. Daniel C. Jackling and Albert F. Holden (than whom no two men are in our judgment better qualified to pass upon propositions of this character). Messrs. Jackling and Holden have subsequently made examination of these properties in person and most emphatically approved their purchase, equipment and development, as may be seen from the extract of their report below.

HAYDEN, STONE & CO.

August, 1912.

* * *

Extract From Report of Messrs. Jackling and Holden.

We have considered the PROBABLE capital requirements for a capacity of 6,000 tons per day, which contemplates a hydro-electric power plant; mine development and equipment, including all the necessary living quarters, both at the Perseverance mine proper and at the mill, and driving the long adit tunnel. We BELIEVE that $4,500,000 will do this work.

Our BELIEF is that the substantially INDICATED ore body is about 4,500 feet long by 70 feet wide. The value of the 600,000 tons of ore THAT HAVE BEEN MINED FROM THIS BODY IN THREE DIFFERENT LARGE STOPES INDICATES that a recovery of at least $1.50 per ton can be made. We BELIEVE that there will be 75 cents per ton profit in this grade of ore. The Sheep Creek Tunnel, which will be driven on the vein as the main haulage level, will develop this ore body at an average depth of about 2,200 feet on the dip of the vein, or about 700 feet deeper than present developments.

The character of this vein is similar in A VERY GENERAL WAY to other large deposits of gold ore in the same vicinity in which the values at a vertical depth of 1,600 feet, or 2,000 feet on the dip of the vein from its apex, are practically the same today as they were on the surface, and have been throughout the development of THE DEPOSITS IN QUESTION. We visited these mines and saw THEIR deep levels, and, if there is any inference to be drawn from the continuity of THESE ore bodies, WHICH ARE NOT, HOWEVER, ON THE SAME VEIN AS THE PERSEVERANCE, one MIGHT BE TEMPTED to say that there is a PROBABILITY of ore 2,500 feet deeper than the so-called Sheep Creek Tunnel which we contemplate driving, BUT, while the PROBABILITY is there of the vein and values extending to great depth, THERE IS NOTHING TODAY TO WARRANT ANYBODY IN STATING THAT IT IS A FACT THAT SUCH WILL BE THE CASE.

There are substantially 50,000,000 tons in the ore body we consider definitely INDICATED. There is a PROBABILITY of another 2,000 feet to the east of the 4,500-foot ore zone previously mentioned, which, from surface indications, would seem FAIRLY CERTAIN to contain ore. Beyond this is some 1,800 feet of the vein concerning which we have NO FINAL OPINION one way or the other. AS WE VISITED NO WORKINGS OR OUTCROPS from which we could secure sufficient data to form accurate deductions. While we cannot at this time state that there IS ore here, there were several SMALL MINES worked almost at the extreme east end of the vein on this property, which INDICATES that this 1,800 feet will undoubtedly produce considerable ore and PERHAPS LARGE QUANTITIES. If we do not consider this in the PROBABILITIES, it is certainly well within the POSSIBILITIES.

This letter is based solely on a consideration of $1.50 recoverable value as ore. If one should figure on lower values, assuming 75 cents as the total cost of mining and milling, the tonnage now indicated in INDEFINITE, but certainly enormous. We BELIEVE that sound mining business will INDICATE that for the installation now proposed and for an operating period of, say, two years, IT WILL BE WISE TO CONFINE OUR WORK TO THE HIGHER GRADE ORE. There can be, in our opinion, little doubt that at some time in the comparatively near future A VERY MUCH LARGER PLANT than the one now proposed will be installed for the purpose of working a larger tonnage of the normal grade ore we now EXPECT will be developed, or of utilizing the apparently vast quantity of lower grade material.

The INDICATED earnings from the installation now contemplated are approximately $1,500,000 per annum. Considering the TREMENDOUS POSSIBILITIES, and we use the word "tremendous" advisedly, we BELIEVE this mine to be a LEGITIMATE purchase at $15,000,000 and A BARGAIN at $12,000,000, provided that, in both cases, a development, equipment and working fund of $4,500,000 is made available. You must understand and appreciate that we do not consider the 6,000-ton per day development and installation as the ultimate possibility of the mine or anywhere near it. The POSSIBLE tonnages of ore INDICATED in this property APPEAR to be greater than any vein deposit WE know about.

We EXPECT the first unit of the new mill to be in operation on or before January 1st, 1915. We really BELIEVE that, barring accidents, the time MAY be made July 1st, 1914.

(Signed, D. C. JACKLING,
July, 1912. A. F. HOLDEN.

* * *

If by any stretch of the imagination consistent with engineering rules universally adopted for the determination of quantities and values of ores in place one could infer the possible realization of quantity and value of ore which these eminent engineers have assumed to be indicated as "possible," "probable," contingent or existent in the property in question, then, measured by the actual cost of operations under the personal supervision either of Mr. Jackling or Mr. Holden upon properties infinitely more susceptible to cheap production of metal than any cost indicated or possible as applied to the mining and treatment of the ore in question this property, whether it contains 50,000,000 or 500,000,000 of tons of "indicated" or real ore, is absolutely without any value whatever.

Of course it goes without saying that the ores of this Perseverance mine must be extracted, if at all, by some method of underground work, the operations of steam shovels being physically impossibl and not suggested by these able engineers. The lowest rate of cost of underground extraction of ores in the properties of the Utah Copper and Ray Consolidated under the supervision of Mr. Jackling is placed in his official reports at over 68c a ton. These orebodies are of several hundred feet in thickness, and extremely soft and friable in character, so that extraction by any process is comparatively cheap, whereas the hard, tough quartz of Douglas Island could only be removed at a relatively much higher cost; but if we add concentrating costs indicated by the reports of Manager Jackling in respect to the operation of the first named properties—which is about 65c per ton—we would have left only about 14c per ton to cover additional costs of amalgamation and cyanidation, to which the ores of that north region are of necessity subjected, in addition to the cost of concentration, leaving no provision for marketing, managerial and publicity expenses. Whereas, in respect to the mines operated under the management of Mr. Holden—the Centennial Eureka, the Mammoth, Gold Roads and other properties—we find the costs of mining alone to range well above, and in some instances double, the assumed recoverable values of the mines of the Alaska Gastineau company, which are the subject of this report.

However, all of this is immaterial in its bearing upon the flotation of the shares of the Alaska Gold Mines Company, because the subscribers to these shares are limited to a so-called clientele of Hayden, Stone & Co., which is found in every community where mining shares are bought and sold. With them no inquiry and no concern is given to the intrinsic or probable value of such offerings, it being understood that parties receiving notice of the promotion of any new issue will be given an opportunity to unload upon others shares so acquired at advanced prices by means of a market which Hayden, Stone & Co. undertake and usually do provide by a process understood as "washed" sales and diligent advertising in a certain class of newspapers whose mining columns they seem to control.

But it is not these first subscribers in whom Mines and Methods is concerned —and clearly they need no counsel or advice from us—for at this writing, although yet four days from the date at which subscriptions will close under the announcement, "rights" to be acquired under the subscription are being bid for in the open market at an addition or premium of $1.50 a share, $5 paid. No one should suppose, however, that transactions of this character indicate real sales, but rather an early initiation of the "washing" process by which the real public investor is to be tempted into the coils.

The Hayden-Stone letter announces that "a large majority of these shares has been allotted to the group of gentlemen who will constitute the board of directors who have already been interested in the acquiring of these properties," but gives no information as to the terms or price or manner by which these gentlemen acquire the large controlling interest of the property, and herein lies the "joker"—the nigger in the wood pile —because no sane person, familiar with the business methods of Hayden, Stone & Co., or the habits of Messrs. Jackling and Holden, will believe for a moment that either of these gentlemen, the firm of Hayden, Stone & Co., or Mr. Charles Hayden, have invested or contemplate the actual investment of a single dollar in this undertaking.

To those who are sufficiently interested to watch the progress and development of this enterprise we predict: First, that by the time the shares are prepared for issue the price will be "washed" up to $10 or more, or a premium of $5 upon the original payment on the subscription price, and that shortly thereafter it will be discovered that an additional issue of shares will be necessary to provide a fund wherewith to acquire the outstanding share and bond interest, or debt, as the case may be, which will finally be found to have had provisional lodgment in the hands of the promoters of the enterprise. Second, this being taken care of, it will be discovered and announced, upon the authority of these great engineers that, upon further examination of the property and revision of the basis upon which original estimates of "possible," "probable," or "indicated" ore was made, that it will be imperative that the contemplated milling facilities be doubled or possibly trebled.

And so, step by step, will arise conditions requiring a constantly increasing issue of shares until the holdings of the promoters have been disposed of and the appetite of the investing and speculative world has been appeased, as was the case with Utah Copper, Bay Consolidated, Chino, and which is now being rapidly approached by the Butte & Superior.

PLAYING ON THE TREADWELL

The Salt Lake Tribune in its effort to support the Jackling-Holden-Hayden, Stone-Alaska gold flotation, as was its duty, in a recent issue quoted what purports to be a statement of average value of ore treated by the Alaska Treadwell over a series of years. The inference, in this case, as in the general presentation of the Alaska Gold Mines Company to the public, is intended to give the impression that the Alaska Gold Mines properties are an extension or continuation of the Alaska Treadwell lode. Unfortunately, however, for this assumption, the Treadwell mines are located on Douglas Island, whereas the Alaska Gold Mines properties are on the mainland, several miles distant and separated by the Gastineau channel.

It will be noted from the statement quoted by the Tribune that the value of the Treadwell ores run considerably over $2 per ton, whilst the "high-grade" ores of the Alaska Gold Mines are reported by Engineers Jackling and Holden as having an "indicated" value of $1.50 a ton. Now, it is quite possible that "indicated" values may not, in practical operation, yield as great a quantity of real gold as the actual values of the ores of the Treadwell mines, determined from the melting pot. Then, again, there is considerable difference between "indicated" values of $1.50 and real gold values of $2.00 to $2.45 recovered from the Treadwell. The rejected sands of the Treadwell ores, as we are reliably advised, contain less than 10c. a ton, which would indicate a recovery of about 96%, whilst an official report of the treatment of the Treadwell concentrates by cyanide gives a recovery of over 97%.

This suggests an average recovery from the Treadwell ores for the years mentioned in the Tribune article of $2.15 to $2.25. Applying the same rate of recovery to the Alaska Gold Mines ores seems to indicate an original value of about $1.60 a ton; but, the fact that this Alaska Gastineau is an entirely different ore deposit suggests the probability, at least, that its contents may not yield to the process of treatment in as high a proportion as that of the Treadwell ores, and this thought finds confirmation in the fact that for a number of years, three ore shoots comprising the richer portion of the Perseverance vein have been worked to a depth of nearly 1000 feet with apparently every facility that a liberal supply of English money and talent could procure, resulting in absolute failure of any profit whatever. On the contrary, in addition to the expenditure of several millions of dollars in machinery, the corporation now seems to be some millions in debt. Of course, the plant operated was not so large as that of the Treadwell or the smaller of the new phorphyry mines; nevertheless, it is just possible that in the mining and treatment of vein ores that the advantage of 6000 tons a day as against 1000 tons will hardly be sufficient to warrant the "indicated" net profit to be derived from the Perseverance of $37,500,000.

WHAT WOULD YOU SAY?

Editor Mines and Methods:
I buy your publication at the news stand and have gained lots of valuable information from it. A friend advised me to sell my interest in one of the best located business properties in this city, that pays 10% net and is increasing in value every year on account of location, and put the proceeds into certain (names of companies purposely omitted) mining stocks at around present prices. He suggested that I invest at least eight-tenths of the funds thus acquired in the stocks mentioned and stated that I would double my money before next Christmas—and I said "maybe." What is your honest opinion? It's next to impossible to get **actual facts** from any of the corporations and I am inclined to be more or less pessimistic—and since reading a few copies of your publication it looks to me as if I had better be **very cautious** or I will get some stocks that I cannot sell to advantage, let alone reap a big profit. Would you advise me to convert my 10% net interest in good, growing investment and hold proceeds for slump—big slump—in copper stocks during the next few months, and buy them outright, or do you think it wise to dabble in any stocks, mining or other kinds? Thanking you for any information you can give me on the situation, etc.

Mines and Methods continually receives communications similar to the one quoted—so many, in fact, that the task of making individual reply is altogether out of the question. We do not pretend to advise our readers as to the manner in which they shall invest their funds; neither are we sufficiently endowed with the power of clairvoyance to predict what may turn out to be good or bad investments. Could we do that with certainty we should soon "own the earth."

Within the last fifteen years or so the business of mining has so changed and the world has developed such a mania for gambling—"taking chances" is the less offense term—that the industry has opened a field to the talents of men possessed of magnetism and the faculty to read human nature, that has proven immeasurably profitable, and particularly to those who have graduated as past masters in the gentle art of stock market deception. Mining for precious metals has always carried with it a fascination possessed by no other calling and, with the rapid advance of mining and metallurgical science during the last twenty years, has sprung up an almost universal desire to reap the golden rewards that ownership in a "mine" has promised through the shrewd manipulators capable of creating a fever and then applying the "balm" in the shape of gilded slips of paper supposed to represent the buried wealth for which the purchaser is seeking and to secure which he is willing to stake his all. This country today contains hundreds of noted millionaires who are worse than "dead broke," millionaires who, were they compelled to make settlement and balance their accounts tomorrow, would find themselves so deeply involved that they could not extricate themselves in 100 years through legitimate effort. Most of these people came from the ranks of those who prospered in legitimate, unexciting avocations, but who could not resist the call to get into the "get-rich-quick" bespangled chariot of the modern mining promoter.

Under such conditions how would you answer questions like those propounded in the letter quoted above? What would you say to a man who tells you that he owns property that is constantly enhancing in value in a thriving city and from which he has a sure income of 10% per annum and who states that he is advised by "a friend" to sell out and buy half a dozen different kinds of mining stocks? Would you tell him the truth and say that possibly the "friend" had those very stocks for sale and that he was likely taking part in the final boom play in which all the "insiders" were working to unload? Or, would you be more circumspect and explain to him simply that mining is usually more or less of a speculation and that all mines deteriorate in intrinsic value in exact proportion to the rate at which the orebodies are depleted, and let it go at that? Or, again, if you cared to be unusually frank, would you show that a property such as he owns, paying 10%, is earning more than most of the so-called "legitimate" mines ever did or ever can be expected to earn; that a world-beater like Utah Copper, for instance, (and granting, for the sake of argument, that its reports are truthful), is paying 5% on $60 a share, and that every time a dividend is declared and paid the mine is worth just that much less, and that you would have to receive that dividend regularly for twenty years to get your $60 back; and would you then explain to him that, while he knows something near what his city property holdings will be worth at the end of twenty years, he could not guess within a mile of what he would have in the way of a tangible asset if he held Utah Copper for that length of time?

You would not tell him that, you say, because it hurts the mining industry. All right, then, we won't tell him, either; we shall just let him go and work out the problem to his own satisfaction, even if there are many other features that should be considered in dealing with the correspondent's queries.

HUMOR AND PATHOS

"Why are you always telling what is the matter with Utah mining stocks? It's time the mines were coming back. All they need is a little boosting. Your paper could do as much if not more good than the dailies because it hasn't got the reputation of lauding everything that comes down the line. People who read it believe what is said in it. Tell some of the good things about the mines and I will mail a hundred copies to eastern customers who are especially particular about getting the straight of things."

The foregoing is what a local broker had to say to the writer of mining and financial "dope" for Goodwin's Weekly a few days ago and it brought forth a couple of columns of pertinent and entertaining comment from which the following choice morsels are culled:

A broker spoke and having spoken he put his feet on the table and settled back to watch the effect of his combined argument, compliment and bribe. The compliment tasted fine; the bribe was dazzling; but the argument seemed to have a screw loose somewhere. It did not fit together well. Restated it came to this: "People believe in your paper because it presents the risks as well as the promises of Utah mining investments. Stop it. Give only one side of the story. Jolly everybody. After awhile no one will believe anything he sees in the paper, but I will have unloaded a choice lot of promotion stock on your readers and made some money."

It is folly to talk of the mines of Utah "coming back." They can't "come back" because they have not been away. So far as the mines are concerned one might fill pages every week in extolling their merits. * * * But there intervenes between the mines and the public the agencies for the control and transfer of mining stock. After these agencies have done their work a mine is not necessarily a mine; it may be a prospect or it may be a mere hole in the ground. Two mines may look exactly alike to the investor who does not take notice that one has twice as many shares of stock outstanding as the other. And if neither has water in its stock one of them may have water in its shaft which depreciates its value by 50 per cent. One mine may be better than another of similar appearance because it has a more economical management, or because it is given better support on the stock exchange, or because it has a better smelting contract, or because it gets a lower freight rate. It is these differences that mean success or loss to the investor and anyone who urges the purchase of shares without calling attention to the elements which affect value is merely a capper for a brace gambling game.

