The Great Comstock Lode.

Written for the MINING AND SCIENTIFIC PRESS
By G. McM. Ross.

The discovery of the Comstock was a natural consequence of the prior discovery of gold in California. From the eastern slope of Mt. Davidson in the year 1850, it was possible to see the trains of emigrants moving westward. Those who had learned the limit of physical endurance of man and beast rested after their weary march across the desert before undertaking the crossing of the Sierra Nevada, the last barrier between them and the land of gold. The young and vigorous men discovered that their camp was made in a plain below a splendid mountain range that could be reached between two canyons, one to the north, the other to the south.

These gulches led to the Comstock, and they were natural concentrators of the metals removed from the outcrop of the lode by erosion. The most northern gulch forked within two miles of the lode, forming the Six Mile and Seven Mile canyons. Six Mile ends at a point just below a massive outcrop; at the end of it, free gold and silver sulphides were found by prospectors on June 8, 1859. Prior to this date the placer miners had followed the gold up through Gold canyon, through the present site of Silver City up to Gold Hill, so that by 1859 the Comstock lode had been reached from both sides.

The value of the silver sulphide was not discovered at once as it was an unknown black metal to all of the prospectors. When the value of this ore was disclosed silver mining sprang into being and moved forward rapidly. The rich gold and silver ores were shipped to San Francisco, while experiments were being tried on the Comstock and at San Francisco on all sorts of processes and devices for the recovery of the metals. The mining companies themselves undertook the reduction of their ore with an equipment whose magnificence was only equalled by its inefficiency. To this work can be credited the imperfect and costly treatment of the Comstock ores that has lasted until the present day. Shrewd men built mills and as a result of their joint efforts the Washoe process was evolved. When this process had been established as the one best adapted for the reduction of the ore, the profits derived from milling were so large that powerful milling companies were formed and any effort to treat their own ores by the mining companies was effectually discouraged.

The Washoe process is the American form of the Mexican Patio process and is used in the following way: The ore is crushed wet in 5-stamp mortars to a fineness ranging from 20 to 40 mesh; the crushed ore is then settled in square vats on the pan-floor; the finest of the slime is settled in a reservoir outside of the mill. The pulp, after settlement, is charged into fast-running grinding pans holding a charge ranging from one to two tons; the pans are either steam-jacketed or arranged to take live steam into the charge; the ore is kept at such a consistence as, with a motion in the pans, will keep the quicksilver in suspension in the charge. The chemicals used are bluestone and salt. The treatment lasts from three to six hours in the pans, which are finally discharged into settlers (a pan of slower motion, to which large quantities of water are added) to insure the settling of the quicksilver with its gold and silver. The pulp is slowly discharged from the settlers, the quicksilver recovered and strained to secure the gold and silver amalgam, which is then ground in a clean-up pan to remove all impurities, re-strained, and retorted; the resulting crude bullion is melted into bars of fine metal.

The equipment is as follows: For ten stamps of 900 to 1,000 lb. each four standard 2-ton pans are required, together with two settlers and a slow-motion clean-up pan, retort, assay-office, etc. The actual horsepower required would be 60, but to provide for extra rock-breaking service, or a modification of the process, it is well to provide 75 for the work.

Such a mill will treat from 30 to 40 tons of ore per day at a cost ranging from $3 to $7 per ton, depending upon the loss of quicksilver, cost of water, power, etc. In the treatment of the ore such a mill will use 50,000 gal. of water per 24 hours, about 50% of which can be settled and used over again when water is expensive. Plate and battery amalgamation is being used successfully. The free gold contained in the ore is amalgamated and recovered upon silvered copper plates before the ore reaches the settling vats; after passing over these plates the ore is treated by the Washoe process as already described. In ores containing heavy sulphides, it has been found that by removing these sulphides before treating the ore in amalgamating-pans, a higher percentage of the metals is recovered at a reduced cost. Any type of concentrator that will remove the sulphides can be used for the work.

With the Washoe process established, the production of gold and silver bullion from Comstock ores was rapidly increased. In 1860 the yield was gold $550,000, silver $200,000; in 1861, gold $2,500,000, silver $1,000,000; in 1864, gold $6,400,000, silver $9,600,000; in 1869 the output of gold and silver dropped to $7,405,578; from 1870 to 1877 there was a rapid increase culminating in the last named year with a grand total of $14,520,614 gold and $21,780,922 silver, or a total of over $3,000,000 per month in gold and silver from the Comstock mines. From 1879 to 1895 the output varied from $7,000,000 to $1,000,000; from 1896 to 1899 there was a steady decrease until in 1899 the output was less than $200,000.

The total output of the Comstock in gold and silver to the end of 1902 is close to $371,000,000; of this sum there was about 60% silver and 40% gold. Besides the amount thus recovered, the losses are estimated at about $60,000,000 and $80,000,000, respectively, of which modern methods would have saved 70 per cent.

The discovery of the silver sulphides having been made by placer miners it was some time before the nature of the lode was understood. The first ore was found in small westerly dipping veins that connected with great masses of ore; these turned when nearing the easterly dipping foot-wall, the main fissure following this wall to a depth of 3,200 ft. below the surface. The great riches of the Comstock created intense excitement throughout the world, so that in a short time every country was represented on the spot by men interested in some phase of mining. Added to them were the speculators and gamblers. The result of their combined efforts was to cover the surface of the earth with hundreds of mining locations, for the speculators and gamblers soon discovered that mining claims had a speculative value. The main lode was soon outlined and reduced to ownership by many companies.

The high wages that were paid to the miners and mechanics attracted the most skillful of these men from the ends of the earth. The managers were thus enabled to meet the unusual difficulties of mining large bodies of ore, handling large quantities of water, and opening up new ground where the temperature was unusually high. All of these difficulties were fairly met. The quartz miners of the Comstock had penetrated the lode to a depth of 3,000 ft. within 20 years of the discovery of silver sulphides on the surface. Within that time the simple hand-windlass had been superseded by more and more powerful machinery until direct-acting hoisting engines of 1,000 hp. were being used. These engines were de-

Attachment Between Rope and Sinking Bucket.

Written for the MINING AND SCIENTIFIC PRESS
By CHAS. B. BRODIGAN.

During the sinking of the deep-level shafts on the Brakpan Mines, Ltd., in the Transvaal, a lot of trouble was caused by the sinking-bucket developing a tendency during the hoist to swing violently and foul the shaft-timbers. This trouble has been experienced in practically every deep-level shaft sunk by the aid of buckets, as distinct from skips, and it generally occurs at a depth of 1,700 to 2,500 ft. The reason for the swing is hard to determine and perhaps, when found, possesses but an academic interest. The writer decided that looking for reasons was a vain pursuit, and that the swinging was a necessary evil; the only thing to do was to shorten the connection between the rope and the bucket and so prevent the swing attaining a dangerous amplitude.

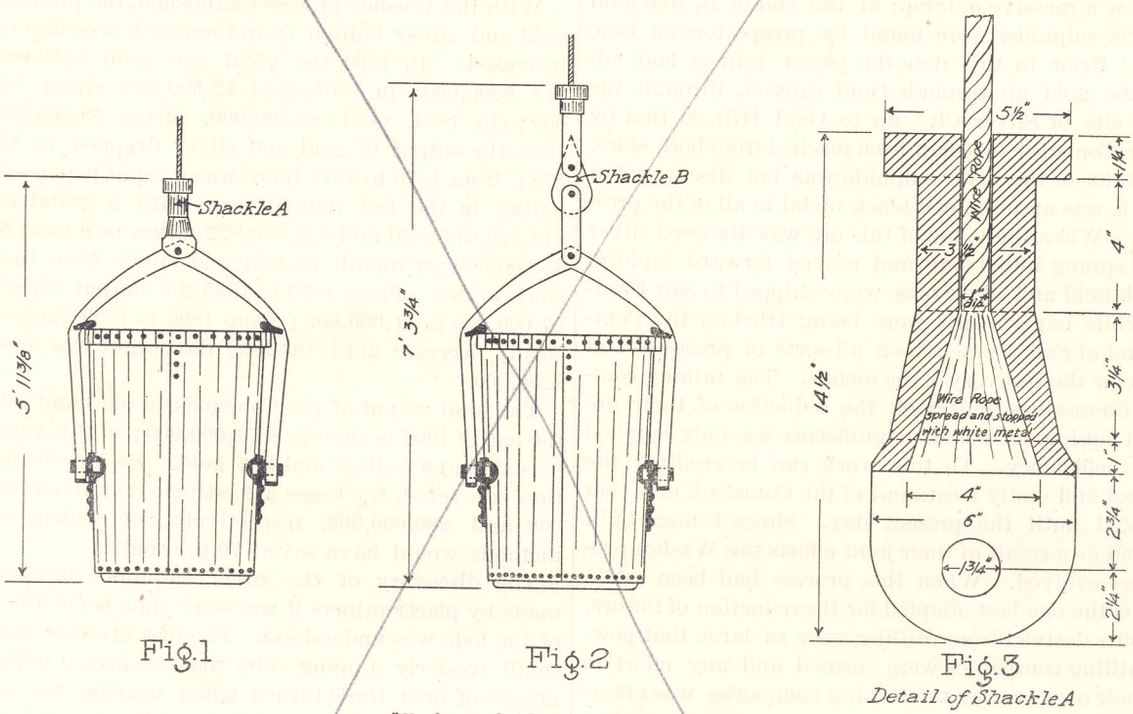
To accomplish this shortening, the 'capping' shown in Fig. 1 and 3 was designed and made. It has now been in use for four months without the slightest trouble being experienced from the swinging bucket. The construction of the attachment is clear from the diagrams, and it will therefore only be necessary to describe how the rope is fixed to the cap.

The rope is threaded through the central hole, and then the end is spread and each individual wire cleaned thoroughly. This is best effected by boiling the end of the rope in a solution of caustic soda, and then wiping the wires with a cloth. The clean wires are then dipped in a solution of zinc chloride and into a bath of molten tin. In this manner a coating of metallic tin is given to the wires, which enables the subsequent stopping of Magnolia metal to adhere firmly to them. As soon as the wires are properly tinned, the rope is pulled back until the tinned wires fill the cone of the cap; Magnolia metal is then poured in, and the attachment is complete.

As regards strength, the writer has had a capping tested in the Government Testing Laboratory, and it was found that the rope broke outside the capping, showing that the attachment is stronger than the rope. The idea of this new capping was suggested by seeing the engineer of the testing laboratory using practically the same white metal cone for testing ropes to destruction, and the only claim made for it is, that applied to hoisting ropes, it satisfied all that was required of it.

In order to illustrate the shortening that was effected by using the new capping, a sketch of the ordinary thimble splice attachment, formerly in use, is given in Fig. 2. The new form of attachment can be fixed up in a shorter time than would be taken in making a splice, the actual time taken being 45 minutes.

THE production of roofing slate in the United States in 1905 amounted to 1,241,220 squares (a square covering 100 sq. ft.), valued at $4,575,000. In 1906 the value of the product was $5,668,000. Generally speaking, the difference between a shale and a slate is that the former is straticulated parallel to the planes of deposition and the structure is due more or less to the pressure of the overlying material, while slate has more even layers, with a smoother cleavage, and has derived its slaty structure from lateral pressure, the plane being independent of the bedding and at right angles to the direction of the pressure. This makes slate an intermediate stage between a clay rock, like shale, and mica schist, and slates may be of any age where metamorphism has altered clay rocks to the slate stage. They are generally absent from the Archean, because if clay rocks did exist in that age they have been changed to mica schists; also, they rarely exist in post-Paleozoic rocks, as these have usually not been exposed to extensive metamorphism. The commercial value of slate depends upon the presence of the perfect cleavage. If jointing is too strongly marked in the deposits, too much goes on the dump as waste, as was found to be the case in the Huronian slates in Baraga county, Michigan. Good roofing slate is quite rare, as either it cannot be mined economically, or because the texture is not uniform, the color not suitable, cleavage not sufficiently, or too highly, developed, or joint planes too numerous. A good roofing slate must have only one well developed cleavage, must be massive and strong, of permanent color, and not too brittle to be cut into regular forms. The principal use is for roofing, but it also is valued for slates, strips, flagging, mantels, sills, washbowls, and many other purposes. Pennsylvania has always produced more than any other State, with Vermont second, and Maine third.



Attachment for Rope of Sinking-Bucket.

signed for work to a depth of a mile below the surface. An adit (the Sutro tunnel) was started and connected with the lode from a point in the valley of the Carson river four miles distant, thus forming a new base of operation 1,600 ft. below the surface. Powerful pumping machinery was installed at various points.

During these years of intense activity the Comstock mines were controlled by individual owners or by small numbers of men with headquarters at San Francisco. The properties were irregular in size and in the number of shares that represented them. The stock of these mines was regularly bought and sold, so that the controlling ownership often changed; but the policy of those in control was always the same: to make the most money possible out of the mines in the shortest possible time, either by manipulating the stock, or by working the mine, or by both. While the management of the mines was generally capable, the spirit of the gambling speculator dominated the situation, and when, after a splendid dash at attaining great depth the workings were threatened with hot water, a retreat was ordered and 1,700 ft. of partially developed ground was abandoned. The reason for this was the fact that no unity of interest had ever been acknowledged by those in control of the various mines on the Comstock, and even science failed to give a reasonably definite statement of what might be expected in depth.

As a vertical depth of 3,300 ft. was reached before the lower levels were abandoned, it was several years before the water again rose to the level of the Sutro tunnel. During these years many millions of dollars were extracted from orebodies that formed the margins of the old bonanzas. It is one of the remarkable features of these orebodies that they begin and end in quartz bodies, quartz being the matrix in which the ore is found, forming a central core or lens surrounded by low-grade quartz. During the mad rush to extract rich ore the heart of the bonanza was literally torn out of its quartz body and in every instance where a bonanza was mined it has paid to work the ground again. It is also true that in several instances a greater tonnage was extracted during the second period of mining than during the first, even when it was not possible to explore the ground thoroughly. Had a more conservative and rational system of mining been adopted, there can be no doubt that many of the Comstock mines would have continued to pay dividends for many years, and that the bullion production would have been much greater.

By the year 1898 the condition on the Comstock was nearly hopeless. Many of the mines were abandoned; ruin and decay were prominent. At this period a few men succeeded in getting together the loose ends of the many interests and in convincing those in control of them that to save the Comstock from complete abandonment a united effort must be made to recover the lower levels of the lode. They were so far successful that a provisional and temporary union of all Comstock interests was formed by 28 mines forming the Comstock Pumping Association. The operations of this Association were successful.

The device used for draining the mines is a modified hydraulic elevator designed to work under a head of 2,000 ft. and over. Using water under such great pressure brought forward problems in hydraulics that are not yet solved. Before $100,000 had been expended more water was discharged into the Sutro tunnel than had been discharged by the $5,000,000 worth of pumps formerly in operation. Shortly afterward it was decided to operate the mines by electric power. A company was formed that secured contracts for power paid in advance of delivery and the power plant was built. The plant is now in successful operation delivering power that is used in mining, pumping, milling, and lighting from a generating station at a point on the Truckee river 33 miles distant from Virginia City.

Of late years there have been no startling developments on the Comstock. The discovery at Goldfield and mining through Nevada, generally, has served to hold the attention of the speculative public, to such an extent that the Comstock has nearly escaped notice. But recent developments to the west and south of the Comstock may serve to attract attention to the famous lode. At Silver City, an important discovery has been made, undoubtedly the result of patient effort, for Silver City has been self-supporting for many years, and judging from the appearance of this camp at the south end of one of the branches of the Comstock lode, Silver City looks as though it could sustain itself without assessments for some time to come.

Encouraging prospects have been found in American Flat, the south branch of the lode; these, if developed, will undoubtedly revive interest in a number of mines that have been practically abandoned for years. Just west and south of American Flat, there are excellent copper prospects that have not been developed, probably because they are so near the Comstock.

The only change in the Gold Hill mines is the change of management at the Yellow Jacket. The new managers are building a large concentrating mill to work the dumps and the ores that are known to exist in the mine, but to be successful they must add a cyanide plant to their concentrating works. At the Ward Combination shaft, there is a struggle between hot water, hot air, and human endurance to get below the 2,560-ft. level. At this shaft, interesting, and what seems to be satisfactory, results were obtained with a light Starrett pump. A station is being opened on the 2,400-ft. level to install one of the series of powerful electric-driven piston-pumps on hand at the Ward shaft. Extensive repairs are being made in the Sutro tunnel. Encouraging developments have been made from the Sutro Tunnel level in the Hale & Norcross and Savage mines. Work is being planned for the Best & Belcher on the tunnel level. Tributers are still able to find ore in the Chollar Croppings. North of the Con. Virginia, all the work is confined to the east vein (which has yielded all the ore extracted since 1904) or a search for it, and no work is being done on the main lode.

To the Butters plant there has been added a modern 20-stamp mill, with table and belt concentrators, sizing devices, and tube-mills for re-grinding the coarse tailing before cyanidation. The Comstock now possesses a complete modern reduction plant that can recover at least 90%, but, unfortunately for the Comstock, this modern mill is not treating the output of the Comstock but outside ores from Tonopah that are delivered to the mill from the Virginia & Truckee Railroad by an aerial tram.

Work in the long tunnel driven into Mt. Davidson by the Hale & Norcross has been temporarily stopped at a very interesting point; there is a good stream of hot water now flowing out of the adit from a westerly dipping formation. The latest geological work on the Comstock, in which appears an account of the formation passed through by the Hale & Norcross tunnel, is given in John A. Reid's paper 'The Structure and Genesis of the Comstock Lode' published by the Department of Geology of the University of California. It is to be hoped that work on the Hale & Norcross tunnel may be resumed and the adit extended at least 1,000 ft. farther west and that the work now being done to the east of the main lode will serve to attract such attention to the main lode that rational development work will be resumed.

Rapid Hoisting With Light Equipment.

Written for the MINING AND SCIENTIFIC PRESS
By GEORGE A. PACKARD.

The visitor to the zinc-lead district of southwestern Missouri, who is accustomed to the almost continual ringing of signal-bells in the shaft-houses of the West, is struck with the quiet system, and wonderful rapidity with which the hoisting is accomplished at some of the mines in the vicinity of Joplin. For those unacquainted with the district it should be said that the ores occur in beds of limestone and chert, lying nearly horizontally, and rarely at a depth of over 400 ft. Until within a few years mining was confined to the pockets of richer ore and was done almost exclusively by lessees. As the lessees also operated their own mills, the mining and milling machinery was naturally rather crude, being constructed with a view to small first cost and possible removal.

With higher prices for spelter has come the development of large bodies of low-grade ore in the 'sheet ground,' company management, and larger daily production from a single shaft. Yet hoisting with a bucket, or 'can,' as it is locally termed, continues to be the usual practice, though the mill has a capacity of 400 tons or more. Perhaps one reason for this is found in the fact that the mills are placed close to the shaft so that no tramming of the ore is necessary after hoisting.

The hoist at the plant of the American Zinc, Lead & Smelting Co., and the results attained, may be considered as typical of the advanced practice.* The hoist is driven by a vertical engine having a single cylinder of 8 in. diam. and 7-in. stroke, under 120-lb. steam, using a double exhaust. The cast-iron pinion commonly furnished is replaced by one of rawhide, giving longer life to the gears. The single drum, loose on the shaft and driven by a clutch of the band type, is 18 by 18 in. as furnished, but is lagged up to 24 in. diam. This machine is hoisting from a depth of 320 ft., and I saw the round trip made in 42 seconds. This speed is kept up for long periods, and I was told by the manager that 620 buckets had been hoisted through the single-compartment in a 10-hour shift, of which three-quarters of an hour should be deducted for dinner. This means an average of 67 buckets per hour, or more than one each minute for an entire shift. To accomplish this only two men are necessary. The buckets, which hold from 850 to 1,000 lb., are delivered by the trammers to the station at the level. One man does all the work here. He pushes the first full bucket into place; the empty is dropped and detached; the full one is hooked on and hoisted. Before the latter is dumped and lowered the empty has been delivered to a sidetrack, from whence it is taken by the trammers, and another full bucket is ready.

On top, the hoisting engine is placed close to the line of the shaft, though at a considerable distance above the ground in order to gain dump-room. The engineer stops the bucket, hooks on to the bottom, and dumps it in the usual manner. He then detaches the hook, lowers the bucket, and after a few seconds starts hoisting again. No signals are given. The engineer simply waits what he knows is a proper time for the empty bucket to be replaced by a full one at the bottom. Then he raises the bucket about six feet, holds it for a second while the man below stops the swinging and gets it in line with the vertical shaft, and hoists as rapidly as possible to the top. The speed of the rope reaches 1,250 ft., and averages 1,100 ft. per minute. In spite of this speed the bucket is almost invariably stopped at exactly the point for attaching the dumping hook. The entire leeway between the top of the well and the sheave is only 10 ft. Of course, signals are used in handling men, timbers, and supplies; and the hoist is made extremely small, and with abnormal wearing surfaces, to stand this service.

*The hoisting-engine is of the type made by the English Iron Works Co., of Kansas City.

The Prospector.

Enquiries sent to this department are answered free of charge, if submitted by subscribers who are not in arrears. The full name and post-office address of the sender must be given, otherwise no answer will be made. Those who are not subscribers must accompany their questions with a fee of $3 for each question. No assays are made.

H. W., of Paris, Cal., sends a piece of Chalcedony.

The specimens sent by T. L. G., of St. Louis, have not been received.

Two Chalcedony pebbles were sent by F. A. F. of Tehachapi, California.

B. W., of Challis, Idaho, sends a specimen of Limonite, the hydrous oxide of iron.

The specimens sent by C. W. E., of Ashland, Ore., are: No. 1 and 3, Carbonaceous Shale; No. 2, Chlorite and Clay.

A specimen of Limestone containing small pyrite crystals was received from S. S. S., of Winthrop, California.

The specimen from Bearmouth, Mont., marked J. S., is rock stained with the red oxide and the green carbonate of copper.

The specimens from Pasto, Porto Rico, marked M. L. M., are: No. 1, Diabase with copper oxide stains; No. 2, Chloritic rock; No. 3, specular Hematite.

The specimen from Girdwood, Alaska, marked G. D. H., is a basaltic rock containing crystals and streaks of pyrite which may carry gold or copper. An assay is necessary to determine its value.

The samples sent by M. C., Silver Hill, Ariz., are: No. 1, Quartz, Feldspar, Garnet, and Pyrite; No. 2, Quartz and Feldspar with specks of bornite and chalcopyrite; No. 3, an altered volcanic, apparently a rhyolite; No. 4, Hematite in garnetiferous rock; No. 5, amygdaloidal Andesite with a copper phosphate, probably Libethenite; No. 6, altered Porphyry stained by hematite; No. 7, Quartz Porphyry.

The large share which manufactures form in the exports of the United States to all parts of the world except Europe is shown by an analysis just completed by the Bureau of Statistics of the Department of Commerce and Labor. These figures show that manufactures formed 86% of the exports to South America in 1906, 85% of the exports to Oceania, 75% of the exports to Asia, 66% of the exports to Africa, 62% of the exports to North America, while even to Europe manufactures formed 27% of the total domestic merchandise sent in the fiscal year 1906. This general group, 'manufactures,' upon which the above percentages are based, includes both manufactures ready for consumption and manufactures for further use in manufacturing. The first group includes all manufactures in the fully completed form and ready for immediate use. The second is made up chiefly of chemicals, leather, naval stores, lumber, copper in pigs, bars, and ingots, and various grades of iron and steel which have passed through a process of manufacture but are to be further used in manufacturing, such as steel bars, billets, ingots, blooms, sheets and plates, tin plate, wire rods, and pig iron.

RECENT WORK ON THE COMSTOCK.

Written for the MINING AND SCIENTIFIC PRESS
By WALTER D. O'BRIEN.

The drainage of the Comstock mines twenty-five years ago was accomplished by a pumping plant the moving parts of which weighed 6,496,400 lb. This enormous weight was raised and lowered 10 ft. nine times per minute. In the Cornish system of pumps then in use 2.7 miles of pump-rod were employed, which, with the balance-bobs, pumps, and moving parts, actually weighed 2230 lb. for every gallon of water raised. A train of cars nearly a mile long would be required to transport this machinery. Can one then wonder that when this stupendous plant was found inadequate, pumping ceased and the mines were allowed to fill with water?

The abandoned pumps, not including foundations, installation, or freight, cost about $1,300,000. Their maximum pumping capacity all told was less than 5400 gal. per min., raised to an average height of 1152 ft. The cost of operating this plant was about $58,120 per month, or $697,440 per year. This did not include the cost of broken parts, but represented daily operating expenses for pumping alone. One would think that such a plant could pump the ocean dry, but it could not handle the water of the Comstock lode. The old records show that in almost every instance where any extensive prospecting work was tried on the lower levels, heavy flows of water were encountered.

In February, 1882, a heavy flow of water from the 2810-ft. level of the Exchequer mine, estimated at 120 miner's inches, flooded the lower levels. The pumps were run to their full capacity, but the water still rose, and not being able with pumps and bailing tanks to control it, all pumping operations were stopped for good on March 28, 1882.

At the time the lower levels were abandoned, the pumps were daily discharging about 4,000,000 gal. hot water (in some places the water was, and still is, 160° F) to the Sutro Tunnel level. The expense of these operations, under the then existing conditions, was enormous, so that finally one company after another withdrew its financial support, and the greatest of all gold and silver mines were practically abandoned, until the Comstock Pumping Association was organized in 1898.

This association was originally composed of 24 mining companies, and each company agreed to defray its percentage of the expense of unwatering the mines. The water then stood a few feet below the Sutro Tunnel level; in fact, some of the South End mines were then overflowing into the south lateral of the Sutro Tunnel.

