MINING AND SCIENTIFIC PRESS.
AND PACIFIC ELECTRICAL REVIEW.

No. 1972.—VOLUME LXXVI. Number 17. SAN FRANCISCO, SATURDAY, APRIL 23, 1898. THREE DOLLARS PER ANNUM. Single Copies, Ten Cents.

A California Gold Mine.

From the Mining Resources of Calaveras Co., Cal., is taken some notes on the working of the Gwin mine, and, incidentally, the general condition of the gold mining industry in that region. The article referred to is conservative and contains much practical information. It is worthy of note as a prefatory statement that the method of treating gold sulphurets by chlorination, which is simply the discovery of the chemical affinity of chlorine gas for gold, was first successfully tried at the Gwin mine, Calaveras Co., Cal. This mine is chosen as illustrative of what intelligent work and investment of considerable capital by California miners will do in making a valuable property out of what had been abandoned and believed to have been "worked out."

THE GWIN MINE HOIST.

The Gwin mine was one of the first quartz gold mines to be opened up in California. Some miners in 1850 having found the surface pay croppings of the Gwin mine, were joined by a few others, and the shaft was sunk 200 feet on the incline of the vein. The method of reclaiming the gold in the sulphurets not being known, the values obtained were entirely from the free gold and the sulphurets went to waste. Dr. Gwin, one of California's first Senators, took hold of the mine about that time, and a water power hoist was put in, with a capacity to sink 1000 feet. Messrs. Deetkin and Garland also introduced the Plattner chlorination process a little later, to treat the sulphurets, which enabled them to work the low grade ores successfully. Even then it was impossible to obtain a profit on any ore not assaying $6 or $8 per ton, although the mill capacity had been increased to handle large quantities of quartz. Very rich ore in streaks was taken out from time to time, but as the mine reached a depth of 1350 feet, the necessity of more effective material became apparent. The management, however, went on taking out such ore as could be made to pay. All the high grade ore in sight was mined, and the mine was thus "gutted out." As the shaft reached greater depths, the water increased. The pumps and buckets were of insufficient capacity. The drifts had been run about 1200 feet north and about 100 feet south, and the mine was allowed to fill up with water. The drop in value of all California gold properties took place at that time, and the owners could not get the means required to reopen it. A little later forest fires devastated the vicinity, and in 1894, when the present company took hold of it, a deserted log cabin here and there, or a coil of rusty rope, with bundles of old iron and steel, scattered down the gulch, were the only traces of former activity.

INTERIOR OF GWIN MILL CONCENTRATING PLANT.

Believing in the permanency of the lode in depth, and knowing of the actual existence of large quantities of low grade ore in the upper levels of the mine, Supt. F. F. Thomas conceived the plan of bonding the

(Continued on page 448.)

A California Gold Mine.

(Continued from page 437.)

land and sinking a vertical shaft 1400 feet through the country slate, and north of the limits of the old workings. The same work had previously been accomplished by Thomas at the Kennedy mine in Amador county. A shaft was sunk there through the comparatively barren belt and struck a body of good ore below. This was an especially bold work to undertake at that time, for the depth of the gold bearing veins, as well as their permanency, was uncertain. Reducing the inclined depth of the shaft of the Kennedy to the vertical, the total depth of the mine reaches 2200 feet, the deepest vertical shaft in the State.