* * * The dealers in mining securities have the best material to work with, but somewhere they are bungling the job. Possibly an association of mine owners and managers such as was proposed at the Commercial club meeting could do something to improve the situation. We have just had an example of the benefits of organization in this field. The Tintic Mine Owners' association, consisting of John Dern and Harry Joseph, sent a large and enthusiastic delegation (Mr. Dern is large and Mr. Joseph is enthusiastic) to Denver to see what could be done about the adjustment of the freight rate on zinc ore from Tintic to the Kansas and Oklahoma smelters which had been hanging fire for several weeks. The delegation called upon the traffic managers of the railroads at Denver and explained that through the oversight of the tariff makers the freight rate on zinc from Tintic was about $2 more than from other Utah points.

"Why, so it is! We never noticed that before," exclaimed the traffic managers. "Here, George, just cut a couple of dollars off that zinc tariff from Tintic. We'd make the new rate effective immediately only the Interstate Commerce commission requires 30 days' notice of a change of rates. Come again, gentlemen. Glad to see you any time."

The committee of the whole of the Tintic Mine Owners' association put the matter up to the Interstate Commerce commission and by return mail received notice that the commission had waived the customary month's notice and would permit the new zinc rate to go into effect at once. The market price of May Day, which has about ten thousand tons of zinc ore blocked out, went up promptly two cents. Could there be a better argument for an organization of mine owners than this?

Messrs. Dern and Joseph might be incorporated as a Utah association if they had nothing else to do, but Mr. Dern has a half dozen companies to direct and Harry Joseph doesn't want to quit running or congress every few days to fix up a freight rate or interview a smelter. It breaks his stride. Moreover, an association, properly conducted, would require more work than the diligence of Dern or the energy of Joseph could compass. It would take a small staff to gather adequate statistics and to discover the many leaks through which profits are lost to the mining companies.

COPPERETTES

The senate committee on appropriations has added to the sundry civil bill $100,000 for the investigation of a method to prevent the enormous waste of minerals and to devise plans for treating low grade ores.—Mining Science.

The senate committee must have heard of the operations of the Utah Copper Company when it decided on the move mentioned in the above item.

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Steam shovel No. 257, a 91-ton shovel, working in the west borrow pit of the Gatun dam, at Panama, excavated 84,519 cu.yd. of material during twenty-six working days of May, or an average of 3250 cu.yd. of material per day. Of the matrial excavated, 42,259 cu.yd. were classified as earth and 42 260 cu.yd. were classified as rock. This is the highest record for a month made by any steam shovel on the Isthmus since the beginning of operations.—Eng. and Mg. Journal item.

We'll just wager a cookey that the steam shovel reporter of the Utah Copper Company can make that Panama record appear insignificant by comparison; only that the character of the material handled probably would be classified as "prospective ore" and "near ore," in place of "earth" and "rock," the material moved at the Gatun dam.

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Constructing Engineer George O. Bradley, accompanied by Metallurgist Frank G. Janney of the Utah Copper, is inspecting the new mill plant of the Butte and Superior company. This concentrator has done its work very acceptably since it was commissioned, and Mr. Bradley has been complimented by metallurgists throughout the country for the manner in which he constructed and commissioned this plant in so short a time.—Salt Lake Telegram, Aug. 14.

Following this deserved compliment to the ability of Mr. Bradley, the same article goes on to say, in substance, that the mill will now be Janneyized according to the ideas of that eminent "metallurgist," so it may be taken for granted that the Butte and Superior plant will now be subjected to several years of "remodeling" along Utah Copper-Ray-Chino lines, when it is likely to be announced—as in the case of Utah Copper during the present month—that this will conclude the heavy expense of rebuilding and "leave only the enlargement of the crushing departments."

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Thompson, Towle & Co.'s "News Letter" of the 14th instant quotes "one of the best informed men in the United States on the copper situation" as follows:

"Consumers of copper in this country are loaded up with business. Every mill that I know of is working to its utmost capacity, having not only all the business it can take care of, but more than it can handle, and from what I can understand this condition is practically the same abroad. There is no longer competition between the mills, for they could not take any more business if same were offered and consequently all competition is eliminated."

And then, so as to show just how much sense there is in this "best informed" man's utterance, the Engineering & Mining Journal's "By the Way" editor takes him down the line in this fashion:

"It follows from this, of course, that if the manufacturers of copper are at 100 per cent capacity and can't take any more business, it is useless for the refineries to increase their output. It is satisfactory to have one fixed point from which to figure. This is a warning to the little mines, just starting up to get a piece of the pie, to keep out. Your copper is not wanted, consumption being already at 100 per cent of the possible."

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* * * It is known also that the United States company is continually on the search for new mines, and in charge of this department is Mr. Jennings. The company examines more mines in the United States, Alaska and Mexico annually than any other organization. * * An idea of the activity of the United States company in the search for new mines can be had from the recent annual report, in which Mr. Jennings told of having examined during the fiscal year 921 properties, of which only one was purchased during that period.—From an interview with A. F. Holden in Salt Lake Tribune Aug. 2, 1912.

The information contained in the above excerpts from the Tribune's interview with Mr. Holden awakens a few speculative thoughts. The first is why, (if the Alaska gold proposition which Mr. Holden, in conjunction with Mr. Jackling, has examined during the month and recommended to the public through Hayden, Stone & Co., was such a big thing), did not the United States company previously grab on to it? Then, it is simply marvelous to ponder over the activity and rapidity with which Mr. Sidney J. Jennings, vice-president of the United States company and in charge of its engineering department, examines mines for his company. He states that 921—nearly three a day, including Sundays—were examined by him during the past year and that only one was purchased. Mr. Jennings' speed in this line of work is probably without a parallel, unless it may have been shaded a little by Messrs. Jackling and Holden, when they passed upon the worth and "indicated" margnitude of the Alaska Gastineau properties for the new Alaska Gold Mines Co.

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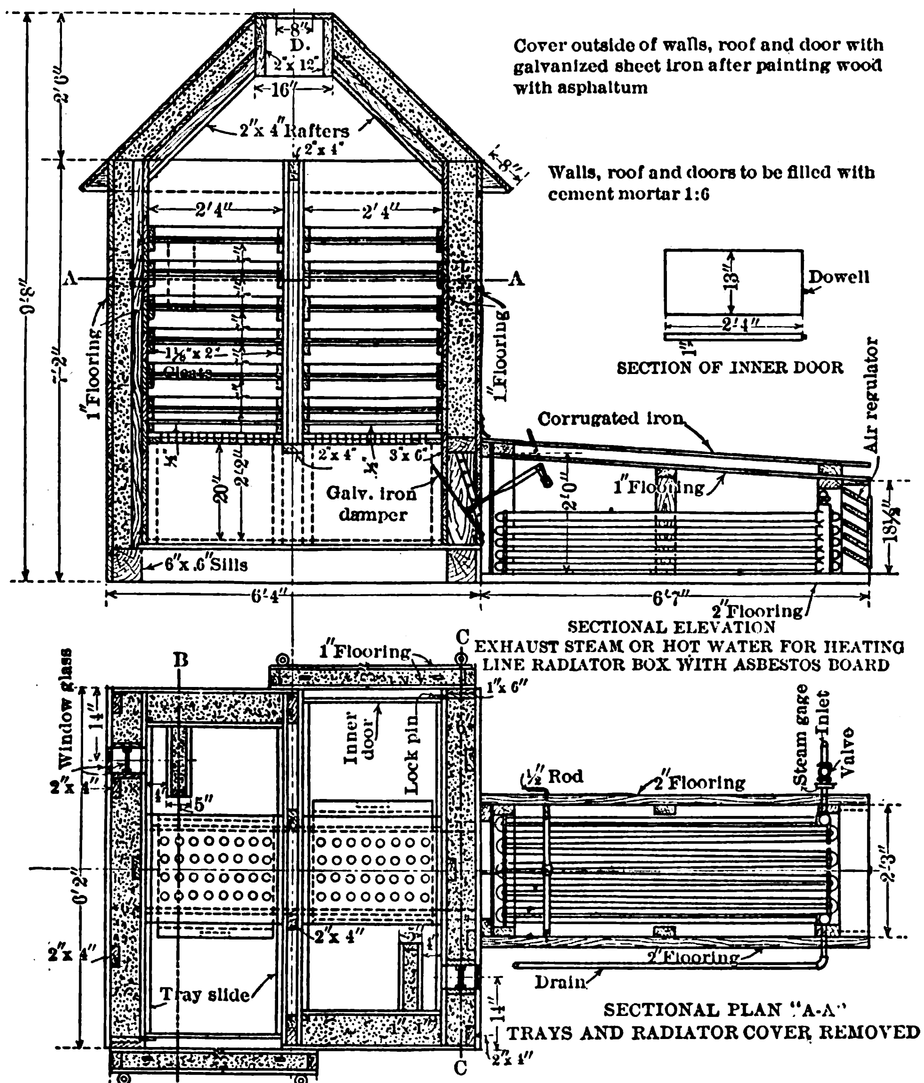
It has been suggested that the 313 Nissen stamps which formed the battery of the late Boston Consolidated mill—now more euphoniously dubbed the Arthur—would go a long ways toward the equipment of the new Alaska Gold Mines plant. Of course these stamps, though entirely successful on Boston Con. ores, under the management of the late Mr. Bettles, refused to work under the new name and were therefore unceremoniously blasted from their foundations. But possibly in that far-off northern atmosphere they may be found more subservient; this provided, of course, as to whether the Holden or the Jackling influence shall finally dominate in any possible metallurgy that may be involved in those ores.

MAGAZINES AND THAW HOUSES

"Magazines and Thaw Houses for Explosives" is the title of Technical Paper No. 18 recently issued by the United States Bureau of Mines. The authors, Clarence Hall and S. P. Howell present the advanced practice abroad and in the United States on the use of material for the construction of magazines and thaw houses and strongly recommend the use of a lean cement mortar consisting of 6 parts of sand and 1 part of cement as the material to be used in the walls, roof, and doors of these buildings in order that the explosives within them may be properly protected, also in order that life and adjacent property may not be jeopardized when magazines and thaw houses are constructed the proper distances from other buildings.

In order that the explosives in magazines may be properly protected they must be guarded against bullets, fire, lightning, and unlawful entry. Different fireproof materials were experimented with to determine their resistance to the penetration of rifle bullets. Sand offered some advantages but was rejected because it would eventually flow out on the floor of the magazine through the cracks in the walls and could not be depended upon to remain in the structure permanently; moreover, gritty materials of any kind are objectionable on the floor of a magazine. Mineral wool overcame this objection but had little value as a medium for resisting the penetration of rifle bullets. Therefore, in order to overcome the objectionable features of sand, portland cement was mixed with it in order to form a lean cement mortar and thus enable the sand to be retained within the walls of the magazine, and still be friable enough to crumble readily under a blow. Tests to determine these two features were so satisfactory that a magazine having this cement mortar as a filling was constructed by the Bureau of Mines at a cost of $400 and having a capacity of 20,000 to 30,000 pounds. A working drawing showing the dimensions and necessary sections are included in the publication. The means provided for ventilation in the magazine of the Bureau of Mines has been found to be adequate, and, accordingly, the storage of explosives in respect to their keeping qualities is favorable.



Sectional Views of Bureau of Mines Cement Mortar Thaw Houses.

The cement mortar construction is effective in resisting the penetration of rifle bullets and owing to its friable nature offers an additional advantage for the reason that, in the event of an explosion in or near the magazine, the large masses of material would not be projected over the surrounding country. The galvanized iron covering is fire resisting and at the same time it serves as an excellent medium for protection against lightning when the four corners of the building are properly grounded with metal rods.

The method of selecting a magazine site is emphasized and suggestions made. The permissible distance which must obtain between magazines and other structures in England, Prussia, Austria, Italy, Massachusetts, and also the proposed American table of distances are contained therein.

The proper method of thawing explosives in either small or large quantities and a suitable method of transporting them to the place where they are to be used is described in this technical paper.

A temperature not exceeding 90° F. is recommended in thawing explosives. In all cases explosives must be protected against moisture and high temperatures and for this reason thawing explosives by placing them before a fire or near a boiler or on steam pipes or by putting them in hot water is condemned.

If you care to know just what is being done at the Chino and understand the situation, read James O. Clifford's article in this issue. The investor, if not the speculator, will appreciate it.

Alexander N. Winchell has resigned from the United States Geological Survey in order to resume work as a consulting mining geologist. He has recently returned to his office in Madison, Wisconsin, after spending several weeks in Nevada in connection with litigation regarding the ownership of the remarkable ore deposits of the National mine in that state.

Horn silver is the common name for cerargyrite.

Interesting Review Of Chino's Mines And Methods

By JAMES O. CLIFFORD.*

The mining properties of the Chino Copper Company are situated at Santa Rita, Grant County, New Mexico, about fifty miles north of Deming, New Mexico, on a branch line of the Atchison, Topeka & Santa Fe railroad. The average elevation of the Santa Rita district is 6500 feet above sea-level.

The total number of mining claims now owned by the company under patent right is 144, the total area thereof approximating 2650 acres; also, there is owned by the company 160 acres of patented land, acquired under agricultural entry, making the total area of lands owned at Santa Rita about 2810 acres. Surface rights only have been acquired covering a considerable area, thereby giving the company practically full control of all the desirable ground in the camp. Among the groups of mining properties acquired by Chino are the Whim Hill, Texas Flat, Montoya, Head, Lee, Romero-Santa Rita and Hearst-Carrasco, respectively, all of which are well known throughout the southwest for their record production of large tonnages of high grade copper ores—principally chalcocite and native copper.

Although officially included in the Central mining district, Santa Rita is distinct, geologically, from the region surrounding the town of Central. However, Santa Rita and Hanover (the latter place being about 2 miles northwest of the former, and separated from it by the low divide between Santa Rita and Hanover creeks, streams flowing south and southwest, respectively,) being in the same geological horizon are generally considered together and are commonly spoken of as the Hanover-Santa Rita mining district.

GENERAL GEOLOGY.

The geology of the Hanover-Santa Rita district is complex, the rocks comprising representatives of sedimentary, metamorphic, intrusive, and effusive types.

The sedimentary series consists chiefly of Devonian limestones and shales and carboniferous limestones having a total thickness of about 900 feet. The metamorphic rocks are sediments altered by porphyritic intrusions—contact-metamorphic rocks—and the old schists formed by regional metamorphism that represent the foundation of the sedimentary series.

The intrusive rocks comprise two porphyries; the first, a quartz-monzonite porphyry occurring as an elongated mass that has domed up the sedimentaries and then been partly exposed by their subsequent erosion, also cuts the sedimentaries in the form of dikes and irregular intrusive projections from the main body. The most noticeable constituents of this porphyry are dark biotite and hornblende, white and green feldspar, and quartz. The common result of alteration of this rock is the kaolinization of the feldspar, and the conversion of the hornblende and biotite into chlorite, epidote, and carbonate. Near the limestone it is locally much epidotized. This porphyry has caused profound alteration of the limetsones and is regarded as the original cause of mineral deposition in the district. The other intrusive rock is a quartz-diorite porphyry which occurs as dikes cutting the quartz-monzonite porphyry and the sedimentaries, some of the dikes being much sheeted parallel to their strike. The most noticeable constituents of this rock are plagioclase feldspar, biotite, quartz, hornblende, and magnetite, the latter in unusual development.

The effusive rock is represented by a reddish colored rhyolite which forms a mass of considerable size immediately southeast of Santa Rita, and is a remnant of the great flow which extends over a considerable area north of Hanover and Santa Rita.

A large block of Cambrian quartzite is found in the heart of the developed area in Santa Rita basin, and smaller masses immediately to the west and south. This quartzite is about 300 feet thick and occurs on the surface at the Romero mine. The schist found immediately underlying this quartzite at the 300-ft. level in the Santa Rita workings is several hundred feet in diameter and is regarded as the pre-Cambrian basement upon which the sedimentaries were deposited. The explanation of the presence of the Cambrian and pre-Cambrian rocks in Santa Rita basin is believed to be that masses of these rocks were torn off by the quartz-monzonite porphyry magma and forced with it up through part of the overlying sediments to the abnormal stratigraphic position they now occupy.

The limestones have been most affected by the contact-metamorphism of the intrusive porphyries; the quartzite is but slightly affected. The metamorphic zones in the limestones are similar to those in many other localities, but the action here seems to have been very intense, and the accession of mineral from the magmatic agents must have been great. Magnetite, pyrite, and zinc blende are locally developed in large quantities. The pyrite carries a little copper as chalcopyrite, and it is probable that the greater part of the copper that has been mined from this district originally existed in this disseminated state. It is evident therefore, that the contact-metamorphism of the limestone was of fundamental importance in the formation of the mineral deposits. The limestone is generally most altered at or near the

General View of Chino's Hurley Concentrator, Looking South.

* Mining and Metallurgical Engineer, Mills Bldg., El Paso, Texas.

quartz-monzonite porphyry contact, but metamorphism has extended through at least 500 feet of the limestone strata, and laterally for much greater distances. The composition and physical character of the individual beds have largely determined the amount of alteration; that is, the degree of metamorphism does not gradually diminish away from the intrusive rock, but varies according to the position of the individual beds.