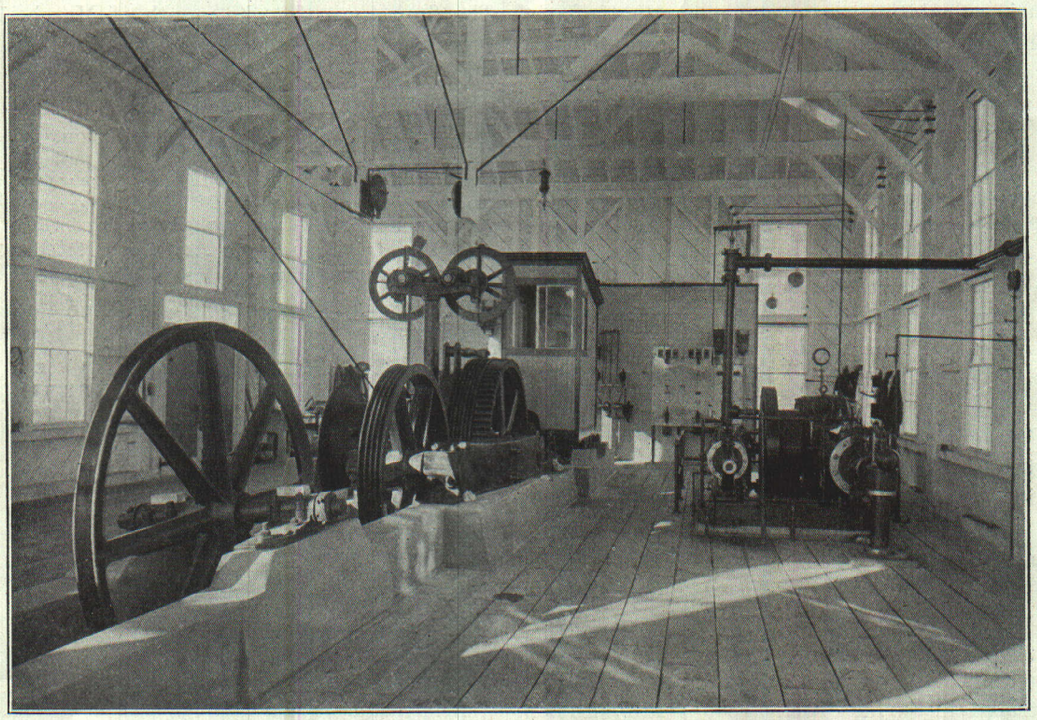


Fig. 2. Hoisting Plant at Union Shaft.

The old superintendents who had charge of the mines previous to 1886 made extensive reports on the conditions and the amount of ore in reserve before the mines were closed down. These reports showed that $600,000,000 had been extracted from the Comstock lode, and that the lower levels had not been thoroughly prospected, on account of the flow of water. In many instances known bodies of good milling ore were left in the old workings.

The best engineers in the country were then employed to devise ways and means of unwatering the mines and to design and equip the mines with the most modern pumping plants. For nine years the Pumping Association has kept alive the old mines, and the fruits of its past efforts should be realized from one to three years hence.

Instead of trying to open each of the old shafts, groups of the companies combined to repair and operate through common shafts. The shafts that drain the different mines are the C. & C. shaft and the

hundred feet of depth and totally change the metallurgical conditions.

In many regions which produce copper it has been found that this metal has been leached out at the surface and concentrated at a lower level; but in northern Sonora there are myriads of copper deposits in which the surface ores are rich, while at a depth of from 200 to 400 ft. the primary ore is reached with only a shallow zone of secondary sulphide enrichment intervening.

The surface ores are largely silicates. Varieties of dioptase predominate and yield frequently assays of 25 to 45% copper. Carbonates are relatively rare. The primary ore is generally iron pyrite containing from 2 to 6% copper, and the cleavages are usually coated with a film of secondary chalcopyrite. The practical miner and the promoter generally assume that this yellow mineral is pure chalcopyrite and base their calculations on a copper content of over 30%, much to the detriment of the ignorant investors who are attracted by their statements. In silver mines also, ores are encountered near the surface rich in native silver, horn silver, and tetrahedrite.

Two features are therefore especially notable here in respect to copper, gold, and silver: (a) that the zone of alteration is comparatively shallow; (b) that the surface ore is often extremely rich.

Since the superficial changes in orebodies are especially dependent on the action of the surface waters, we are led to consider what relation these local phenomena have to the Sonora climate. The rainfall of northern Sonora is well known to be very light. Carefully kept records are lacking, but the average precipitation at Tucson, Arizona, for 11 years was but 11 in. per year, the minimum being less than 8 in. On the other hand, the annual evaporation is upward of 60 in. It is reasonable therefore to attribute the shallowness of the alteration to the lack of water and the richness of the surface ore to lack of erosion.

The chemical actions and reactions and the exact physical conditions by which gold and silver are concentrated in surface rock are not fully known. The formation of the rich silicate ores of copper may well be due to the action of circulating waters, since the descending waters carry carbonic acid rather than silica. This is well shown by the abundant formation of the calcareous deposit known as *caliche*, its lime being in many places chiefly derived from the feldspars of volcanic rocks by the solvent action of atmospheric water. Of course, to these generalizations, there may be many exceptions. There are in Sonora, gossans underlain by commercial ores and there are many barren gossans that have never been explored. Further, in some mines relatively rich ores have persisted to a substantial depth. At La Sultana good ore is found to a depth of 1000 ft. or more. At Minas Prietas secondary enrichment has persisted to the lower levels in the rhyolite, though in the underlying granite ore is lacking. At Cananea some of the gossans covered good ore. These conditions, however, seem to be exceptional rather than regular, for this region, and may be due to special local causes, which can be determined by careful study. A fact of interest, frequently observed in Sonora, is that sulphides often occur far above the permanent water-level. This in turn must be attributed to the limited action of the surface water, which is usually the most active agent in oxidation.

It will be of interest to compare notes on these points with other observers in arid regions, and possibly some rules of the relation of climate to secondary enrichment in ore deposits may be established for the guidance of prospectors.

F. J. H. MERRILL.

Nogales, Arizona, May 29.

Cyanide Costs.

The Editor:

Sir—In view of the fact that the precipitation and clean-up costs at various cyanide plants have been recently published, the following summary of these costs at the Liberty Bell mill may be of interest. The figures are for the month of March, 1908, and therefore represent present practice; they are complete only as to labor, supplies, and power, and do not include the distributed charges of heating, lighting, superintendence, and depreciation.

Ore milled (tons of 2000 lb.)	10,548
Solution through zinc-boxes (tons)	24,510
Precipitate recovered, washed and dried (lb.)	1,275.5
Bullion from same (oz.)	16,016.8
Metal in precipitate (per cent)	86.1
Bullion fineness (gold and silver per 1000)	950

COSTS.

PRECIPITATION.		
Zinc, 4700 lb. at 8.97c. per lb	$421.60	
Cutting	65.00	
Labor	81.55	
Power and supplies	26.65	
		594.80
CLEAN-UP AND FILTER-PRESSING.		
Labor of cleaning and re-packing boxes, and de-watering precipitate (There are 12 five-compartment boxes, each compartment having 20 cu. ft. of zinc space.)		43.50
REFINING.		
Acid treatment and washing.		
1050 lb. sulphuric acid at 4.6c. per lb.	$ 48.30	
Labor	55.30	
Power and repairs	8.45	
	$ 112.05	
Drying and melting.		
Coal, 750 lb. at $6 per ton	$ 2.25	
Coke, 2500 lb. at $17 per ton	21.25	
Flux	32.75	
Crucibles	36.00	
Labor	29.00	
Repairs and sundries	3.05	
	$ 124.30	$ 236.35
Total cost		$874.65
COST PER TON OF SOLUTION.		
Precipitation		$0.0243
Clean-up and filter-pressing		0.0018
Refining		0.0096
Total		$0.0357
Refining cost per Troy ounce of bullion		$0.0148

W. A. MOULTON.

Telluride, Colorado, May 1.

Ward shaft. The Union shaft is also below the Sutro Tunnel. The mines are now drained to the 2550-ft. level of the Ward, 2450-ft. level in the C. & C., and the 2450-ft. level of the Union shaft.

By the use of hydraulic elevators, the water in the C. & C. shaft was lowered from the Sutro Tunnel level to the 2150-ft. level, it having required 200 miner's inches under a pressure of 900 lb. per sq. in. to accomplish this feat. On the 2150 level of this shaft three $6^{11}/_{16}$ by 24 in. Riedler pumps have been installed. Fig. 1 shows these pumps in place. The station containing the pumps is 20 by 20 by 119 ft. in the clear. The timbers are 14 by 14 in. and lagged. These pumps have a capacity of 4500 gal. per min. and are operated by means of three 200-hp. Westinghouse induction motors. They handle all the water in the North End mines, lifting the water from the 2150 level to the 1650 or Sutro Tunnel level, through which it is discharged.

By the use of hydraulic pumps, the water has been lowered to the 2475-ft. level, where there is installed a hydraulic pump that makes one lift of 3000 gal. per min. to the electric Riedler pumps on the 2150 level. For operating this pump 1400 gal. per min. pressure water is used, under a pressure of 1100 lb. per square inch.

On the 2400-ft. level of the Ward shaft there is an electric pump, operated by means of a 200-hp. motor at 1720 rev. per min., that makes one lift of 900 ft. to the Sutro Tunnel level, pumping 600 gal. per min.

monthly expenditures and costs of operating the pumps to unwater the mines on the Comstock lode:

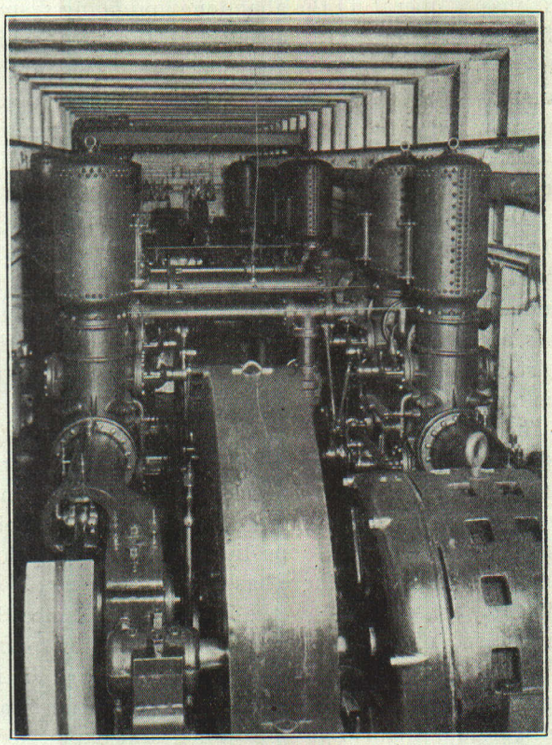
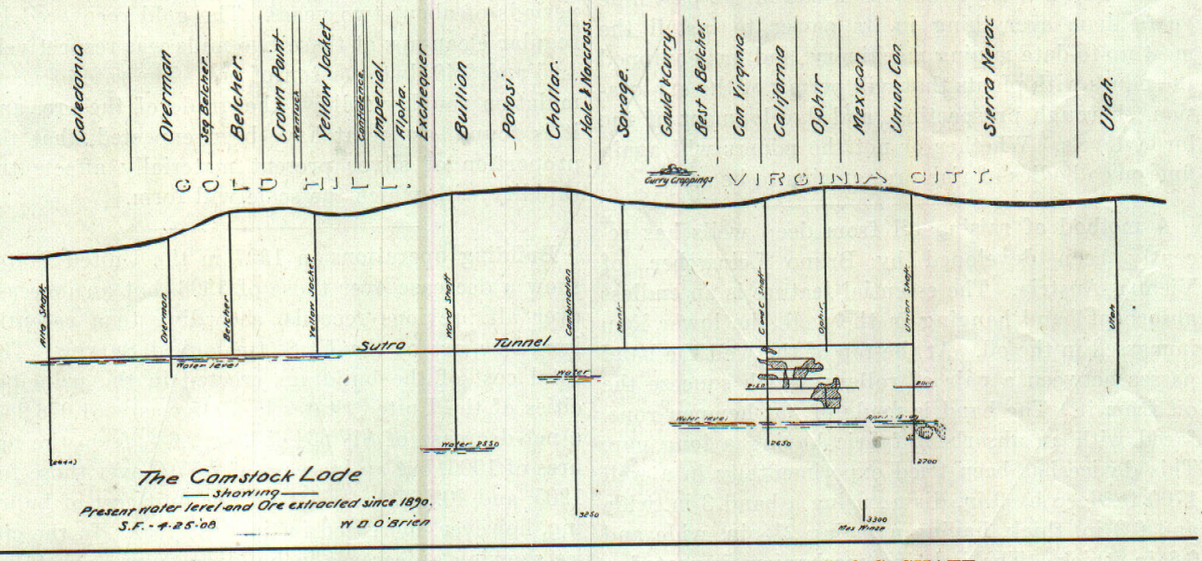


Fig. 1. Riedler Pumps, at the 2150 ft. Station of the C. & C. Shaft. Capacity 4500 Gal. per Minute.



On the 2475-ft. level of this shaft the finest electrically driven pumping plant in the world is now being installed. The capacity of this one unit of the ultimate system is 1650 gal. per min. The mine will be equipped with this unit to sink to the 3100-ft. level, where a second unit will be installed.

The cost of this new pumping system, not including installation, was about $200,000, this price covering the two new units on hand and to be installed in the Ward shaft. Compare this cost with $1,300,000, the cost of the antiquated pumping plants. The capacity of the old installation was about 5,000,000 gal. daily, as against 9,000,000 gal., the capacity of the new installation.

The following gives an itemized list of the present

C. & C. SHAFT.

Electric power	$2360
Water power	2200
Labor	900
Labor changing throats	25
Repairs and renewals	400
Oil waste, etc.	100
Compressed air	100
	$6085

WARD SHAFT.

Electric power for pumps	$1125
Electric power for compressor	400
Labor	660
Repairs, etc.	100
Oil waste, etc.	75
	$2360

The total monthly cost of pumping is, therefore, about $8445, as against $58,120, the former monthly expense of operating the abandoned pumping system, of less than half the capacity of the new, which makes a saving of $596,100 per year. The present pumps also save from $50,000 to $100,000 on repairs and new parts not included in the above saving.

A hoisting plant recently installed in the Union shaft is shown in Fig. 2. It is operated by means of a 100-hp. General Electric motor. This hoist handles 20 tons an hour from the 2000-ft. level, at a cost of about 3 cents per ton for power. This does not include expense of engineering or mining. The hoist uses a continuous cable with two cages. A similar hoist is installed at the C. & C. shaft and is set up back of the old steam hoist now in use.

The accompanying tabulated statement gives a list of the shafts that have been opened up below the Sutro Tunnel level and the orebodies extracted since the organization of the Comstock Pumping Association. Outside of the Consolidated Virginia, Ophir, Mexican, and Union, there has been little or no development work done below the Sutro Tunnel since the unwatering of the Comstock. When the new pump is installed on the 2475-ft. level of the Ward shaft, connections can be made with the Combination shaft and the mines can then be drained and explored to a depth of 3100 ft. with good ventilation.

From the foregoing, it can be readily seen that the management of the Comstock mines, through the Comstock Pumping Association, has in the past nine years done everything in its power to install the most up-to-date mining machinery, and has equipped the mines with plants that will permit of the exploration, thorough prospecting, and development of the lower levels. Whether or not the miners will again find large bodies of rich ore remains to be seen.

A method of raising oil from deep wells has recently been developed by Bruno Leinweber, of Vienna, Austria. The essential feature is an endless absorbent band hanging in the well, the lower loop immersed in the oil. At the top of the well the band passes between a pair of rollers, which squeeze the oil from it. The band is made of flat hempen rope, faced with an absorbent fabric having a long nap. This device has been tried experimentally in a well 1700 ft. deep by 9 in. diam., using a band 3 in. wide and 0.3 in. thick, having a facing 2½ in. wide and 0.8 in. thick. The hoisting mechanism imparted a speed of 8 in. per second to the band. In spite of this slow speed, and other imperfections in the details of the machine, the oil was raised at the rate of 0.85 lb. per yard of band-length. It is claimed for the device that it may be used to depths of 5000 ft., in either vertical or inclined bores, and is applicable for lifting the heaviest and thickest oils, as well as those containing paraffine and sand.

Molybdenum may be determined qualitatively by adding H_2O_2 to concentrated solutions, followed by a little excess of NH_4OH, producing a brownish red color. The color is discharged by large excess of NH_4OH or by dilution. A perceptible reaction was observed with 0.001 mg. MoO_3.

ACCUMULATION AND ABSORPTION OF GOLD AMALGAM BY COPPER PLATES.

In the bulletin of the Institution of Mining & Metallurgy, Edward Halse gives the results of experiments showing that actual absorption of gold into the copper is practically a negligible quantity, in no case exceeding a fraction of a grain to the ton of ore milled. A separate paper on the same subject by W. F. A. Thomae expresses a judgment in full accord with this, setting the limit of absorption at not more than 10 oz. to a plate 4 ft. 6 in. by 12 ft. The experience of Arthur L. Collins at the Hidden Treasure mill, at Black Hawk, Colorado, is recalled, where plates in use 10 years yielded 8 oz. fine gold after being thoroughly scoured. It is pointed out that a copper plate will absorb mercury to saturation, which point is reached at about 1%, in approximately 16 days. The gold, instead of penetrating the copper, tends to accumulate in the form of hard scale upon its surface. The effect of silver-plating is to restrain absorption at first, since the mercury has to diffuse through the silver, but eventually the absorption reaches saturation as in the case of plain copper. The rate and amount of accumulation of hard scale varies extremely under different conditions. Comparisons between long-continued observation on this point at the Drumlummon mill, in Montana, and at the Sucre mill, in Colombia, show such wide discrepancies as 0.499 and 1.721 dwt. fine gold per ton of ore milled at the two places through periods of about two years. The gold recovered by regular clean-ups at these two mills was respectively 4.65 and 9.49 dwt. per ton of ore. The rate of accumulation roughly follows the grade of the ore, and it is found, as might have been expected, that the proportion of silver present materially affects the rapidity with which the scale will form.

Building operations in 1907 in the United States show a decrease over those of 1906, but an increase over all previous records, according to a recently issued report of the U. S. Geological Survey. The total cost of the buildings erected in the principal cities of the United States in 1907 was $661,076,286, a net decrease of $17,634,683, or 2.6% from the figures of 1906, but an increase of 2.55% over those for 1905, and 40.86% over 1904. The unit cost of building, however, increased in the past year. In the cities showing a decrease in building, New York takes the lead with a falling-off of $41,591,982, or 26.84%; St. Louis is next with $8,045,526, or 26.87%; Chicago next with $5,616,245, or 8.68%, and Brooklyn last with only $149,304, or 0.21%. Naturally, San Francisco leads the list in the increased building operations. The total number of building permits issued during 1907 was 12,126, for buildings to cost $91,502,240, an increase of 162% over the building in 1906. In 1905, before the fire, the cost of building operations was only $18,268,753.—*Engineering News.*

To anneal the core of an electro-magnet, first heat it to a low red and cool in soft soap; then reheat it to the same point and allow it to cool while covered in slaked lime.

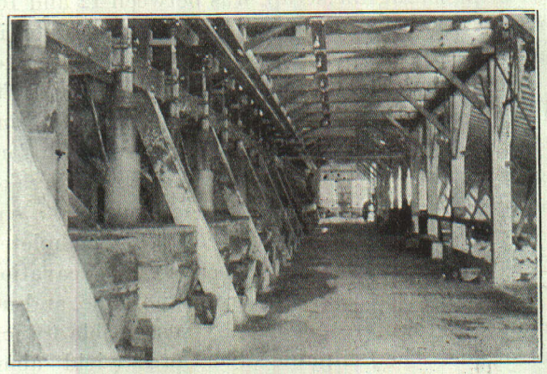
YELLOW JACKET MILL, COMSTOCK LODE.

Written for the MINING AND SCIENTIFIC PRESS
By WHITMAN SYMMES.

The Yellow Jacket Mine, at Gold Hill, is the first mine on the Comstock Lode to attack the problem of low-grade mining. The mill was completed in February, 1908, and since then has been regularly treating about 180 tons per day. The management is attempting to solve the problem by simple concentration. The men in charge take the view that they can concentrate ore that assays as high as $8 per ton and leave less than $2 in the tailing, and they maintain that their $2 tailing cannot be cyanided at a profit. On the other side of this milling debate is Charles Butters & Co., Ltd., who have 20 stamps, two tube-mills, and a 250-ton cyanide plant in the canyon two miles below Virginia City. In March, 1908, this Company obtained leases on the Chollar and Potosí croppings, and has since been doing considerable work in opening up the two old surface-tunnels and their many drifts. Mr. Butters appears to be preparing to work ore that assays as low as $7. He must pay 18% of the bullion-value to the lessors, the usual 4% royalty to the proprietors of the Sutro tunnel, and also the local taxes. Therefore he will have to mine, mill, and cyanide for less than $5 per ton, in order to make a profit on $7 ore with 90% extraction. His work will be watched with a double interest, for it is understood that he will undertake to reduce expenses by cutting out concentration, with its attendant shipping expenses, as much as possible, and will substitute cyanidation of the sulphides. Low-grade mining opens new possibilities on the Comstock, and there is an immense tonnage awaiting a solution of the problem. The Yellow Jacket mine has a bullion-record of $19,000,000. The lower levels were flooded in 1882, and the mine was then worked in the upper levels for the lower-grade ore which had been passed by in the bonanza days. The water now stands a little below the 1400-ft. level, but the mine is not open below the 1100-ft. level. In 1906 H. L. Slosson and associates bought control of the mine on the Stock Exchange, and took over the management from the Morrow-Sharon interests. The latter gentlemen had previously held undisputed sway in Gold Hill, but they did not own the stock of the mines that they managed. The new owners are now working the low-grade ore in the out-croppings, and are preparing to work the 'gold vein' between the 1100 and 1500-ft. levels, until such time as the water is lowered and access can be had to the deeper workings. Before acquiring control of the mine Mr. Slosson had a verbal option on the Yellow Jacket dump, which was supposed to contain 200,000 tons that would yield a profit of $1 per ton; but the promotion missed fire. The mill has been placed convenient to the dump, and about 2000 ft. from the hoist; but silver has fallen from 70c. per ounce to 52½c., and the dump is not now so highly cherished.

Yellow Jacket Hoisting-Works, Gold Hill, Nevada.

Formerly Mr. Slosson sold Kinkead mills for Henshaw, Bulkley & Co., of San Francisco, and when he acquired the Yellow Jacket property he had the courage to swallow his own prescription—the mill he erected has twenty of them. The Kinkead mill at Goldfield has passed to the cemetery; and when Charles Butters & Co. leased the Kinkead mill in Virginia City belonging to the Best & Belcher Co., the operation was said to have been accompanied by



Interior of Yellow Jacket Mill.

costly repairs and extensive profanity. But the inventor seems able to keep his machinery in a better humor. The Kinkead Mining & Milling Co. began operating on the C. & C. dumps in Virginia City, and for several years past has been running without intermission on ore from the Ophir. The new type of crusher in the Yellow Jacket has also run for four months now without trouble. Mr. Kinkead superintends both of these installations. The Kinkead mill consists of a bowl, 40 in. diam., and an inverted mushroom for a muller. The stem is given a small eccentric motion, at 240 revolutions per minute; the ore is fed in through a hole in the centre of the muller, and discharges through screens on the periphery. The total weight on the muller, including the shaft, is about 5000 lb. The original claim for the mill was that it did not slime the ore; but there are considerable quantities of silver sulphide floating on the vanners when working the Ophir $30 ore.

At the Yellow Jacket the ore from the breaker is ground to 40 mesh in the mills, and is then classified into three parts, in home-made box-classifiers, one for each two mills. The concentrating room has 30 six-foot, plain-belt, Risdon-Johnston concentrators, in three rows, each row taking one size from the classifiers. In April 1908 the mill treated 4632 tons of ore assaying from $5 to $7 per ton, and extracted 178,000 lb. of concentrate. The value in the concentrate was 75% gold and 25% silver. The concentration was 52 into 1, and the extraction was about 70%. The tailing assayed from $1.25 to $1.86 per ton and the average was close to $1.75. In May 1908 the mill treated 5472 tons, and all but 750 tons was oxidized ore from the outcrop. One-third the value was silver and two-thirds was gold. The extraction by concentration was 68%. The concentrate generally assayed about $175, but one shipment went $579. The expenses of mining and milling were a little less than $18,000 or $3.30 per ton. Allowing for smelter-deductions, the cost was about $3.50 for a 68% recovery. The milling and concentrating cost about 75c. per ton, and the cost of shoes and dies, after selling the scrap, was between 12 and 16c. per ton. The cost of marketing the concentrate, including smelter-deductions, amounted to 54c. per ton of original ore. The breaker runs two 8-hr. shifts. The mill runs three shifts, with two men at a time at the mills and two at the concentrators. Mill foremen work one shift only. The mill and rock breaker averaged, by meter, 115 hp. for the month, at a cost of $5 per hp.-month. The mill cost when completed, $82,000, of which $8000 was expended for excavation.

There are three classes of ore in the mine, and unfortunately they are not equally susceptible to concentration. The sulphide-silver ores yield about 70%. The oxidized outcrop yields between 60 and 70%, and only 50% of the silver content is extracted. The 'gold vein' on the foot-wall, has practically no silver, and yields by concentration fully 80% and sometimes as high as 88. Each month the drop-boxes below the Kinkead mills are cleaned out and the sand is panned with quicksilver. About $1200 is thus obtained, which is nearly all gold. If the simple concentration-process adopted by the Yellow Jacket has any advantage, it is evident that it can hold that advantage only below a certain limit, which is determined by the cost of cyaniding. The Kinkead Mining & Milling Co., at Virginia City, is working $30 ore from the Ophir, using Frue vanners, without classification, and also a small canvas plant. The concentration is 33 into 1, and the extraction by concentration for six months has averaged about 71% on the mine-car samples, and 75% on the mill-pulp assays. The gold extraction was 84% and the silver 59, based on battery assays. The tailing assayed from $5 to $8 and were sold to the cyanide plant of Charles Butters & Co. The Yellow Jacket has not given the final solution of the problem of working the immense quantities of low-grade ore in the Comstock veins, but it is the first mine on the Lode to mine and mill its ore at as low a figure as $3.50 per ton.

The Prospector.

This department makes a charge of 25 cents to subscribers not in arrears and $3 to non-subscribers for each determination.

A. M. M., Millspaugh, California: Amphibolitic schist, derived from a basic igneous rock; shows some pyrite.

F. J. S., Goldfield, Nevada: Hornblende-andesite altered by carbonate waters that deposited metallic sulphides in the rock.

J. V. R., New Denver, B. C.: Highly altered rock, probably andesitic, decomposed by carbonated mineral waters and filled with calcite and pyrite.

W. C. R., Nashville, Arkansas: Thoroughly decomposed plutonic (crystalline) igneous rock, probably originally a gabbro.

W. S. S., Silver Peak, Nevada: No. 1, quartzite; No. 2, decomposed obsidian showing iron spots; No. 3, garnet; No. 4, obsidian, showing effect of earth movements.

H. G. G., Gold Circle, Nevada: No. 40, andesite, partly decomposed and leached of most of its iron; No. 41, pitchstone—volcanic glass; No. 42, nearly fresh andesite; small traces of a mineral looking like cinnabar were present but in too small amount to test; No. 43, nearly fresh andesite showing flow-planes; No. 44, andesite, altered and showing flow-planes; No. 45, altered andesite.