The Gwin Co. erected a complete water power hoisting plant and the shops in the summer of 1894. Sinking was steadily prosecuted for two years, until the 1000-foot level was reached. Drifts were run at the 700 and 1000-foot levels. At the 1000-foot level a well-boring machine was used to sink a prospect hole, in advance of the shaft work and down past the old drift. It encountered the north prolongation of the ore body at 1195 feet. This bore hole was sunk to the 1300-foot (vertical) level and happily just escaped the old drifts enough to ensure safety in sinking the shaft down near them. The shaft was then continued to the 1400-foot level and the work of opening up the ore body began on the 1200, 1300 and 1400 foot levels, where the vein in a great many places was over 20 feet in width of milling rock. As soon as these lower levels had been opened up and the levels connected, the ore was extracted, sent to the surface in large buckets termed "skips," and then run by hand cars into the bin of the 40 stamp mill, which in the meantime had been erected. An engraving of the mill on this page shows foundation, mortar blocks, water pipe and pressure box. The mill is run by water, which also supplies both power and electric light. In the north drift, at the 1400-foot level in the stopes, a rich vein about 2 feet wide, running through the main fissure, was encountered, full of free gold. The writer was present when a piece of quartz filled with free gold was taken out. The piece was about the size of an orange and afterward $2500 worth of gold was extracted from it. But it is not this rich specimen rock that keeps the mill going steadily, but the large bodies of quartz are yielding $3 and upwards per ton. The gold sulphurets now are all utilized. The percentage of these sulphurets is between 2 and 3 per cent and average from $60 to $100 per ton when concentrated.

As the south drifts in the 1200 and 1300 levels approached the old workings it became necessary to open them up and drain out the water. Several schemes were thought over, one to tap the old workings by diamond drill holes in the lower levels; but this necessitated compressed air for power. To run such a large hoist under 365 feet pressure, and the mill under 375 feet head, required at least 200 miners' inches of water every twenty-four hours. This was purchased from the Mokelumne Canal Co. at 15 cents per inch per day of twenty-four hours. This water was running to waste, but a plan was devised to put in a settling tank and carry it under pressure in a 15-inch sheet iron pipe 4500 feet to the bank of the Mokelumne river, where 380 feet effective pressure head could be obtained. A large Pelton water wheel, 19 feet in diameter, was then put in, and compressed air enough to readily generate 250 H. P. was obtained. This compressed air was sent back in a 6-inch pipe laid alongside the water pipe, not only to the settling tank, but 1670 feet farther to the old original south shaft. An air receiver was put in there, giving the power to pump out the water from the old shaft. Receivers for the air can be placed at any point where power is needed to perform general hoisting or any other work in the future.

The new 40-stamp mill has been going steadily since January, 1897, grinding out the ore and yielding a monthly dividend satisfactory to the stockholders, for it shows what the mine will do when thoroughly opened up. When the old south shaft is pumped out all the reserves of low-grade ore can be obtained, and, the capacity of the mill as well as the average of the ore being known, the profits can be calculated to a nicety.

Some idea of the extent and value of these ores can be obtained by taking an average section of any one of the mines along the lode, 100 feet in length by 100 feet in height. A rough estimate of this section, taking the average width of the vein at 20 feet, would give 10,000 tons. A 40-stamp mill grinds up 3600 tons of ore a month when running steadily, and this section of loose quartz would be crushed in a little less than three months. Now, take a general average of $5 gross yield per ton, and place the cost of mining and milling at $2.50. The profit on this ore would be $25,000 for the above time. This does not take into account any rich ore found from time to time, that is generally utilized in bringing the gross yield up to its usual standard, when for any reason it may be necessary to shut down the mill. In all of these large mines when the ore is blocked out it is simply a question of the capacity of the stamp mill going at full speed to realize a steady income. The principal mines of the mother lode, at the deep levels, have chutes of ore over 1000 feet in length, with varying widths—from 10 to 40 feet, and even more. It needs very little figuring to show that they will last for years, and while one level is being worked others can be exploited.

With permission of the Supt. of one of the mines mentioned, a statement is given for an average month of last year. During this month 116 men were employed, and the average assay value of ore sent to the mill was $7.50.

DISBURSEMENTS FOR ONE MONTH.