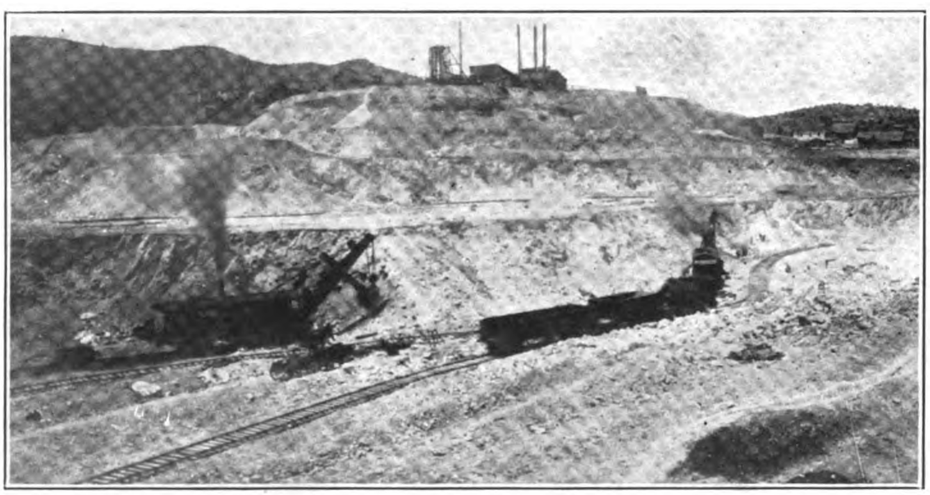
The quartz-monzonite porphyry is much jointed, especially in two directions approximately vertical and at right angles. The northeast system is somewhat more pronounced than the northwest. Many of the quartz-diorite dikes follow one or the other of these joint systems and have themselves been sheeted by later adjustment along the same plane.

ORE DEPOSITS.

The ore deposits of the Hanover-Santa Rita district are divided on the basis of origin into three groups—(1) vein deposits in quartzite and porphyry; (2) contact-metamorphic deposits occurring at or near the contact of limestone and porphyry, and (3) concentrations as the result of oxidation and transportation—deposits of secondary enrichment.

The principal ore deposits found at Santa Rita lie in an area about a mile square that is known as Santa Rita basin. The greater part of the copper that has been mined existed as the native metal, occurring principally in the quartzite, but also in the porphyry, especially in those portions much kaolinized. The native copper is found in the fractures of these rocks in pieces ranging in size from thin flakes up to slabs an inch or more thick and several feet square. The quartzite and porphyry are traversed in all directions by these cracks, wherein there are zones or streaks or copper-bearing ground that can be followed for considerable distances. In some of the softer porphyry native copper is found as irregular grains and lumps surrounded by kaolin. The surface of these pieces of native copper is coated with more or less of the red oxide, cuprite, which is commonly crystalline. Much of the thinner scales of native copper have now been completely changed into cuprite. Close to the surface some of the oxide has been converted into the green carbonate, malachite, but at moderate depths it is present only as thin coatings if at all. A little chrysocolla is present, and azurite occurs in little nests in the porphyry near the surface.

Next in importance to the native copper and cuprite is the cuprous sulphide, chalcocite, or copper glance. This mineral is confined almost entirely to the altered porphyry, but little of it having been found in the quartzite. The ore of this character that has been mined occured as stock-works and heavy impregnations of that mineral in the kaolinized and silicified porphyry.



General View of Santa Rita Steam Shoveling Operations; Romero-Santa Rita Main Shaft Hoisting Plant in Distance.

The principal bodies of native copper have been found in the uppermost 200-250 feet, and none have been found below the quartzite which is approximately 300-ft. thick. The workable lenses of chalcocite ore are confined to the uppermost 400 feet in the porphyry. For example, the Romeo shaft which was sunk to a depth of over 450 feet encountered little ore below the 400-ft. level. Similar conditions obtained at the other principal mines of the district. In this connection it is interesting to note that the largest single deposit of chalcocite ore found in the district was encountered in running a cross-cut from the Hearst shaft to connect with the 300-ft. levels of the Romero and Santa Rita shafts. This body of ore was approximately 200 ft. long by 60 ft. wide by 80 ft. high, and averaged throughout 10% copper per ton, although many carload shipments therefrom returned an average copper content of 36%. Similar occurrences are encountered from time to time in the other properties of the district, although they are small compared to the above mentioned deposit.

The principal ore deposits of Santa Rita basin seem to follow two well-defined channels of enrichment having respective strikes of northwest and northeast, following the contact of the quartz-diorite with the quartzite mass mentioned in a previous paragraph as occupying the central portion of the developed area of Santa Rita basin. These channels of enrichment seem to have their point of intersection near the Romero shaft. Extending in respective southwesterly and southeasterly directions from the Romero shaft along the channels mentioned small lenses of chalcocite ore, and seams of almost pure native copper are encountered. The ore occurrence referred to as having been encountered in the cross-cut from the 300-ft. leevl of the Hearst mine to a similar level of the Romero property is a representative occurrence of the ore bodies in question, although those at present being found are not by any means so large.

It is probable that the source of mineral forming the various types of deposits was the quartz-monzonite porphyry magma, and that while the deposits in limestone at the contact were formed at the time of the porphyry intrusion, the veins were formed later—after the rock had solidified and fractures had been developed.

The presence in the lenticular bodies of chalcocite of cores of pyrite, and aside from the ore bodies of masses of pyrite similar in distribution to the ore bodies, as well as in a more disseminated state, and all more or less coated with chalcocite, makes it certain that a great part of the cholcocite replaced and was precipitated by pyrite. There is no doubt that much of the native copper was derived by the oxidation of the sulphur of chalcocite, but no other explanation than deposition originally as sulphides offers itself, although it is evident that a considerable quantity of the native metal or oxide was not precipitated on pyrite, but was deposited from solution in open spaces in the quartzite, and as replacements in the porphyry.

There is no zone of leached ground overlying the ore bodies of sufficient thickness to have supplied the copper deposited below. On the other hand it is believed that the contact-metamorphosed limestone containing cupriferous sulphides that are present on several sides of Santa Rita basin, originally overlay the region of the present ore bodies, and that the copper they held was dissolved and finally precipitated in the underlying rocks.

In scattered parts of the contact-metamorphosed limestone present on the several sides of Santa Rita basin enrichment has gone on chiefly in a portion of the original deposit itself.

CHINO ORE DEPOSIT.

The Chino ore deposit occurs in the form of a horse-shoe of mineralized quartz-diorite porphyry encircling a core of slightly altered quartzite. The mineralized quartz-diorite porphyry contains a wide variety of copper minerals; native copper, cuprite, and chalcocite however, predominating. The quartzite core is traversed by numerous seams of rich native copper ore. The seams of native copper, and the small lenses of high-grade chalcocite which permeate the mineralized zone have been found in those portions of the porphyry much kaolinized and in close proximity to the porphyry-quartzite contact.

A noticeable feature of the Chino deposit is observed in any of the deep workings of the older mining properties, viz., Hearst, Romero, Santa Rita, et al. With especial reference to the bodies of chalcocite ores found in the porphyry it is apparent that the central core of the ore deposit is almost pure copper glance, the values decreasing in value outward from the center. Similarly, as development progresses laterally from the enriched channels constituting the Chino deposit in its entirety, a marked impoverishment of the copper content is observable. This condition is responsible for the wide variation of the copper content of the ores developed and mined, and precludes any uniformity of the copper content within the entire developed area other than if only the enriched channels are mined uniformly. By the same token it will be noted that, as outlined under the caption 'Geology' there is a marked impoverishment of the ore deposit with increased depth, the reason therefor being given in an earlier paragraph.

PROSPECTING AND DEVELOPMENT.

The Chino ore deposit has been prospected and developed by churn-drilling operations, and underground mining methods, respectively.

Churn-drilling operations ceased last January at which time approximately 500 holes aggregating 200,000 feet of drilling had been completed, the average depth of each hole having been 400 feet.

Underground development is still under way, extensive cross-cuts at present being run from the 100-ft. and 200-ft. levels of the Hearst-Carrasco and Romero-Santa Rita shafts. Incident to the underground development of these properties some high-grade ore is being shipped direct to the smeltery at El Paso, chiefly native copper.

The principle of drilling at Chino has been to sectionize the entire property area into 200-ft. squares, and to drill regularly on the corners thereof; or, where any uncertainty as to values was probable, the ground was drilled at more frequent intervals of space to fully demonstrate the facts. It is interesting to note in this connection that prior to the commencement of churn-drilling operations to effect delimitation of the ore deposit, there already had been fully developed by the underground workings of the older mining properties approximately 20,000-000 tons of disseminated ores, and partially developed about 7,000,000 tons.

Churn-drilling the Santa Rita district practically has been a failure. At best it is, even under the most favorable conditions, an imperfect means of delimiting ore deposits. Drill holes sunk even at intervals of 200 ft. distant do not afford assurance that all the intervening space is occupied by ore of commercial grade. Even tunnels and shafts, with their accompanying cross-cuts, which may have been driven in valuable ores at much shorter intervals of space may have been luckily or wisely directed along enriched channels, bordered by practically barren, or worthless ground. The physical character of the Santa Rita basin deposits precludes even fairly accurate results from churn-drill prospecting. To say the least it is extremely difficult to accurately sample the ores encountered through the underground workings.

The tonnage of ore developed to date by churn-drilling operations and underground mining methods is officially stated as approximately 55 000,000 tons, said to contain an average content of 2.21% copper per ton. Of this tonnage it may be safely stated that at least 60% was developed by underground methods.

The average thickness of the Chino ore deposit is approximately 110 feet, capped by an average overburden of 095 feet, or if due allowance as overburden is made for the so-called oxidized ores that are removed and placed in stock for future use, 110 feet.

The average cost of steam-shoveling is officially given at 31.68 cents per yard of material removed. Therefore, if we assume a ratio of 1:1 of overburden to ore, the cost per ton of ore mined will be 31.68 cents.

At the present time steam-shoveling operations, insofar as ore shipments are concerned, are being confined principally to the Romero, Whim Hill, and Hearst-Carrasco pits. Of particular interest in this connection is the fact that operations are chiefly along the lines of the enriched channels extending from the Romero main shaft. The average grade of ore from this section ranges from 2.592% to 3.18% copper per ton, and in some instances higher, and it is ore of approximately this average grade that at present is being sent to Hurley for treatment. In general it seems to be Chino's plan to mine its richest ore reserves first as evidenced by the proximity to which it works in toward the older workings of the mines that have produced high grade ores.

There are parts of the Chino properties which cannot under any reasonable circumstances be steam-shoveled, and, in view of the extensive underground development which existed previous to the beginning of actual mining operations it seems reasonable to believe that under the then existing conditions that underground mining methods should have been given preference over steam-shoveling. However, it is quite probable that in the near future the percentage of ores mined by underground methods will, relatively, be greater than the tonnage supplied by steam-shoveling.

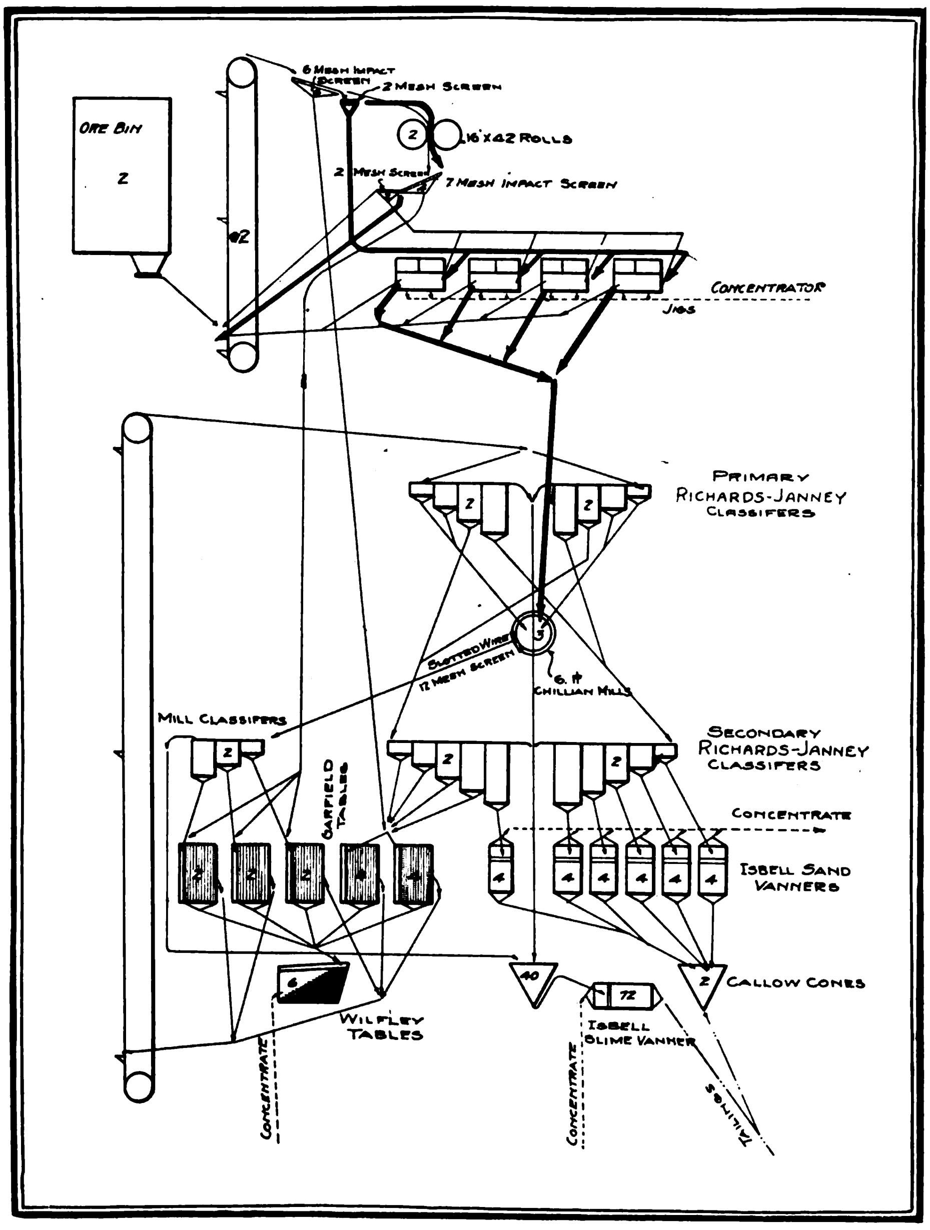
CHINO MILL AT HURLEY.

The total area of property owned and controlled at Hurley and in that vicinity for millsite purposes and in connection with water rights is approximately 7200 acres, of which total 700 acres are leased from the State and individuals, the area directly owned by the company being 6500 acres. Hurley is about nine miles south of Santa Rita on the Whitewater-Santa Rita branch of the Santa Fe railroad. The Chino concentrator is about three-quarters of a mile east of the railroad depot and on the west bank of Whitewater creek.

Power Plant.—Steam is generated by eight 500-h. p. Heine water-tube boilers set in batteries of two, 180 lbs. steam-pressure being the normal working load. Green chain-grate stokers are used exclusively for automatic firing, and feed water is supplied by three compound duplex Wheeler pumps equipped with feed water heaters. Green suction ash-handling system for the removal of ashes has been installed recently. The water from the engine condensing system is delivered to two cooling towers over the 3-000,000-gallon concrete storage reservoir.

The equipment of the electrical generating plant consists of three-Nordberg-Corliss cross-compound engines operating at 100 r. p. m. These engines have 28 in. high pressure and 60 in. low pressure cylinders with a common stroke of 48 ins. The generators are of Allis-Chalmers 3-phase, 60 cycle type, generating at 480 volts, direct mounted on the engine crank shaft, the nominal rating of each generator being 1250 k. w. Power is transmitted to the Santa Rita mines and the several pumping stations at 24,000 volts, step down transformers to 480 volts being provided at the several sub-stations for the various points in use.

Water is obtained from four pumping stations as follows: Apache Tejo, four miles south of Hurley, equipped with two Aldrich quintiple-geared electric-driven pumps—one pump being held in reserve for emergency use; Whiskey creek, four miles northwest of Hurley; Cameron creek, one mile north of Whiskey creek; and B ranch, one mile northeast of the concentrator in Whitewater creek, the three last mentioned stations each being equipped with one Aldrich triplex-geared electric-driven pump.



Flow Sheet of Chino Mill—Light Lines Show Present Arrangement. Heavy Lines Show Previous Arrangement of Jigs.

CONCENTRATOR.

The crude ore bins, having a capacity of 15,000 tons of ore, and the coarse-crushing plant, having a capacity of 450 tons per hour, form one structure. The crude-ore bins are equipped with two standard guage railroad tracks above, and two separate lines of conveyor belts beneath, the latter fed by automatic caterpillar ore-feeders. The coarse-crushing plant consists of one No. 8 McCully gyratory crusher and one set 20 in. x 72 in. Garfield rolls. The coarse-crushing plant is connected by an inclined belt-conveyor, 265 ft. long between centers, to the main mill building containing the fine-ore bins.