C. E. S., Sweetwater, Nevada: No. 1, missing; No. 2, quartzite; No. 3, schist, derived from basic igneous rock, probably andesitic tuff; No. 4, sericitic silicious schist, partly decomposed and filled with limonite seams containing traces of sulphides; No. 5, silicious schist with traces of sulphides nearly completely removed; partly stained with limonite; No. 6, impure mixture of iron silicate, limonite, calcite, and some silver; No. 7, biotite-andesite; No. 8, fluorite on quartz and stained with earthy oxide of manganese.

expectation that a profit would result commercially, the mill undoubtedly gave a very fair test as to what could be expected from the ores when treated on a large scale in a mill fully equipped for handling the ore in the most economical manner. The test also resulted in a complete re-sampling of the mine in sections of practically 30 or 40 ft. Each level was taken by itself, and the test made consisted of ore taken along a drift or cross-cut as nearly equal as possible over a length of 30 or 40 ft. Every eighth shovelful of this ore was thrown upon a sample-sheet at the head of the mill, and at night before the mill was finally closed, this sample was coned and quartered in the usual way, and the remaining portions of the sample put through the plant. The mill was sampled every half-hour, and thoroughly cleaned up every night; that is, samples were taken of the feed into the first compartment of the classifier, of each machine-heads and tails, of the round-tank slime, and of the tailing down the canyon. These samples were carefully decanted, dried over night, and assayed the following day. The mill was operated for two or three days before being put in regular commission on September 11, 1904, and was operated daily thereafter until December 1, during which time 48 separate recovery-trials were made. The results on all of these tests are set forth in the table herewith. The percentage of copper in the shovel-sample refers to the percentage in the shovel-sample, being every eighth shovelful of ore that was shoveled onto the grizzly. The map-average refers to the samples that were taken from day to day as the mine was developed, over every five-foot section. It will be noted that the map-average is somewhat higher than the shovel-sample, and considerably higher than the average of the percentage of copper in the crude ore, which was the sample taken every half-hour from the spout of the Huntington as it discharged into the first compartment of the classifier. A daily detail-sheet was compiled showing the work of each machine, a copy of one of which is presented hereto. Unfortunately, this is the only detail-sheet in existence, the originals all having been destroyed in the San Francisco fire.

It is an interesting fact that the result of some 150 assays made by the cyanide method, and compared with the same number from the same pulp made by the iodide method, showed a variation of 0.12%, the iodide being the greater. Cyanide was found to be entirely satisfactory on low-grade mate-

DAILY ASSAY REPORT.

EXPERIMENTAL MILL.

Run November 25, Lot No. 51. Ruth, Nevada, November 27, 1904.

	Copper %	Concentrate Produced Lb.	
General Head—Shovel-sample	3.27		
Mill-head	3.29		
General Tailing	1.01		
General Concentrate			
Apparent recovery, %	69.30		
Wilfley:			
Head	3.13		
Tailing	2.44		
Concentrate	12.69		900
Middling	14.88		
Slime	2.06		
Apparent recovery, %	22.00		
Frue No. 1:			
Head	2.47		
Tailing	1.45		
Concentrate	15.37		600
Slime	....		
Apparent recovery, %	41.00		
Frue No. 2:			
Head	1.37		
Tailing	0.80		
Concentrate	6.95		150
Slime	....		
Apparent recovery, %	41.00		
Johnston No. 1:			
Head	1.78		
Tailing	....		
Concentrate	14.76		600
Slime	....		
Apparent recovery, %	....		
Johnston No. 2:			
Head—Slime tank	1.64		
Tailing	1.07		
Concentrate	6.95		200
Slime	....		
Apparent recovery, %	35.00		
V Tank:			
Elev. returns	2.83		
Compartment No. 1	....		
Compartment No. 2	....		
Compartment No. 3	....		
Compartment No. 4	....		
Compartment No. 5	....		
Round Tank Slime	1.64		2,450

	Cars Crude Ore.	Gross Weight Lb.	Moisture %	Net Weight Lb.	Copper %
	7	13,439	5.50	12,700	3.29
Concentrate		2,257	14.25	1,935	14.27

SCREEN ANALYSIS.

ELEVATOR RETURNS.

Mesh.	Weight %	Copper %	Total Copper %
On 20	12.6	2.39	10.9
On 30	12.4	2.54	11.4
On 40	19.2	2.50	17.3
On 60	18.4	3.06	20.0
On 80	5.7	4.10	8.4
On 100	5.0	3.90	7.0
On 200	8.7	2.84	8.9
On 200	18.0	2.45	16.1
	100.0		100.0

SCREENS USED.

Trommel, 3 mm. Mill, 3 mm.
Wilfley, 1 mm.

DETAILS OF TESTS ON 500-FT. LEVEL.

Date, 1904.	Lot, No.	Dry Crude Ore, Lb.	Crude Copper, %	Copper Tailing, %	Approximate Extract, %	Dry Concentrate, Lb.	Copper Concentrate, %	Copper Crude Copper, Lb.	Copper Concentrate, Lb.	Actual Extract, %	Ratio.	Shovel-Sample Copper, %	Shovel-Sample Copper, Lb.	Map-Average Copper,	Map-Average Copper, Lb.
Sept. 11...	1	32,570	3,235	1.29	60.00	4,237	16.10	1,054	682	64.70	7.68:1	3.40	1,117	3.49	1,136
" 14..	2	29,296	5.315	0.97	79.90	6,714	18.57	1,557	1,247	80.00	4.36:1	5.48	1,605	5.57	1,632
" 24...	3	140,204	2.800	0.67	76.00	21,088	13.05	3,925	2,752	70.00	6.65:1	2.97	4,164	3.06	4,290
" 27...	4	19,350	3.200	1.46	54.40	3,154	10.68	619	337	54.50	6.14:1	3.37	652	3.46	659
" 30...	5	14,264	1.240	0.64	48.40	2,070	6.40	176	132	75.00	6.90:1	1.41	201	1.50	213
Oct. 3...	6	31,835	2.600	0.44	83.36	4,209	16.71	830	703	82.29	7.56:1	2.77	881	2.86	910
" 4...	1	11,495	5.050	0.98	80.59	2,680	17.57	580	471	81.21	4.25:1	5.40	621	4.85	557
" 5...	2	11,767	1,910	0.85	55.50	1,728	5.43	224	94	41.96	6.81:1	1.89	222	2.22	261
" 6...	3	12,200	1.960	0.53	72.90	1,681	7.89	239	133	55.65	7.25:1	2.00	244	2.27	276
" 7...	4	12,620	1.910	0.32	83.20	2,228	9.76	241	217	85.90	5.66:1	2.00	252	2.42	305
" 8...	5	10,648	2.400	0.24	90.00	1,470	14.40	255	212	87.00	7.24:1	2.50	266	2.93	312
" 9...	6	10,825	2.700	0.51	81.11	1,715	14.27	292	244	83.56	6.31:1	2.70	292	3.20	346
" 10...	7	10,830	2.600	0.47	82.00	1,500	13.80	281	207	73.70	7.22.1	2.77	300	2.53	274
" 11...	8	12,272	1.860	0.37	80.10	1,206	13.55	228	163	71.50	10.17:1	2.00	245	2.18	267
" 12...	9	12,322	2.190	0.56	74.42	1,642	14.15	270	232	85.92	7.50:1	2.44	301	2.28	281
" 13...10		11,877	2.710	0.82	70.00	1,925	11.93	322	230	71.46	6.17:1	2.89	343	3.14	373
" 14...11		11,622	1.700	0.49	71.17	1,667	8.47	197	141	71.57	6.96:1	1.73	211	2.48	288
" 15...12		11,137	1.870	0.38	79.68	1,461	12.29	208	179	86.05	7.62:1	2.11	201	1.98	220
" 16...13		12,215	2.440	0.36	85.00	1,582	14.55	298	230	77.19	7.72:1	2.86	349	2.82	344
" 17...14		11,752	2.410	0.38	84.23	1,545	16.00	283	247	87.27	7.61:1	2.48	291	2.65	311
" 18...15		11,636	1.980	0.24	87.87	1,223	14.30	230	175	76.08	9.52:1	2.10	244	1.90	221
" 20...16		11,490	1.830	0.35	80.00	1,428	11.03	210	158	75.24	8.04:1	1.91	219	2.14	246
" 21...17		11,458	3.050	0.70	77.00	1,492	19.50	350	291	83.14	7.68:1	3.59	411	2.83	324
Total	465,685	58.960	14.02	1,736.83	69,648	300.40	12,869	9,477	1,720.89	163.00		62.78	13,632	64.76	4,046
Average		2.560	00.61	75.51	.....	13.06	.....	....	74.79	7.09:1		2.73	.....	2.81	....

Composite lot, 71,323 lb., 14.76% Cu, 22% Fe, 27.5% S, 30% SiO_2.

RECAPITULATION: 500-FT. LEVEL.

Per cent copper in crude ore as per above average shovel sample	2.73	Lb. copper concentrate as per above statement	9,477.00
Per cent copper in crude ore as per above average map average	2.81	Lb. copper in composite lot	10,527.00
Per cent copper in crude ore as per above average mill-heads	2.56	Lb. copper lost in tailing (12,869—10,527)	2,342.00
Per cent copper in crude ore as per lb. Cu in crude ore (12,869÷465,685)	2.76	Per cent apparent extraction as per above average	75.51
Per cent copper in tailing as per above average	0.61	Per cent actual extraction as per above average	74.79
Per cent copper in tailing as per lb. copper lost (12,869—9,477)÷465,685	0.72	Per cent actual extraction as per lb. copper (9477÷12,869)	73.64
Dry lb. concentrate produced as per above statement	69,648.00	Per cent actual extraction as per lb. copper in composite lot (10,527÷12,869)	81.80
Dry lb. concentrate produced as per composite lot	71,323.00	Per cent actual extraction as per lb. copper in shovel sample (10,527÷13,632)	77.22
Lb. copper in crude ore as per above statement	12,869.00	Per cent actual extraction as per lb. copper in map average (10,527÷14,046)	74.94
		No. of lineal feet of cross-cuts sampled and milled	825.00
		Lb. of crude ore milled per lineal foot	564.00

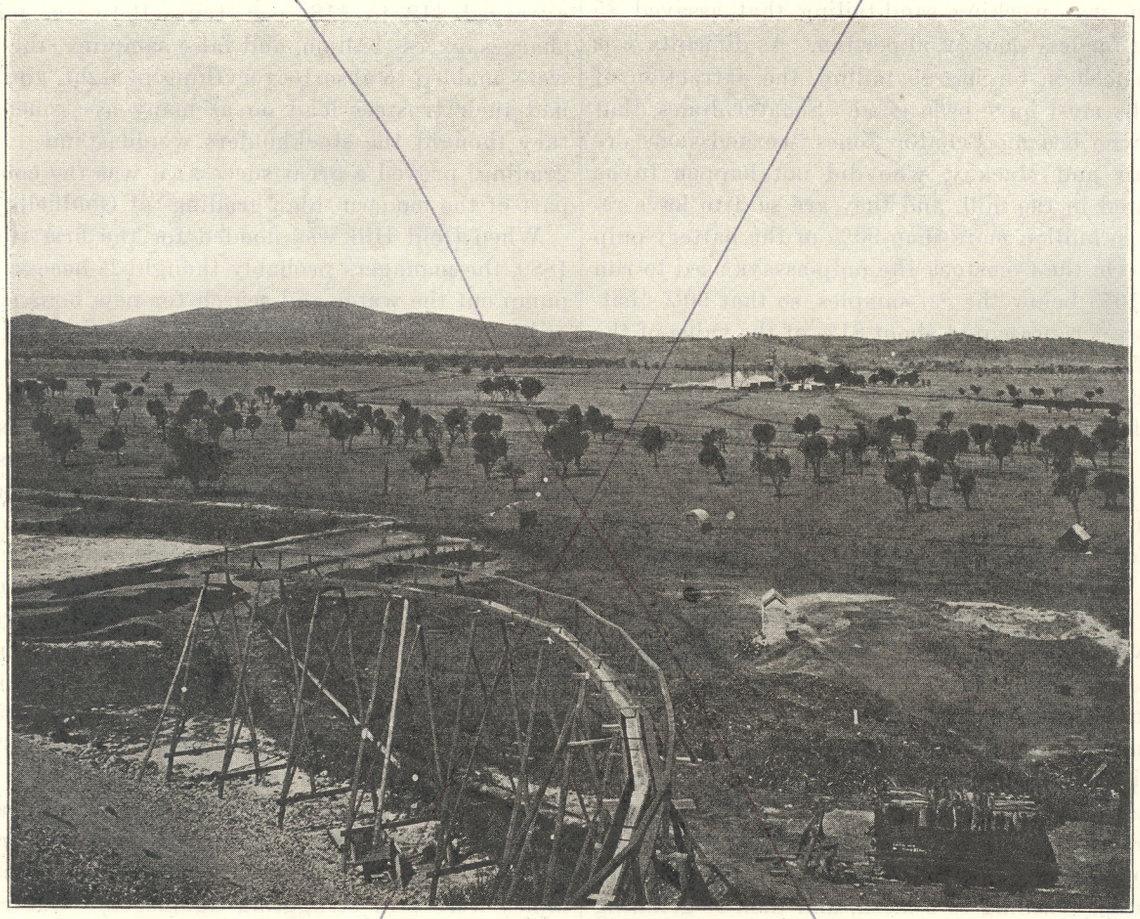
FINAL SUMMARY OF RECOVERY TRIAL.

Total lb. of dry crude ore delivered to mill	751,695.000	Pounds copper per ton of crude ore as per shovel-sample	56.300
Total lb. of concentrate produced	114,529.000	Pounds copper per ton of crude ore as per mill-heads	52.500
Ratio of concentration	6.56:1	Pounds copper recovered as per composite lot samples	41.930
Total lb. of copper in crude ore as per shovel-sample	21,169.000	Per cent copper lost in tailing as per shovel-sample	0.580
Total lb. of copper in crude ore as per mill-heads	19,735.000	Per cent copper lost in tailing as per mill-heads	0.530
Total lb. of copper in concentrate as per composite lots	15,758.000	Per cent actual extraction as per daily shovel-sample	74.500
Total lb. of copper in tailing as per shovel-sample	4,411.000	Per cent actual extraction as per daily mill-heads	79.700
Total lb. of copper in tailing as per mill-heads	3,977.000	Total number of feet of cross-cuts and drifts sampled and milled	2,185.000
Per cent copper in crude ore as per shovel-sample	2.815	Average number of pounds of ore taken per foot of cross-cuts and drifts	344.000
Per cent copper in crude ore as per mill-sample	2.625		

close on each side. A door about 6 in. thick is hung with strong hinges in such a way that a man can close it easily behind him, being cut in two on the bevel in the same way as a stable door. These doors are not made air-tight, as the compressed air in the event of an inrush of water would blow them out. Experience has shown that where there are a number of these doors along a level, a large accumulation of sand may be found between the doors nearest the face, but the sand will not, as a rule, reach the pumps.

When the mine has been drained, or at least the great pressure of water taken off, and not till then, is it practicable to open up the lead in a systematic and profitable manner; but managers have frequently found it difficult to convince directors and shareholders of this fact, so they have been forced to drive into the wash, with disastrous results to all concerned. The proper time to attempt to open up the wash is after several bore-holes have eased so much that they have started to draw in air, and the pressure-gauge indicates about 20 ft. of water above bedrock, and even then it is advisable to be extremely cautious and attend to everything likely to insure the safety of life and property. A short cross-cut should be driven off the main level at a point outside the deepest run of wash, and a door hung near the opening. A raise should then be constructed near the end of the cross-cut, and opened out in bedrock, the back of the drift being slightly above the level of the deepest wash proved by boring over the back of the main drift. About 12 ft. from the top of the raise another door should be hung, so that in case of a rush of water the men could close the door and so be enabled to descend the 'jump-up' safely.

In conclusion it may be remarked that deep-lead mining has been somewhat under a cloud for several years, but this is due principally to the great cost entailed in pumping out the heavy flow of water, and not because the gold-content of the leads is much inferior. These periods of inactivity have recurred at intervals in the past, and then some mine would make a discovery that would give an impetus to the industry sufficient to cause fortunes to be made and large areas prospected. At present the outlook is promising, as some of the mines with famous histories are approaching that stage when shareholders expect to be rewarded for their outlay.



The Loddon Valley Deep-Lead Mine, Victoria.

Paper from rice straw is reported to be a commercial probability, according to experiments recently made at Bargor, Maine. It is claimed that $2 per ton may be realized in the rice straw which is now wasted.

Emery was produced in the United States during 1907 at but two localities—Chester, Mass., and near Peekskill, N. Y. The total amounted to 1069 short tons, valued at $12,294.

The world's coal production during 1907 amounted to 1,209,184,109 short tons, of which the United States furnished 480,363,424, or nearly 40 per cent.

DECLINE AND REVIVAL OF COMSTOCK MINING.—II.

Written for the MINING AND SCIENTIFIC PRESS
By WHITMAN SYMMES.

In the early sixties, many mines put up their own mills, but the men who controlled the mines soon separated the mining from the milling business, and held the mills as their private graft. The 'bonanza firm' privately owned the mills that worked the Con. Virginia and California ores; they likewise owned the Omega mill, which worked the tailing from their other mills. By 1876, the Comstock mill-men had learned how to get a pretty good extraction from the ore. The best managed of these, the Lyon mill, at Dayton, was working sand-tailing that assayed $5 per ton for less than $2.50 per ton. As difficulty was experienced in buying $5 tailing, the extraction of the mills must have been good. Senator Jones, that is, he who became Senator Jones, worked some ore for Fair and Mackay, who did not happen to be interested in the mill, and they are said to have received in bullion more than 90% of the battery-pulp assay. On the Comstock the pulp-assays used to run about 10% below the car-samples, so that 90% 'battery-assay' represented about 81% of the value of the ore. The mines did not have their own assay-offices, neither did the mills, but there was a general assay-office for the mines and mills controlled by each 'ring.' The mines did not sample the ore shipments, but let the mill-men do it; this was in the interest of economy, as it was manifestly unnecessary for the same partnership to sample the ore twice. The mills were supposed to return to the mines in bullion not less than 65% of the average battery-assay (which would be equal to about 58.5% of the car-sample assay). There are but few examples on record where the mills returned more than they had to. In 1876 the Belcher mine shipped to the mills 131,328 tons of ore yielding returns of $2,920,460 in bullion, an average of $22.23 per ton. For milling the mine paid the sum of $1,534,925. The mills on the Carson river (putting through 4 tons per stamp, crushing to 6 mesh, and then re-grinding in pans) worked for about $3.50 per ton. At first they paid $2 for transportation, and later $1. They charged the Belcher $10 for milling and transportation, thus making a profit of $4.50 per ton, or $590,000. In 1876 they probably extracted about 85% of the battery assay-value and delivered to the mine 65%. Thus they retained 30% more bullion than they delivered to the mine owners. The mill profits were thus $590,000 from milling charges and $875,000 from excess bullion, making a total profit of $1,465,000 from the Belcher alone, while the mine accounts for the same year showed a loss of $600,000. Crown Point was similarly looted, and during the year its stockholders were assessed $500,000. These operations were made possible by the trustee system; the five directors of the Crown Point in 1876 held an aggregate of only 175 shares.

The Comstock mines, which produced more than $25,000,000 in 1875, produced only $5,300,000 in 1880, and $1,700,000 in 1881; in fact, at the end of 1880 not a stamp was dropping on Comstock ore—all the mines were exploring for new bonanzas between the 2000 and 3000-ft. levels. The profits of the mill-men had disappeared, so they began a new deal. In January, 1881, Sam Jones started 16 stamps at the Mexican mill on Crown Point ore, taking the poorer rock that formed the periphery of the old bonanza orebody, and which had previously been considered too poor to pay. In April the Vivian mill started on Belcher ore, and the Brunswick followed on ore from the Yellow Jacket. It was not long before the Belcher was producing as much as 6500 tons per month, Crown Point 6000, and Yellow Jacket 5000 tons. The bullion returned by the mills to the Gold Hill mines during the eighties generally averaged $12 to $18 per ton. Between milling charges, excess bullion, and false sampling, the mills were enabled to absorb everything in sight, and they had their trustees load on as many assessments as they thought the stockholders would stand. 'Low-grading' proved a great success; it was the counterpart of the modern 'high-grading' at Goldfield.

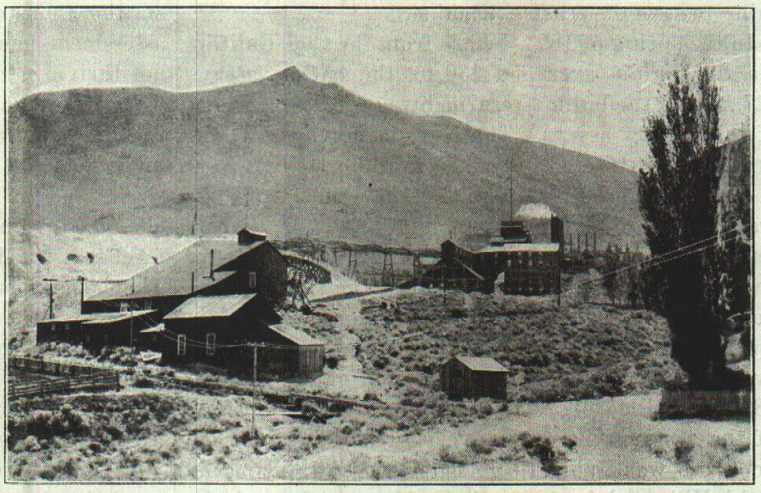
When Gold Hill was flooded for the first time in 1880, the managers probably thought it necessary to pump out the water and search for new bonanzas in order to find ore for their mills. When Gold Hill was flooded for the second time in 1882, they saw that pumping was unnecessary. They had then been milling low-grade ore from the upper levels for nearly a year. Why should they spend the assessment-money in pumping and in deep exploration, when they could divert an equal amount into the milling business, which was the same as their private bank account? Gold Hill remained flooded, and J. P. Jones carried the low-grade system into Virginia City. In 1885 he fixed up a deal with the Consolidated California & Virginia (consolidated November, 1884), leasing the ground above the 1550-ft. level at a flat rate of 50c. per ton, which was 3% of the bullion he says he took out. At the same time the Con. California & Virginia Co., having abandoned its lower levels to the flood, went to work on the 1750-ft. level. By April, 1886, when the middle mines were still struggling against the water and heat near the bottom of the Combination shaft, 'low-grading' was such a success that there was not an idle mill in the district. During 1887, 30,000 tons per month was being crushed. The bullion output of the Comstock slowly and steadily increased during the eighties, and in 1890 the Comstock was the liveliest mining camp in the West. But by that time the low-grade ore of the bonanza orebodies was nearly exhausted. What was stolen during this era will never be known. It is significant, however, that while in 1888 the mine accounts show a production of $5,500,000 in bullion, Wells, Fargo & Co. carried out $7,500,000, and this latter amount does not cover the midnight drives to the Carson Mint.

The monotony of 'low-grading' was varied by the finding on the upper levels of some bonanzas that had been overlooked in the earlier days, and in consequence there were several stock deals that brought back the excitement of the sixties and seventies. It

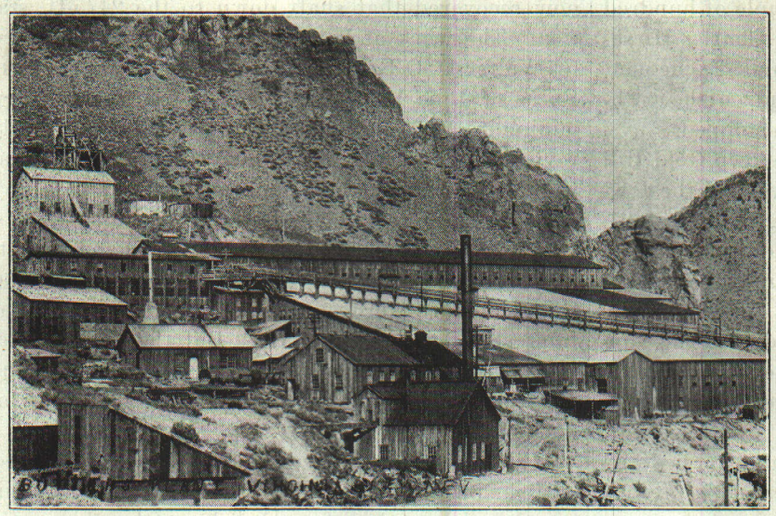
is said that Senator Jones found a new bonanza 'fissure' just to the east of the old Con. Virginia stopes,

Gold Hill, Nevada, Showing Crown Point, Yellow Jacket and Exchequer Mines.

while working his leased ground, and that Mackay took him into the deal to keep him quiet. In October, 1886, the 'middle' mines ceased pumping at the Combination shaft, and it was generally considered that the days of profitable mining on the Comstock had passed. The search for deeper bonanzas was over; low-grade mining in the mountains of ore on the upper levels of Gold Hill had been tried for five years, and had brought only assessments to the stockholders. Many of the brokers sold the stocks short, and Mackay and Flood took all that was offered. Then the news of the strike was let out, and faith



Kinkead Mill, C. & C. Shaft, with Mt. Davidson in Distance.



Butters Cyanide Plant, Virginia City, Nevada.

in the upper levels returned. To assist the deal Mackay went to Virginia City, and the report was given out that he was going to remain there and take charge of Con. California & Virginia. In two months Con. California & Virginia went from $1.95 to $55, Ophir went form 65 cents to $35, Hale & Norcross rose from 55c. to $9, and Best & Belcher, Savage, and several others went up similarly. The 'shorts' were trapped, and there were many failures among the brokers. Robert F. Morrow (the ablest operator on the street since James Keane went to Wall Street), who nearly always operates as a 'short,' is said to have an unpleasant recollection of the deal of 1886.

During 1887 Con. California & Virginia produced 125,876 tons of ore that assayed more than $30 per ton, and the mine yielded $3,527,000 in bullion. Dividends of $1,080,000 were paid. The next year the same mine produced over $4,877,000, and paid dividends of $1,188,000. Hale & Norcross found a new bonanza on the 700-ft. level that brought the mine $840,000 in bullion for 1888, and paid $224,000 in dividends. Confidence found a bonanza on the 1100 and 1200-ft. levels, and produced $977,000 in bullion, and paid $175,000 in dividends. The 'shorts' were caught again, and in two months Confidence was sent from $8 to $52.