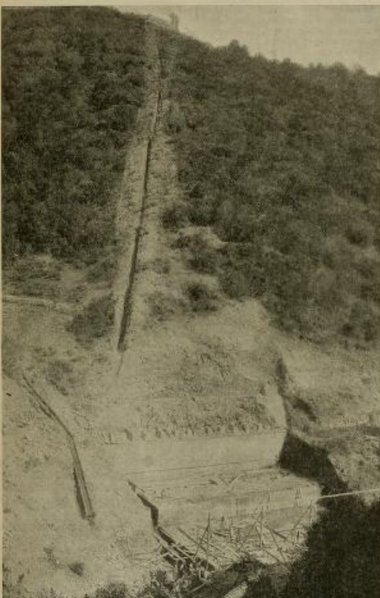
Mine labor	$ 7,833 45
Mill labor	640 00
Mine supplies	755 32
Mill supplies	315 59
Chlorination supplies	390 35
Timber and lumber	2,422 30
Assaying supplies	41 00
Water for power	1,551 35
Wood for power	115 56
Salary of superintendent	400 00
Salary of secretary	300 00
General expenses	67 25
Express charges (sulphurets)	10 50
Express charges "free gold" bar	64 00
Total	$15,707 06

During this month the mill receipts were $26,000, rent, etc., $300, a total of $26,300, leaving a net profit for the month of $10,592.94.

This is only an average report, and when one of these large ore bodies are properly developed, such returns can be regularly obtained steadily for years.

In the wheel-pit of the Gwin mine hoist a pressure of 365 feet is obtained by a total length of 840 feet of 15-inch sheet-iron pipe. The three-compartment vertical shaft, 12 feet by 9 feet in the clear, has been sunk to the 1400-foot level at an average cost of $36 per sinking foot. The hoisting machinery, new 40-stamp mill and all other expenses, except shaft sinking, aggregate $180,000. The air compressor plant (when completed) will probably cost $20,000. The ore is run through a crusher before going to the mill, making the quartz that is to be crushed by the stamps of uniform size. About 350 feet of railroad track connects the hoist and mill. The mine averages 30,000 gallons of water every twenty-four hours, which is readily handled with large skips, dumping automatically. Below the 1400-foot level there is a 40-foot pump, and reservoirs at convenient levels keep back the water accumulating in the drifts. The miners work eight-hour shifts, and their pay averages $2.50 per day. Each shift of men generally excavate about fifty tons of rock. The bin in the upper part of the mill has a capacity of 500 tons. The ore is run through the forty stamps, each of which, when "shod up," weighs 904 pounds and has a 6 to 8-inch drop. The stamps run day and night, and each stamp will crush three tons of ore in twenty-four hours. A 16-mesh screen is placed in front of the stamps and dies, and the pulp is run first on the outside plates, which have a general grade of 1½ inches to a foot and are each 4 to 6 feet long.

These outside plates retain most of the free gold upon their silver faces. The residue lodges at the base of the screens, where the inside plates are placed. The outside plates are cleaned up every day, and the amalgam of gold and quicksilver squeezed into balls of convenient size to handle, through pieces of drilling or cloth. A few drops of cyanide of potassium and also quicksilver are rubbed on these plates before again replacing them in their proper position. After leaving the plates, the pulp is carried in wooden troughs to large concentrators or vanners, which pan out the sulphurets automatically. After concentration, the sulphurets are



FOUNDATION AND WATER POWER OF GWIN FORTY-STAMP MILL.

A TRESTLE ON THE COMPRESSOR LINE—GWIN MINE.

shipped to the chlorination plant to be roasted and the gold reclaimed from them. There are two concentrators for each 5-stamp battery at the Gwin mill.

At the end of each month there is a general clean-up of all the pulp in and around the stamp and dies. This pulp is placed in a barrel with some mercury, and revolved until the mercury has thoroughly penetrated the mass. The amalgam is worked down and afterwards treated by a method similar to that used on the plates, until all the amalgam is collected in convenient shape to be retorted. The slimes that leave the mill are assayed from time to time, and if they show value to any extent, are again caught up and run over stationary canvas tables, placed on grades sufficient to allow the slimes to slowly run off. Such treatment is sometimes quite lucrative, and it is not uncommon for some of the mines to sell the privilege of washing these slimes to contractors for over $1500 per month.