The fine-ore bins are circular steel tanks, each bin having a normal capacity of 1,000 tons, equipped with automatic caterpillar feeders and necessary belt conveyors. At the head of the inclined belt-conveyor delivering from the coarse-crushing department to the fine-ore bins is an automatic sampler for taking the head sample.

At present the concentrator comprises five units having a normal daily capacity of 1000 tons per unit. Three of the units are in operation; a fourth will be placed in commission September 1st, and the fifth about November 15th.

Flow Sheet.—From the coarse ore bins the mine-run ore is delivered by belt-conveyors to a bar grizzly of 1 in. spacing, the undersize going to the inclined belt-conveyor for delivery to the fine-ore bins, and the over-size passing through the No. 8 McCully gyratory crusher to pass a 2¼-in. ring. This crushed material is then elevated by a vertical bucket-conveyor to another bar grizzly of 1 in. spacing, the undersize going to the fine-ore bins, and the oversize going through the 20 in. by 72 in. rolls being reduced to pass ¾-in. ring. This material is dropped immediately upon a 1 in. screen grizzly the over-size going to the bucket conveyor, and the undersize to the fine-ore bins. The crushed ore, therefore, has a maximum size of approximately 1 in.

The fine-ore bins deliver the ore to two vertical bucket-elevators which in turn deliver at the top of the mill to six 6-mesh impact screens. The oversize from these screens goes through two 16x42-in. Garfield rolls, the undersize going to the first eight Garfield 'roughing' tables. The rolls product passes over four 7-mesh impact screens, the undersize from which is sent to the second series of six Garfield 'roughing' tables, and the oversize is immediately passed over a 2-mesh screen, the undersize from which is directly delivered to four 'bull' jigs, and the oversize returned to the bucket-elevator pit.

The first and second series of Garfield 'roughing' tables, a total of 14 tables deliver a head product to 6 Wilfley tables, the latter yielding a concentrate. The middling and tailing from both sets of tables are sent to a third bucket-elevator which delivers the product to four primary 4-spigot Richards-Janney classifiers. The sizes from spigots 1 and 2 of these classifiers are sent to the feed tanks supplying three Chilian mills. The third spigot product of the primary classifiers goes to two 5-spigot Richards-Janney classifiers. The sizes from spigots 1 and 2 of these classifiers are sent to the feed tanks supplying three Chilian mills. The third spigot product of the primary classifiers goes to two 5-spigot Richards-Janney classifiers, the fourth spigot of the primary classifiers being delivered to the other set of two secondary 5-spigot Richards-Janney classifiers.

The product of the first four spigots of the set of secondary classifiers treating the third spigot product of the primary classifiers is sent to the first series of eight Garfield tables. The fifth spigot product going to one set of Isbell sand vanners. The two secondary 5-spigot classifiers treating the fourth spigot product of the primary classifiers serve five separate groups of Isbell sand vanners.

The re-ground material from the first and second spigots of the primary classifiers, reduced in the Chilian mills to pass 12-mesh, goes to two 3-spigot Richards-Janney mill classifiers. Each of the spigots of these classifiers deliver to separate groups of the second series of Garfield tables.

The overflow from all the classifiers is uniformily delivered to 40 Callow cones for de-watering, the thickened pulp therefrom being treated on 72 Isbell slime vanners.

The first true tailing product of the closed circuit is made by the group of 24 Isbell sand vanners, the tailing from which is sent to two large Callow cones for de-watering in so far as possible.

Inconsistent Methods.—It is quite evident from a general review of Chino milling practice that there are many inconsistencies in the treatment of its ores. For example, the two 3-spigot mill classifiers evidence a purpose of classifying the Chilian mill product and delivering different sizes to three different groups of Garfield tables. However, it will be noted that this attempt at classifying is offset by the direct mixing of the undersize from the second set of 7-mesh impact screens with the classified material from the mill classifiers on the Garfield tables. In this connection if Chino contemplates the treatment of an unclassified pulp on the Garfield tables the mill classifiers are, in the main, an unnecessary adjunct. On the other hand if a classified pulp is desired it seems reasonable to believe that the 7-mesh impact screen product should be diverted into the mill classifiers. In the absence of a more definite excuse for this apparent neglect of an important milling problem it is quite probable that Chino realizes the unusual sliming of its ores resulting from the abrasive action of the Chilian mills and consequently desires to eliminate the slime at the earliest practicable stage, although even in the absence of the mill classifiers it could as effectually be removed by the primary and secondary classifiers.

Of especial interest is the installation of a battery of four 'bull' jigs to each unit of the mill, which evidently was not contemplated in the original mill plan. The several important changes that have been made in placing the jigs at points wherein it was assumed the maximum efficiency thereof would be obtained is clearly outlined in the diagrammatic flow-sheet plan herewith given. In the first instance (that is, the initial operation of the mill) the undersize from the upper impact screens, which at that time were approximately 4-mesh, was sent direct to the Chilian mills.

Later the jigs were installed between the primary and secondary classifiers and the oversize from the first six 4-mesh impact screens in lieu of being sent directly through the 16x42 in. Garfield crusher was first passed over a 2-mesh screen, the undersize from which was sent to the jigs, and the oversize then to the rolls. The tailing from the jigs was then delivered to the Chilian mills for further regrinding. That arrangement proving unsatisfactory, the jigs were removed to the position which they now occupy immediately beneath the 16x42 in rolls, and the 2-mesh screen from its place near the upper 6-mesh impact screens removed from their former position and so placed that the oversize from the second set of 7-mesh impact screens is immediately dropped thereon, the undersize going to the jigs, and the oversize to the bucket-elevator pit. As now arranged the jig tailing goes direct to the bucket-elevator pit, and in view of change outlined the fine-crushing department has been changed from dry to wet service.

Primarily the reason for jig installation is the removal of the coarser native copper which commonly occurs in the Santa Rita ore deposits and reference to which has been made under an earlier heading.

Operating on Richest Ores.—With three of its five units of the mill in operation Chino is treating approximately 3900 tons of ore daily. While the normal capacity of each unit is rated at 1000 tons per day, as much as 4100 tons has been known to be handled by the three units in about 24 hours on several occasions.

The ores which have been milled, and at present are being milled, are mined chiefly from the enriched channels bordering the Whim Hill, Hearst-Carasco, and Romero-Santa Rita fissures, and commonly known as the Whim Hill, Romero, and Hearst steam-shovel pits, respectively. The physical character of the different ores from those sections are subject to wide variations in structure and copper content evidenced by the lack of uniform distribution as outlined in the description of geological conditions in a previous paragraph. Consequently the average grade of ore treated, and the relative percentage recovery, will be subject to constant fluctuation.

While the average copper content of the Chino ores is officially stated at 2.21% per ton, it is interesting to note that the grade of ore treated at the mill to date has been derived from the enriched ore channels mentioned in an earlier paragraph, (commonly termed respectively Romeo, Whim Hill, and Hearst steam-shovel pits,) the average copper content ranging from 2.592% to 3.183%, and in some instances even higher.

Maximum percentage recovery of copper is sacrificed to tonnage treatment of material, with the consequent result that extraction at the Hurley plant never has been greater than 58% of the copper content of its highest grade ores, and, of the copper recovered, at least 60% represented the native metal and cuprite.

Water Shortage and Copper Costs.—Chino is short on water notwithstanding its four pumping stations. There never has been sufficient water to supply the first three units for any considerable period of time. So that sufficient water might be recovered from the three units now in operation to care for the two additional units which will shortly be placed in commission, first the sand vanner tailing was subjected to de-watering in so far as practicable, and, recently, an elaborate system of wooden settling tanks comprising thirty rectangular sections each approximately 20x18x8 ft. The tail race from the mill empties into this series of tanks, and the recovered water is returned to the storage reservoir. It is stated by those who are in position to know that this latest improvement will effect recovery of 67% of the total water used by the first three units of the concentrator, a quantity of water exactly sufficient to supply units four and five when they are placed in operation. However, in order that a permanent water supply will be assured the company contemplates the construction of a large concrete dam in one of the mountain draws near Hurley to impound the annual flood waters of a portion of the Santa Rita watershed. If this last mentioned project proves successful it is the intention of the management to increase the capacity of the Hurley concentrator to eight, and possibly to ten units; also, to construct and operate its own smeltery at Hurley.

Official reports state the cost of copper production at less than eight cents per pound, with a probable reduction in cost to less than seven cents. Those production costs that have to date been stated as seven to eight cents per pound, respectively, are grossly misleading, for the special reason that only the approximate mining and milling costs are included, omitting the important factors of prospecting costs; expense stripping ore deposit of overburden; amortization of plants; smelting, refining and marketing charges. It is quite apparent, therefore, that the major percentage of production cost is carired as deferred payments, or charged to capital account. Under the most favorable conditions Chino has never produced copper at a cost less than 11.034 cents per pound net, an allowance of 2.115 cents per pound having been made for contained gold and silver.

CONCLUSION.

Chino is unquestionably the best of all the southwestern 'porphyries'. In fact the Hanover-Santa Rita district in its entirety is one of the best known copper producing sections in the southwest, as evidenced by the extensive holdings of the Phelps-Dodge Company, Calumet & Arizona and other large interests, although practically only the Chino is actively operating at present.

The coming year will witness several marked changes in the mining and milling practice of Chino, which it is hoped will be for more rational mining methods, and greater efficiency of its milling practice, which at this time is deplorable.

MINERAL DEVELOPMENT SOUTH OF CANAL ZONE

By C. F. Z. CARACRISTI*

The approaching completion of the Panama canal will stimulate the early development of an empire of mineral and agricultural wealth in South and Central America. The expansion of these industries is usually in proportion to the necessities of mankind rather than the outcome of purely sentimental or premature financial efforts. No industry can be successfully promoted and maintained upon a sound basis that has not as a surrounding quality the demands of pure necessity. The increase of the world's population, attended with the demands of mankind upon nature's storehouses, will shortly force industrial progress in remote regions, that but a few years ago were neglected.

The Panama canal will shortly bring into the path of progress the countries of Costa Rica, Panama, Colombia and Ecuador.

In years past the development of tropical countries has been somewhat impeded by the fear of yellow fever and other diseases peculiar to these countries. This impediment, however, has been almost removed by the work of Dr. Rudolph Ezdorf and Col. Gorgas, who, by scientific investigation and a campaign against these diseases have given to the world more territory than Columbus. They have made possible the development of regions which in years past have been but pest holes on the face of the earth. The conquest of the fever bearing mosquito and the system of tropical sanitation, due to American science and American energy, has given mankind vast future possibilities and reclaimed areas so great that the mind can hardly conceive of their importance. Had the war with Spain brought about no other result, this achievement alone would have well repaid the great sacrifice of life that this war cost the American people. The work of these American doctors has made it possible for the white man and his posterity to lay claim to tropical America and Africa. It has made the Panama canal possible and given a new impetus to the development of unlimited tropical resources. The Isthmian canal and the sanitation of the tropics are no longer dreams. The canal will bring the whole world in touch with equatorial America and the knowledge that the miasmic pestilences of the past need no longer be feared, will promote the energetic development of the fertile country and rich mines that surround the interoceanic water-way. In Costa Rica, Colombia, Panama, and Ecuador alone there are 580 million acres of land capable of supporting a population of over 15,000,000 people.

But we must increase our detailed knowledge of the possibilities of these countries and it is the duty of the countries themselves to aid in the work of promoting their national welfare. Hundreds of millions of acres of fertile lands are found in Costa Rica, Panama, Colombia and Ecuador that are subject to the influence of the Isthmian canal, but our knowledge of the region is so nebulous and vague, that we know of it only in a general way from hearsay from some more or less responsible spirits who have entered the region in search of wealth or adventure. Little if any scientific work has been systematically practiced and even the best known sections lack that fund of information that is required to induce capital to venture its ever fickle expansion into the "terra incognita" of tropical America.

GEOLOGICAL SURVEYS NEEDED.

Some years ago after making an examination of the mineral resources of Colombia, a part of Venezuela and Ecuador, I discussed the establishment of a temporary geological survey with President Ricardo Jimenez of Costa Rica and this progressive and able executive was considering this project when the terrible earthquake devastated his country and depleted the national treasury. The establishment of geological surveys in these countries will do much towards drawing attention to their great mineral wealth and the attraction of capital for its development.

There is a highly interesting country that extends from the Nicaraguan boundary to a point some forty miles east of the volcano of Chiriqui or Varu in Panama. Taking this volcano as a center and drawing a circle with a forty mile radius a country of great mineral and agricultural wealth is to be found which gives promise of great future development. The country away from the seaboard is high and healthful, rich in minerals, with fertile soil and good climate and ample water. It must some day become the abode of an important people and industries. Both on the Carribean sea and the Pacific ocean are found spaceous bays and harbors. A peculiar kind of lignite is found in the region that contains over 66 per cent of combustible gas and may be substituted for cannel coal in the manufacture of illuminating and producer gas for internal combustion engines. Some copper, gold, silver and lead have been found in the region but no important efforts have been made to work any of these. Prospecting is difficult owing to the heavy soil overburden and the rank growth of the tropics.

This fact is true of all torrid America. In fact I have located mineral deposits and after three months absence could not find the outcroppings. Further south in Panama, between Porto Bello and the territory occupied by the San Blas Indians, manganese, iron and mercury are found. To me the mercury has always been a source of wonder because it has been invariably found in the metalic state in rock cavities after rains. No cinnabar was encountered, but I believe that future exploration near the intrusive dikes and the thermal springs of the Isthmus, vast deposits will be found. I believe that the phenomenon of finding metalic mercury, in lieu of the cinnabar, is due to the breaking down of the sulphide by heat action, the rains washing it out and depositing it in basins formed by erosion.

At the southeast end of Panama and also across the border in Colombia on the Isthmus of Darien, in the territory occupied by the Occidental Indians and in the Isthmian Andes are found gold, silver and copper.

WHERE INTEREST CENTERS.

But of more intimate interest to the world's progress is that part of the world

*Civil and Mining Engineer of Mexico City, in Mexican Mining Journal.

that forms the northwestern extremity of the South American continent, that stretch of territory that is encompassed between the Rio Atrato forming a north and south boundary on the east and the Pacific ocean on the west. This is the noted Choco country—the land of gold and platinum. It is platinum that today attracts the attention of the industrial world. The prohibitive price that this precious metal has reached commands the serious attention of the electrical world. The solution of the platinum problem rests with the placer beds of Choco. Some more systematic method of washing must be found; the work must be carried on by more important efforts than the dissolute and haphazzard will of Indian and native negro labor. The world's demand for platinum should stimulate a more complete study of the Choco region. Washing in the Choco belt in the dry season (it is practically impossible to work during the rainy season) should be carried on by the use of artesian well water, which may be had in many sections. From what I have seen of the Choco belt during the dry season, when water is low and unavailable at points where the gold-platinum bearing drifts are found, the only solution is the possibility of the use of artesian well water. The platinum bearing placer beds, while in an aggregate covering an extensive area, do not at any place possess sufficient local extension to warrant the expenditure incidental to the installation of expensive flumes, etc. Nearly all of the region has been metamorphosed by excessive local ingenous influences so much so that one needs not to be a geologist to note the weird peculiarity of that part of the landscape when the rocks are exposed to view.

East of the Choco and of the Rio Atrato, on the rios Leon and Sucio, in the country that lies between the Gulf of Darien and the Rio Mulato in the extension of the Abibe mountains, coal, petroleum, copper, iron, lead and silver are found. Here, too, are lands that have no superior in the way of fertility anywhere on earth. These lands are accessable to good harborage. Here is a land practically uninhabited that has ideal surroundings and only awaits the man of brain and energy to convert them into a proftiable domain.

The treatment of Colombia by the United States over the Panama canal, unless that country will consent to the arbitration of the dispute by the Hague tribunal, a request that is only just and which the American government should do everything to promote, has temporarily at least created an adverse feeling towards Americans, but has not developed any adverse acts of personal resentment. The Colombian people realize that the masses of the American people are not responsible for the vagaries of an ex-president and for that reason citizens of the United States are not disturbed in any way in the enjoyment of their justly acquired rights.

PETROLEUM IN ABUNDANCE.

Along the Colombian coast, on the costal plains and the maritime Andes are found petroleum in abundance. On the rios Zulia and Catacumbo in Venazuela, just south of the great lake of Maracaibo are also found extensive petroleum fields that should attract attention and development. It is doubtful if the coal fields of the coastal plains, especially those southwest of the city of Rio Hacha in Magdalena will ever be worked profitably, because of the grade of the coal itself the great amount of water that the mines will encounter with depth, the softness of the hanging walls and the heat that is developed near the equator with depth and the difficulty of ventilating the mines.

In Colombia, also, the proper prospecting of the Sierra Nevada de Santa Marta should present scope for mineral development.

The interior of Colombia presents a vast field for future development when the railway facilities are to be had for getting into this country, and when the canal is completed and the proposed inter-continental railway, the dream of the late Hinton R. Helper, who projected the idea before a convention in the city of St. Louis in 1848, becomes an accomplished fact.

In Ecuador the most attractive field today, that is presentable to foreign investment seems to be the oil fields of the region surrounding the bay of Santa Helena. Oil, sulphur and rock salt are found here in abundance on the Pacific costal plains.