But these were the 'leaders' that were used to sustain interest in the Lode and extract assessments for the other mines. The reversals of form were sudden and violent. The MINING AND SCIENTIFIC PRESS made trouble. In June, 1889, it wrote to the title 'What Becomes of the Bullion?' and followed it up under such head-lines as 'The Mines in

the Hands of the Mill-Men.' In July, 1890, it reported that the "Hale & Norcross managers are building another reservoir to catch the rich slime that is allowed to escape through their peculiar mode of milling. Our correspondent says that this slime assays from $30 to $40 per ton, which he thinks is very good slime to come out of $20 ore." This mill, being in Carson City, was more accessible to observation than most of the others, which were 20 miles away, on the Carson river. The MINING AND SCIENTIFIC PRESS further reported that "in the Confidence on the 1100-ft. level they are in good ore, assaying $60 per ton, which they are running out through the Yellow Jacket, but of which no further record is kept." In other issues it was pointed out that the Con. California & Virginia and the others, did not sample their ore, as required by law, and that only the millmen sampled it; that the mills could extract 85 to 90% of the battery-assays, while they returned 65%, and that some mills were steadily working 100 and 200 tons of tailing per day. The trustees were slow to act, but they finally found it necessary to do something to save the trustee machine.

In the spring of 1893 the ore from the Con. California & Virginia averaged $30.46, the battery-assays $27.43, and the bullion returned was $23.98, or 87.4% of the battery-assays. The Nevada mill, which had previously extracted only 30% for the Hale & Norcross, now worked $27 ore for the Potosí, and extracted 79% of the car-sample and 88.3% of the battery-assay. But the good results arrived too late. As occasionally happens in the land of the free and the home of the brave, the grafters had remained free and brave long enough to get away with nearly everything in sight. The production of the Lode in 1892 had fallen off to two millions, and for the rest of the nineties there was 'very little doing.' Some good ore was found to go below water-level in the Gold Hill, and in 1890, R. F. Morrow formed the Gold Hill Pumping Association. After a year of delay a steam-pump was started in the Crown Point incline. The water was lowered a couple of hundred feet, but the expense was enormous. Charles Hirshfeld, in command of the Bullion and Exchequer, could not collect the assessments, and on the withdrawal of those mines, pumping was stopped.

Morrow and Sharon, in an effort to keep Gold Hill alive (and their mills in business) worked the low-grade 'gold vein' on the foot-wall, beginning in 1891. The ore milled gave assays from $14 downward, and up to the year 1894 considerable quantities were extracted from the richer portions of the gold vein. The ore was milled and concentrated on Frue vanners at a charge of $2 per ton, and the railroad made a special rate of 65c. per ton to the Carson river. By piecing out with a liberal levy of assessments, Morrow, Sharon, and others were able to bear up against their fallen fortunes. The trustee system faced hard times in 1893. The Exchequer company took in 66% of its stock on a delinquent assessment; the Alta took in 51%; Hale & Norcross, 23%, and so with others. Then the miners were asked to accept a reduction of wages from $4 to $3 per day; but the miners, being 'wise to' the situation, gave the retort courteous. They told the companies that they would have to reform themselves first. They pointed out that A. C. Hamilton was drawing $2500 per month as superintendent of six mines and the Ward shaft, and was spending most of his time elsewhere than on the Comstock Lode; also that other superintendents were doing likewise. The miners' committee pointed out that the salaries were out of all proportion to the number of men employed. In Alta, for example, not a pick was swinging, but the salary list was $675 per month, and the monthly expense reached $3475; Alpha spent $60 for wages and $375 for salaries; Confidence had one miner, and paid $300 in salaries; Overman spent about as much money for salaries as for miners; and so it went. The managers beat a hasty retreat, lest the miners might give the public further undesirable information. The Comstock may languish, but it is never dead. Just when the public had lost interest, the system again found a leader. Con. California & Virginia, a never-ending wonder, in 1894 found some $80 ore, and cheered the market with a dividend. It takes only one leader on the Comstock to furnish 30 other mines with assessment money. The system survived, but it was not thriving.

In 1898, the Comstock Pumping Association was formed by Charles Hirshfeld, a stockbroker. After many delays the water was lowered in the C. & C. shaft, and as a consequence Con. Virginia (name changed again) found an orebody on the 2050-ft. level that was followed across the line into the Ophir. The latter has been stoping ore continuously since October, 1903. This orebody, which has been producing both shipping and milling ore, is proof positive that the former criticisms by Becker and other writers were warranted: namely, that the lower levels were never properly explored in the eighties, and that there are large areas below the 2000-ft. level that have never been explord at all. In consequence of this success the Ward Shaft Association was formed by the 'middle' mines in 1903, and has now recovered that shaft down to the 2475-ft. station. The work at both these shafts was described by Walter D. O'Brien in the MINING AND SCIENTIFIC PRESS of June 13, 1908. With the renewal of deep mining in 1903, affairs on the Comstock were slightly revived. Many men who knew the history of that wonderful district again took an interest, and have since been regularly contributing to the assessments. It was represented that the Comstock managements had reformed; that there was no more graft; that the companies were now being run honestly in the interests of the stockholders. But the public gradually recovered from this pleasant delusion, and 1908 came in with almost universal expressions of distrust.

It must not be supposed that the Comstock trustee-system, fashioned like a political machine, has survived for more than four decades without some assaults upon it. In 1876 there were a number of changes in the directorates. After the report of the Belcher for that year there was an attempt to get the stockholders together, but without success. In 1890, M. W. Fox brought suit against the directors

of the Hale & Norcross to account for some of the 'very good slime' that had been going through their privately owned mill, and in 1895 he got a judgment. The Mining Stock Association was formed in 1890, ostensibly to combat the 'system.' The stockholders of the Kentuck brought suit against Governor Stevenson of Nevada, who was milling the Kentuck ores, and the Governor compromised. Attempts have been made to amend the laws. In his message to the California legislature in 1877, Governor Irwin said: "There should be legislation to better protect the stockholders in mines from the mismanagement and rascality of the directors. . . . The laws should compel directors to operate mines in the interest of all the stockholders, and not in the interest of an inside ring." In consequence, stockholders got the right to inspect their own mines, which the managers had formerly denied to them; but the 'system' was left intact. In 1880, Senator Felton introduced a bill to make presentation of certificates good for votes at company elections; but it also had the impractical provision that the names of both trustees and trustors must be entered on the books of the company. In 1891, Assemblyman Bert introduced an act to give bona-fide stockholders the right to vote their stock, whether it stood in their own names or in that of the trustees. And in 1905 a law was passed providing that only bona-fide stockholders could vote. This endangered the vote of trustees who did not know who their trustors were, but no advantage was taken of it, and the law was repealed by the next legislature. The only way thus far by which the system has been worsted has been by a group of men buying control. In the last couple of years the Virginia 'system' has thus lost the Best & Belcher, and the Gold Hill 'system' has lost the Yellow Jacket and the Crown Point. The trustees, of course, own no stock. They never would think of paying assessments. When a few stockholders have kicked, the machine has laughed at them; when the machine has been tackled hard, it has pretended to reform. In 1883, the MINING AND SCIENTIFIC PRESS published an editorial on 'The Top-Heavy System.' "It was a poor way," it said, "to raise $100,000 by assessments, and fritter away $75,000 of it in useless expenditures, the other quarter going to the mine. With the new order of things now going on there is a much better prospect for the mining interests." But the old order, and not the new, was what the stockholders found in existence on the Lode in the spring of 1908.

There were two systems in control: The Gold Hill mines (except the Yellow Jacket) were controlled by R. F. Morrow, of San Francisco, and W. E. Sharon, of Virginia City. It is the same old game, although the plum tree is not as fruitful as of yore. Morrow was in the Gold Hill 'mill-ring' more than a score of years ago. W. E. Sharon is a nephew of the man who was the father of Comstock high finance. The Morrow machine collected $153,234 in assessments in 1907, and kept about a dozen men at work (one shift) underground. That means that only about 10% of the money was spent in miners' wages. The Gold Hill mines did no pumping, and the rest of the money went into general expenses, including salaries. When H. L. Slosson, Jr., took over the Yellow Jacket from the Morrow interests, he made it produce 180 tons per day, instead of nothing, and his salaries amounted to just one-half of what they were under the graft régime. So little was being done by the Morrow machine that one man had time to be foreman of seven mines. The superintendency of these seven mines was of course an honorary office, of the pleasant type evolved under the trustee system.

The Confidence, Challenge, and Imperial are jointly running a drift toward the west outcrop from the bottom of their shaft on the 70-ft. level, not much below the bottom of their dump. They collected nearly $40,000 assessment money in 1907, and are advancing 10 to 11 ft. per week. This means that the gross cost of this drift is $70 per foot; it could be run by contract for $15. The Morrow managers are good fellows, and as jolly entertainers as can be found anywhere, but from the financial standpoint, their mines are bad actors—even for the Comstock.

In the Virginia district the trustee machine was found to be composed entirely of brokers. They did not hold stock persistently. Look on any stock-book for the men who had the smallest number of shares and you identified the board of directors. At the Ophir stockholders' meeting of 1907, 26 shares were represented in person. At the Chollar meeting of 1908, the directors had 31 shares (total market value $3.10) in their own names. It was the same old system. Coherence is given to the Virginia system by means of the Comstock Pumping Association and the Ward Shaft Association, an offshoot of the former. The same men being in control of all the mines (except the Best & Belcher and the Hale & Norcross), they could dip into the different treasuries for pumping expenses as they saw fit, just as though the assessment money of the different mines had all been thrown into a common treasury. For instance, Con. Virginia, and not the pumping association, paid $100,000 for the Riedler pumps, and for many years (up to February, 1907) that mining company also paid for the six men who attended those pumps—because Con. Virginia has a name that can raise money. When Con. Virginia had ore it paid 50% of the Comstock Pumping Association's expenses, and Ophir paid 35%. When Ophir got ore, the figures were reversed. It is evident that the mines must contribute to the expense of pumping, but it is disquieting to the stockholders of one mine to have no written agreement with the other mines, and not to know for how much the trustees may dip into the treasury. Gould & Curry is 2100 ft. nearer to the C. & C. shaft than to the Ward shaft, but it contributes more than half its income to the latter. The fact that Gould & Curry will probably never use the Ward shaft does not seem to occur to its board of directors—as the Ward shaft needs the money. Honorary superintendencies still exist. The State Treasurer of Nevada, D. M. Ryan, is superintendent of the Sierra Nevada, Mexican, Union, Bullion, Alpha, and Exchequer. The Secretary of State, W. G. Douglas, is superintendent of the Gould & Curry, Chollar, Po-

tosí, Justice, and Alta. The town clerk also gets on the salary-roll. This is no argument against the gentlemen mentioned, but against the system that employs mining superintendents who do not have to spend all of their time at the work of mining. D. M. Ryan's work at the Union shaft was excellent, and the plant was spick and span. But the Sierra Nevada, Union, and Mexican collected $120,000 in assessments in 1907, and were employing underground not much more than two miners per mine. Instead of spending 50 to 75% of their money for miners' wages, as other mines that have no smelting charges are able to do, the Union Shaft mines spent about 8%. Ophir was found to be grinding out money for pumping expenses and salaries, but with ore that averaged above $30 per ton, and stopes 25 ft. wide, opened on two levels, it was producing only 40 tons per day. On April 18, 1906, it had $50,000 in bank, and at the end of 1907 it had $19,000. For the six months from October, 1907, to March, 1908, inclusive, its average receipts per ton were $25.70, and the expenses were $25.06. Considering the work to be done, its expenses were probably the highest in the world. Gould & Curry collected $32,400 in 1907, contributed $17,500 to the Ward shaft, and absorbed the balance without one miner being at work—in fact, it had not done any mining for many years. Savage had only two or three miners at work (through no fault of its superintendent); likewise the Hale & Norcross; likewise the Chollar and Potosí together. The Julia and the Bullion contributed to the Ward shaft, but the only mining man in sight was W. C. Ralston, secretary. The Alpha and the Exchequer also contributed and did no mining.

The Comstock system is cleverly devised. By giving a man a number of salaries the amount entered on the books of any one company seems small, but the aggregate is much larger than would be paid for the same service in the competitive world. Behind the mines stand the shaft associations and the pumping associations. These spend the money for the mines. For example, the Ophir does not pay its own miners nor purchase its own supplies. A stockholder cannot find out whether his money is being honestly spent except by going through a great multiplicity of accounts. The accounts are not kept after the ordinary manner, and it is impossible to determine what are the different components of the cost of mining except by observation on the ground. For instance, a clerk may be on the salary list, and also gets $40 more salary on the pay-roll. One half of the time of the chief machinist at the C. & C. shaft was charged to compressed-air, not because the compressors had been repaired, but because it was necessary 'to charge his pay against something.' As a matter of fact, he had been very busy on other work. The Con. Virginia has been running a drift on the 2350-ft. level to ventilate the Ophir stopes, and has been paying for it at the rate of $60 per foot for labor alone. It is of no use to the Con. Virginia, but the five Ophir directors are all Con. Virginia directors; so they dipped into the Con. Virginia treasury for the coin.

The trustees do not appear to have exercised ordinary business ability in their dealings. In 1899 they had $100,000 on hand with which to obtain electric power. The Riedler pumps (to be installed) required a maximum of 600 hp., and 1000 hp. would fill all the requirements for some years to come. The field was open, and the mines could have built their own power-plant on the Truckee river, and have put up a 26-mile transmission line, from the money they had on hand. But instead of doing that, they gave the $100,000 to the Fleishackers with which to build a plant. Of course, it was pretended that they got the $100,000 back in the form of rebates, but that was a mere matter of phraseology. If it is figured that they paid $5.60 per horse-power month on peak-load (they now pay $5), then they did not get it back. The advance was $67 per horse-power on the plant installed, and was about enough to build the cheap type of 1500-hp. plant that was constructed. The company is said to have paid a dividend a month after it started. The Fleishackers have since installed 1000 hp. more, and are getting about $100,000 per year out of the stockholders, with more to come. Ophir has been paying for a rock-breaker, and then paying the Kinkead Mining & Milling Co. $2.70 per ton for milling and concentrating. For the last two years it has had enough money in its treasury to build a mill, and enough ore in sight to pay for the mill by the saving in cost of milling. The Kinkead Mining & Milling Co. is said to pay 100% dividends per annum.

There has been no evidence of an appreciation of the relation of fixed cost to total cost of mining or exploration. It does not appear to matter how much money is used for salaries and pumping while the Ward shaft is being put down, or while the Savage, the Hale & Norcross, the Chollar, and Potosí are waiting for transportation in the Sutro Tunnel. It is interesting to note what happened when the Con. Virginia was shut down during the late financial crisis. In his report of November 8, 1908, the superintendent said: "All work in the mine has been suspended." Mining was not resumed until January, 1908. The mine expenses average $13,000 per month; in December less than $4000 per month was cut off, and less than $2500 per month was saved by stopping the mining work that had been going on. During the Company's fiscal year 1907, more than 81% of the cost was for fixed expense, and less than 19% was for mining work on the 1600, 2250, 2350, and 2450-ft. levels. If we except the 2350-ft. drift, which was run to ventilate the Ophir stopes, then less than 10% of the stockholders' money was used for actual exploration, other than fixed expenses. One of the noticeable features on the Lode today is the slowness with which the drifts are advanced. In the seventies and eighties it was the exception for a drift to be advanced less than 30 to 40 ft. per week. This refers to average ground and not to drifts like the Chollar-Potosí 3100-ft. level, which was advanced in the black dike on the footwall for week after week at the rate of 80 ft. per week. The best work done recently was in October, 1905, when the Ophir reached the 2200-ft. level by a

winze that had been sunk 200 ft. through rich ore. The drift from the bottom of the winze was advanced for two weeks at 25 ft. and for three weeks at 30 ft. per week. After that, lethargy set in again. In the Con. Virginia the average progress on the 2250-ft. level during the calendar year 1907 was 15.8 ft. for the 33 weeks that work was being done. The big men of the bonanza days may have been grafters, but there were a few miners among them.

It is only reasonable to suppose, from the few instances related, that the 'commission' system has been pretty generally in vogue as a small graft. It was the custom to purchase supplies in Virginia City without inquiring what the price would be, and the mines paid higher prices than individuals. The powder graft is noticeable, not because of the amount of money abstracted, but because of the fact that no shame seems to be attached to it. Zadig & Co., stock brokers, are agents for the Hercules dynamite at Virginia City. They have formed a combination with the agent of the Giant Powder Co., who is a clerk in the employ of the mining companies of which Mr. Zadig is a director. Mr. Zadig cannot see any reason why he should not be a trustee for numerous stockholders, and a director in numerous mining companies, and should not at the same time charge his trustors 18c. per lb. on 13c. dynamite.

Much of the work of exploration on the Lode appears to be aimlessly done. It is not known today by the mine managers what can be done with the Comstock ores under modern metallurgical treatment, and at what expense. So far as practical work has gone, the firm of Chas. Butters & Co., cyaniding the Ophir tailing, has a monopoly of the present knowledge. There are some large bodies of low-grade ore above water-level, but what can be done with these is a question yet to be decided. Not a 'system-controlled' mine on the Lode has a mill of any description. In the work of mining, the Comstock Lode is far behind other districts. For driving and sinking, heavy drills made in Reno are used, though the porphyry does not require them. Light air-hammer drills for stoping, which have proved such a success in other camps, are unknown. The work at the Ward shaft is of great moment to the stockholders who are putting up the coin. More than $550,000 has been expended, but no definite program has been announced. The general opinion is that the work there is being done for the purpose of opening up the ground in the vicinity of that fatal drill-hole on the 2810-ft. level of the Exchequer which flooded Gold Hill in 1882. The only official reports at that time spoke of stringers of low-grade ore having been cut on the 2400 and 2810-ft. levels, but ever since that time dramatic stories have been in circulation to the effect that the drillings assayed high, and that a miner, fleeing before the steaming flood, carried in his hand a piece of bonanza ore. As a journalist, one well known upon the Lode, has remarked: "It is a difference of opinion that gives rise to horse-races." Whether the Ward shaft will proceed to use the big electric pump now being installed, for the benevolent purpose of draining an ocean of water from the Gold Hill mines, which are not contributing to the expense, or whether it will spend some more years in sinking to the 3100-ft. level, of which there is occasional mention, is unknown to the stockholders, although the Ward gets half their assessments. The practice of selling the Comstocks 'short' has had something to do with the laxity of management, and with the failure of the brokers to use their best efforts to make the mines pay. Not every speculator can sell the stocks 'short.' Only the brokers, and those to whom they wish to grant the privilege, can go 'short' of the market. A broker has in his office 10,000 shares of a certain stock, the certificates having been left with him by his customers. He may be holding them awaiting sale at a given price, or he may be holding them for a customer for the convenience of his paying the assessments on them, or he may have advanced money on them, or advanced the money to pay an assessment on them. The broker does with these certificates just as a bank does with its deposits. He figures that all of the 10,000 shares will not be called for at once, and that 5000 shares will meet all probable demands; so at the right time he goes 'short' of the market by selling the other 5000 shares for, say, 30c. per share. He can loan the $1500 thus received to his customers, and charge them good interest on it. The time for the inevitable assessment gradually approaches, and if a 'strike' has not been made in the mine, the price declines. For, without a 'find,' the stock is going to be worth about the same amount after this assessment is paid as it was after the last one was paid. The stock that was worth 30c. has a 10c. assessment levied on it, and slowly declines until on the day the assessment is delinquent it is worth about 20c. The next day, the 10c. assessment having been paid, it sells for 20c. plus 10c., or 30c. again. If the speculator is afraid to stay 'short' of the stock for a long time, because of possible developments, he buys back, when it is 20c., the stock that he sold at 30, and returns the certificates to the broker's office. He has thus made $500 by the transaction. If he stays 'short' of the stock at the time the assessment is delinquent, there are then only 5000 shares in the broker's office, while the customers send the money to pay the assessments on the 10,000 shares of stock deposited with him, being a total of $1000. The broker takes $500 into the office of the mining company, together with the 5000 shares, and has the certificates stamped "Assesment No. 23, Paid"; and he keeps the other $500 as his profit on the transaction. The people to whom he has sold the other 5000 shares pay the assessment to their brokers or to the mining company direct, and get their certificates stamped "Paid," and the 'short' has no responsibility in that regard. In other words, there are more assessments paid to the brokers and to the mining company direct, than there is stock in existence, by the amount of the stock that has been 'shorted' out of the broker's office. If a man is 'long' of a stock when a dividend is declared, he gets the dividend in cash; if a broker is 'short' of a stock when an assessment is delinquent, he gets the assessment in cash. As a confi-

dence game, 'shorting' the Comstocks is without a peer. The brokers on the inside can see to it that certain mines do not strike a bonanza, and as long as the stock does not go up, and force them to cover at an advanced price, there is no possibility of their losing, except through the stock being cornered. The business may seem trivial, but it is the nickels that make the street-cars pay. The Comstock mining companies collected $810,000 in assessments in 1907, and the further amount of assessments collected by the 'shorts' must have been no inconsiderable sum. Much of the financial history of the Comstock has been made by the 'shorts,' who have many times been cornered in the earlier days, causing a particular stock to jump hundreds of dollars per share without apparent cause. And then the price would fall again as rapidly as it rose. Some brokers, or their friends, stay permanently 'short' of the stocks for years at a time, just as a bank always has a part of its deposits loaned out. Of course, this system has evoked criticism. In 1877 the MINING AND SCIENTIFIC PRESS said: "A great deal of attention has been called of late to the custom among brokers of lending stocks not belonging to themselves, but to their customers. In many cases this is prejudicial to the bona-fide owners of the certificates. Now that so much public comment has been made concerning the practice, it is possible that some remedy will be applied." The difference between stockholders and stock-owners is an important one. In all cases in which the brokers act as trustees they are the legal stockholders, because their names are entered on the certificates and on the stock-books of the corporations. The people who have bought the stock-certificates, and who pay the assessments, are the stock-owners; but generally they do not become stockholders, in the sense above stated. They can not vote at the annual elections unless they obtain new certificates, made out in their own names. The majority of the stock-owners are not stockholders, and can not vote, therefore the directors ignore them.

The Comstock system is like a political machine. Every one connected with it is expected to work to get the names of the right men on the certificates as trustees. Then the trustees vote for the right board of directors, and the salaries are dispensed. Next the brokers put out their lines of 'shorts,' and then come the assessments and the profits. A few judicious reports from the system's managers on the Lode, in regard to certain work that is being done in a selected place, will boost the price up; and a few certificates borrowed from the customers' deposits in the brokers' offices will drive it down again. It is an ever revolving cycle. Trustees, salaries, shorts, and assessments. As long as the machine is preserved, and the public will take an interest in the stocks, there is no need to work the mines, as mines. Whenever the public refuses to pay assessments, it is necessary to find some ore and make a 'leader' in order to bring back the crowd. There are many personal antipathies among the brokers. They may have played their little deals against each other, and have had their quarrels; but up to 1908 they have all stood together like henchmen about a political boss in order to preserve the Comstock machine.

In the first few months of 1908 the assessment payers were tired out again. Some of them investigated and grew belligerent. Papers were prepared to take the matter into the courts; but the unexpected happened. Charles Hirshfeld, president of the Comstock Pumping Association and the Ward Shaft Association, also president of a string of Virginia mines, together with B. F. Shaw, another broker, invited certain assessment payers to take an interest in the management and to offer suggestions. Accordingly some new men were installed upon the directorates of the Mexican, Ophir, Con. Virginia, and Exchequer, without waiting for the annual elections. Their suggestions have been acted upon in certain particulars. There is now a committee of three to make purchases of supplies in the open market. Salaries have been cut, both in San Francisco and at Virginia City by all the companies in which Hirshfeld and Shaw are prominent, and the aggregate saving thereby is placed at more than $50,000 per year. It is agreed that each mine that has ore shall accumulate a fund whereby ultimately it can build its own mill; and exploration is now a little more active. But as soon as reform made an entry, all the forces of reaction commenced to gather and to get under steam. Some brokers had strongly objected to the stock-owners in the first place. The Gold Hill system would have none of them, and was resolved from the start to hold on to its ancestral perquisites, or to die with its boots on. The old system still controls the boards of directors of the Virginia mines, and the assessment-payers are only in the management on sufferance. If the men who are putting up the money to run the mines take an active interest in affairs, and take over the management of their own properties, then the Comstock is likely to have a genuine revival, and once more to become an important camp. This is true not only from the technical standpoint, but also from the speculator's standpoint, for every important boom in the Comstock that has lasted more than a few days has been based upon actual mining development. But as yet the revival is not assured. There is evidence that the reforms are not being accepted in good faith, and it would be strange if they were. Many brokers are known to have grown wealthy out of the old order of things, while the stockholders have been heavy losers. The Comstock has passed through a long and exciting history, but it has never yet been reformed.

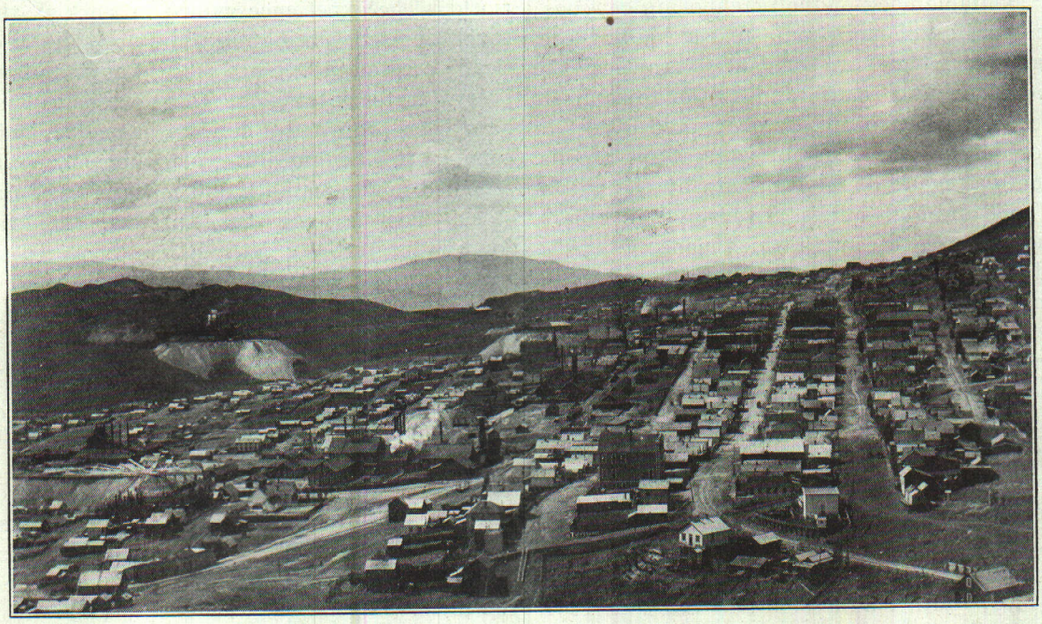
Safety fuse is defined in the Western Australian 'Mines Regulation Act' as a fuse "which burns and does not explode, which does not contain its own means of ignition, and which is of such strength and construction that in burning it will not communicate laterally with other like fuses. Its rate of burning must not be less than 80 seconds nor more than 100 seconds per yard."

Butte heads the list of California counties in the production of the precious metals during 1907, the total being $2,795,807.