The retort house is fitted up with a closed and an open furnace. The former is used to heat the amalgam until the quicksilver is condensed. The vapor passes through a cooling tube until again converted into liquid mercury. In this operation only a very small percentage of the quicksilver is lost. The rough masses of gold left in the retort are then taken out and all melted together in a crucible in the open coke furnace. After a thorough melting, the gold is moulded into bricks and sent to the mint or smelter. An assay of the gold brick is made at the mine office as a check upon the refiner. This rough gold varies, but is generally worth from $16 to $18 per ounce.

The canyon or gulch in which the Gwin mine is situated is very steep and narrow. Recently it became necessary to build a flume from the south shaft down the gulch and under the main dump. This carries the water through the canyon and prevents the dump from caving. This flume is built large enough to carry easily the heavy streams of water rushing down the gulch during the severe winter storms. The air-compressor line is also flumed where it crosses the gulch. Altogether, the work of the company is done thoroughly and is justified by the present encouraging developments.

The Gwin mine is a close corporation, controlled by a few vigorous mining men, who personally overlook the work. They control the entire stock and none of it is on the market, the few shares offered having been subscribed at the time of organization. It is typical of modern ingenuity and skill, and its history is a history of California since the gold discovery.

At the annual meeting of the Gwin M. & D. Co. last week, Supt. Thomas reported that near the north end of the 1400 level a winze struck into 50 feet of ore running from $5 to $6 a ton. The water has been taken out of the old or south shaft to a depth of 1009 feet. The ore available at present is very low grade. During the year the amount of ore worked was 48,180 tons, the net return on which was $168,-823.79 in bullion and $39,963.35 in sulphurets. The election resulted in the choice of M. W. Belshaw, Pres.; E. C. Voorheis, Vice-Pres.; C. C. Eells, F. F. Thomas, D. McClure, additional directors, and J. J. Crawford, Sec.

Treatment of Slimes.

NUMBER III.

The Precipitation of the Gold.—It will be noticed that in the foregoing operations we have reversed the ordinary methods of metallurgy. In every other metallurgical operation, successive concentration is the means by which we finally obtain the metal, for which we are working; but in this case we pursue the opposite course. The final operation of winning the gold takes place from a grade of material worth less per ton than was the material with which we started. We have simply changed the physical condition of the gold from the state of a solid into that of a liquid, and it is with this diluted liquid that we have now to deal. Precipitations of metals from solutions present many curious and interesting problems, and one of these is that with the same reagents it is very much more difficult to produce perfect precipitation from a very dilute solution than from a concentrated solution. There are certain chemical and physical laws in connection with this question which I do not think are very well understood. For instance, in precipitating gold from a solution of its chloride by means of ferrous sulphate, a fairly rich solution containing one to four ounces of gold to the ton admits of a very perfect precipitation, if sufficient time is given for settlement, more especially when there are few other metallic salts in solution. A similar solution, but containing only one or two dwts. to the ton, allows of very imperfect precipitation, by ferrous sulphate. This is only one of many illustrations that could be brought forward in connection with chemical precipitation, wherein the results obtained differ widely from what might be expected. In electrolytic precipitation we have a different set of laws governing the electro-deposition of metals from those which operate in chemical precipitation. In the course of our experiment on the precipitation of dilute cyanide liquors we have tried many methods of precipitation solutions containing six to twelve grains of gold per ton, but failed completely with such dilute liquor; whereas the same methods acted perfectly on five dwts. or ten dwts. solution. With a dilution of gold down to six dwts. per ton, which is about one part in 100,000, it would be natural to think if it was one part in 100,000, or one part in a 1,000,000, or one part in 10,000,000, there would not be very great difference in the resistance of such very minute proportions of dissolved gold to precipitation, whether by electro-motive force or by chemical reaction; but the difference between the action of a liquid containing six dwts. per ton and one carrying six grains per ton is most marked, both in chemical precipitation and in electrolytic deposition. In general we have found that we could effect the precipitation of gold in these dilute solutions best, and most economically, by means of electrolysis. We have found that we are more independent in this method of dilution of the gold, and that varying chemical constituents do not have to be looked after quite so closely. It is independent of the amount of cyanide contained in in the liquor, and precipitation takes place whether the solution is alkaline or acid.