But the two points that seems to have the greatest present advantage are those localities found on both sides of the border of Costa Rica and Panama and the country that lies in the Caribbean Andes and their spurs, from Rio Atrato to the Great Lake of Maracaibo.

On the coast of Boajira peninsula, in Colombia I examined pearl and sponge beds equal to those of Panama; while the fisheries of the Colombian coast cannot be surpassed anywhere.

The present government of Colombia presents every outlook for a peaceful stability. It is headed by men of energy and integrity, combined with that personal force of character that is required to govern a people who have inherited from the Spanish conquerors a love for war and deeds of martial valor.

Everyone who knows him at all will believe that President Carlos E. Restropo will make Colombia the greatest of all countries of northern South Africa. He is a man of learning, honest to a fault, slow to act in diplomatic matters without first accepting the best of advice; but with it all he is a man of vigorous energy who well deserves the hearty support of the Colombian people and the respect of foreign powers. I believe that President Restropo will regenerate Colombia and bring out all of the dormant good and riches that now only await the confidence of foreign capital to make them a factor of importance in the wealth of the nations.

While I cannot fail to condemn the action of President Roosevelt and the American government in its treatment of Colombia in the sham war of Panama and the methods of acquiring the Isthmian canal concessions; yet I can see in the realization of an interoceanic canal the future up building of Colombia as a nation of the first importance, through the incoming of foreign capital and the development of its vast resources.

While American dollars may look upon Latin America as their inherited right, there is something more powerful than wealth to be considered in international relations. We must command the hearty respect of our neighbors, which mere money cannot purchase. The sooner that the claims of Colombia are recognized by the United States, the better for us all.

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A new apparatus, simple of construction and easily workable has been thoroughly tested at the testing shaft of the Prussian Mining Department, for the purpose of signaling from cages in motion. The results are said to be very satisfactory. The shaft is 420 meters deep, the usual ascending or descending speed of the cages is 6 m. per second and for the testing purposes the speed was increased to 7 m. per second and the apparatus was found to be absolutely reliable and signals can be given at any time from the moving cages. The bridging over of the plats and intermediate levels by the contact lines does not present any difficulty. The apparatus is also provided with a telephone, which by the application of a very simple device can, in cases of emergency, be used for telephoning from the moving cages.

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The appearance of a raw clay is no criterion whatever as to the color of the burned product. The colors of clay vary widely, from the white of kayolin to the dark red, or black, of the red burning clays. The main coloring constituent of clays is iron oxide, and according to the amount present it gives colors ranging from buff to red.

LEACHING APPLIED TO COPPER ORE* (XXI)

COST OF ELECTROLYTIC EXTRACTION OF COPPER FROM ITS ORE (CONTINUED)

By W. L. AUSTIN.†

An example of the application of ferric chloride as a chlorine conveyor in the lixiviation of copper-ore is found in the Baker-Smith process, described in U. S. patent No. 843,986, dated Feb. 12th. 1907. The characteristic features of this leaching method are: the bringing of fresh chlorine into contact with the ore continuously during lixiviation, and its adaptability to unroasted material. It differs from other processes employing ferric chloride as lixiviant, (wherein a batch of ore is treated with a solution which is constantly diminishing in strength), by the method of continually applying fresh chlorine. Naturally, unless the strength of a lixiviant is maintained, toward the end of the operation the solvent action must be weakened. In the Baker-Smith process a strong solution of ferric chloride is agitated with ore, and as fast as it is reduced to ferrous chloride it is withdrawn from the vat and recharged with chlorine. The advantage of such a mode of procedure is that one is working with a strong lixiviant up to the time that extraction of the metal has been completed. By this method the chlorine is continuously raising ferrous chloride to ferric, and in consequence that powerful reagent is only transferred to those substances which reduce ferric chloride, such as metallic sulphides. The presence of much ferrous chloride prevents the escape of chlorine gas, and it is not wasted by entering into useless combinations.

Metallic sulphides are attacked by ferric chloride, the metal going into solution and sulphur being liberated. If chlorine were applied direct to the ore-pulp, the chlorine would combine with separated sulphur, forming chlorides of sulphur, which would consume the reagent to no purpose. Sulphur chlorides are decomposed by water, yielding hydrochloric acid, sulphurous acid, and sulphur. This is avoided in the Baker-Smith process by combining the chlorine with iron outside the leaching apparatus. Sulphur separated from the ore by decomposition of the copper sulphide, rises to the surface of the pulp, and is removed as formed. Chlorides of sodium, calcium and magnesium are not desired in the lixiviant, as they are said to interfere with the recovery of any zinc the ore may contain The inventors of the process are ambitious, for they aim to recover copper, lead, zinc, manganese, silver, gold, and sulphur from mixed sulphide ore.

A lixiviant of from 1.2 to 1.5 specific gravity, containing two grams metallic iron per litre, is recommended by Baker and Smith, and the pulp is heated by live steam. The ore is ground and put through screens ranging from 16 to 40 meshes to the linear inch. The patent specifications are very full and show that much thought has been bestowed on the subject. The theory involved in the process is sound; but it would seem as though the apparatus advocated, and the mechanical manipulation suggested in the specifacations, might be improved.

Applying the Baker-Smith process to ore containing: copper, 2.76 percent; silica, 46.0%; alumina, 8.2%; iron, 12.4%; calcium oxide, 0.7%; and sulphur, 11.6%, the weight of chlorine necessary to decompose the copper sulphide would be theoretically 61.5 pounds for 100 percent extraction. At $0.025 per pound the cost of the chlorine used as lixiviant would be $1.54, or $0.027 per pound copper. Some chlorine in addition to that used in dissolving copper, would be consumed in forming combinations with other ingredients of the ore, and some would be lost through adhering to the tailings. On the other hand, if the lixivium is electrolyzed in recovering the copper, most of the chlorine combined with that metal would be set free, and could be used over again. The actual consumption of chlorine would then be confined to an excess of ferrous chloride formed, which might have to go to waste, and to loss in the tailings. If the leaching department is charged with chlorine used in bringing copper into solution, then the cost of electrolytic deposition of the metal could not be also included in the total, and vice versa. So that in practice, when leaching with chlorine is conducted in the manner described, the expense for electrolytic deposition would probably work out somewhere between one and two cents per pound copper recovered, and the cost of lixiviant would be practically nil.

PRECIPITATION BY IRON

The next item to be considered in the cost of leaching is deposition of the metals from the lixivium. If iron is used to throw down copper, the expense will be the cost of anywhere from one to three pounds of metallic iron, (according to the skill of the metallurgist), to one pound copper obtained in the form of precipitate. To this must be added the expense of reducing the precipitate to merchantable metal.

Precipitate, (to which the name of cement-copper is often applied), is generally a mixture of metallic copper with basic iron-salts, particles of ore, pieces of iron, graphite, silica, some antimony and arsenic, ferric arsenate, etc. The copper content naturally varies greatly. Precipitate resulting from treatment of mine-waters is generally purer than that produced from liquors derived from artificial leaching. This is partly because natural waters carry free sulphuric acid, and therefore deposit less basic salts which interfere with the subsequent refining, and those which do form are carried away by the current.

Because of impurities asociated with precipitated copper, this substance is usually subjected to a mechanical treatment—washing and screening. If chlorides are left in the mixture, they occasion a loss of copper in the furnaces; but if the precipitate is bricked with lime as a binder, any chlorine present is rendered innocuous. To remove pieces of metallic iron, the raw precipitate is washed through screens with holes about one-eighth inch diameter, the iron-scrap remaining on the screen. Material passing through the screen may be washed on concentrating tables to remove the basic salts. An alternative plan has been to wash in a revolving screen under water, and in some instances the fines have been passed through launders which gradually increased in size so as to give the heavier particles an opportunity to settle out.

At some German works three products were made by mechanical treatment: (1) sand carrying ninety percent and upward in copper; (2) fines with from 50 to 70 percent copper; and (3)

† Mining Engineer and Metallurgist, Riverside, California.

slimes—content 20 to 25 per cent copper. At Duisbourg and Hemixen the precipitate was washed on a grating composed of copper bars. All but the large pieces of copper, and iron fragments, passed through, collecting in a vat below. This vat had the form of a series of steps; the best copper collected on the upper steps—impurer metal on those lying lower. The fines were then carried to a series of planes, where further quantities of copper were separated: the fines contained most of the arsenic. The cement-copper (70 to 80 percent metallic copper) was placed on a draining-floor, and afterwards was dried on heated plates. Sometimes cement-copper has been bricked to prevent oxidation, for it oxidizes very rapidly when exposed to the air; if it is desired to preserve it as such, it should be kept under water.

According to C. H. Jones, (Transactions of the American Institute of Mining Engineers, Vol. XXXV, pages 9 to 10), at Rio Tinto the crude precipitate is thrown upon a perforated copper plate, and is then washed through the plate and down a long launder. Leaf-copper and pieces of iron remain on the plate, and the precipitate passing through is concentrated by repeatedly turning over against the current. A red mass, containing 94 percent copper and less than 0.3 percent arsenic, collects in the first few yards of the launder. Further along the material carries 92 percent copper and between 0.3 and 0.75 percent arsenic: below this settles a very fine material carrying on the average 50 percent copper and 5 percent arsenic, all the graphite from the pig-iron used in precipitation, and the greater part of the antimony and bismuth. The first two classes are dried and bagged: the third is moistened with acid liquors, made into balls and dried in the sun. It is smelted to matte, and the matte is blown to crude-copper, in which operation arsenic, antimony, and bismuth are said to be removed.

SMELTING THE PRECIPITATE

A similar method of treatment has been used elsewhere, for it was discovered at several works that smelting impure precipitate to matte was preferable to making black-copper. Simply smelting and refining was found to yield an unsatisfactory product, because of the presence of basic sulphates, arsenic and antimony. In smelting the purer grades of precipitate to black-copper, reverberatories have been used in preference to shaft-furnaces, although they produce much flue-dust. Cement-copper has also been roasted and dissolved in sulphuric acid for the purpose of making copper-vitrol: it has also been worked up into paint. At Butte, Montana, precipitate is dried to about eight per cent moisture, barreled and shipped to Great Falls, where it is smelted in reverberatories. At Anaconda, and at Clifton, Arizona, it was the custom to throw it wet into blast-furnaces with the ore-charge, reducing it to matte; but recently the Anaconda company has completed a drying plant for treating the precipitate made at its Meaderville precipitating works.

When precipitate is smelted in a reverberatory furnace some of the copper is oxidized. To reduce oxidized metal the fused mass is "poled," and the proper amount of poling is when just sufficient cuprous oxide is left to oxidize the impurities present in the molten product. Upon cooling, cuprous oxide gives up its oxygen to other metals and metalloids present. Underpoled, or overpoled copper is brittle and of inferior conductivity.

It is difficult to give an approximate figure for the cost of producing merchantable copper from lixivium by precipitation with metallic iron, and subsequent treatment of the cement-copper in the manner outlined in the preceding paragraphs. Much will depend upon the quantity of material treated, as well as upon the skill of the metallurgist. It is, however, safe to assume that copper treated by the methods described will cost more, and probably will be less pure, than when the lixivium is electrolyzed, provided power is available at a reasonable price. Therefore, the cost of electrolytic treatment of liquors will be alone considered in making an estimate of the expense of reducing ore by lixiviation processes.

The cost of electrolyzing a cupriferous lixivium, using insoluble anodes, will depend primarily upon the price of power, and secondly upon strength and character of solution. Passing an electric current through a solution of copper salts, with view to extraction of the metal, means an expenditure of power, and when that power is consumed in doing work other than deposition of the desired metal, the expense incurred must be correspondingly higher. Apart from loss of energy due to short-circuiting, leakage, diaphragms, chemical reactions, counter-EMF, etc., it is important to consider the resistance of the electrolyte itself. It must be borne in mind that the passage of electricity through an aqueous solution of any salt is always accompanied by movement of matter—in other words, power is expended in transporting ions of dissociated salts, and when there are present ionized bodies other than the metallic salts which are the object of the operation, energy can be wasted in doing unnecessary work. Some power is consumed in that it is transformed into heat through friction of the ions during transit from one portion of the electrolyte to another. The rise in the temperature of an electrolyte when the current is turned on is very marked, and the higher it gets, the more energy is being dissipated. It follows, that relatively the more copper-ions present (up to a certain maximum), and the less distance they have to be moved, the more copper will be deposited with a given expenditure of power from an electrolyte containing mixed salts. The influence of concentration of solution upon power expended is illustrated in the following table which gives the resistance offered by different strengths of a cupriferous solution to the passage of an electric current:

Table showing Ohmic Resistivities of Solutions containing varying Percentages of $CuSO_4$.

Percentage of $CuSO_4$ in solution.		Resistivity. Ohms per cu. cm.
0.01596		5438.32
0.0399		2469.74
0.0798	0.01 normal	1393.9
0.1596		801.28
0.399		390.93
0.798	0.1 normal	228.05
1.596		132.76
2.394		93.89
3.99		64.9
5.00		52.91
7.98	normal solution	38.8
10.00		31.25
15.96		24.87
23.94		20.83

As the EMF necessary to drive a current of a given strength through an electrolyte is in direct ratio to the ohmic resistance of the bath, it is clear that more energy is required to electrolyze a weak solution of copper sulphate than in the case of a strong one. For instance, a solution carrying 0.0399 per cent $CuSO_4$ (or 0.0158 per cent copper) would be comparable to ordinary cement-water issuing from a mine. To pass a current of thirty amperes per square meter (= 0.003 amps. per sq. cm.) through such a solution, the electrodes being five centimeters (about two inches) apart, would require $2469.74 \times 5 \times 0.003 = 37.046$ volts. But to electrolyze under same conditions a solution containing 7.98 per cent $CuSO_4$ (or 3.17 per cent copper) would require $38.8 \times 5 \times 0.003 = 0.582$ volt. The energy expended (kilowatt-hours) in overcoming ohmic resistance alone would be in the relation of 63.7 to 1, and in both cases the theoretical amount of copper deposited would be the same. It is therefore evident why electrolytic treatment of mine-waters has been unsuccessful, and it is also shown that it is more economical not to attempt to extract all the copper from a lixivium, but rather to utilize the cupriferous liquors as lixiviant after the point of economical extraction has been reached.

CONDUCTIVITY INCREASED BY SULPHURIC ACID.

In electrolyzing a copper sulphate solution, while copper is removed, thereby weakening strength of bath in $CuSO_4$, free sulphuric acid is added to the solution in corresponding ratio, and deterioration in conductivity is therefore not as great as indicated by decrease in percentage of $CuSO_4$ contained in the liquor. However, the sulphuric acid formed is also subjected to electrolysis, which means an expenditure of energy. Hydrogen escapes at the cathode, and the oxygen liberated at the anode attacks the carbon composing that electrode. As an illustration of the quantity of energy consumed in electrolyzing a pure copper sulphate solution, even when considerable free sulphuric acid is present, reference is made to Table II (Mines & Methods, Vol. II, page 283). It is there seen that in electrolyzing a solution containing 3.26 per cent copper and 3.85 per cent free sulphuric acid, three volts were required to drive a current of about 6.1 amperes per square meter (=0.00061 amps. per sq. cm.) through the bath, even when sulphur dioxide was employed as a depolarizer. In this case the distance between electrodes was greater than five centimeters (about 10.4 cm.). The two cases, (the one mentioned in the foregoing paragraph and that just stated), are not comparable, because in the first instance only energy applied to overcoming ohmic resistance was considered, while in the last example cited the total EMF expended was given.

From the foregoing it is evident that deposition of copper through electrolysis of a copper sulphate solution will depend upon cost of power, composition and strength of bath, distance between electrodes, and other factors, and the best way to determine this cost is to experimentally electrolyze some of the solution in question. In the Reinartz investigation, which has been repeatedly referred to in these papers, it was determined experimentally that a copper sulphate solution containing 2.54 per cent copper could be electrolyzed at 1.9 volt. The details are given in Mines and Methods, Vol. II, page 284, Table IV. The cost of depositing copper in this instance was $0.0086 per pound, assuming power to cost $0.01 per kilowatt-hour ($65.37 per horsepower per year). This figure can be taken as a fair approximation of the expense entailed in depositing copper from a solution of the character and strength given, under working conditions that can be easily realized. At the same time, and in the same operation, Reinartz produced a liquor strong in sulphuric acid, which, if used in leaching ore, would rapidly accumulate ferrous sulphate.

To accomplish this economical deposition of copper, depolarization by means of gases from the roasting furnace is necessary. It has already been shown that 65 per cent of the oxygen liberated at the anode would combine with sulphur dioxide of said gases to form sulphuric acid and sulphates.