COMSTOCK BEGINNINGS.

Written for the MINING AND SCIENTIFIC PRESS
By JOSEPH T. GOODMAN.

Commemoration is a duty usually assigned to posterity, but the jubilee anniversary of the discovery of the Comstock will be celebrated the most spiritedly by the very men whose young blood was set astir by the event they commemorate. Their ranks will be thinner and their step less elastic than when they went to the front fifty years ago, but enough of the old guard and of the old spirit survives for them to make a brave and enthusiastic display on this memorable occasion. Of necessity, however, there will be something more than parading and rejoicing. When 'the tumult and the shouting' have died away it will be impossible for the veterans not to be as reminiscent as jubilant. And there will be so much scope for recollection! Little could they have dreamed that the day of the discovery of that 'blue-black stuff' in Spanish ravine fifty years ago was a moment from which should date a history more wonderful than that of many an empire. Naturally their thoughts will travel back over that history, which itself now seems almost like a dream.



Virginia City, Looking South From Cedar Hill.

The beginning was so obscure and unnoteworthy—like the germ state of every kind of growth—and everything was so befogged by inexperience and ignorance. Some prospectors working in a ravine cut a mass of blue-black stuff whose character was to them a mystery. A specimen of it sent to California for assay proved it to be silver ore. That did not mean much to the average miner at the time, for few people on the coast knew anything about silver mining; and so distrustful were the discoverers of the value of a silver mine, even when informed of the richness of the ore, that they sold their claim for a mere pittance to capitalists who were willing to venture upon the experiment of working it. The outlook was not promising for these bolder men at the start. Had it not been for the remarkable assays, and the returns from the ore shipped to Swansea, it is doubtful if they would have been encouraged to continue development, for the initial arrastre, patio, and other processes of treating the ore at home, brought but poor results. The working of the mine also was conducted in such a primitive way that, in the light of present methods, it seems pitiable. For more than a year the ore from the Ophir and Mexican mines was brought up in rawhide buckets on the backs of Mexicans, who climbed steps cut in logs placed at an incline from level to level, and all the pumping was done by hand. But the indisputable richness of the ore had created widespread excitement, and every foot of the Comstock, and of the parallel veins, was not only quickly claimed, but doubly claimed in most instances, the locations generally overlapping if not actually overlying each other—a circumstance that gave rise to the expensive litigation in which the principal mining companies were involved for the first four or five years. Upon the wave of this excitement came the founders of Virginia City in such numbers that from its single saloon and boarding-house tent the place sprang into a town as if by magic. Of course not everybody was at once well housed. There was a brief era of tent and tunnel and almost every other kind of shelter. But the sound of construction was to be heard incessantly, until within three years there arose a city of imposing structures, with a population estimated at 30,000.

Virginia City was incorporated as early as February 1861—only a year and a half after the discovery of the Comstock. She already had an efficient fire department and police force, several churches and places of amusement, and the organization of public schools soon followed. That was quick work for even a frontier settlement. But the city was only keeping pace with the rapid progress being made in the development of the Comstock. The primitive style of mining at first in vogue had given place to a great hoisting works and pumping machinery; Deidesheimer had solved the problem of securely support-

ing the mines by square sets of timber; and it had been decided that it was more profitable to mill all the ore at home than to ship part of it abroad, even if there was a large percentage lost in treating it, and in consequence great reduction works were springing up in every direction. Activity was no longer confined to Spanish ravine, where the Ophir and Mexican works were situated. The Central, Gould & Curry, Savage, Hale & Norcross, Potosi, Chollar—in short, nearly every company on the lode—were getting under way, and some of them on a scale more extensive than had even been dreamed of before. The Comstock and Virginia City had fairly entered upon their marvelous career.

In the full tide into which that career swelled and swept on for years, the eastern slope of Mt. Davidson was the busiest and most picturesque sight ever seen. Immense hoisting works studded the mountain-side for miles, with their huge dump-piles and capacious ore-bins; quartz-mills were thundering and grinding in every available nook of the neighboring canyons; a continuous line of many-mule teams, hauling ore, wood, and merchandise, constantly crowded the streets and outlying roads; and in the town itself were such throngs of people as one would expect to encounter only in the heart of a great metropolis. The scene was made doubly animate by the prevalence of hope and high spirits. Everyone had money, or felt rich from the ease with which money was to be acquired; and all met on an equal footing, for the under one today might be at the top tomorrow. There was a deal of drinking, gambling, shooting, and other indulgences not looked upon with favor in a well-regulated state of society. But, upon the whole, the community was a surprisingly law-abiding one.

Under this careless surface life, as beneath the very ground on which the city stood, a mighty force was ceaselessly at work, with an earnest spirit and purpose. Nevada seems to have been predestined for two great missions. Her organization as a Territory, in 1861, and her admission as a State, in 1864, before she had population enough to entitle her to a single member of Congress, were both essentially war measures; hence she is justly proud of her distinctive title of the 'Battle Born'. The Government needed the assistance of her loyal people in the legislation necessary for the preservation of the Union, and right loyally it was given, together with aid by every other means in her power. In proportion to her population, Nevada sent more men to the ranks and contributed more money to the Sanitary fund than any other Territory or State; she was the first to ratify the Constitutional Amendments that secured the fruits of the war and cleared the way for reconstruction; and the output of treasure from her mines was a principal factor in sustaining the national credit. The importance of that product, in the estimation of the greatest and wisest statesman of that time, is shown by the words of Abraham Lincoln on two occasions: "I am glad to see you here," was his first greeting to Senator Stewart; "we need as many loyal States as we can get; and, in addition to that, the gold and silver in the region you represent has made it possible for the Government to maintain sufficient credit to continue this terrible war for the Union." And the very day he was assassinated he requested Speaker Colfax, who was about to visit the Pacific States, to carry a message from him to the miners. "Tell them," said Mr. Lincoln, "that during the war, when we were adding a couple of million dollars a day to our national debt, I did not care about encouraging an increase in the volume of our precious metals; we had the country to save first; but now that the rebellion is overthrown and we know pretty nearly the amount of our national debt, the more gold and silver we mine will make the payment of that debt so much the easier." True to the expectation and trust of the martyred President, Nevada has never ceased pouring out a stream of treasure to aid the Nation and enrich the world, though in her munificence the generous State has left herself comparatively poor.

A mission of almost as much importance, and as faithfully performed, was the guidance the Comstock was destined to give to the mining industry of the world. The experience gained in working that lode revolutionized mining on a large scale, and practically created the science as it is known today. From every quarter of the globe where extensive operations have been projected a demand has come, and is still coming, for engineers and workmen skilled or schooled in the methods and machinery of the Comstock. There is a significant promise in the fact that for fifty years the great lode has pioneered the way for others to follow. The genius and determination that overcame every obstacle in the past should be equal to the problems of the present and the future, hence it is only reasonable to hope that the mission of the Comstock will not be entirely fulfilled until an example is set of successful silver mining at a depth never before attained.

The restrictions of time and space preclude anything like a full review of the past fifty years of the Comstock and Virginia City—the fluctuations in the fortunes of the mines, the vicissitudes in the life of the town, the changes wrought by the railroad, the great Sierra water-system, and the introduction of electric power—but even a cursory notice would be incomplete without mention of some of the men whose names will remain most closely connected with their history. In that regard, precedence should probably be given to those who controlled the mines, and thereby to a great extent shaped the destinies of the lode and the community. The first of these, in point of time as well as of executive ability, was William Sharon. He went to Virginia City in 1863 to establish a branch of the Bank of California. The bank and the capitalists associated with it already controlled the principal mines, and Sharon soon devised a way by which he and a few others became the owners of a majority of the mills as well. Quite a number of men had built what are termed 'custom-mills', that is, they had no mines of their own, but worked ore for any company that would furnish it. Most of them, however, had involved themselves and were in need of financial aid, and Sharon, as manager of the branch bank, generously came to their assistance. But no sooner had they secured a loan than their supply of ore was cut off, and as a matter of course their mills in due time fell into the hands

of the bank. These properties, however, did not go into the assets of the bank for the benefit of its stockholders. They were taken out by Mr. Sharon and his friends and organized into the Union Mill & Mining Co., which thenceforward became an instrument for absorbing the wealth of the Comstock mines. If a mine had a rich body of ore, more than an equal share of waste rock was mixed with it to feed the insatiable maw of the great milling company; if the ore was poor, the stockholders were assessed to make up the deficit in the cost of reduction.

Such was the general condition of things under the Sharon régime, relieved only by a few companies which independently managed their own affairs, notably the Crown Point, that under the control of Alvinza Hayward and John P. Jones developed one of the greatest bonanzas in the history of the Comstock. But two comparatively obscure men, John W. Mackay and James G. Fair, both practical miners, and familiar with every inch of the lode, had quietly been getting a line on matters, and in conjunction with James C. Flood and William S. O'Brien, of San Francisco, they wrested the control of Hale & Norcross from Mr. Sharon and his friends, in 1868, and quickly turned it from an assessment to a dividend-

Divide From Wheeler Mounment.

paying mine. That was the first appearance of the great Bonanza firm upon the scene; but their uncovering of the immense orebody in the Consolidated Virginia and California a few years afterward, and the enormous fortunes realized from it, thenceforth left them undisputed masters of the Comstock, until death or voluntary retirement put an end to their reign. It would be difficult to say if in the long run stockholders fared better under any one of these managements than under the others.

Probably the lawyers constituted the next most noteworthy class of men in the early history of the Comstock. It has been estimated that $10,000,000 was the cost of litigation within five years from the discovery of the lode. That implies either an extraordinary quantity or quality of legal talent, and Virginia City had both. There was scarcely a California lawyer of prominence who did not establish himself there or form a partnership through which his services might be enlisted in the great mining cases. It would be invidious to cite a few out of a list of more than a hundred, but there was one who deserves particular mention, William M. Stewart. Not that he was superior to many others in professional ability, but his force and integrity of character inspired a confidence that raised him to the position of legal representative of all the Comstock mining companies, and it was by his efforts that the rules and regulations of the miners were crystallized into statutory form and became the law of the land. Nor is this all for which Nevada is indebted to Senator Stewart. It was through his untiring zeal and energy that she acquired her enlarged boundaries; that by the exchange of the worthless sixteenth and thirty-sixth sections for valuable lands she was endowed with her magnificent school fund; that the land-grant and annual appropriation were obtained for the support of the State University and the Agricultural Experiment Station; and that the Government provided for the establishment and maintenance of the Indian school at Carson. Not only the miners of Nevada, but the people of whatever occupation, owe more to the late William M. Stewart than to any other man who ever lived in their State; and it would be a crowning act of this memoral occasion to take some step toward erecting a worthy monument to his memory.

Of less influence in their day than any of those mentioned, but of more importance in perpetuating the fame of the city and the lode, were two young men employed in the humble capacity of reporting for one of the daily papers, the *Territorial Enterprise*. The name of one, Samuel L. Clemens, or Mark Twain, is now the foremost in the world of literature. That of the other, William Wright, or Dan de Quille, is scarcely known away from the Pacific Coast, but of the two he performed the greater service for Virginia City and the Comstock. Mr. Clemens came on the scene in 1862, and remained until 1864, a period just covering the palmiest days and the most riotous life in the history of Virginia City. He was then only a literary beginner, and it was there that he assumed the pen-name he has made immortal. The reckless, rollicking, tragical sights he daily witnessed thrilled every nerve in him and schooled him into that irreverent and humorous way of dealing with facts, and that scorn for sham, which have been his stock in trade ever since. He has never pretended to write an accurate account of his sojourn on the Comstock, but so thoroughly impressed was he by his experience there that in 'Roughing It' he has caught the spirit of the tumultuous, graceless life of those early days, and has given a better presentation of it than any one who has ever attempted to reproduce it. Dan de Quille was a more matter-of-fact and plodding man than Mark Twain, though possessing quite as rich a gift of humor. He was acquainted with the Comstock almost from the date of its discovery, and probably there was never another man in Nevada who had so exact a knowledge, and who kept so close an account of the condition of every mine on the lode, as he did for more than twenty-five years. He was an unusually keen observer of persons and incidents and everything else that came within his range of vision, and he had moreover a wonderfully retentive memory. The store of information acquired by him in the course of time was embodied in his book, 'The Big Bonanza', the completest account of the Comstock lode and Virginia City ever written, and a work that will forever remain the great repository of facts relating to them.

DISCOVERY OF THE GREAT COMSTOCK MINE.

By Dan De Quille.

*In the spring of 1859 Peter O'Riley and Pat McLaughlin set to work well up at the head of Six Mile canyon near Gold Hill. They used rockers and found small pay. They continued to work at this point until June 1, 1859, gradually extending their operations up the slope of the hill. They had started a little cut or trench and were washing the dirt taken from this in their rockers. Before they started the cut they were making only from $1.50 to $2 per day; in the cut their pay was even less. They were becoming discouraged, and were thinking of going to Walker river to try their luck, but concluded to work on where they were a few days longer.

Having but a small stream of water, it became necessary for them to dig a hole as a sort of reservoir, in which to collect it for use in their rockers. They set to work a short distance above to make the water-hole, and at a depth of about four feet struck into a stratum of the rich decomposed ore of the Ophir mine, and of the now world-famous Comstock silver lode. What they found was not glittering native silver, but a great bed of black sulphuret of silver—a decomposed ore of silver filled with spangles of native gold. This gold, however, was alloyed with silver to such an extent that it was more the color of silver than of gold. The gold dug in the placer-mines of California is worth from $16 to $19 per ounce, whereas the gold taken from the croppings of the Comstock was worth no more than $11 or $12.

When the discoverers struck into the odd-looking black dirt, they only thought that it was a sudden and rather singular change from the yellowish gravel and clay in which they had been digging. As any change was welcome, they at once concluded to try some of the curious-looking stuff in their rockers. The result astounded them. Before, they had only been taking out a dollar or two per day, but now they found the bottoms of the rockers covered with gold as soon as a few buckets of the new dirt had been washed. They found that they were literally taking out gold by the pound. However, as the gold they were getting was much lighter in color and weight than any they had found below in the canyon, or even on the surface in their cut, they began to fear that all was not right. They thought that, after all, what they had found might be some sort of 'bogus stuff'—base metal of some new and strange kind. It is not strange that these impecunious miners, tinkering away there on the side of a lone, sage-covered mountain, with their rockers, should have felt a little alarmed on account of the great quantity of gold they were getting, as in a few weeks after the discovery had been made they were taking out gold at the rate of $1000 per day. This they were doing with rockers. Taking the harder lumps left on the screens, one man was able to pound out gold at the rate of $100 per day in a common hand-mortar.

In the evening of the day on which the grand discovery was made by O'Riley and McLaughlin, H. T. P. Comstock made his appearance upon the scene. 'Old Pancake', who was then looking after his Gold Hill mines, which were beginning to yield largely, had strolled northward up the mountain, toward evening, in search of a mustang pony that he had out prospecting for a living among the hills. He had found his pony, had mounted him, and with his long legs dragging the tops of the sage-brush, came riding up just as the lucky miners were making the last clean-up of their rockers for the day. Comstock, who had a keen eye for all that was going on in the way of mining in any place he might visit, saw at a glance the unusual quantity of gold that was in sight. He was off the back of his pony in an instant and down in the thick of it all—'hefting' and running his fingers through the gold, and picking into and probing the mass of strange-looking 'stuff' exposed. Conceiving at once that a wonderful discovery of some kind had been made, Old Pancake straightened himself up, from a critical examination of the black mass in the cut, and coolly proceeded to inform the miners that they were working on ground that belonged to him. He asserted that he had some time before taken up 160 acres of land at this point, for a ranch; also that he owned the water they were using in mining, it being from the Caldwell spring, in what was afterward known as Spanish ravine.

Suspecting that they were working in a decomposed quartz vein, McLaughlin and O'Riley had written out and posted up a notice, calling for a claim of 300 ft. for each and a third claim for the discovery; which extra claim they were entitled to under the mining laws. Having soon ascertained all this from the mine before him, Comstock would have 'none of it'. He boisterously declared that they should not work there at all, unless they would agree to locate himself and his friend Manny (Emmanuel) Penrod in the claim. In case he and Penrod were given an interest, there should be no further trouble about the ground. After consulting together, the discoverers concluded that, rather than have a great row about the matter, they would put the names of Comstock and Penrod in their notice of location. This being arranged to his satisfaction, Comstock next demanded that 100 ft. of ground on the lead should be segregated and given to Penrod and himself for the right to the water they were using—he stoutly asserting that he not only owned the land, but also the water, and, as they had recognized his right to the land, they could not consistently ignore his claim to the water flowing upon it. In short, he talked so loudly and so much about his water-right that he at last got the 100 ft., segregated, as he demanded. This 100 ft. afterward became the Spanish or Mexican mine, and yielded millions of dollars.

Comstock would probably not so easily have obtained what he demanded, had the men who made the discovery been fully aware of its great value. They, however, did not know that the 'blue stuff' (sulphuret of silver), which they had dug into, was of any value, and even the gold itself seemed altogether too plentiful as well as a good deal 'off color'. Comstock had probably at some time posted up a notice claiming 160 acres of land, somewhere in that neighborhood, as a ranch, but if he did so he never had his

*From 'The Great Bonanza', by Dan De Quille (Wm. Wright), 1876.

notice recorded. Men in those days, while roving about the country, frequently wrote out and stuck up notices claiming land, springs, the water of streams, quartz veins, gravel deposits, or anything else that they might for the moment think valuable, but unless such claims were properly recorded and worked they could not be held, as all miners and others well knew—a mere notice expiring at the end of 10 days, when the property might be taken up, recorded and held by the first man that came along. Comstock had some show of right to the water and to the placer-mines along the upper part of Six Mile canyon, as the year before, he, Old Virginia, and Penrod had bought of old Joe Caldwell a set of sluice-boxes and the water of a spring. However, the possession of a set of sluices on the canyon and a right to use water from a certain spring in the neighborhood, by no means gave Comstock or his friends the right to lay claim to a vein of quartz found in a hill somewhere in their section of the country.

John Bishop, who bought Old Virginia's interest in the sluices, gravel-diggings, and water, got no share of the quartz vein discovered by Pete O'Riley and Pat McLaughlin, though he managed to get in on the lead, locating the mine known as the Central No. 1; now a part of the California, one of the bonanza mines with millions of ore in sight. Bishop put up the first arrastre ever built on the lode, starting it up two or three days before that of the Ophir began running. He sold his interest in the Central No. 1 for $4000, and shortly afterward the purchasers sold the same ground for $1800 per foot—now (as incorporated in the California mine) the ground is selling at over $50,000 per foot, and John Bishop still works, as a miner, at Gold Hill.

After Comstock had managed to become largely interested in the new discovery, and after the gold taken out by O'Riley and McLaughlin had been carried down to Gold Hill and exhibited and examined, there was at once a great local excitement in regard to the new diggings, and all were anxious to get an interest in the claim, or on the lead as near to the original discovery as possible. Those who were finally recorded in the Ophir notice as original locators were the following persons: Peter O'Riley, Patrick McLaughlin, H. T. P. Comstock, E. Penrod, and J. A. ('Kentuck') Osborne. The men named had one-sixth each of 1400 ft. of ground on the lead and, in addition, Comstock and Penrod had 100 ft. segregated to them, making 1500 ft. taken up by the party. The 100 ft. of Comstock and Penrod, though in the midst of the 1400 ft. of ground, was not reckoned as a part of the Ophir claim and was soon sold and worked as a separate mine, under the name of the Mexican or Spanish mine. The Ophir claim was the first that was located, as a quartz claim, at any point on the Comstock lode, though as early as February 22, 1858, Old Virginia (James Finney or Fennimore) made a location on a large vein lying to the westward of the Comstock. This vein is known as the Virginia lead or Virginia croppings. It has never yielded much ore, but contains vast quantities of base metal of various kinds. At one time it was thought by some that this would prove to be the main or 'mother' lead of the range, as at the surface, and for a considerable distance below the surface, the Comstock vein dipped west toward it. Parties bought Old Virginia's claim, and began suit against the Ophir company, asserting that the lead on which they were at work was the same as that located, in 1858, by Old Virginia. It was a sort of speculation on the part of those who brought the suit, and it is understood that they succeeded in obtaining $60,000 from the Ophir company. At the beginning of this suit it was necessary, if possible, to produce the original notice placed upon the croppings of the lead by Old Virginia, but the parties to whom he had sold his claim could never get him sufficiently sobered up to show where it could be found. Growing desperate, they at length seized the old fellow one evening, and thrusting him into the mouth of a big tunnel, closed and locked upon him a heavy iron gate. The next morning when they went to the tunnel they found Old Virginia sober, but very savage. He would say nor do nothing until they had taken him down town and given him half a tumbler of whiskey. This swallowed, he was ready for business. He marched directly up the side of the mountain, and going straight to a large tower of croppings, drew out a small block of rock, and lo! behind it was seen snugly stowed the much-desired notice.

It was probably on account of his having made this location that Old Virginia was given the credit of having been the discoverer of the Comstock lode, his interest in which he was said to have sold for an old horse, a pair of blankets, and a bottle of whiskey. He sold a third interest in the sluices, water, and diggings in the canyon to John Bishop, for $25. James Hart, who had an interest in the sluices, and diggings in the canyon, sold his right to be 'considered in' on the big discovery to J. D. Winter, of Washoe Valley, for a horse and $20 in coin.

MINERAL DEPOSITS IN FIJI.

Prospects of future importance as a mineral producer are apparently turning the thoughts of the colonists of Fiji from the production of copra and sugar cane. There seems to be some doubt yet as to what the mineral deposits actually consist of, but reports are to the effect that copper, gold, and silver have been found. The existence of tin is also suggested. The assay returns of a 15-ton parcel sent to Sydney for treatment, it is said, gave a valuation of 40% copper and 2½ oz. of gold, with a certain amount of silver. To what extent this result is to be relied upon, and what is the bulk of the deposits of this richness are matters too risky to forecast, but it can be safely prophesied that, if there is much of such ore, the copra and sugar cane growing industries will soon be relegated to places of minor importance. The prospects of the colony from the mining man's point of view have at least drawn the attention of Western Australian mining men, and The Fiji Prospecting & Option Syndicate has been formed to verify or refute the statements as to the mineral wealth of this portion of the South Sea Islands. Several Western Australian mining men are responsible for the formation of this pioneer venture, and they are now in Fiji.—*Australian Mining and Engineering Review.*

THE COMSTOCK MINES TODAY.

Written for the MINING AND SCIENTIFIC PRESS
By WHITMAN SYMMES.

It is just fifty years ago since a few placer miners, working up the gulches from the Carson river, found their 'pay' stop at the outcrop of the Comstock Lode. During that time mining on the lode has swung through a complete cycle, and its semi-centennial witnesses the fact that deep mining is being re-established, and along successful lines. It is interesting to note that one of the little party of the lode's discoverers, E. Penrod, is still alive and still a mining man, and that he will leave his claims in Mono county to attend the Comstock Golden Jubilee.

The policy that is now being pursued in unwatering the mines is radically different from that followed in the early eighties. The pumping plants at that time being insufficient to completely unwater the lower levels, it became customary to bulkhead the wet drifts, plug the diamond-drill holes that had struck water-seams, and confine exploration to the drier portions of the lode. This method was, of course, doubly disastrous. Not only did the miners have to retreat from those areas that were wet, and therefore fissured and most likely to contain ore, but the water that was held back by the bulkheads soon found its way to the levels below, whence it required more power to lift it to the surface. The pressure of the water above also increased the liability to the sudden 'rushes' that so frequently overwhelmed the pumps.

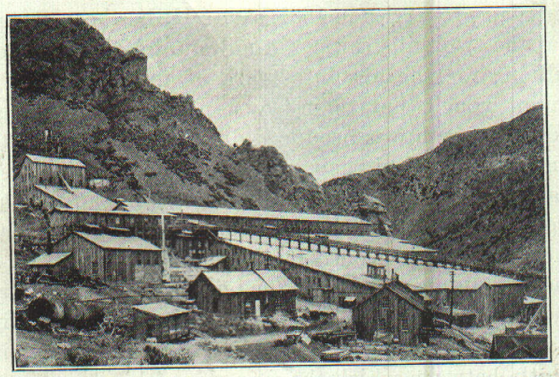
The opposite policy has now been adopted. The lode will be drained, level by level, in advance of the exploration for orebodies. Complete drainage accomplishes a double purpose. A drift that is dry can soon be cooled by ventilation, but when steaming water is dripping from the roof of the drift it brings in so much heat that a proper reduction of temperature is impossible, even though the 'snowshed' method of lining the drift be adopted. A year ago the 2250-ft. level of the Consolidated Virginia was hot and steaming, but since the 2350-ft. level has been run beneath, it has become a cool drift, and its 'snowsheds' are no longer kept in repair. The method of exploring coincidentally with complete drainage has already brought important results. In the first attempt at exploration of the deeper levels of the north end it was repeatedly announced in the reports that the drifts were kept to the west for fear of encountering too much water. It is now proved that those drifts were also kept too far west to penetrate the best part of the mineralized zone. Since 1903, when the water at the C. & C. shaft was first lowered sufficiently, several million dollars have been extracted from the Consolidated Virginia and Ophir mines between the 1900 and 2300-ft. levels.

Virginia City From the Outcrop of Comstock Lode.

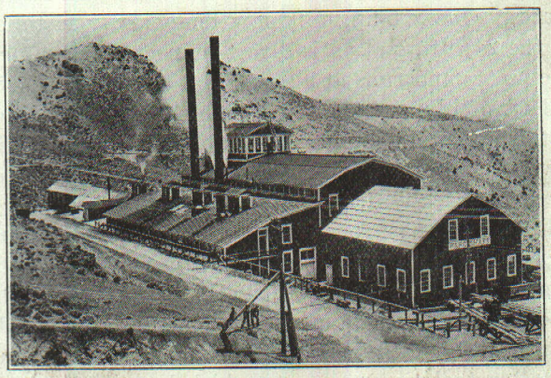
Thus far the only area to be drained is that adjacent to the C. & C. shaft, at the north end of the lode. The Ward shaft has reached a depth of 2560 ft., and a drift now being started on the 2450-ft. level will ultimately be connected with the Combination shaft, and will thus drain all of the middle mines to that depth. It is intended to begin the drainage of the southern portion of the lode as soon as the principal Gold Hill mine-workings are cleared as far down as the Sutro Tunnel level. This will be at no distant date.

At the north end the water now stands a few feet below the 2450-ft. level, corresponding to the 2300-ft.