The principal points in electrolytic precipitation that it is desirable to study are the amount of current per square foot of anode and cathode, and the time the current is exerted, taken in conjunction with the value of the solution. One of the first points requisite in the electrolytic deposition of gold is that the liquor shall contain no solid matter; that is to say, that it shall be absolutely clear. Otherwise, the great surface which is presented by the cathodes and anodes serves to collect all the fine particles that remain in the liquor; necessarily settlement of any kind upon the metallic surface of the anode or cathode increases the resistance of the precipitating box and results in imperfect adhesion of the particles of the gold to the cathode. This difficulty is easily overcome by passing the liquid before precipitation through a sand filter, or through an intermediate settling vat of large capacity. An example of a good filtering device may be seen at the Central Works of the Rand Central Ore Reduction Company, or at the Simmer and Jack slimes plant; also one of large settling capacity may be seen at the Geldenhuis Estate. The liquid which is drawn from fresh slimes is much more readily clarified than the liquid drawn from accumulated slimes. The liquor from accumulated slimes contains a considerable amount of iron and lime salts in solution, and the settlement of the fine clayey particles is retarded. This may possibly also be due to the organic matter which it contains.

Other substances in the liquid which affect the surface of the cathode are those salts which are in solution upon entering the box and are there deposited on the large surface exposed, or are electrolyzed. Lime which has been used for settlement, and also to neutralize acidity, is in the form of carbonate of lime, sulphate of lime, and hydrate of lime. This precipitates partly as carbonate and partly as sulphate upon the cathodes and anodes, more especially on the former, and, to my mind, is precipitated partly by means of the electrolytic current. Then there are the products of the decomposition of the solution itself, which (in the case of iron salts, resulting from the decomposition of the pyrites in the ore) are separated in the form of Prussian blue and hydrate of iron. Then, again, there are the products of the decomposition of the anode plates.

The clearness of the solution depends largely upon the solution of the anode. The iron plate anode in use to-day in the Siemens and Halske boxes, with properly proportioned current, is a very perfect anode, easy to be obtained in any quantity, and as easily manipulated and secured in the boxes. With a current density as low as 0.03 or 0.04 amperes per square foot, very little decomposition of the iron anode takes place. An anode three-sixteenths of an inch in thickness and with a current density of 0.035 amperes per square foot should last for five years and possibly much longer. There seems to be a limit of current density up to which an iron anode will show very little corrosion, but beyond that point oxidation seems to take the place more rapidly than the proportionate rise of current density would indicate. Where the division and tension of the currents has been very carefully studied and regulated very little decomposition of the anode need take place.

With the peroxide of lead anode which was discovered by Mr. Emile Andreoli in the early part of 1895, practically no corrosion of the anode plate takes place, and although up to now this anode has only been used in a small way, I feel confident that its introduction into this country on a large scale would prove satisfactory. With perfectly filtered solutions and with peroxide of lead anode, working with fresh slimes, and by watching carefully the amount of lime added to the slimes, there should be very little trouble in maintaining a perfectly clean anode surface for the planting of the gold. One point worthy of study by all chemists in connection with the maintenance of a clean anode surface is to see either how the lime salts can be prevented from precipitating in the boxes, or if any economical method could be devised to reduce the amount in solution. I think it is next to impossible to find any substance that would economically replace lime in the settlement of slimes, but some means might be found to obviate its deposition from the solution in the precipitation boxes. The subject of the production of suitable anodes for precipitation of gold from cyanide solutions is probably not exhausted, but the field has been very thoroughly explored by able electricians and chemists, and, beyond the two anodes mentioned, I do not know of any that will fulfill the required conditions.