Collecting the costs designated in the foregoing as representing the expense incurred in the various stages of reducing an ore to metal, and assuming the ore treated to have an average content: copper, 2.76; iron, 12.4; and sulphur 11.6 per cent, the following total cost is derived:

	Per ton ore.	Per pound copper. (90 per cent extraction.)
Mining	$2.75	$0.0553
Milling	0.85	0.0171
Roasting	0.50	0.0100
Deposition of copper and preparation of lixiviant	0.4272	0.0086
Freight to seaboard, refining, marketing, etc.	0.7651	0.0154
Repairs and renewals	0.0676	0.0014
Total	$5.3599	$0.1078

No mention is made in this summary of interest and amortization, for the reason that it is the practice of mining companies to ignore these items when giving figures indicating cost of metal produced. Neither is credit taken for precious metals which might be recovered, as it is customary to do in giving cost of copper. The recovery is placed at 90 per cent of the copper in the ore as a conservative figure. If the extraction were 70 per cent—and this would be good practice with the methods now in use—the cost of mining per pound copper would be $0.0711 instead of $0.0553. With mining at $0.50 per ton, and extraction 90 per cent, the copper would cost $0.0625 per pound.

LEACHING PORPHYRITIC ORE.

With regard to leaching porphyritic ore similar to that upon which the above calculation is based, some data furnished by Rudolf Gahl (U. S. patent 1,021,768, dated April 2nd, 1912), are pertinent. Gahl found that in leaching unroasted mill-tailings with a cold, dilute solution carrying sulphuric acid and ferric sulphate, a high extraction of copper could be effected at low cost in a short time, when grinding is carried far enough. As an example of the constituents of the lixiviant with which these results might be obtained on a slime carrying one per cent copper, Gahl mentions a solution containing less than one per cent ferric iron, and somewhat in excess of one per cent free sulphuric acid. The content of the solution in ferric sulphate is of minor importance: a weak solution works nearly as efficiently as a strong one, but the solutions must be freshly prepared (compare Mines & Methods, Vol. II, page 6).

Betts (U. S. patent No. 969,833, dated September 13th, 1910) supplies some interesting data with reference to the manufacture of ferric sulphate for leaching purposes. Betts states that if a solution of ferrous sulphate and sulphuric acid be electrolyzed at a temperature of 50° to 100° C., using a carbon anode, electrolysis proceeds without appreciable polarization at the anode, and without evolution of gases, and a large percentage of the ferrous salt is converted into ferric with high current efficiency. Betts mentions an instance where a liquor containing 2.8 grams iron in the form of ferric sulphate, 1.6 grams as ferrous sulphate, 1.75 grams copper as copper sulphate, and about four grams free sulphuric acid, in 100 cu. cm. solution, was electrolyzed at a temperature of 86° C. with a graphite anode. The current density at the anode was eleven amperes per sq. foot. Only a slight polarization was in evidence beyond that necessary for forming ferric sulphate. The same solution at a lower temperature, or at increased current density and 84° C., showed extra polarization.

In leaching with sulphuric acid, as ferric sulphate is a strong oxidizing agent—readily parting with some of its oxygen and being reduced to the ferrous salt—it might in some cases be expedient to oxidize the liquor coming from the precipitating vats in the manner indicated by Betts. In depositing copper from a sulphate solution, utilizing sulphur dioxide as depolarizer, naturally most of the iron present would be reduced to the ferrous salt, which if raised to the ferric would assist in oxidizing any copper sulphide remaining in an ore.

In the Bulletin of the Colorado School of Mines, January, 1908, there were published the results of some lixiviation experiments carried out at that institution by Messrs. Hollis, Lannon, Quayle and Grommon. The material treated was Anaconda slimes, a partial analysis of which gave the following composition:

SiO_2	82.6 %
Al_2O_3	2.7 %
Fe	3.3 %
S	4.8 %
Cu	2.23%
Pb	0.28%
Ag	2.07 oz.
Au	0.03 oz.

A sizing test showed that 96.6 per cent passed a 200-mesh screen.

Preliminary tests made upon the raw slimes indicated that no extraction of copper could be made by treatment with water alone, nor did the result differ when dilute sulphuric acid was used. When, however, sodium chloride was added to dilute sulphuric acid, an extraction was obtained amounting to 24.7 to 27.8 per cent of the copper present. This result indicated that dilute hydrochloric acid was a more efficient solvent for the particular copper minerals in those slimes than was dilute sulphuric acid. In this connection it is well to remember that when an ore carries sulphides, the addition of free acid can produce sulphuretted hydrogen, and the liberation of a sufficient quantity of this reagent will precipitate copper as fast as the metal is dissolved. In this manner an impression can be acquired that a certain solvent does not attack the mineralized copper in an ore.

The leachings from which the data given below were obtained were carried out with roasted slimes. A series of preliminary tests showed that the best results were forthcoming when the slimes had been roasted in a muffle-furnace for forty-five minutes at a temperature between the limits 400°-470° C.—about the melting point of zinc, which fuses at 420°C.

Tests made to determine the proper proportion of free sulphuric acid to employ as lixiviant, showed that there were only very slight increases in copper extraction when the percentages of sulphuric acid varied between 0.25% to 5%. When five per cent of acid was used, iron commenced to go rapidly into solution while the percentage of copper dissolved increased very slowly. For this reason the lixiviant used in the following tests was made up to carry 0.25 cu. cm. sulphuric acid in 100 cu. cm. solution. It was further found, that the best ratio of lixiviant to roasted slime was seven parts by weight of solution to one part dry slimes, and that from three to six hours was ample time in which to complete the leaching. Addition of sodium chloride to the lixiviant gave no beneficial results with roasted ore.

EFFECT OF AGITATION.

Agitation during leaching, through the introduction of compressed air, resulted in an extraction of about 94.2 per cent of the copper, as against about 72.6 per cent by percolation. The exact percentage is not clear from the wording of the original, which does not give an analysis of the roasted pulp; the above percentages are calculated from copper-content of the raw slimes. Mechanical stirring without air did not give the same increase in percentage of extraction. Froelich (Metallurgie, April, 1908, pages 208-209), records a similar experience.

Froelich found that chemical action was greatly augmented through exposure of the pulp to the oxidizing action of the air during agitation as against simple mechanical stirring. Froelich (Mines & Methods, Vol. II, page 69), employed for the purpose an agitator comprising an endless screw working in a central well. By this means fresh surfaces of the pulp were rapidly exposed to air. Under such conditions any ferrous sulphate present in a liquor will be to more or less extent oxidized to ferric sulphate, thereby furnishing the lixiviant with a powerful oxidizer in addition to the solvent reagent, and this is, of course, beneficial.

In the Colorado tests the influence of ferric sulphate was indicated by the further fact, that after electrolytically depositing the copper from the lixivium the regenerted lixiviant worked better on the ore than did the original solution—it contained more ferric sulphate. If iron accumulates in the liquors in undesirable quantities, it may be removed by passing them over brush-piles (Mines & Methods, Vol. II, page 69.)

When the filtered lixivium was electrolyzed, it was found that if a high current-density was used the copper deposited was black and did not adhere firmly to the cathode. This was due to impurities present—iron sulphates, arsenic and antimony. It will be recalled that ferrous sulphate is electrolyzed at theoretical drop of potential of 2.02 volts: ferric sulphate at 1.62 volt, and copper sulphate at 1.21 volt. It was found that when the bath was not agitated the potential drop was not constant, and varied with amount of copper in solution. After electrolysis had proceeded for some time, unless the current-density was slightly decreased, the cathodes showed a dark deposit. When the current density was dropped to a certain point, good deposition was maintained until all the copper had been removed from the solution.

At the copper-lixiviation plant erected near Arlington, N. J., in 1901, decrease in current-density was effected by increasing the number of electrodes progressively down the series of vats. Although th amperes of current sent to each vat was the same, the increase in electrode surface compensated for decrease in copper content of the electrolyte as it flowed through the succeeding vats Thus the density of current may be 15 to 20 amperes per sq. foot of cathode surface with a six per cent copper solution, and three amperes with a 0.5 per cent, provided proper circulation and sufficiently rapid movement of the electrolyte be kept up. At the Arlington plant it was expected that the expense for mining and metallurgical treatment of a two per cent copper ore would not exceed $2.50 per ton—at 90 per cent extraction this would amount to $0.0694 per lb. copper.

In the Colorado tests it was found that agitation of the electrolyte, either by compressed air or by stirring, permitted raising the current-density at least 100 per cent, depending upon amount of agitation and temperature of solution. The best results were obtained with a current density of one ampere per sq. foot at starting, with gradual decrease to 0.32 ampere per sq. foot at close. The lead plates employed as anodes produced a greater counter-EMF than carbon.

These tests were considered to afford a basis for the following estimate of cost of treating Anaconda slimes with an experimental plant of twenty tons capacity in 24 hours:

Interest, depreciation and insurance—20% on cost of plant..	$ 5,000.00
Roasting 20 tons per diem—300 operating days—6,000 tons@ $0.50	3,000.00
Five men—300 days@$4.00.....	6,000.00
Fifty electrical horsepower-years @$50.00	2,500.00
Acid—35 lb. per ton ore, 220,000 lb.@$0.01	2,200.00
Total operating cost per year.	$18,700.00

With an extraction of 34 lb. copper per ton raw slimes (76.23 per cent) the yearly output would be 204,000 lb. copper, at a cost of $0.092 per lb. copper.

In the above estimate the assumed percentage of extraction is very low, and could be much improved in practice. Furthermore, the cost of acid could be eliminated, and the power consumption reduced, by utilizing roast-furnace gas as a depolarizer.

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MORE ON CHINO IN PARIS

"L'Argent" of July 19th takes another clip at Chino and pays a compliment to Mines and Methods, as follows:

"Chino Copper—In April last we issued a statement of valuation on this society (company) which has been confirmed for the most part by our co-workers. But the last mail from America has just proved to us that the ideas did not know any bounds. The luxurious and very important review, Mines and Methods, reproduces in full what we wrote on this subject. The technical men who manage the publication in question have acquired a very special standing in the mining domain; they have reckoned, from having seen them, the value of the porphyric beds.

"The introducers (promoters) of Chino have tried to lay on the French public a fantastic commission in selling for $34 (170 francs) the shares ($5 par, or 25 francs) of an enterprise which has not yet given one cent of dividend. The stock is so suspected that one of our weekly co-workers (contemporaries) has demanded of the introducers nearly $1200 (6000 francs) to lend, for a single issue to the society (company) half a page of advertisement. Our very sincere congratulations to the courageous organ on the occasion of the destruction of this molar; it is as much as enters into the national patrimony."

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Marcasite has the same composition as pyrite, but is distinguished by its crystallization and lighter color.

LOON CREEK DISTRICT; ITS GEOLOGY AND MINES

By J. B. UMPLEBY.*

The Loon Creek district is notworthy at present because of its gold deposits. These include lodes in which chalcoyprite and siderite carry most of the gold and placers along the streams in favorable places below them. From the lodes $350,000 has been derived, and from the placers possibly $1,000,000. The lode deposits have yielded $150,000 in copper along with the gold. Lodes of lead-silver have also been recognized in the district, but are inadequately developed. The ore found in them, however, is of excellent grade, being in many places clean galena carrying from 60 to 100 ozs. of silver to the ton.

Excellent iron and lime fluxes are abundant along the contact between the Paleozoic limestones and the quartz diorite south of Ivers. These contain about about 60 cents in gold and 1 oz. in silver to the ton—almost sufficient to pay for handling them. Whether or not they are contact-metamorphic deposits has not been established.

GOLD-PLACER DEPOSITS.

The Loon Creek Hydraulic Placer Co. owns six claims—in all, 470 acres—which extend from a point near the mouth of Canyon creek to the Loon Creek Narrows, 4½ miles north. The average width is approximately 1,000 ft. A strip about 75 ft. wide and 1 mile long, comprising the upper part of the central channel, was worked during the early '70s and is said to have produced a large amount of gold, occasional pans containing as much as $300. The gravels here were from 2 to 6 ft. thick, but back of them are gravel terraces which were not explored during the early days. The present owners prospected these terraces during two seasons, making an average saving of 25 cents a cubic yard. A flume capable of delivering 80-sec.-ft. of water to any point on the ground is partially completed and is part of a matured plan for hydraulicing the entire deposit. Heretofore water has been derived from two small streams—Grouse creek and White creek—but the present plans include a diversion of Loon creek at a point well above the placers.

The auriferous gravels rest upon a floor of schist which as now explored presents a comparatively even surface. The gravel beds are rarely more than 15 or 20 ft. thick, although locally attaining a depth of 30 or 40 ft. The individual pebbles are usually less than 6 ins. in diameter, but locally boulders up to 3 ft. and rarely 6 ft. in diameter are found at various distances from the base of the deposit. Being loosely cemented, the gravels fall apart readily when undermined by the giant. The gold is near bedrock, commonly in joints and shallow depressions in it, and as a rule is coarse, nuggets weighing more than an ounce being not uncommon, and perhaps 50 per cent of the product averaging 25 cents a color or more. Its market value is $18 an ounce.

GOLD-COPPER DEPOSITS.

A description of the Lost Packer vein constitutes essentially a description of the known gold-copper deposits of the district. Other veins are recognized, but they are little developed and have produced only returns from test samples. Promising among these is the Effa ledge, which outcrops a few hundred feet west of the Lost Packer vein. The Sunset and South Packer groups also present some encouragement to the holders, although the small amount of development on them has not revealed commercial deposits.

The Lost Packer vein is a fissure filling inclosed in mica schist throughout most of its extent, though in places it traverses granite dikes. Later than the vein are a number of flat-lying dikes of granite porphyry and diorite porphyry, which vary in width from 5 to 80 ft., those about 30 ft. across being most common. Ten of these dikes have been encountered and each one traverses the vein. The ore adjacent to them is usually crushed, and in places is separated from the intrusion by a gougelike layer as much as 3 ins. thick. The most important effect of the dikes on the ore body, however, consists of offsets. In places, there is a small lateral displacement of the vein as if the dike had entered a plane fault, but usually the intrusion has acted simply as a wedge, prying apart portions of the vein formerly contiguous and leaving them opposite each other along a course at right angles to its surface. As the dikes roughly parallel the ore body in strike but dip westward at a much lower angle than it, there is a series of offsets to the east with increasing depth on the vein.

The Lost Packer group of six claims and two fractions covers the known extent of the Lost Packer vein, which begins at Ivers and extends northward, successive portals being near the bed of the steep gulch which it approximately follows. The vein strikes north and south and dips 75 degrees west. The development consists of 10 tunnels aggregating about 10,000 feet in length, which explore the deposit to a level 1,000 feet below its highest outcrop.

The vein varies in width from a fraction of an inch to 4 or 5 ft., averaging perhaps 20 ins. In most places it lies between well-defined walls which stand about 5 ft. apart, the intervening material being gouge, sheeted schist, or ore. In many places all three appear in the same cross section, but even there the ore is usually a separate band, next to either the hanging wall or the footwall, more commonly the latter. In a few places small lenses of ore occur in the schist as far as 20 ft. from the vein, but this is exceptional; usually the mineralization is confined to the fissure.

Three ore shoots, locally designated the north, south, and middle shoots, are recognized in the vein. These are connected on some levels by stringers, but as they are not of the same degree of importance and as they present somewhat different types of mineralization, they will be discussed separately. The north shoot is reached only by No. 4 and No. 3 tunnels. On the former it is 120 ft. and on the latter 250 ft. in length. Its average width is about 2 ft. The ore consists of coarse-textured milky to bluish-white quartz, with chalcoyprite and a little pyrrhotite and pyrite irregularly scattered through it, the chalcopyrite in places inclosing small crystals of the other minerals. On No. 3 level siderite is rare, but on the next level below it is equally abundant with chalcopyrite and presents a similarly irregular distribution. This ore body is comparatively lean, roughly sorted material running about $20 a ton—half an ounce of gold, 2 ozs. of silver and 3.5 per cent copper.

The middle shoot is by far the most important in the mine. It lies 200 ft. south of the north shoot and is developed from the seventh level to the quartz latite capping, 700 ft. above. Like the two others, it has a general pitch to the south. The southern limit of ore is a fairly regular line, but the north boundary is not parallel to it. Thus the shoot is about 500 ft. long on No. 2 level, but narrows both above and below, so that its average length is about 300 ft.

In places this ore body stands in slight relief at the surface as a honeycombed quartz heavily stained by iron, together with a little manganese oxide and copper carbonate. Usually, however, it has little or no surface expression. Oxidation is unimportant in the deposit, primary ore predominating at a depth of

* From "Contributions to Economic Geology," Bulletin 530; U. S. Geol. Sur., 1912.

30 or 40 ft. and being exclusively present below 70 or 80 ft. The ore averages about 20 ins. in width, but locally is as much as 4 or 5 ft., wedging out on the ends of the shoot. This wedging out of the shoot seems to bear a definite relation to the tenor of the ore, for it has been commonly found that as the ore body narrows its assay value diminishes. Thus the ends of stopes temporarily abandoned are usually in ore running about $25 a ton, whereas the portion removed varies between $60 and $80 a ton. On No. 4 level the middle shoot is shorter than anywhere else in the mine and here also it contains a minimum amount of gold. Ore from levels both above and below ran 2 to 3 ozs in gold to the ton, but here less than 1 oz. was present.