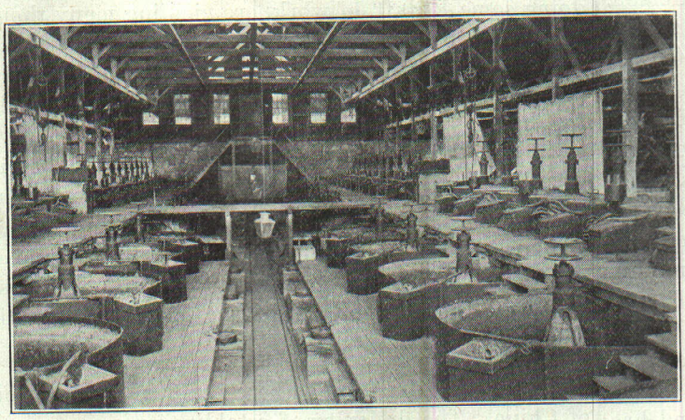
level in the Ophir. Everything is on hand to take the water down to the 2650-ft. station, which is the bottom of the shaft. A 30-in. wooden-stave pipe is being installed in the Sutro Tunnel to carry the drainage from the mines, and more than half of it is already in place. As soon as this is completed, it is intended to begin sinking in the C. & C. shaft, instead of opening up the levels below that point by a complicated series of winzes, as was formerly done. The fire in the Sutro Tunnel last January was a great misfortune to the mines, as it not only entailed a heavy expense, but also delayed the installation of this pipe. Therefore the further lowering of the water at the north end was also delayed. The mine-water is now lifted to the Riedler pumps on the 2150-ft. level of the C. & C. shaft by means of a jet-pump, and the cold pressure-water from the Virginia & Gold Hill Water Co.'s ditch serves to lower the temperature of the mine-water, with which it mingles. When the stave-pipe is finished, it will be possible to pump direct from the sump to the Sutro Tunnel. If this were now done, the hot water, flowing through the tunnel in the open, would so heat it as to make necessary repairs impossible. The Ward shaft is now sinking through a 'pocket' of hot water of 163° F., and is pumping direct to the tunnel without mixing its drainage with cooling-water. At present it affords only about 300 gal. per minute, against the 2300 gal. of hot water that is coming from the C. & C. shaft.



Butters Cyanide Mill.



Ward Shaft.



Interior of California Pan Mill.

A year ago no miners were employed in active exploration for ore in the Mexican, Crown Point, or Belcher. At these important old mines the ground is now being energetically prospected. Also the Bullion, Chollar, Potosi, Julia, Hale & Norcross, and the Savage will at no distant date be enabled to resume deep-level exploration from the 2450-ft. drift which is now starting from the Ward shaft. The upper levels of the Gold Hill mines are being re-opened, and the Crown Point is now being explored on the 1100, and the Yellow Jacket on the 1200-ft. level. The Yellow Jacket mill is working the so-called 'gold ledge' and is today extracting about 80% from a $6 ore by concentration alone. The principal Gold Hill mines are now so nearly able to pay expenses that their manager, George S. Sturges, has hopes of getting them upon a self-sustaining basis as low-grade properties. The water-level is between the 1400 and 1500-ft. levels, and considerable low-grade ore is believed to remain on upper levels. No work has been done below the 1400-ft. level in Gold Hill since the flood of 1882. The best producer on the lode is still the Ophir. During the past year the milling ore has averaged about $30 per ton, and the shipping ore $80. About one-half the value is in gold, and the other half in silver. Charles Butters & Co., Ltd., have leases on the upper levels of the Chollar and Potosi mines. They are extracting ore by ordinary mining methods and by means of 'glory holes' along the outcrop. As they pay royalties on ore assaying as low as $4 per ton, it is believed that they can mine, transport the ore two miles by aerial tramway, and cyanide it in their mill for about $3.50 per ton. They are undoubtedly now mining and cyaniding a gold-silver ore at a lower cost than any other company in the State of Nevada. At present the Chollar and Potosi outcrop affords them about 200 tons per day, which amount will soon be largely increased. They are also milling ore from the Ophir and the Consolidated Virginia mines. In the bonanza days at the Comstock pan-amalgamation was developed, and reached there a state of perfection which won it world-wide acceptance for the treatment of ores rich in silver sulphides. It was known as the Washoe process, in consequence of its Nevada origin. In effect it was an adaptation of the old patio process of Mexico. Instead of waiting for the slow reactions occurring in a *torta* or mass of pulp containing silver sulphide, to which copper sulphate and salt have been added, the

mass is ground and agitated in a grinding-pan, the reactions being hastened by the injection of live steam. Thus the work which required two weeks in the patio was accomplished in several hours in the pan. The process is now being superseded everywhere by cyanidation, and it will soon become interesting only to the metallurgic antiquary. The interior of one of the old Comstock mills, the California, is shown in the accompanying illustration.

The Ward shaft pumping plant is designed to be the largest of any precious metal mine in the United States. One 800-hp. unit now temporarily installed on the 2475-ft. station is direct-connected to an electric motor and runs at a speed of 196 revolutions, or 523 ft. of plunger speed per minute. The behavior of this pump in a long test by practical operation will have an important effect upon the future design of large electrically driven mine pumps in this country.

During the past few years a great deal of necessary 'dead work' has been accomplished. The men on the Comstock believe that the fiftieth anniversary of the discovery of the lode marks also the date of its substantial rehabilitation, and that the mechanical and metallurgical improvements which have lately been made there will enable the miners of today to work the low-grade ores and to explore in search of bonanzas those portions of the lode which the men of thirty years ago were unable to enter.

JEFFERSON CANYON, NEVADA.

Written for the MINING AND SCIENTIFIC PRESS
By GEORGE A. PACKARD.

In Nye county, Nevada, five miles easterly from the new camp of Round Mountain, and 50 miles north of Tonopah in an air-line, is the old camp of Jefferson. For nearly forty years the stage from Austin to Belmont followed the road up Jefferson creek from the Big Smoky valley to the summit of the Toquima range, but after the opening of the mines of Manhattan and the discovery of Round Mountain, the route was changed, and a detour made to the south to include these places. During the seventies several mines were worked in Jefferson canyon, which was then known as the Concordia or Green Isle mining district. The largest producers were the Jefferson and the Prussian companies, owning adjoining claims, the Prussian South and Prussian, on the same lode. This vein has a northwest strike, with a dip to the northeast of about fifty degrees, and has been traced for several thousand feet. It lies between a porphyry hanging wall and a slate foot-wall, though the occurrence of slate is limited. To the southwest quartzite may be seen overlying limestone, and this in turn lies upon granite. In passing up Jefferson canyon this hanging wall porphyry shows two rocks quite unlike in appearance, one a very light brown, the other gray in color. Microscopic examination of slides shows, however, that these are not materially different. Both may be termed rhyolite, and show a strongly marked flow-structure, as does the country rock at Round Mountain, which they closely resemble. The darker shows, with the high powers, a ground-mass, once glassy, of indistinct crystals crowded with decomposition products such as kaolin and calcite. The quartz phenocrysts, which are fairly abundant, are large, and are generally somewhat rounded crystals. More abundant than these are the crystals of albite, now largely replaced by calcite. The rock also shows orthoclase, biotite altered to chlorite, and grains of magnetite. The ground-mass of the lighter rock is similar to that of the darker, except that it is more discolored with ferruginous matter, which also appears in the phenocrysts. There is somewhat less calcite.

Alexander Trippel, reporting on the Jefferson and Prussian properties in 1881, says: "It has been stated that the two mills shipped a million dollars worth of bullion; for the absolute truth of this statement I cannot vouch, but to my own personal knowledge $200,000 worth was produced during one year. Both companies worked their mines by means of inclined shafts sunk on the vein, the Jefferson company to the depth of 700 ft., and the Prussian to the depth of 250. The width of the vein varied from 2 to 7 ft., with a smooth and regular wall on either side. The ore was not uniformly distributed, but was found in obliquely inclined chimneys several hundred feet in length, between which the vein was either low grade or barren." These properties have not been worked since 1876, except for a short time by lessees. Apparently they were closed because in depth the amount of water increased and the ores became too 'base' to work by methods then known. The ore in this vein contained silver chiefly, and at water-level sulphides and sulphantimonides were found.* In the hanging wall porphyry are a number of veins which have been held and worked by a single miner for over thirty years. Some of these parallel the Prussian vein, but others are apparently nearly at right angles. In doing some 4000 ft. of work, ore yielding many thousand dollars has been sorted and shipped, but the bulk of the ore is comparatively low grade. Recently two New York men have acquired control of this property, and are erecting a mill. This ore differs from the ore of the Prussian contact-vein in that it carries more gold than silver, though the proportion of silver is larger than in the ore occurring in the similar porphyry at Round Mountain. There is also some work being done to the southwest of the Prussian vein, on the contact of the granite and sedimentaries.

Wireless stations are to be erected in the interior of China. The difficulty of establishing communication by telegraph across the deserts between Peking and the extreme northwest of the Empire is to be surmounted by the installation of an extensive wireless system under the control of the Chinese Government. The Board of Posts and Communications is now making investigations as to the best system to adopt.—*Far Eastern Review.*

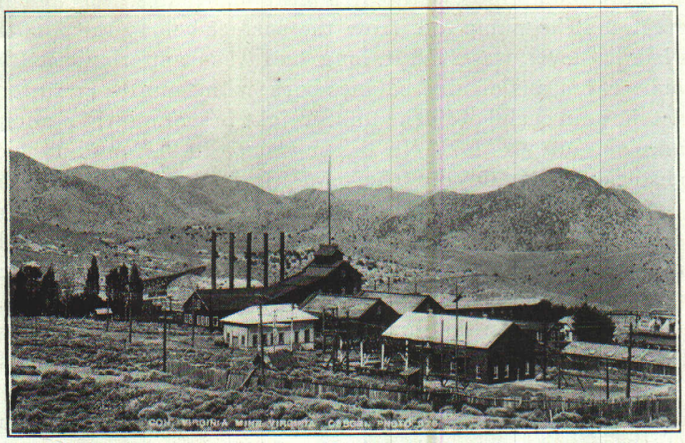
The lower limit of manganese steel is determined by the fact that alloys between 7½ and 5½% of manganese are weak and brittle. The characteristic strength and toughness can only be given to steels having more than 8 per cent.

*Mineral Resources of the United States, 1875, p. 281, and 1876, p. 138.

COMSTOCK DRAINAGE PROBLEMS.

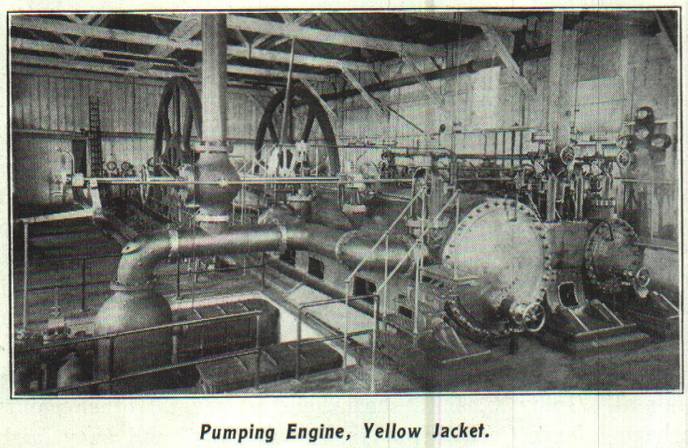
Written for the MINING AND SCIENTIFIC PRESS
By LEON M. HALL.

The first mining of any magnitude on the Comstock was upon the orebodies adjacent to the surface or embraced directly within the outcrop of the vein.



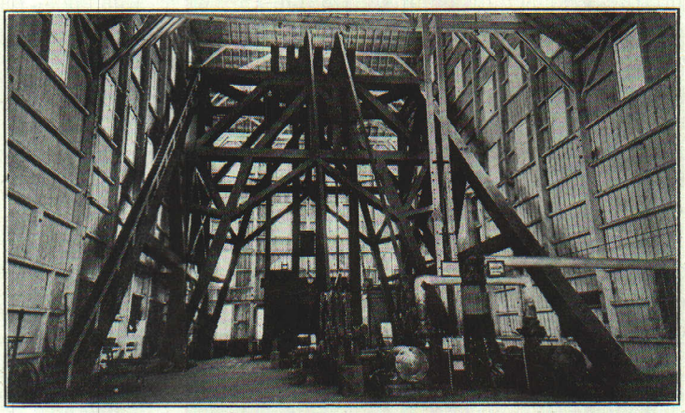
Consolidated Virginia Shaft.

From the surface the lode paid handsomely, and the early development brought forth the great bonanzas. These were enormously rich and of large extent, but they were soon denuded of the masses that could pay by the crude methods then in vogue. Between these orebodies and the deposits unearthed in the Bonanza mines, the Belcher and Crown Point, there was a zone of barren or low-grade quartz, which is usually the case in all gold and silver lodes. The second line of bonanzas has been practically exhausted; at any rate, down to the depth of the Sutro Tunnel. When operations were discontinued, the workings were in the second zone of barren quartz, and while no rich bonanzas were then in sight, there were no discouraging features developed; on the contrary, in many parts the prospect was bright. The indications in both the Hale & Norcross and the Belcher pointed to a large deposit at no great depth below the workings at that time. The Yellow Jacket (Taylor shaft) passed through the vein at about the 3000-ft. level, and here the foot and hanging walls were 60 ft. apart, with an unusually promising body of quartz between them.



Pumping Engine, Yellow Jacket.

It was about this time (February 13, 1882) that an immense reservoir of exceedingly hot water was encountered on the 2700-ft. level of the Exchequer. This was of such volume that the appliances then extant were entirely inadequate to handle the river that was pouring into the Gold Hill mines. In the middle and north-end mines the state of affairs was different. New shafts had been sunk to the east of the second line of workings, and a vast amount of prospecting was being done, when orders came to abandon deeper mining and to return to the ore left behind, in the search for new and possibly vaster deposits. At the time when work was discontinued in the deep shafts and a return was made to operating the upper levels, the Combination shaft, then one of the deepest vertical shafts in the world, had reached a depth of 3250 ft., and the Yellow Jacket a depth of 3000, the Sutro Tunnel intersecting the former at a depth of 1590 ft. and the latter at about 1513 below the surface. A similar ratio existed in all of the deeper mines. Thus, with the advent of the Sutro Tunnel, a new and lower working-surface was created, and the depth for operating was virtually reduced about 1500 ft., making it possible to sink to the 3000-ft. from this level with the same facility as was formerly done from the surface.



Head-Frame, 80 Ft. High, Forman Shaft.

During this period all of the principal shafts on the Comstock were equipped with magnificent hoisting plants, some of which were capable of operating to a depth of 4000 ft. Among the most notable may be mentioned the large first-motion engines that were installed at the Yellow Jacket and Union shafts. These hoists consisted of double 30 by 96-in. engines, equipped with flat-rope reels and a flat rope 8 in. wide. They were capable of making the trip from the 3000-ft. level with a load of 10 tons in one minute. At many of the other shafts large geared hoists were installed, which, together with numerous large air-compressors and the attendant necessary boiler-plants, made an imposing equipment. At several of the more important shafts it was not an uncommon

occurrence to consume 60 cords of wood per day.

Nearly 20 years have now elapsed since most of the largest mining plants for the Comstock were planned and installed. Criticism of the past from the standpoint of today, with the experience and advancement made in all pumping appliances before us, is liable to be harsh and unjust. The defects are readily seen, while the causes that led to them are forgotten. Furthermore, nearly every system as planned in practice falls short of its calculated efficiencies, and is handicapped and confused by the multiplicity of commercial interests involved, and no mining district has had greater difficulties to contend with in pumping than were met by the engineers on the Comstock Lode.

The completion of the Sutro Tunnel, and its employment for drainage purposes by the several companies, changed nearly the whole system of pumps as originally designed. The costly and massive pumping engines were left on the surface, while all intervening pumps were removed to below the tunnel-level, where they were doubled up, two being placed at each tank-station. This change left about 1700 ft. of heavy pump-rods between the surface engine and the first set of pumps. Double the work was being done on the lower end of the rods that was originally intended, and the fibres of the rods became fatigued and over-strained. Velocity diagrams taken from the pump-rods underground showed that their motion was not regular or uniform with the surface engines. The effect of the elasticity, and the great length of the rods, produced accelerations and consequent strains that many times exceeded the direct strain due to pumping alone. In the case of the Ophir rod at the 2400-ft. level, strains were found that exceeded the proper one by over nine times. The cause for the constant need of renewing pump-rods, broken balance-bobs, pins, and strapping plates, that was almost a weekly occurrence, was thus made apparent. As for the remedy, there was none with that class of pumps and machinery, necessarily placed at such a great distance from the water to be pumped.

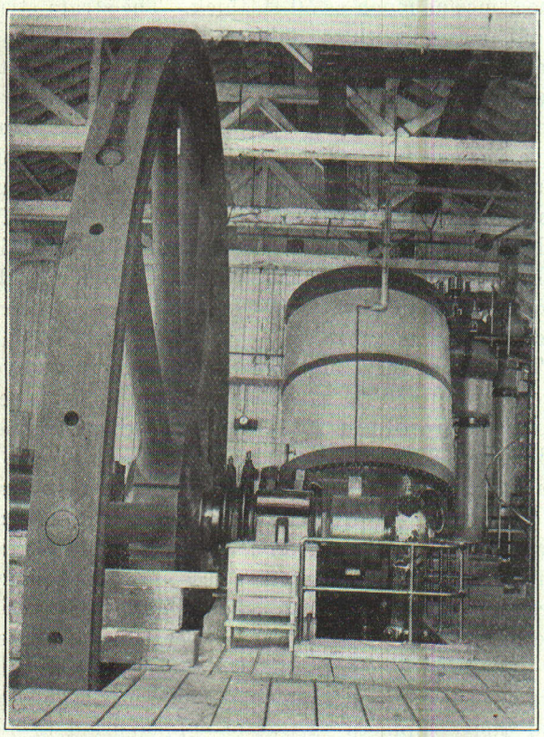
For the benefit of those not familiar with the magnitude and the extent of the pumping plants erected and operated on the Comstock up to the year 1886, a brief description is here given, as it will enable them to better understand the reasons for some of the enormous expenditures in pumping in the past, compared with what is being accomplished at the present time. The Mexican-Union pumping engine was originally built in Europe as an overhead-beam Cornish engine. It was brought over, re-built, and changed to the compound condensing fly-wheel type. The cylinders were placed over the main beam, and inclined to each other with their connecting rods attached to the beam, one on each side of the beam-centre. The pump-rod was connected at the pit end, and the connecting rod of the fly-wheel at the other. The fly-wheel was 36 ft. diam. and weighed, with the shaft, 208,700 lb. The wrought-iron beam under the cylinders was 22 ft. long between the pump and the fly-wheel pins, and weighed, when completed with braces, 238,610 lb. The high-pressure cylinder had a diameter of 64 in. and a stroke of 6 ft. 9 in. The low-pressure cylinder was 100 in. diam and 8 ft. 6 in. stroke. The air-pump was single-acting, 54 in. diam. and 6-ft. stroke. The nominal stroke of the pump was 10 ft. The engine was first started in April 1880, with a double line of 14-in. plunger-pumps discharging into the Sutro Tunnel. In January 1883 the 14-in. pumps were replaced by 10 plungers 17 in. diam. In making this change a thousand feet of new 18-in. pump-rods, with extra strapping plates, were put in. The pump-rod, from the surface-bob to the 2700-ft. level, was 2618 ft. long, and was counterbalanced by means of nine balance-bobs, with from 18 to 20 tons in each bob. The total weight in motion while pumping was 1,620,500 lb., or about 620 lb. for every foot of pump-rod. The total lift from the pump at the 2700-ft. station to the lateral drift of the Sutro Tunnel was 1180 ft. On account of the great length, elasticity, and weight of the pump-rod, the actual strokes of the plungers averaged by measurement 9.7 ft., when the surface stroke was 10 ft. A similar loss of stroke was noticed on all the Cornish pumps in use on the Comstock.

The hydraulic system installed and started at the Combination shaft in May 1881 consisted of a surface pumping engine, compound-condensing type, with horizontal cylinders, actuating direct from the cross-head four pumps with plungers 8½ in. diam. The stroke, designed for 10 ft., was variable under the control of the Davey valve-motion. These pumps forced the water into a large surface air-chamber, and from there down the shaft to the underground hydraulic pumps. The cylinders of this engine were 30 and 70 in. diam., respectively. An air-pump and cooling pond were used for condensing purposes. In each of the underground stations, cut at the 2400, 2600, and 3000-ft. levels, as the shaft was sunk there were placed two hydraulic engines. Each engine had four power-plungers of proper size to operate two pump-plungers that raised the water from the station to the Sutro Tunnel discharge. The ratio of the power-plungers to the pump-plungers was properly proportioned so that for a 10-ft. stroke the pumps could make about six or seven strokes per minute. After a trial of a few months, with numerous breaks and want of satisfactory results as to efficiency, the use of the surface-power engine was abandoned. A 12-in. pipe was laid from the Virginia & Gold Hill Water Co.'s tank near their flume, which gave a pressure-head of 2016 ft. to the Sutro level. With this steady power the pumps worked smoothly, without a jar, and gave quite efficient results. Under this system of pumping, all the water used for pumping was discharged with the mine-water through the Sutro drain.

At the Yellow Jacket, Belcher, Overman, Alta, Ophir, C. & C. shafts, and at several other points, large Cornish pumps were installed and gave fairly efficient service until their capacity was greatly overtaxed. All of the above-mentioned pumping machinery cost, without foundations, installation, or freight, about $1,300,000. Its maximum pumping capacity, all told, was less than 5400 gal. per minute, lifting an average height of 1152 ft. The cost for six months, taken from the books of the different companies, for operating the same was $34.13 for each indicated horse-power per month. The average water pumped

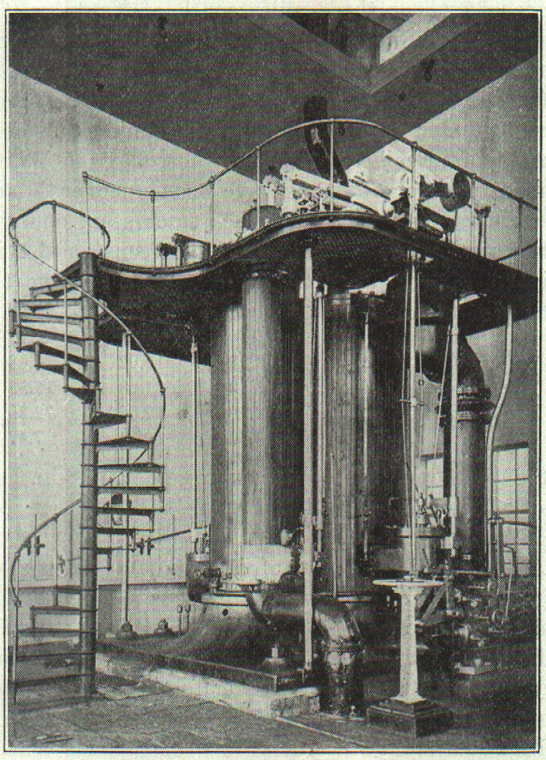
during that time was 5040 gal. per minute, raised an average distance of 1074 ft. The total indicated horse-power was 1703. The cost per month was $58,120, or $697,440 per year. This does not include the cost of new fly-wheels, broken bobs, strapping-plates, pump-rods, or new plungers, but represents the daily operating expense for pumping.

As for the enormous cost of operating expenses, it must be borne in mind that a great part was due to the local conditions, not to be found in any other mines the world over, hot water often reaching 160° F., at an elevation of 6000 ft. above the level of the sea. Ice was one of the staples in the list of supplies and lubricants for plungers, and all underground bearings were rapidly consumed, and otherwise wasted. The wood burned cost $10 per cord, and in the previous year cost $12. From January 1882 up to January 1884, the C. & C. Shaft Co. paid $6000 per month for water-power to operate their hydraulic pumps, and $10,000 after that date. This water was furnished under a static head of 2016.5 ft. to the Sutro Tunnel level. As an average of six months pumping in 1884, from the 2400 and 2600-ft. levels with the hydraulic pump, the cost of water raised per horse-power was $20 per month, a little more than the cost of wood with the Cornish system. But in 1886, when the 3000-ft. level pump was running, the price fell to $11.50 per pump horse-power.



Pumping Engine, Mexician-Union Shaft.

In comparison with the above enormous pumping equipment, high costs and operating expense, a brief description of the present electrical pumping equipment at the C. & C. shaft may be interesting. Hydraulic elevators were installed in the C. & C. shaft, and with them, in connection with the electric pumps, the water has been lowered 750 ft. Under existing conditions, I believe this device is the most practical sinking pump in existence. It is true that the efficiency is only about 25% at best, but the cost of repairs is very small and the reliability superior to other systems. At a depth of 450 ft. below the Sutro Tunnel level the limit of power from the water-supply was reached, and on the 2150-ft. level a large electrical pumping-plant, with a capacity of 4500 gal. per minute, was installed. This plant consists of three duplex, double-acting ($6^{11}/_{16}$ by 24-in.) pumps, driven by three 225-hp. Westinghouse type C motors. The pumps are of the ordinary Riedler pattern, with mechanically closed valves, and operate at 110 rev. per min. Compared with the previously mentioned pumping plants, this shows a marked advance in engineering methods; and the cost, which is about $80,000 in running order, is but a fraction of what was formerly paid, while the running expense is about $4000 per month.



Pumping Engine, Forman Shaft.

YUKON TERRITORY WEST OF LEWIS RIVER.

By D. D. Cairnes.

*The season of 1908 was chiefly devoted to the mapping and geological examination of those areas north of Whitehorse and south of Tantalus known to contain coal or to be underlain by coal-bearing formations, it being more particularly desired to ascertain the nearest points accessible to Whitehorse at which coking coal similar to that at Tantalus could be obtained. The entire district strictly belongs to the interior plateau region of the Yukon Territory, which, originally eroded to peneplain conditions, was subsequently subjected to a rather rapid uplift.

There are two coal-bearing horizons of economic interest in this portion of the Yukon Territory. An upper horizon occurs near the top of the thick assem-

*Abstracted from Summary Report, Geological Survey Branch, Department of Mines, Canada, 1908.

blage of conglomerate beds forming the upper half of the group of Cretaceous sediments, and to this higher zone belong the seams at the Tantalus mine and on Tantalus bluff. A second, lower coal-bearing horizon lies toward the base of the Cretaceous column as seen at the Five Fingers mine, also at a point west of the 69-mile post from Whitehorse on the Whitehorse-Dawson road, and elsewhere. The seams of the Tantalus bluff and the Tantalus mine doubtless extend a number of miles to the north and south of these places, but prospecting for coal is rendered particularly difficult there by the thick mantle of glacial and recent alluvial material which covers the greater part of the district. Beginning within a distance of two or three miles south of Tantalus, the Cretaceous sedimentary rocks are, for the greater part, covered with more recent Tertiary basalts, basalt tuffs, etc., so that careful prospecting will be necessary to find it suitably located for mining purposes.