(*To be Continued.*)

Purification of the Electrolyte in Copper Refining.*

The systematic control of the composition of an electrolyte for copper refining is requisite, to avoid the deposition of foreign metals at the cathode whereby the quality of the copper would be impaired, and to maintain the strength of the electrolyte at its proper point. The copper content of the electrolyte tends to increase, because the copper at the anode dissolves rather more quickly than it would if its rate of dissolution were strictly proportional to the current. This is due to the fact that copper exposed to the joint action of air and sulphuric acid slowly dissolves, irrespective of its function as an anode; copper containing oxide will, of course, dissolve faster than the metal free from this body and dependent for its oxidation on the presence of atmospheric oxygen. The proportion of copper thus dissolved to the quantity of copper dissolved electrolytically will be greater the smaller the current density and the more vigorous the circulation and consequent aeration of the electrolyte. Spontaneous evaporation—not to be neglected when the electrolyte is used slightly warm, e. g., at 30° C. to 40° C. = 86° F. to 104° F.—also tends to increase the concentration of the electrolyte, and thus it comes about that there is a continual tendency for the quantity of copper sulphate in the tanks to augment until an elimination of a portion of it is a necessity. It is evident from this that the purification of the electrolyte should be accompanied by a withdrawal of a portion of its main constituent, copper sulphate.

At the copper refinery of the Baltimore Copper Co. about one-fifth of the electrolyte is removed from time to time to be worked up for copper sulphate, and a suitable (but not necessarily equal) amount of pure copper sulphate solution is added, so that the content of the electrolyte in impurities is diminished, and, at the same time, the strength of the electrolyte in copper sulphate is adjusted to its normal value. The importance of this regulation lies in the fact that in a large refinery containing a multitude of small units of plant it is essential for smooth working that the conditions of current density, resistance of solution and the like should be maintained as nearly uniform as possible. It is for this reason that any process of purification which would regenerate the electrolyte continuously, instead of periodically, would present many advantages.

Using this method, the Baltimore Copper Co. produce a considerable quantity of copper sulphate, which is sold with profit to the Western Union Telegraph Co. The final liquors are precipitated with iron scrap to recover the last portion of copper, amounting to 2 or 3 per cent.

At the works of Guggenheim Bros., Perth Amboy, N. J., the liquor is run into lead-lined vats and boiled with scrap copper with free access of air, so that the copper may be dissolved, the free acid neutralized, and the solution so enriched in copper sulphate that it can be readily crystallized to yield this salt. The copper sulphate is deposited on lead strips hung across the crystallizing tank. The mother liquor contains almost the whole of the antimony and arsenic, together with a small quantity of copper. The latter is precipitated by iron plates, on which the arsenic is also deposited as soon as the copper has been thrown down. Ultimately a black precipitate, containing as much as 60 per cent of arsenic, is obtained. This may be worked up either for crude copper or for the production of arsenic compounds, such as Scheele's green, paris green and white arsenic. In the Chicago Copper Refinery the bulk of the copper sulphate is recovered by crystallization, and the mother liquor is boiled down to a point at which both copper sulphate and arsenious acid crystallize out. The mixture is extracted with just enough water to dissolve the copper sulphate, which, being thus fairly freed from arsenic, is returned to the vats.

In the foregoing cases a part of the whole of the electrolyte is worked up for copper sulphate, and this purified recovered salt is returned to the process. Other methods have been proposed for the direct elimination of the chief impurities in the electrolyte and its restoration to a proper working condition without recourse to crystallization of the whole quantity of copper sulphate. These include boiling the liquor with metastannic acid to precipitate arsenic, filtration of the liquor through a layer of cuprous oxide, which is a base strong enough to precipitate most foreign metals as hydroxides, and oxidation of some of the impurities, notably iron, by aeration, and constant precipitation of certain other impurities, e. g., arsenic as ferric arseniate. All these methods, singly and conjointly, have met with

*Condensed from the London Electrician.