The ore consists essentially of chalcopyrite distributed as bunches, small patches, irregular grains, and interstital fillings in a gangue of coarse white quartz. The copper mineral constitutes about one-third of the total material mined. Siderite is present in small amounts, but is not an important constituent. The chalcopyrite and quartz carry each about 3 ozs. in gold to the ton, but less than half an ounce is present in the siderite.

The south shoot of ore differs markedly from the other two in the high percentage of siderite which it contains. It lies 500 ft. south of the middle shoot and is developed from No. 10 level to its outcrop near the portal of No. 6 tunnel. This ore body varies in length from 75 to 100 ft. and is about 20 ins. wide. It consists of siderite and chalcopyrite in a gangue of coarsely crystallized quartz, in such proportions that the ore runs 26 per cent of iron and 4.5 per cent of copper. Gold and silver, averaging half an ounce and 3 ozs., respectively, are present. This shoot of ore is a valuable asset to the mine because it combines a fair amount of the precious metals and copper with an excess of iron, an element which must be added in the smelting of ore from the other shoots.

The three ore shoots worked in the Lost Packer mine have been described as separate units and as such they are mined, but in reality they are not distinct. All occur on the same fissure and on most levels stringers of low-grade ore connect them.

Considerable ore is blocked out in the mine and this will probably be materially increased during the present year. Returns from the last smelter run will be used to extend No. 7 tunnel beneath the north shoot and No. 10 tunnel beneath the middle shoot.

SILVER-LEAD DEPOSITS.

Silver-lead deposits have been found near the limestone area south of Ivers. The Lost Eagle claim and the Metcalf group are the principal properties, but neither is sufficiently developed to afford a satisfactory idea of the nature or extent of the ore bodies. Their difference, however, is thought to be of special significance and in order to emphasize this they will be described briefly. The Lost Eagle is situated on the divide between Canyon and Deer Creek cirques, at an elevation of 8,800 ft. above the sea. It is inclosed in Algonkian schist, though removed but a few hundred feet from an area of Paleozoic dolomitic limestone. The development consists of a shaft 50 ft. deep and a short drift from it. The vein, which strikes north 5 degrees west and dips 85 degrees southwest, is about 6 ft. wide and is bordered by well-defined walls. Between them is crushed wall rock inclosing bands and interstitial areas of argentiferous galena, pyrite and a little chalcopyrite in a quartz-siderite gangue.

The Metcalf property, situated about 1,000 ft. northeast of the Lost Eagle shaft, contains an irregular vein partly developed for about 100 ft. along its outcrop. The deposit is a fissure filling inclosed in granite near its contact with Paleozoic dolomitic limestone. The ore consists of argentiferous galena, which fills the fissure almost exclusively and varies from a narrow stringer in most places to a body 3½ ft. wide locally. The galena contains about 1 oz. of silver to the unit of lead.

In both of these deposits the amount of ore actually found is not of so much significance as its mode of occurrence. Both deposits are inclosed in rocks which are not nearly as favorable to the deposition of lead ore as limestone, even where that is impure; hence, in the opinion of the writer, the area of dolomitic limestone adjacent to them should be encouraging territory for the prospector. In the few places where time permitted an examination of the dolomitic limestone it was found to be rather intensely mineralized. The three iron mines which supply flux to the Ivers smelter illustrate this point. Each is a deposit of pyrite, now oxidized, which has replaced the dolomitic limestone.

SUMMARY OF CONCLUSIONS.

The more important points brought out in this preliminary report may be summarized as follows:

1. The Loon Creek district is a poorly prospected area of more than ordinary promise.
2. It is held back primarily by inadequate transportation, the nearest railroad point being 110 miles distant.
3. There are noteworthy gold placers in the area.
4. The principal gold-copper deposit has been explored to a depth of 1,000 ft, and throughout this extent the ore has ranged in value from $25 to $90 a ton, giving no evidence of impoverishment with increasing depth.
5. The area of dolomitic limestone near the head of Deer creek is thought to be a promising field in which to prospect for lead-silver deposits.

GEOLOGY'S RELATION TO ORE DEPOSITS

By WALTER HARVEY WEED.*

The Bisbee district of Arizona is second only to Butte, Mont., as a copper producer. Discovered in 1876, when lead ores were found, the ore body of the Copper Queen was discovered the year following, and has been mined ever since. The yearly production of Arizona is about 300,000,000 lbs. of copper. Of this Bisbee produces about half.

To the average desert prospector, the district shows very plain evidences of intense mineralization. The surrounding region has gray limestones, or cretaceous rocks, without any of those earmarks which experience has shown the world over to accompany great ore deposits. At Bisbee, however, there are craggy and castellated masses of dark red and brown ironstone gossan. Siliceous "blow-outs" occur in the limestones; reefs of rusty silica traverse the slopes; there is a characteristic coloration, silicification and presence of clayey, residual products, and a fine network of silica films along the crackled limestone, indicative of intense alteration.

It is evident that there was and is, no large amount of copper ore outcropping over the great ore bodies of the camp, but there are other evidences, and enough copper staining to arouse the interest of any keen-eyed and experienced prospector.

The district embraces the southern end of the Mule mountains, which like other desert ranges in Arizona, rises above the surrounding flat and gently rising plain, as abruptly as an island above the sea.

*In Mining World.

The mountains are composed of many kinds of rocks, which disintegrate under the torrid Arizona sun, and are split up and washed down by the torrential downpours of the rainy season, to form extensive talus piles and alluvial fans, stretching out from the steep mountain slopes, and binding height and plain with a skirt of greasewood-covered slope. Profound fault walls exist as bald cliffs, and other faults are marked by gulches swept clean by cloud bursts. It is a region where nature has laid bare the anatomy of the earth crust.

The immediate district is an area of Paleozoic limestone, resting on quartzite, that in turn lies over a great mass of schistose rocks. These limestones have been warped, folded and faulted in great blocks, and altered by intrusive masses of igneous rocks, notably the porphyry of Sacramento hill. This porphyry has come up along fault fissures, and spread out very irregularly as dikes and sheets, in part following the bedding of the limestone. In the ore-bearing areas this porphyry is much more important underground than it is at the surface. It has not only produced intense alteration of the limestones near it, changing them to marbles and a mass of lime-iron silicates, peppered with pyrite, but it has been the ore-bringer. The most recent developments of the district show a marked dependence of the workable ore upon the presence, or close proximity of porphyry, when near fault fissures.

All the known ore bodies occur within a block bounded by Mule creek on the north and by the open valley on the south, and extending from Quarry hill to a line through the Warren townsite on the east. These boundaries correspond closely to the chief faults of the district. Cretaceous rocks to the north and east cover the older beds and the porphyry, but are of little economic importance.

A close study of the ore occurrence of the camp shows that ore bodies occur in all the Palaeozoic limestones. It is apparently immaterial, at any rate from a mining standpoint, whether a claim is covered by Cambrian, Devonian or Carboniferous limestone.

A map of the known ore bodies of the camp, with cross sections, shows that the ore bodies occur is a gently inclined zone about 400 ft. thick, coming near the surface at the Copper Queen open cut (Czar), opposite the Copper Queen hotel and dipping about 15° southeast, so that the horizon becomes progressively lower and lower, southeast of Bisbee, and in places lies beneath the Cretaceous beds. The plane of this ore horizon corresponds closely to that of the tilted Cretaceous measures. No ore has been found north of the Dividend fault, and the ore-bearing zone extends about 3500 ft. west of it. Outside of the ore-zone thus delimited, only small and relatively unimportant ore bodies have been found.

Detailed studies of the workings of all the mines made by the several companies have shown that there is a significant association of ore bodies with certain breaks or fault fissures, and with masses of porphyry. These dislocations, of great lateral extent and proportionate vertical throw, have dissected the Bisbee Quadrangle into irregular blocks. Nearly all the producing mines are enclosed within an area bounded by the Dividend fault on the west and the Escabrosa line of fractures on the south. The main porphyry masses follow lines of faulting, but the intruded magma penetrated the sedimentary beds, bringing about conditions favorable to ore deposition. Again the cooling of this intruded mass induced a secondary series of fractures, contraction breaks, which have assisted in the general mineralization near intrusive contacts. The bedding of the limestones also has a marked relation to the ore bodies, but this relationship is more or less obscured by the cross fracturing and metamorphism of the country rock in the vicinity of an ore body. However, there is a decided parallelism of the tabular shaped deposits to the bedding planes of the limestone.

In a nutshell, close attention should be given to intrusive contacts and structural detail in the search for ore bodies in the district.

In the Bisbee district there is but little actual ore or quantitative evidence of the great mineral wealth existing below. The ferruginous ledges which occur in the limestone are here, as elsewhere in other parts of the world, certain indicators of mineralization. It is seldom that these limonitic croppings are orebearing though they always show some copper stains; but where found they are frequently associated with an ore body below. The limestones have been pyritized as a result of the invasion of the porphpry, and the reddish outcrops are the oxidation products of the pyrite. The soluble copper salts have been carried down by the percolating waters and deposited below, while the less soluble silica has been left on the surface.

The oxide ores are the resultant products of altered sulphides.

The two main lines of mineralized faulting in the district run 10 to 20° east, and an east-west series, called the Czar and Dividend faults respectively.

The irregularity of the ore bodies makes any estimate of ore reserves difficult. It is said that the former manager of the Copper Queen, when turning the mine over to Walter Douglas, said: "At last we are through with the southwest stope; about two weeks more will finish it up."

That was over 10 years ago, and the stope has been worked continuously ever since, yielding many million pounds of copper. This irregularity, making the estimation of ore reserves uncertain, is due to the projecting "fingers," which may extend out irregularly from the main body of ore like tentacles on a devil fish, or again to the amount of clayey "casing," the altered material surrounding the oxide ores, and due to reaction between the decomposing sulphides and the enclosing rock. The great crystal studded caves, for which the district was noted in the early days of its workings, are now worked out, the stopes extending deeper to the sulphide zone in all the older mines, though a new cave was opened up two years ago with mossy malachite walls, and a chamber 75 ft. or more across. No other district in America has furnished the amount or variety of malachite given by the Copper Queen, nor handsomer crystals of azurite, cuprite and chalcotrichite.

The newer mines of the Calumet, Arizona and other companies have not yielded the wealth of mineral specimens, but their ores have been equally rich as sent to the smelter. The ore bodies opened up in the Shattuck mine, in 1910, yielded 21,050 tons that averaged 17.24% copper.

The sulphide ores which underlie these great bodies of rich oxides, are much lower grade, and often contain much pyrite. Chalcocite is common in the immediate zone, both massive and disseminated, in the soft, sooty form, but so far as observed by the writer, is not primary.

The primary mineral is chalcopyrite, often forming great masses of solid mineral, as in the Junction mine, but more often occurring mixed with pyrite, so that the ore as shipped to the smelter carries 2 to 3% copper. The camp has yielded little concentrating ore, the mine product going direct to the smelter. The limestones above and near the foci of mineralization, show a netting with silica films that are sometimes iron stained, but more often merely pale, brownish or weathered surfaces. This netting is apparently due to silica deposition along fractures in a crackled rock, and closely resembles the similar netting of siliceous and ferruginous films, characteristic of the rocks above the ore body of the Miami mine, and the ore bodies of Ray, Ariz. Large fractures, which are sometimes faults, but more usually breaks in the rock without measurable displacement, are marked by lines of pale brownish silica, a coarser netting, with yards, instead of inches, between the fractures. On the borders of the developed ore bodies such quartz reefs, or barren veins, may be traced for a half mile or more, across the bare limestone slopes. The Shattuck fault is marked by siliceous masses, "blow outs," along its course, and the recently discovered ore body of this mine is beneath a chimney-like mass of this material, lying a hundred yards up the gulch from the main shaft of the mine.

As already noted igneous contacts have proven sure ground for prospecting, and the observant mine foremen have learned to follow dike contacts, until ore bodies are found. As far as I can learn this was first recognized as a guide to the discovery of ore bodies by Mr. Walker in the Shattuck mine, but both here and elsewhere it has proven to be a most useful trail to follow in running prospect drifts underground. In the instances observed by the writer, the contact is marked by some alteration, but the amount is often so small as to appear insignificant, and the absence of even a trace of ore is disheartening in many cases, though one may be quite close to an ore body.

The evidences of mineralization seen on the surface of the porphyry area near the Copper Queen mine, are to the writer's mind very strong and convincing, although apparently overlooked by most visitors, or if noted, disregarded, because the Copper King shaft failed to encounter rich sulphide ore. The writer's efforts to obtain control of this acreage some years ago were unsuccessful, and its exploration was urged at that time with great earnestness. It is now common talk at Bisbee that the development of this porphyry mass has revealed large bodies of rich ore, which will become an important factor in the production of the camp.

At the present writing the Junction is perhaps the most important single mine of the camp. As was fully expected and predicted years ago, large bodies of primary sulphide ore—chalcopyrite and pyrite—have been found in depth, and as the ore channels are traced towards the open valley, at lower and lower horizons, and in different geological formation. Naturally the most promising areas, judging from surface indication alone, were the first taken up, and the acreage owned by the Superior & Pittsburg—in part covered by a cement rock, a recent conglomerate—was not promising on casual examination. Where areas of limestone appear, there are, it is true, evidences of breaks and alteration by mineralizing solutions, but it required geological deduction, based on the platting of observed facts, to recognize that the trend of the chain of ore bodies laid in this direction, and this inference, drawn by Hovland and Smith, was the basis on which these properties were acquired and developed by the present owners. It was an application of geologic facts and inference to practical mining. To the writer, such use of geologic work to achieve commercial success, is not, as many geologists formerly held, a prostitution of science to commercialism, but a successful proof of the usefulness of science. It is a well recognized fact that mining fraternity throughout the world. Such investigation is usually too costly for any one company, even if the services of sufficiently skilled men could be secured. It is in the use of the results of such investigations and its application to individual properties that the usefulness of the independent practioner in mining geology is of value. The writer does not agree with those who expect the government expert to outline new development work or to predict strikes in any particular area. The most that can be expected of him is to show the value of surface evidences, and by careful consideration of the facts, structural and mineralogical, to give a diagnosis, even as a consultant physician called in by the ordinary practitioner in a difficult case, carefully considers the symptoms and gives an opinion.

EVOLUTION OF STAMP MILLING AT HOME AND ABROAD

By AL H. MARTIN.

Ore crushing with stamps was practiced by the ancients. In the time of Agricola the stamp mill was an established reality, and the ancient specifications were largely used throughout the limited gold sections of the world in mill construction until California practice developed departures and improvements. The ancient mill stamp consisted of a piece of timber with an iron head, with various expedients provided for its operation. Prior to the discovery of gold in California American gold mining was confined to the districts lying along the Southern Appalachian mountains, with the gold fields of Georgia yielding several million dollars. The ore yielded readily to the simple methods of treatment, and replicas of medieval mills adorned every active property.

The first plants erected in California naturally followed the design prevalent in other fields. The Georgia gold miners were regarded as most proficient and their lead was followed in all things pertaining to the mine and mill. But other men had come from the east—men of ingenuity and recourse—men admirably adapted for the consummation of the great work, demanded of their skill and patience. With such men devoting attention to the unwieldly plants, it is not strange that improvements were gradually made and that out of the numerous experiments emerged the prototype of the modern comprehensive reduction plant. All the old mills had square stems and lacked the power of rotation. The first round stem was designed in 1851 by C. P. Stanford and installed in a small mill operated on Nathemas Creek, El Dorado county. The round stem naturally compelled the use of a similar form for the shoe, boss-head and tappet. The bed for the mortar block and battery frame was composed of a successive layer of timbers, crossing each other at right angles. Sand was used to tamp the whole securely and water turned on to harden timber and sand into a compact body. The timbers and mortar block were placed directly on the ground. On the platform was mounted the battery frame. A low mortar surmounted the block, with planks used to build the sides to desired height. Screws, rods and bolts were freely used to secure the planks to the main structure. The first test was made with two iron stamps, 12 feet long and 2 3-4 inches in diameter. Results were so satisfactory that in February, 1852, a five-stamp plant was erected. After several months' activity, it was apparent that efficiency would be increased if the stems could be made to rotate. Several attempts were made, but to Isaac Fisk, an ordinary machinist, fell the honors. At first trials the corner of the cam rasped the edge of the tappet, and only after careful work and patient calculation was the cam given the proper curve to prevent excessive wear of the parts. Zenas Wheeler invented the gib-tappet in 1862 and installed it in a plant at Gold Hill, Nevada. The employment of copper plates for amalgamation developed in 1853. The perfection of the tangent-cam, deep vertical mortar block and other devices has been claimed by many, but records fail to attribute the discoveries to any particular individual. The adaption of these improvements was evolved from the experience of numerous metallurgists, and their employment developed almost simultaneuosly in various fields of the state. With the development of the famous Comstock lode Nevada millmen introduced innovations, and to the men of this state belongs jointly with California inventors many of the devices used by early California operators. Most of the early mills were exceedingly crude in construction, and it was not uncommon for the mill to run the first half day and be hung up the second while repairs were made. By 1870 the California stamp mill had been developed to virtually its present form. The stamps usually ranged from 500 to 800 pounds in weight, with five stamps generally allotted to a battery, and two batteries operated from one cam-shaft. In some cases three batteries were thus driven. The standard stem ranged from ten to 12 feet long, with a diameter of three inches. Stems tapered as in modern models. The stamps generally dropped 60 to 80 times per minute from a height of eight to eleven inches. In some instances the mills recovered better than 90 per cent of assay values, according to official records, while in others the rate of recovery was low. Ore running less than $20 per ton was considered low-grade, despite its free-milling character.