About four miles west of mile-post 69 from Whitehorse a number of seams have been uncovered, and probably others exist. Of the seams seen, one was 7 ft., another 4 ft., and several between 6 and 8 in. thick. Samples analyzed by F. G. Wait gave the following results:

	I.	II.	III.
Water	8.98	12.02	4.68
Volatile combustible	29.62	34.28	15.59
Fixed carbon	48.30	42.56	72.26
Ash	13.10	11.14	7.47

Sample I represented the average of an 18-in. bed, II of a 7½-ft. bed, and III of a 2-ft. bed, seen between mile-posts 113 and 114.

A few miles southwest of Montague are a number of claims, locally known as 'Macks copper'. The property is reached by a branch road leaving the Whitehorse-Dawson road, about six miles above Montague and following approximately the old Dalton trail southwesterly up the Hutchi river. From a point about eight miles in on this road a trail ascends the hills to the north of the claims, which virtually are on the summits, about four miles distant from and 1900 ft. above the valley. Practically all the ore in the vicinity appears to be on one claim. It appears in a fine-grained greenish porphyrite, at or near its contact with limestone, and consists chiefly of magnetite, with hematite in minor quantities, both being more or less impregnated with copper minerals, chiefly chalcopyrite, malachite, and azurite. The main mass of mineral is in the form of a small knoll of iron ore, about 200 ft. wide by perhaps 300 or 400 ft. long. On the south side of the hill the iron carries considerable copper, while the ore on the top shows none. The orebody in the more westerly locality is only 10 to 12 ft. wide, and lies next to and more or less in the limestone. The following samples were taken by the writer and have been assayed by Robert Smart, Government assayer at Whitehorse. No. I is an average from the end of a tunnel, No. II is an average of the best 4 ft. of the open-cut:

	I.	II.
Gold, ounces per ton	Trace	0.025
Silver, ounces per ton	Trace	3.400
Copper, percentage	1.80	5.55

On both sides of Gilltana lake, which lies some 15 miles in a northwesterly direction from Hutchi lake and village, are claims known both as the Gilltana Lake claims and as the Hutchi copper. The ore on the northwest side of the lake occurs at the contact between granite and limestone, and is in the form of narrow lenses of mineralized matter and quartz. The widest lens seen had a breadth of about 4 ft., but as a rule the bodies are only from 1 to 2 ft. wide and have at present no economic value. Across the lake the claims are chiefly located over the face of a hill rising about 1200 ft. above the water. The country rock consists mainly of mica schists, interbanded with which are some beds of quartzite and limestone, the latter generally being narrow—3 to 4 ft. wide, but sometimes as much as 50 ft. thick. The strata strike about parallel with the lake and dip into the hill, so that the different bands of schist extend along the face of the hill, one above the other, maintaining an almost horizontal outcrop. In places these bands have become mineralized with magnetite, generally carrying copper minerals, chiefly chalcopyrite and malachite, and these constitute the orebodies. The original schists show all degrees of mineralization and replacement, from portions entirely non-metalliferous to others now consisting of almost solid iron ore.

The best of these mineralized bands or zones average from 6 to 10 ft. in width, although one was seen having a breadth of 20 ft. and consisting of almost solid ore. The mineralized bands generally can be traced for 50 to 100, or even 200 ft., when the iron and copper minerals gradually disappear, or at times seem to be continued along other parallel bands. Three prominent, with other less important bands, were observed at different elevations on the face of the hill. At the surface the copper minerals appear to have been leached out. On the Helen claim, up Franklin creek, some open-cut work has been done, and there in places streaks of copper ore 1 to 3 ft. thick were seen, included in wider bands that are much richer than observed elsewhere.

Apparently the ores are connected in origin with the intrusive granites found in the vicinity. The strata have been cut by dikes of light colored hornblende andesites and dark fine-grained basalts, but these have had no visible effects on the ore deposits. The district is well worth prospecting and a number of the claims look very promising. The following represent the results of assays of two samples from this district. No. I is a sample taken across the strike of one of the best looking bands, which had a width of about 6 ft. No. II is a sample of one of the 3-ft. streaks of copper ore on the Helen claim.

	I.	II.
Gold, ounces per ton	Trace	Trace
Silver, ounces per ton	Trace	Trace
Copper, percentage	1.35	9.00

Since the season of 1905 the Venus, on Windy Arm, has been worked continuously, with very satisfactory results, so that now a large amount of ore has been blocked out and some small high-grade shipments have been made to outside points. During the past year this is the only property in the district upon which important work has been performed.

The Washoe Process

Written for the MINING AND SCIENTIFIC PRESS
By A. D. HODGES, Jr.

You, Mr. Editor, have asked me to describe the parentage, development, and metallurgical and mechanical limitations of the Washoe process. You have given me a task which deserves a volume. And you beg me to be brief. Under the circumstances the best I can do is to rehearse concisely certain facts, and let you draw what conclusions you can.

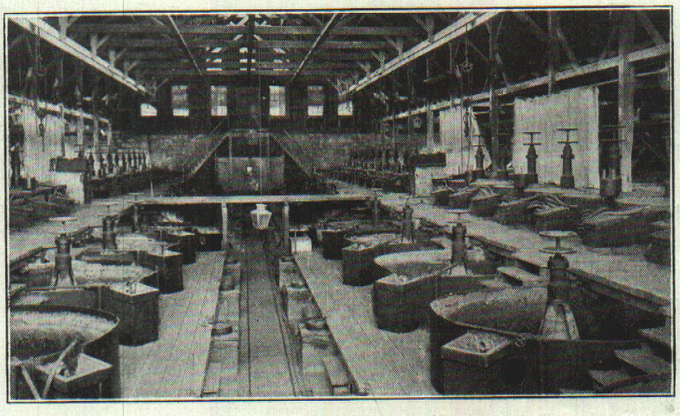
The father of the process was that energetic, enthusiastic, and capable millman, Almarin B. Paul. He was the first to conceive and carry out the idea of treating the sulphuretted auriferous silver ores of the Comstock with the chemicals of the patio process in the pans which he had used in the gold mills of California. His project was received with general distrust, but he perservered, and on August 11, 1860, his Pioneer mill began successful work in Washoe. Paul's mill, constructed in San Francisco, hauled over the mountains and set up in Gold Canyon, all in the space of two months, was necessarily imperfect; but its success led to the erection of a host of others. These were built by the able mechanics of San Francisco and Washoe. The problem submitted to these men was to construct machines which would treat the ores economically and rapidly and extract an amount of the precious metals sufficient to pay dividends. They solved this problem well. But as the millmen were unversed in chemistry and never were allowed to know what percentages of gold and silver was extracted in their mills, the first development of the Washoe process of necessity was purely mechanical.

Let me here mention that during my active experience in Nevada, I knew of only two silver mills treating unroasted ores in that State, which checked their work by proper weighings and assays and knew exactly what they were doing.

Louis Janin was living on the Comstock, and with him were associated his brothers Henry and Alexis, all of them educated mining engineers. They were the next persons to develop the process, which had halted with the rich ores holding simple sulphides. Investigating the chemical side of the question, they discovered that, by the rational use of certain reagents, the poor ores and the tailing (slime and sand), which held multiple sulphides, could be worked profitably. Henry Janin took out a patent for the use of dichloride of copper, but nothing was ever done with his process; for the employment, in proper amounts and proportions, of salt and bluestone was found satisfactory. Louis Janin purchased and ran with pecuniary success the Dayton Reservoir mill so long as he could obtain tailing to work.

The Lyon mill at Dayton copied Janin's methods and improved them. This mill had an excellent superintendent, George Langtry, who was a fine millwright. It also had an assayer who was in charge of the sulphuric acid, the bluestone, and the bullion departments. Careful tests on a working scale were constantly made. The pans and settlers were perfected. The process was watched with loving vigilance and modified whenever, and as soon as, a change was found desirable. Observers were fond of saying that the Lyon mill never ran the same for two consecutive days. This of course was an exaggeration, but it illustrates the close watch kept over operations.

The Lyon mill, in the period from 1873 to 1877, treated sand and slime holding from 3 to 20 oz. of silver and 0.05 to 0.25 oz. of gold per ton, and extracted in the shape of bullion 70 to 85% of the precious content, and paid continuous dividends. The percentage of gold obtained varied from 25 (in the poorest grades) to 60 (in the better material); that of silver, from about 80 to nearly 90. The variable extraction percentage of the gold *seemed* to be due chiefly to the varying nature, amount, and gold-content of the iron sulphides whose behavior was erratic. Many thousands of tons, averaging about 0.055 oz. gold and 2.8 oz. silver, were worked at a profit of about 75c. per ton paid in dividends. The tailing escaping from the mill held about 0.036 oz. gold, less than one-half ounce silver, and a negligible amount of quicksilver.



Interior of California Pan Mill.

The liberal use of chemicals resulted in a very base bullion which, at this mill, contained on the average about 85% of copper. No one had ever succeeded in refining such material (which could be sold only at a very heavy discount) until the assayer of the Lyon mill devised a cheap and easy process,* whereby the copper was recovered in the useful shape of sulphate, and fine silver and fine dorée bars were produced, while the losses in refining were so small as to be imperceptible. This completed the development of the Washoe process on the Comstock Lode, so far as known to me.

About 1870 Alexis Janin went to the Meadow Valley mill in Pioche where he was associated with, and later succeeded by, Gardner F. Williams who was afterward the brilliant manager of the famous Kimberley diamond mines. Janin and Williams introduced the Washoe process at Pioche, modifying

*Described in the Trans. of the Amer. Inst. Min. Eng., XIV:731.

it to suit local conditions, and ran it for years with great success although the ore contained noteworthy amounts of lead and other troublesome constituents. Mr. Janin published an interesting and instructive article which appeared, if my memory serves, in one of the reports of the United States Commissioner of Mining Statistics.

In 1886 mill tests of the Washoe process were made at Cerro de Pasco, Peru, in a broken-down mill, on *cascajo* ores holding from 12 to 18 oz. silver. The exact mineral composition of these ores—an ever varying composition—has never been determined. But here is an analysis which is fairly representative of a very large class:

	Per cent.
Silica	73.00
Alumina	6.50
Iron peroxide	13.50
Iron protoxide	0.50
Iron pyrite	2.00
Lead carbonate	1.25
Copper	0.05
Zinc	0.50
Silver	0.042
Antimony	0.37
Arsenic	0.03
Manganese peroxide	0.70
Lime and magnesia carbonates	1.50
	99.942

Gold occurs in mere traces. Thallium has been detected in some ores.

Tests for the condition of the silver have given diverse results. Charles A. Stetefeldt, to whom large amounts were submitted for lixiviation experiments, found 25 to 30% as chloride, about 20% in the native state, a slight amount in undecomposed pyrite and in lead carbonate, and the remainder in an unknown combination. The numerous tests made at the Cerro on samples representing thousands of tons indicate 50 to 60% in a metallic condition and as a chloride, the rest held in combination with sulphides, antimonides, arsenides, and lead carbonate in ever varying proportions. The ores tested in the mill yielded, with mercury alone, in fine bullion, 50 to 60% of the silver, equalling the results of the patio process. With the addition of salt and bluestone, such ores as the one whose analysis is given yielded 85%, but the bullion was very base.

To me amalgamation is the most fascinating of all metallurgical processes. It is neat and clean and speedy in its returns and full of alluring mysteries. It was my dream for years to have a large mill with a well equipped laboratory wherein the constantly occurring problems could be investigated. Perhaps if the Comstock merger be effected, my dream may be realized for somebody else. Until then I know not how the question of the possibilities and limitations of the Washoe process can be settled.

The metallurgical works of San Francisco have always formed a prominent feature of our local home industry. The recent addition of argentiferous ore to the auriferous, has opened a new and profitable field, which has lately been occupied by the Ophir Works, situated at the foot of Taylor street, North Beach.—June 30, 1860.

PRIMITIVE MINING

We reproduce below from one of the early issues of the MINING AND SCIENTIFIC PRESS, a wood cut illustrating methods of mining in California in the days when the industry was young. The two part-

ners, with only pick, shovel, and pan, are typical of the men who laid deep the foundations of American mining. Such pictures help to make clear how much early mining depended on muscle.

The pioneer ship of a Japanese coal fleet has arrived at this port from Kuchinotzu. She is the British ship Aigburth, and made the passage in the smart time of 33 days. Other vessels, coal-laden and consigned to E. C. Evans, agent for the Japan mines, and on the way, are the American schooner Puritan, the American bark Mt. Washington and the British ships Bandaneira and Lord Downshire. Some of the coal is in pressed bricks, but the most of it is destined to enter into competition with the cheaper grades of coal prevailing here.—December 16. 1893.

The Ophir Cyanidation Plant

The new plant of the Ophir Silver Mining Co., operating on the Comstock Lode, has now been in operation a little over a month, and was briefly described in the *Virginia City Chronicle*, by Walter Techow, who, after designing and erecting the mill, is now in charge of its operation. In building the plant an excellent record for speed was made. It was ordered by the directors June 22. The first work of grading began on July 15, and while the lumber did not arrive on the ground until the end of the month, the actual construction began early in August. The frame was put up during that month, and the building inclosed early in September. The machinery was also installed in September, the finishing touches made early in October, the plant started October 14, and has been running continuously ever since. The plant is complete with the exception of the clean-up room, now being added, and soon to be placed in commission. With the melting facilities available, the first clean-up will be made.

According to Mr. Techow, the plant was designed for a capacity of 100 tons per day. During the first two weeks after starting, it treated 1065 tons. During the third week 625 tons was handled, and during the past week the plant has been running at a rate of more than 100 tons per day. The process adopted consists of re-grinding the coarse part of the tailing from the old Kinkead mill, agitating the re-ground tailing with cyanide solution, and separation of the gold and silver-bearing cyanide solution from the now barren tailing. The tailing is re-ground in a 5 by 22-ft. tube-mill furnished by the Union Iron Works. One problem in connection with the erection of this mill was how to get the wet and sticky material to the tube-mill, and the method adopted was to sluice it from the pond to the tube-mill. This method has proved successful and economical, as the cost of getting the tailing into the mill is only about 9c. per ton. The tailing is sluiced into the tube-mill with dilute cyanide solution and is continually in contact with cyanide solution from the moment it leaves the pond until the treatment is completed.

From the tube-mill the re-ground tailing passes to a Dorr thickener 28 ft. in diameter by 8 ft. high, where it is settled and the excess of the cyanide solution is removed. This solution is pumped back to the tailing pond and is kept continually in circulation. The settled slime is elevated from the bottom of the Dorr thickener into one of a series of three agitating-tanks, 16 ft. high and 22 ft. in diameter. These agitating-tanks are equipped with Trent agitators. They require little power and do excellent work if properly erected and looked after. After about 24 to 36 hours agitation with an additional amount of cyanide, the slime is transferred to a storage tank and passes from this tank to the Butters filter. The gold and silver-bearing cyanide solution leaves the filter clear, and passes on to the precipitating-boxes, while the tailing is discharged from the Butters filter and allowed to run to waste.

The original estimate of the cost of operation of this plant was $1.25 per ton. It appears now, however, after one month's operation, that the estimate was too high. The cost of treatment will probably not exceed $1.20 per ton, and possibly may be lower. The consumption of cyanide is at present less than three-quarters of a pound per ton or an equivalent of $0.19 per ton. The total cost of labor will come to about $0.40 per ton. The power consumed during the first two weeks was at the rate of 100 hp. It will probably be less in the future, as all the machinery was new and in the process of being limbered up.

Up to the present time, by the records at the plant, the tailing treated has averaged about $5 per ton before treatment and $1 per ton after, thus indicating an extraction of approximately 80%. It is believed, however, that further experiments and improvements will raise the extraction to 85%, or possibly higher. It will be of interest to again recall that the tailing is the product of the Kinkead mill, which by the process of concentration, extracts 84 to 87% of the original value of the ore as shown by the smelter bullion returns. It can thus be concluded that a final loss of $1 per ton represents only 2 to 3% of the first head sample at the Kinkead mill. The total extraction at the mill and cyanide plant will, therefore, undoubtedly average 97% or better of the gross value of the ore. This extraction, according to figures furnished at the Ophir office, is being obtained at a total cost of $3.75 per ton for both milling and cyaniding.

A Souvenir Medal

We present below a picture of the beautiful medal struck in commemoration of the visit of the American mining engineers to Japan in 1911, and sent by them to their Japanese friends. The medal was designed and manufactured by Tiffany & Co., and is made of gold bronze framed in ebony. Replicas have been sent to each of the members of the general committee and to others prominent in entertaining the visitors. In addition, life memberships in the American Institute of Mining Engineers have been purchased and presented to Reija Kanda, M. Otagawa, and W. Watanabe, to whom the visitors were indebted for many especial courtesies. The selection and presentation of the souvenirs was made by a committee consisting of D. W. Brunton, F. C. Smink, and F. H. Daniels.

Of the industries of the Union of South Africa, mining is by far the most important. The total value of the principal minerals produced in South Africa up to the end of last year was approximately as follows: gold, $1,579,715,000; diamonds, $777,600,000; coal, $113,210,000; copper, $43,740,000; and tin, $7,260,000. During December 1911 the mining industry of the Union gave direct employment to 31,700 white and 259,600 colored persons. The amount of gold ore crushed during the past year was 25,000,000 tons, yielding 8,250,000 oz. of gold, valued at $170,000,000. The profits amounted to $57,348,000, and the dividends $38,991,780. The increase in the production over 1910 was $14,895,900, principally due to new producers. The value of the output of the other principal minerals during the past year was as follows: diamonds, $38,510,420; coal, $9,438,120; copper, $2,702,160; and tin, $2,016,900.

THE oil industry in the Taranaki division of New Zealand has excited a good deal of comment from time to time. The first attempts to prove the oil-bearing country were from 1865 to 1868, and the second period of activity was from 1889 to the present. There are now four oil companies holding property in or near the area examined, but the combined output is little over 100 bbl. per week.

Special Correspondence

LONDON

CAMP BIRD REPORT.—FURTHER INVESTMENTS BY THE COMPANY.—MESSINA DEVELOPMENT.

The annual meetings of the Camp Bird, Ltd., The Santa Gertrudis Co., Ltd., and the Messina Development Co., Ltd., have just been held in London. The Camp Bird company carried forward a surplus of £51,000, against £39,000 brought forward last year. The profit and loss account, as made up from quarterly reports, covering fourteen months, from May 1, 1911, to June 30, 1912, showed £245,000, less £11,000 charged off for taxes, £8000 for depreciation and other sundry expenses, amounting to a total of £22,000, leaving a balance to the profit and loss account of £223,000, Camp Bird's proportion of Santa Gertrudis profits during a like period amounting to $202,000 net, being 81%—a total of £250,000 to the credit of the Santa Gertrudis profit and loss account. One of the chief items of interest in the Camp Bird balance sheet is an expenditure of £79,225 invested in the purchase of the Aviado-Recuperadora shares. These shares have since been transferred to the Santa Gertrudis company.

The principal item of interest discussed at the meeting was the outlook for further production from the old Camp Bird mine, and in this regard A. M. Grenfell, chairman of the board, said in part:

"I think we may look forward with every confidence to another prosperous period; but as the Camp Bird becomes exhausted we begin to depend more on dividends from Santa Gertrudis. The developments at Camp Bird seem to justify Mr. Cox's estimate that we may still expect a profit in Camp Bird of £60,000. The orebody being developed is quite promising, but inasmuch as the finding of ore at this horizon is contrary to the expectations of the experts, I do not care to attempt to prophesy, though there does seem a sporting chance of our finding a fair orebody here. There is always a possibility—a small one, perhaps, but still a possibility—that we may be on the top of an entirely new body. Mr. Cox has thought well enough of the prospects to sink the shaft down 200 ft. below the present drifts, and, as I have said, should we find that the values are maintained at this depth, we may begin to speculate on the probability of considerable future profit from the Camp Bird mine." In reference to the Santa Gertrudis, Mr. Grenfell said: "I will say here that if the estimates of the engineers of the Santa Gertrudis are borne out, that mine should give a profit this year of £360,000, taking silver at 55c. per ounce, or if you take silver at the price of today, the profit should come up to £412,000, of which the Camp Bird proportion would be £304,000. Adding this to the £60,000 we should receive as profit from the Camp Bird, we may look forward fairly safely, I think, to an income this year of £364,000, so that we have every reason to congratulate ourselves, not only on the past, but on the immediate future. Furthermore, from the reports of the Santa Gertrudis, it appears that that mine has sufficient ore in sight to yield very large dividends during the next four or five years, so that not only are we in an exceptionally good position today, but I think we may look forward to very satisfactory profits during the next few years; in fact, our position appears to me to be so strong and so satisfactory that the board are of opinion that we should take advantage of our prosperity to establish ourselves on a really sound and lasting basis."

One of the important items of discussion at this meeting was in regard to the policy of the Camp Bird company as to the making of further investments similar to that made in the Santa Gertrudis property. As to this Mr. Grenfell said: "During the next four or five years it should be our policy to build up a reserve fund of £600,000 or £700,000, if we can do so without in any way impairing the real benefits of the shareholders. As it is, today we are dividing our profits up to the hilt. We are making little provision for the maintenance of dividends or for accidents or shut-downs which might happen to Santa Gertrudis, just as it happened in Camp Bird, the idea being that shareholders in mines arrange for their own sinking fund, but in all properly managed industrial companies the board of the company incurred this responsibility, and I think that all shareholders who really think out the position of the company will come to the conclusion that I have come to, namely, that undoubtedly the soundest policy is for us to make hay while the sun shines, and to so shape our policy now, when everything looks prosperous, to assure our future beyond all possible question. At the present moment we are considering—together with probably one of the strongest groups of mining people in America, and with one of the strongest groups in France—purchasing a very well known mine in Mexico. It is a mine that has been reported on by nearly all the best known engineers; but the owners' idea of its value was too extravagant, and we have acquired an option on it on terms which, with small modifications, may be considered satisfactory. As the negotiations are still going on, and as our preliminary corps of engineers has only just reached the mine, you will not expect me to make any definite statement as to which the mine is or what is the purchase price; but suffice it to say that even the third share which has been reserved for Camp Bird will require a considerable sum of money, and provided that the results of the examination satisfy our engineers, there is no doubt, in my opinion, that it is an opportunity that should not be missed. Had we been in the fortunate position of having a lot of spare cash, I would like to have had a bigger interest for the Camp Bird. As it is, our participation is such that we can see our way to financing it, and the profits which should accrue to the company would be considerable."

With reference to the Messina development, the situation is covered by Mr. Grenfell's statement to the effect that the option which the Camp Bird holds on the 125,000 shares of Messina Development now shows a paper profit of between £30,000 and £40,000. It is very interesting to note the work which the Camp Bird is doing in Mexico, and it is not out of the way to say that there is hardly a precious-metal mining company in America that has as well satisfied a list of shareholders as is possessed by the English companies, including Camp Bird, Esperanaza, and El Oro. The full reports made by these companies are a source of satisfaction to the investors, and while there has been some strong criticism leveled at the Camp Bird management as to the manner in which the Santa Gertrudis purchase was made, similar deals made by American companies are hardly noted as a matter for adverse comment.

BLACK HILLS, SOUTH DAKOTA

HOMESTAKE CHRISTMAS PRESENT.—DEVELOPMENT OF THE REPUBLIC.—WORK AT THE GOLDEN REWARD

Appreciating the loyalty and efficiency of its employees, the Homestake Mining Co. announces that on December 31 it will pay to each employee a sum equivalent to 7% of the pay drawn during the past year. In connection with this announcement, the statement is made that the company is enjoying the most prosperous year in its history. The output of the mines is larger than ever before, and everything is running smoothly. The royalty contracts with C. W. Merrill, under which the cyanide plants of the Homestake were operated, have all expired, the last to be canceled being the contract for the big slime plant. The two cyanide plants and the slime plant will be operated, as in the past few years, under the direction of A. J. Clark, the company's metallurgist, ably assisted by W. J. Sharwood.

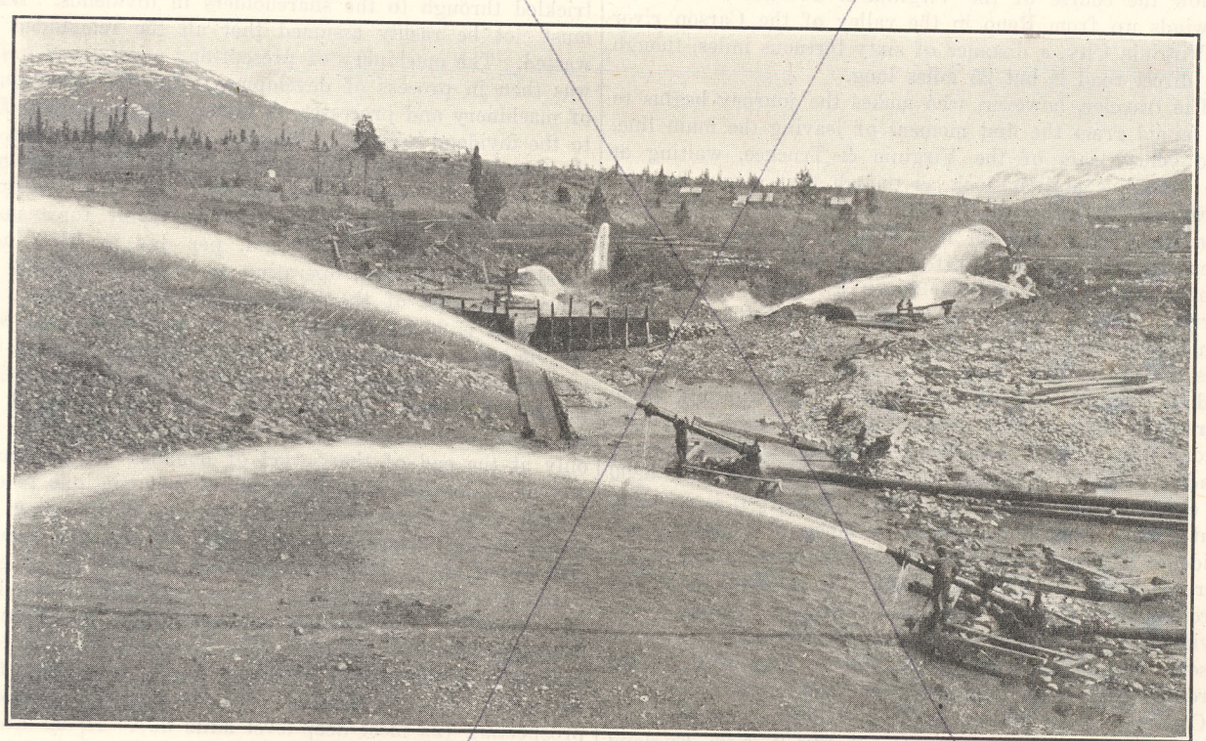
The Republic Mining Co., a reorganization of the old Golden Gate Mining & Milling Co., has started work on its property at the head of Blacktail gulch. The Golden Gate company was one of the first in the Black Hills to successfully adopt the cyanide process. After a shut-down of 14 years, the owners decided that a little more work might put their property on a paying basis, and the stockholders, who are wealthy men of Chicago and Oregon, Ill.,

Stacking Hydraulic Tailing

By W. W. Edwards

A novel method of handling the tailing from a hydraulic mining sluiceway has been devised by the North Columbia Gold Mining Co., under the management of J. M. Ruffner. This company operates hydraulic leases on Pine creek in the vicinity of Discovery, about six miles above Atlin, B. C. The method as shown in the illustration operates with poor dumping facilities, but with an abundance of water, and permits the handling of material cheaply by a new application of the monitor's stream. The company's ditch supplies 15,000 miners' inches to the giants under about 100-ft. head. This ditch, by the way, was dug by a steam-shovel mounted on a scow, which floated down an old ditch line, enlarging it from a previous capacity of 1000 miners' inches. There are two complete hydraulic installations about half a mile apart. The grade of bedrock on Pine creek here is only about one per cent. This makes impossible the disposal of tailing by ordinary means. A sluiceway 150 to 200 ft. long, with angle-steel riffles and block paving is ordinarily used, set on a grade of 3 or 3½ in. per 12-ft. box. The discharge end of the sluice is placed on clean bedrock. The grade used thus brings the sluice intake a foot or two above bedrock, but with the large amount of water available the material is easily driven into the sluice, through the action of four or five monitors used at the intake end. Ordinarily the dump would block this sluice immediately. Two or three monitors are placed at the lower end of the sluiceway with their streams directed at right angles to the tailing stream as it leaves the sluice. The heavier gravel, which would pile up in a heap, is thus forced to the side. Gradually a pile of tailing is started below the mouth and to the side of the sluice line. As this pile grows and the monitors continue to drive out more material, the stacking monitors are raised slowly, their streams following up the slope. When a monitor has driven its charge of gravel to the top of the pile, it is again lowered and the operation repeated. By this means the coarser gravel is all stacked. A good deal of the finer material is carried on down the creek by the water and fills up the creek bottom, but as this lower ground has been worked out already no harm results, especially as a great deal of this fine material is boomed out in the spring by the freshet and carried down to Atlin lake. The sluice-boxes are moved from one location to the next by teams and rollers. The piles of tailing look like dredge tailing and are about 15 to 20 ft. high, with slopes of about 2 horizontal to 1 vertical.