All stamps used in early California practice were not of light pattern, the Rocky Bar mill, near Grass Valley, consisting of 16 1025-pound stamps, while the Allison Ranch mill in the same district contained 12 stamps weighing 1000 pounds each. The daily duty of a stamp was placed at two or three tons. After passing the copper plates the pulp was treated on blanket tables, and the resultant tailings permitted to flow to waste. In some mills a rough pine board was placed immediately beneath the iron lip of the mortar to indicate the interior condition of the battery charge, Hayward and other metallurgists preferring the board to a copper plate.

As practically all the ore handled in early California mining and milling yielded easily to crushing, amalgamation and blanket concentration, the problem of reduction did not offer especial difficulty, once a satisfactory type of plant had been evolved. Had the gold quartz of California presented the same refractory properties that marks the ore of many others fields, it is doubtful if gold mining in the west would have assumed such magnitude before long years after the discovery of the great veins of the Mother lode. Numerous valuable mines were deemed worthless because the gold failed to yield readily to simple treatment, and it remained for later generations to convert to profit what their fathers had scorned and passed by. With their own problems solved California metallurgists rested on their laurels and complacently watched workers in other fields develop more advanced methods. The average California stamp mill of today does not differ materially from the design perfected in 1870, save that larger stamps are employed, and vanners reinforce the canvas tables. In some districts the cyanide process is employed, but this method is still a virtual stranger in the great Mother lodge gold zone. With the ore yielding satisfactory values by simple methods, there has been no reason for the installation of complicated and costly processes merely because they have been advantageously employed in less favored fields.

With the experience of the California metallurgists and engineers guiding their way, the millmen of Nevada, Colorado and other American states have done much to add to the knowledge of metallurgy, while the engineers of Mexico, the Rand and other fields have played a prominent part in bringing the stamp mill to its present high state of efficiency. On the Rand particularly has the recent evolution of the stamp mill progressed along lines unrivalled by other fields. Many of the principles employed in the more pretentious mills recently erected in America are based on lessons and methods developed in Rand practice. The great aim of Rand metallurgy has been the crushing of immense quantities of ore at a low cost per ton of treated ore —a problem accomplished by employing massive stamps and mammoth plants. By this method low-grade ore has been treated profitably, and the Rand developed into the most stupendous gold field the world has ever seen. Of late many engineers contend that in the mania for an increasingly large production the limit of economic recovery has been passed, and there are signs of a reaction that will eliminate the abuses that have crept into the system. But whatever may be the merits of the different modes of treatment, it must be conceded that the Rand metallurgist has been a potent factor in placing the gold milling industry on its present basis. Engineering problems of a nature unapproached in most fields have been met and mastered, and the culmination of metallurgical enterprises is marked by the mighty mills that dot the reefs.

Pre-eminent among the great mills of the Rand is the monster Central mill of the Randfontein Central Gold Mining Co., Ltd., a subsidiary of the Randfontein Estates Co. The mammoth establishment embraces 600 stamps, each weighing 1650 pounds. In this country a 100-stamp mill is considered a massive installation, while stamps weighing over 200 pounds are considered extremely heavy. When it is considered that the Central mill is larger than six American 100-stamp plants, the magnitude of the wonderful Rand installation begins to be appreciated. The largest plant in the world, it also embraces features that makes it pre-eminent among gold-ore plants, apart from its gigantic dimensions. The mill building has a length of 635 feet and width of 70 feet, and is composed of steel. All of the mill framing is of timber, securely embedded on concrete foundations. Timber pads are placed under the mortar boxes, with bitumastic concrete under the concrete pile blocks. The massive stamps are arranged in units of ten, with four timber king posts assigned to each unit. A 100-hp. electric motor operates each two units of 20 stamps.

Each stamp has a rated capacity of 9¼ tons per day, but with the assistance of the tube mills a much larger tonnage is handled. The mill storage bins have a capacity of 13,000 tons, or sufficient to supply the plant about two and one-half days. The stamps are reinforced by 16 huge tube-mills, each 22 feet long and five feet six inches in diameter. All the other departments are built on the same colossal scale. The sand plant is arranged in two independent departments and contains 36 steel tanks, with diamaters of 60 feet. The upper tiers of tanks serve as collectors, each of which delivers to two treatment tanks. The sand plant consists of 23 tanks 70 feet in diameter. The sides are 14 feet high, with seven-foot cone bottoms. Three 12-inch Robeson-Davidson centrifugal pumps are used for circulating, transfer and discharge purposes. Two ten-inch turbine pumps handles the solution decanted from the slime tanks, while a secondary pumping system returns the surplus solution to the main plant. The extraction department embraces five zinc lathes, six 24-inch filter presses and 40 steel extraction boxes, the whole contained in a steel-framed building 310 feet long by 70 feet wide.

Five mines supply the mammoth mill with ore. As the rock is taken from each shaft it is loaded into 40-ton hopper cars and hauled over a railroad by locomotives to the 1000-ton reinforced concrete storage bins, located directly underneath the railway. Six belt conveyors receive the ore and deliver to revolving trommels, 14 feet long by four feet diamater. Conveying and sorting belts are provided to handle the fine and coarse rock, and the clean material passes to six steel sectional jaw-crushers, operated by 50 horse power motors. Cross conveyors gather the product and feed to two main incline belts commanding the main mill bins. From the latter the product is fed to the mammoth stamps.

The pulp from the mortars pass to the tailings pumps without amalgamation. Six ten-inch Robeson-Davidson pumps, operated by 125-horse-power motors, receives the coarse sands, while four similar machines are provided for the fine material. The tube mill discharge passes over 96 stationary copper plates, having dimensions of five feet three inches by four feet. The tube mills are arranged in two parallel rows, with all the amalgamating plates located between the two sections. Before admission to the tube-mills is permitted, the coarse sands are first elevated to cone classifiers, the underflow passing directly to the tubes. The classifier overflow goes to 128 tables, located in the middle of the building and above the tube mill plates, and on to the fine sand pumps which command the sand collecting tanks. Electricity is used throughout the mill, the company generating power at its own plant. The voltage is 3-phase-60 cycle, with 6000 volts delivered. By erecting and maintaining its own plant this company has not only reduced power costs, but has rendered certain the constant delivery of power, a factor that is appreciated by the operators depending for their current upon independent power companies. The dynamos are driven by steam, generated by 24 Babcock-Wilcox boilers

Besides the main Central mill, the Randfontein Central Co. operates four 100-stamp mills on its estate, making a total installation of 1000 stamps. The smaller plants are complete in every respect and excellent examples of modern mill construction, although naturally dwarfed by the colossal magnitude of the main Central installation. The Central mill commenced activities March 1st, 1911, and according to late advices is operating at approximately full capacity. With all the stamps operating at full capacity the company expects to treat about 3,100,000 tons per annum. In 1911 2,159,033 tons were treated, with an approximate recovery of $13,000,000. The company was the second largest producer on the Rand in 1911, following after the East Rand but ranked third in value of output, with the Crown Mines leading and the East Rand second. However, the Randfontein Central is expected to take first position in 1912, although it is certain its leadership will be determinedly contested by its two giant rivals.

Total value of ore per ton treated at the Central and auxiliary mills during last year was approximately $5.90. Costs averaged around $4.04 to the ton. Milling costs slightly exceeded $1.12 per ton. The Central mill was not operated at full capacity, and it is thought costs will be lower for 1912. The company has been handicapped in the past by scarcity of labor, and it was impossible to operate the gigantic plant at top speed throughout the past year because of this factor. The Central mill, because of its predominating dimensions and other notable features, stands forth as the most finished gold reduction plant in the entire world, and has been selected as a fitting culmination of the wonderful advance made in gold mill design and construction during the past forty years. Compared with the first crude mills erected in California, the wonderful Central plant towers like the gigantic skyscraper of the city above the unpretentious cottage of the village—a magnificient testimonial to the enterprise, ingenuity and recourse of the mining industry. The Central is not alone in its glory; there are other plants on the Rand approaching it in magnitude and accomplishment, and other fields have developed splendid examples of the modern mill, but the Central with its 600 giant stamps looms forth like the tungsten lamp among the ordinary electric carbons.

The builder of the Rand mill has had wonderfully favorable environments to spur on to great accomplishments. In the country nature has builded on a colossal scale. The mines are giants among giants, and what would be termed large properties in other climes are here considered insignificant. The property of the Randfontein Central alone is a fitting illustration of the magnitude of gold mining on the Rand. The holdings embrace over 2600 acres, and extend along the massive outcrop about seven miles. Along this ore-belt two main shafts have been sunk to average depths of 1630 feet, and over 87,500 feet of development work was driven in 1911 alone. At the end of the year the ore reserves were estimated at 6,637,271 tons. Despite the immense amount of work performed the property has not been excessively opend, and large areas remain for exploration. And this property is smaller than either of its two great rivals, the Crown Mines or East Rand. When nature designs along such lavish lines it is not strange that man is stimulated to endeavors undreamed of in less favored fields. Under such conditions it is probable that many of the great problems remaining unsolved in gold milling will continue to claim paramount attention on the Rand—particularly the reduction of ore to the limit of economic efficiency.

SOLUTION METER FOR LEACHING PLANTS

By JAMES SPIERS.*

The machine to which I wish to call your attention is what is commonly known as a solution meter. Several of these machines have been described at various times, but so far as I have been able to learn, their use has been very limited. This seems rather strange, for the value of a machine which will automatically sample and register the amount of solution in a plant must be apparent to everyone. I cannot at the present moment recall the details of the machines which I have seen described, but it seems to me that there must have been something radically wrong in their design, or else they would have come into more extended use.

The solution meter here described is known as the Worthington liquid weigher, and was designed primarily for use in steam plants where the determination of the quantity of feed water used is frequently of considerable importance. Although generally used for measuring water, it has also been used for measuring oil and other liquids. Its use as a solution meter in cyanide plants is an adaptation of the machine to an entirely new line of work, but I believe that if you will follow the description closely you will agree that it is admirably fitted for this class of work.

As will be seen from the accompanying drawings, the machine consists of two measuring tanks of equal size (A-1 and A2), fitted each at one end with a siphon pipe (C) and at the other with weights (D). The tanks work on the knife edges (B), which are located at less distance from the counter weights (D) than the siphon pipes (C). The solution to be measured flows through the inlet pipe (E), passing along the deflector (F) into either tank, as for instance as shown in the drawing, into the left-hand tank (A-1). The weights (D) are so adjusted that the tanks will remain in a horizontal position until they contain a certain definite weight of liquid; then they tilt into the position shown by the dotted lines, and the liquid then begins to flow through the siphon pipe (C). After the flow has been started and the level of the liquid in the tank has fallen suffi-

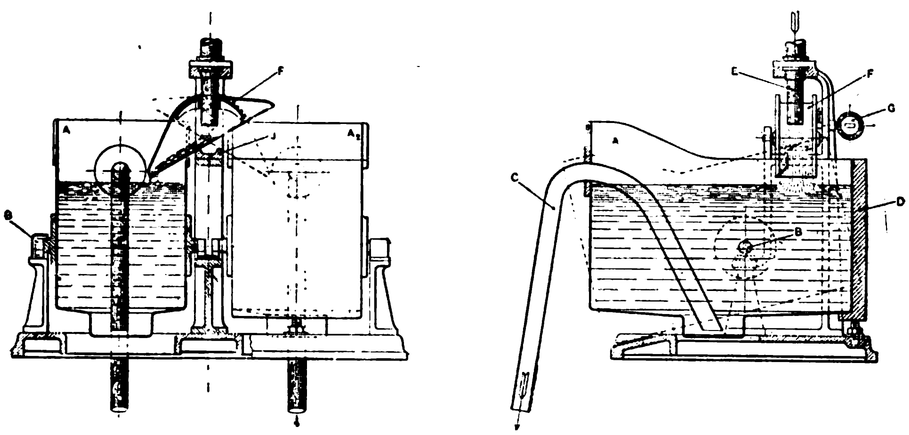
*In Transactions of the American Metallurgical Society.

ciently, the tank is returned to its original position by the influence of the weights (D), the siphon continuing in action until the tank is emptied. As each tank assumes the position indicated by the dotted lines, it suddenly tilts the deflector (F) over so that the liquid, instead of continuing to flow into the tank, (A-1), begins to flow into the other tank (A-2), when the same operation already described is repeated and continued. It will thus be seen that both tanks are filled automatically with fresh liquid, while the measured liquid runs into a collecting tank from which it can be drawn off continuously into the zinc boxes. As each tank tips, it registers the number of pounds contained on the automatic counter (G), which is actuated by the deflector (F).

When either tank is in a horizontal position the deflector (F) rests upon the support (T), not touching the tanks, therefore the time of tipping and the accuracy cannot be affected either by the weight of the deflector or by the pressure of the running liquid in the deflector or by the resistance in the mechanism in the counter.

It should be noted that the tilting of the tanks (and consequent recorded measurement) is accomplished entirely by the introduction into them of a definite weight of liquid, irrespective of variations in volume due to specific gravity. It is customary in cyanide work to base the tonnage calculations on the volume rather than on the weight of the solution. The use of a meter of this type in cyanide plants would necessitate a change being made either in the method of taking the solution for assay or in the character of the counter (G). The amount of error introduced by a calculation of a sample which has been measured out is not very great, but it is an incongruity and should be remedied. Personally, I would favor allowing the machine to remain as it is and the counter to register the amount of solution passed in pounds, and to weigh out the sample taken for assay, but I believe that the general opinion would be to favor a counter which would register the number of cubic feet of solution. A better way perhaps would be to design a meter specially for cyanide solutions and have the tanks so proportioned that the counter will register the quantity of solution which has passed through in tons and decimal fractions thereof.

The foregoing is a description of the machine as it is ordinarily constructed to weight solution. In order to use it as a sampler it is necessary to provide an auxiliary device which will remove a portion of the solution during the period of transfer. There are several ways by which this can be accomplished. The best way would be to provide an auxiliary siphon tube of glass alongside of the large siphon and which would come into action with it simultaneously. By drawing the tip down to a fine point, the quantity of solution delivered could be regulated to a nicety. If a siphon of this kind were placed on each tank an absolutely accurate sample of the entire quantity of solution sent through the boxes could be obtained. The only objection to this method of sampling is the large volume of solution obtained. This objection can be overcome without any great sacrifice of accuracy by putting a siphon on only one of the tanks, or by cutting off the short arm so that it extends down into the tank only a short distance. By regulating the length of this arm, the size of the sample taken can be adjusted to a nicety.



A Solution Meter for Cyanide Plants.

It will be evident to all that these meters will have to be used in pairs or even in sets of three or more, depending upon the number of kinds of solution handled in the plant. Where two or more zinc boxes are used for the same grade of solution, one meter can be used for the set, as they can be arranged to take their feed from the same tank.

In order to have a check on the zinc-box "clean up," it is necessary to provide a means of sampling the solution after it has passed through the zinc. This will have to be done by a separate device, of which there are a number of excellent ones which can be installed with very little trouble or expense.

The subject of providing solution meters and efficient sampling devices for the cyanide plant is not a new one, but it has apparently received very little attention. It is a matter, however, which will grow in importance, for it is becoming more generally recognized every day that, wherever possible, exact sampling methods must be substituted for guesswork. The machine which I have brought to your attention is one which I believe can be used very successfully in securing the exact amount and at the present time is very much needed in a great many cyanide plants.

"Thomas," said the professor, "mention an oxide." "Leather," replied Thomas. "What is leather an oxide of?" "An ox'ide of beef."—Exchange.

At the Bergwerkswohlfahrt mine (Zellerfeld district, Prussia), trials have been made with the Murex process for the further concentration of the galena containing intermediate products. After having been reduced by the reduction plant here to 1 mm. grain size, the ore is intimately mixed with magnetite dust and oil, and then passed over a strong electromagnet, which extracts the magnetite-coated galena particles and automatically deposits them in a laterally-attached storing bag, while the non-metalliferous stone particles pass on to the residue dump. The concentrates thus obtained contain up to 50 per cent metallic lead, and no more than 2 per cent remain in the residues.

Powder smoke can be quickly cleared from the face of an adit, where ventilation is secured by the use of a small blower and the usual galvanized-iron pipe, by reversing the direction of the blower. The smoke is thus sucked into the pipe and carried away without becoming mixed with the air of the adit or drift. A method commonly employed where machine drills are used is to turn on the compressed air just before firing the round of shots and allow it to escape continuously while the smoke is clearing away. The disadvantage of this is that the use of compressed air is an expensive means of securing ventilation, and since the smoke must be driven out through the full-section of the drift, a much longer time is required to clear away the smoke.

Gold is dissolved by acqua regia, a mixture of strong nitric acid and hydrochloric acids.