The abundant water-supply is also utilized to run an air-compressor which furnishes air for hammer-drills. These drills are used in breaking up the fallen slabs of clay overburden, thus saving blasting charges. High duty cannot be claimed for the water with the above described system of operation, but where, as in this case, water under a low head is plentiful, this method of tailing disposal has much to recommend it.



STACKING TAILING AT THE NORTH COLUMBIA MINES.

Zinc Production of Utah

The production of zinc in Utah in 1911, according to Victor C. Heikes of the U. S. Geol. Survey, was 17,840,261 lb., valued at $1,016,895, against 16,367,104 lb., valued at $883,824, in 1910. This shows an increase of 1,473,157 lb., or 9%. The Park City mining district alone produced 8,596,564 lb. of zinc in 1911, and the Bingham district 4,715,121 lb. The zinc concentrate, amounting to 13,156,682 lb., all came from Salt Lake, Summit, and Wasatch counties. There were 208 mines producing gold, silver, copper, lead, or zinc in 1911, against 183 in 1910. The total quantity of ore sold or treated in Utah in 1911 was 7,268,530 short tons, an increase of 879,132 tons. The average total recoverable value per ton was $5.07 in 1911, against $5.04 in 1910. The average value per ton is low on account of the large tonnage of copper ores, of which 6,121,099 tons was sold or treated. Of the total ore of all classes, 267,111 tons went to gold and silver mills, 5,840,091 tons to concentrating mills, and 1,103,054 tons to smelters.

The production of lead in Nevada in 1911 was 3,263,657 lb., valued at $146,865, against 4,871,130 lb., valued at $214,329, in 1910, a decrease of about 33%. Lead decreased in all counties but Clark and Douglas. The mines of Clark county, the largest producer, yielded 1,629,571 lb., an increase of 319,887 lb. over the production of 1910.

The Premier Diamond company employed 11,865 natives during 1911.

Impressions of the Comstock

By Thomas T. Read

The modern American resembles the ancient Athenian in that new things engage the greater part of his attention. Though the Comstock orebodies are in many ways the most remarkable in the world—the hottest, and richest, at one time the most studied, and now the most neglected, the scene of the invention or devising of many useful appliances and methods of work, developed by the deepest shafts and equipped with the finest machinery of their time—they have now sunk to the status of counters in the game of stock-selling. Their rôle in the history of mining in America has been one with which every engineer should be reasonably familiar, but engineers of the younger generation, while no stranger to the South African 'banket', the 'reefs' of Australia, and the placers and mines of South American countries, commonly retain only vague memories of a hasty perusal of the volumes by 'Dan de Quille', of Church, Lord, Richthofen, King, and others; books so eagerly read thirty years ago, but now quietly gathering dust upon the shelves undisturbed, except for the moment by some curious student. Twenty-five miles north of the lode, hundreds of engineers pass and repass yearly along the main line of the Southern Pacific railroad, but almost none linger by the way to follow the course of the Virginia & Truckee railroad as it winds up from Reno in the valley of the Carson river to Virginia City, a distance of sixty tortuous miles, though the direct road is but 25 miles long.

The traveler, however, who makes the journey begins to be repaid from the first moment of leaving the main line. The yellow cars of the Virginia & Truckee, waiting at the main-line station, look as though they might be well preserved specimens of the first rolling stock of the road. The story is told that in 1868 William Sharon, then local agent of the Bank of California but fast budding into a captain of finance, sent for Isaac E. James, the leading surveyor of the district, and asked him whether he could run a road from Virginia City to the Carson river. "Yes," was the reply. "Do it, then, at once," was the rejoinder, and before the end of 1869 trains were running from Carson to Virginia City over a track 13½ miles long, with a total curvature of seventeen full circles, with a maximum grade of 116 ft. to the mile, Virginia City being at 6200 ft. elevation and Carson City 1575 ft. lower. It is recorded that the line was built by Chinese labor, and confirmatory evidence is found in the interior of the cars, which surely were decorated by Chinese artists. As the train pulls out through the valley of Steamboat creek and across a low divide into the Carson valley, one accustomed to the gray deserts which border the main line is astonished at the verdure of these surprisingly green and broad valleys.

Carson City is quickly reached, but yields a sense of disappointment, for it seems more like a New England county seat than the capital city of what is, in many ways, the most remarkable mineral-producing state of the Union. Still, it is scarcely fair to judge any city by that portion of it visible from the railroad, unless, like Cincinnati, it is so conveniently inclined as to present the whole expanse to the observer in a car window. After leaving Carson City, the train soon begins to follow the course of Carson river, and the ruins of the early mills are conspicuous objects. Henry De Groot has described* vividly and in detail the pioneer mills, and their builders, and I will only note here that the first mill in Nevada was built in 1860 by Almarin B. Paul, four miles south of Virginia City, near Gold canyon, and his first contracts provided for a treatment charge of $25 to $30 per ton, even though the ore crushed was richer in gold than in silver. Some of the later mills were remarkable. The Ophir mill, near Lake Washoe, covered an acre of ground, and it is recorded that up to April 1, 1862, some 3000 tons had been milled at a cost for milling, freight, and office expense of $115 per ton. The Gould & Curry mill was built in the form of a Greek cross at a cost of $900,000. After treating about 5000 tons of ore, at a cost of nearly $50 per ton, it was remodeled, almost from the foundations, at a cost of $560,000. It need not be added that the first two decades of the history of the Comstock was a period of romance and prodigality. Fortunes were quickly made, and often as quickly dissipated. Only men of balance and a sense of proportion retained their gains and made them a basis of solid prosperity. Fair, Mackey, Flood, O'Brien, Sharon, Jones, and others thus became prominent figures in the world of finance, while scores with less balanced judgment threw their winnings into hare-brained schemes and saw them vanish as quickly as they had come.

By the middle of 1880 the Comstock had produced $306,000,000, not including the tailing, which averaged over $43 per ton, or nearly $50,000,000 more. Over one-third of this, or $108,861,230, was produced by a single bonanza found in the Consolidated Virginia, California, and Ophir, from a little over a million tons of ore. The early records are contradictory, but it has been estimated that 16 bonanzas produced $272,000,000 from 6,350,000 tons of ore; an average yield of nearly $43. In 1879 the issued capital of the companies which had been formed was $364,000,000, and only $116,000,000 in dividends had been paid.

Only about a third of the gross output of the mines had trickled through to the shareholders in dividends. But it must not be rashly assumed that all the remainder was wasted. The machinery of present-day mining and milling was then in process of development, and the development of machinery and processes on high-grade ore is ever fatal to the dividend account. Pumping was expensive, too, for the Sutro tunnel did not hole through into the Savage mine until July 1878, and it was almost a year later before it became effective for drainage, while the Ophir, for example, had been pumping 146,000 gal. per day in 1872, using wood-burning engines, operating at a cost of $72,000 per year. The cost of the Sutro tunnel is interesting. The main part is 20,489 ft. long and cost $2,100,000, and, since the contracts between the mining companies and the tunnel company provided for a royalty upon the ore hoisted instead of a charge for the amount of water pumped into the tunnel, it was indeed hard lines that it reached the lode only at the end of the period of bonanza ore production and has since served to drain mines that continue to exist largely upon assessments. In a way the Sutro tunnel was a tremendous disappointment. The Government commission appointed in 1871 reported that it would be of great practical value in exploring the ground east of the lode, but its service for drainage and ventilation would not be commensurate with its cost. The investors expected large returns from the royalty of $2 per ton of ore hoisted from the mines which it drained. But it proved valueless in prospecting (as most deep-level adits do). It has carried away rivers of water from the mines in the past thirty years, but the greater part of all the output of the Comstock had already been hoisted before the tunnel was completed.

Another great disadvantage was the heat, which began to make itself felt as soon as the mines began to reach considerable depths, and gradually increased until on the 2840-ft. level of the Yellow Jacket the rock had a temperature of 154°F. and the air of the drifts reached 110°F. and higher. Nearly all the other mines were equally hot, and only a visit to the lower levels will convince one accustomed to the summer climate of New Mexico and Arizona that such temperatures are almost unbearable. Engineers who have come to examine the Lode have found their energies almost totally consumed in conveying them from one water-spray or ice-water tank to the next, and the efficiency factor of underground labor can readily be inferred. Conditions of work underground present surprises. The men drink liberally of ice-water, with no bad effects, though the

Mining and Scientific Press, February 10, 1877.

casual visitor not unnaturally fears a congestive chill. At mealtime at some of the shafts the miners rush to the station, pull off their dripping garments, and put on others equally wet and are hoisted to the surface, where the temperature is 35 to 75° lower, to eat their dinners. It is not remarkable that, as the superintendents remark, after they have been up a little while they are glad to get back to work. A uniform wage scale of $4 per shift is paid, having been put in force in 1867. Wages elsewhere have steadily risen, but not on the Comstock. The explanation is simple, the wage is 'what the traffic will bear.' A company which exists upon assessments is not a good employer from whom to demand an increase of wages. In 1880 and 1881 assessments amounted to $12,041,590 and dividends to $370,000. In 1910 the Comstock mines produced $502,843 in gold, and in 1911 this rose to $977,349, besides which in the latter 618,006 oz. of silver was shipped, according to figures compiled by the U. S. Geological Survey.

With men working for a moderate wage under arduous conditions it might be expected that only the lowest class of workmen could be secured. But the tabulation made by Eliot Lord in 1880 showed that of a total of 2770 workmen, 816 were Irish, 770 Americans, 640 English, 191 Canadians, 83 Scotch, and less numbers of other nationalities, only 14 being Italians and 1 Slavonian. This preponderance of the Anglo-Celtic element still holds good. To me it seemed that the fascination of a bonanza must appeal strongly to the imaginative Celt, else why should a skilled miner continue to work in what is a foretaste of Gehenna for the same wage as in other mines? The workmen I saw were of fine physique, but the training of a crew offers obvious difficulties where the shoveler receives the same wage as the skilled miner.

Will the Lode yield other bonanzas? Who knows! Thirty years of desultory work has not served to disclose them, and meanwhile the mines pour out an unceasing flood of hot water. J. A. Church, who advanced the theory that the heat is generated by the kaolinization of the feldspar in the eruptive, saw no hope that the mines would ever penetrate beyond the hot zone. The water is a heavy burden, and the earlier belief that it is derived from the vadose circulation is somewhat shaken by the fact that the water being pumped from the lowest level is as hot as at first, after thirty years of pumping. It must be said that if bonanzas can be found neither heat nor water will act as effective deterrents to their exploration. Not long ago a daily chronicled the story of a mine in the southwest where the owners, in their search for ore, were driven back by an inflow of water too great to handle. After a few years of inaction the directors came to visit the mine to devise, if possible, some means of reopening it. Lo, the mine was dry; the lowest levels were even dusty. Some geomorphic movement had opened new channels and drained away the water. The apocryphal story is typical of the spirit of the miner, at once the most practical and most mystical of men.

The Comstock is notable as well because it has contributed so largely to the development of mining in America. The Burleigh drill was perfected while driving the Sutro tunnel, and square-set timbering was devised by Philip Deidesheimer to support the wide stopes necessary in taking out the bonanzas. It is perhaps less generally known that I. L. Requa, the father of M. L. Requa, devised the first self-dumping skip for use in the Combination 4-compartment shaft, which, at the time it was completed, was the deepest and best equipped in the world. The Wheeler pan and the Washoe process were likewise products of the ingenuity called forth by the exigencies of Comstock conditions. The glory of the Comstock, like the glory of Israel, has departed, but it, like the ancient people, makes its influence felt in contemporary achievement.

THE Transvaal Miners' Phthisis Sanatorium building and equipment cost $260,000, and has accommodation for 70 patients. Twenty-eight were in residence at the end of 1911. Maintenance of the institution for the term cost $18,300.

Mining in Western Australia in 1911

The annual report of the Mines Department of Western Australia is now at hand. Although the past year's work has been noted to some extent, the remarks of the Secretary for Mines, H. S. King, are of interest, as well as the corrected figures of mineral production.

There has been another decrease in the total mineral output which is being experienced by the other states of Australia. In spite of the falling output, it is hoped that the new discoveries made during the year, together with judicious advances for machinery, provision for crushing, and other facilities will cause an improvement before long. At the same time, it is to be feared that, unless capital is more easily obtained to carry properties beyond the prospecting stage, any marked increase in the gold yield is, on present prospects, unlikely. The discoveries at Payne's Find, in the Yalgoo goldfield; at Mt. Egerton, in the Peak Hill goldfield, and Weston's, in the Yilgarn field, all separated from each other by considerable distances, are encouraging and promise to come up to expectations. The severe drought has retarded operations generally. Another factor to the falling output is the general reduction in the grade of ore as greater depth is attained. The Government continues to render assistance to bona fide prospectors by loans of equipment and means of transport. That the prospector is not idle is shown by the fact of 10,028 acres being held as prospecting area for gold and minerals. The area held under mining lease for all minerals is 65,258 acres, a decrease of 843 acres against 1910. For prospecting coal and oil, 38,500 acres is held, a reduction of 11,789 acres. There was a decrease of 857 men employed in gold mines, and 264 at copper and coal mines.

During the year, 2,735,943 tons of gold ore was treated at all mines, a decrease of 148,355 tons. The East Coolgardie (Kalgoorlie) field showed an increase of 90,453 tons. On this field 5836 men are engaged at all work, and the production of $16,050,130 was recovered from 1,726,998 tons. The output is lower, but generally the field is encouraging. On the East Murchison field three mines closed down and two others reduced their output. Large decreases were reported from the Broad Arrow, North Coolgardie, Mt. Margaret, Murchison, and Coolgardie fields. In the Black Range district, the Yuanmi mine should add considerably to the output; while in the Murchison, the Cue district shows an improvement. The Day Dawn district is quiet and the Great Fingall's output decreases. Around Coolgardie there are promising developments. The prospecting which followed on the Bullfinch discovery has resulted in opening of fair prospects in outlying centres. A plant is being erected at the Bullfinch and should soon be working. At the close of the year there were 33 state mills at work, and from the inception of this system 843,780 tons of gold ore was treated, with a yield of $18,600,000; and 51,553 tons of tin ore produced tin worth $343,000. During the term under review only 59,373 tons was handled, yielding $1,161,654 in gold. There was a loss on working the mills of $37,400; $1,450,000 has been spent to date on all plants, and the total loss is $144,000. The Geological Survey department consists of 19 officers, who have been busy throughout the state at varied problems. Assistance to small mines, under the Mining Development Act, totaled $42,500. The Water Supply branch sunk 14 shafts, 993 ft. in all; hand-drilled 169 holes, 11,622 ft.; and diamond-drilled 6 holes, aggregating 1907 ft. Tanks and reservoirs were enlarged, improved, and roofed at several points.

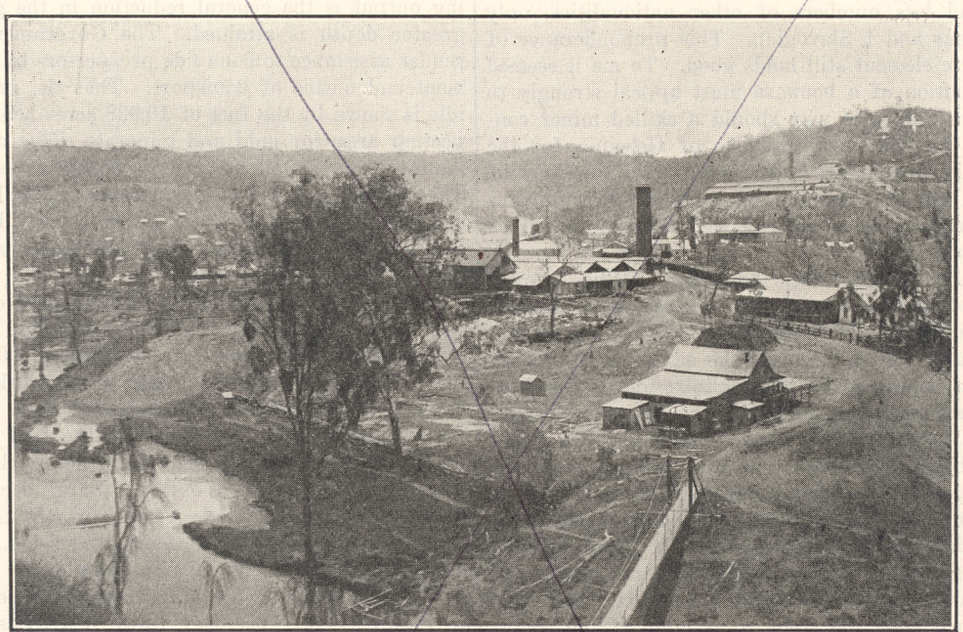
The production of all minerals during 1911 was:

Gold, value	$29,115,000
Coal, tons	249,980
Copper ore exported, 22,676 tons, worth	$390,500
Tin ore exported, 560 tons, worth	$303,500
Lead ore exported, 1549 tons, worth	$75,000
Pyrite mined, 9739 tons, worth	$17,600
Wolfram mined, 194 tons, worth	$4,350
Silver recovered at mines, worth	$91,500

Mt. Morgan Gold Mining Co., Ltd.

Attention has of late been directed to the operation of this great gold and copper mine, on account of its gold and copper output, shortage of power, change of smelting practice, change in management, and low profits made. The power shortage has been remedied by the addition of four new blowers, and now four blast-furnaces can be kept going. Ores from this mine were formerly roasted and treated by chlorination, the copper being smelted, the necessary limestone and ironstone fluxes being obtained from Marmor and Ironstone island, in Queensland. From precipitation of mine-water, a fair amount of copper has always been won. When the Many Peaks pyrite orebodies, containing up to 2.25% copper and some gold, were opened, and the mine connected by rail with Mt. Morgan, it was decided to start pyrite smelting. Trouble was experienced, and experts from Mt. Lyell were called in to help. The present position is that the whole concern is being investigated. The local press in Australia has criticized the company for indifferent bookkeeping and high cost, but it is fair to remember that those in charge have had many unforeseen difficulties to combat. The annual report of the company for the year ended May 31, 1912, gives the following particulars:

Ore treated (oxidized, silicious sulphide, auriferous copper, and Many Peaks), tons	351,858
Limestone flux used, tons	64,066
Ironstone flux used, tons	367
Waste rock removed from open-cut, tons	222,446
Waste rock removed from underground, tons	8,752
Total gold yield, ounces	134,575
Total copper yield, tons	7,440
Auriferous copper ore content:	
Gold, dwt.	9.93
Copper, per cent	2.71
Total revenue	$ 4,945,000
Total expenditure	3,656,000
Gross profit	1,289,000
Dividends paid	1,000,000
Depreciation	245,000
Reserve funds, total	1,030,000
Ore reserves (copper, 3.5%; gold, $10), tons	1,499,000
Ore reserves, total (copper, 2.5%; gold $5 per ton), tons	2,027,000
Total revenue to date	$89,820,000
Total dividends to date	$39,395,000



MT. MORGAN IN 1889. THE WHITE CROSS MARKS THE TOP OF THE MOUND.

Mining in the Transvaal in 1911

The annual report of the Transvaal Chamber of Mines is a voluminous affair of 509 pages, which goes into every detail connected with the mining industry, which produced $190,530,000 in gold, diamonds, coal, tin, and copper during 1911. An analysis of the gold production of this state of the South African Union shows the following:

Ore hoisted and taken from surface dumps (short tons)	27,389,872
Percentage of waste sorted on surface	13.01
Tons milled	24,456,821
Average number of stamps at work	10,020
Average number of tube-mills at work	223
Duty per stamp per 24 hours, tons	7.76
Gold yield from amalgamation	$107,780,000
Gold yield from cyanidation	$67,175,000
Total value of yield	$174,955,000
Value of ore per ton milled	$6.74
Working costs per ton milled	$4.34
Working profit per ton milled	$2.40
Total profit	$58,625,000
Total gold output of Transvaal since 1884	$1,625,635,000
Total dividends paid since 1887	$415,855,000
Labor employed, white, average	25,655
Labor employed, colored	201,075

In addition to the above data from gold mining, the report gives the diamond output at 1,843,341 carats, valued at about $8,140,000, which mostly came from the Premier mine; 4,343,680 tons of coal; tin ore valued at $2,070,000; and copper ore at $258,000.

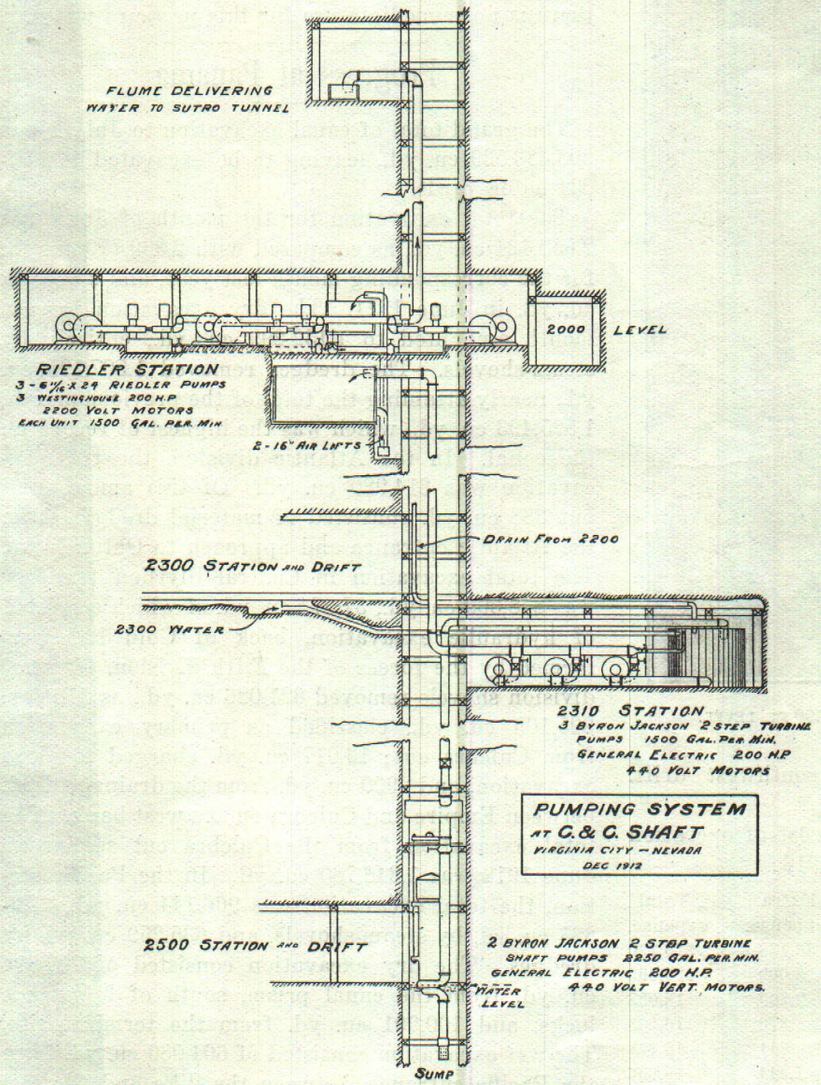
The various committees of the Chamber of Mines have dealt with what appears to be a vast amount of work in regard to native labor; miners' phthisis; the Mines and Works Act No. 12, of 1911, especially with reference to the non-working of plants on Sundays; Mining Taxation Act, 1910; Stamp Duties and Fees Act; Companies Act of 1909; Irrigation Act; Local Government Ordinance; Commerce and Industries Commission; Financial Relations Commission; patents, explosives; Workmen's Compensation Act; Water Supply. About 190 pages of the report are taken up with statistics of gold production, coal and diamonds, dividends paid; labor employed and mortality data; and amounts of stores purchased on mines. Native labor seems to be an important feature on the Rand, and much space is given to the subject from recruiting natives to the mortality statistics.

Pumping at the Comstock

By A. M. Walsh

The water question has always been a serious one at the Comstock mines, where the mine water has a temperature ranging from 130 to 155°F., and is contaminated with alum and acid. The temperature of the air on the pump station varies from 105 to 125° F., and it can be readily seen that ventilation is just as important as pumping.

By arrangement with the mining companies, the United Comstock Pumping Association is doing its best to handle the water, and the following notes and illustrations should give an idea of the work done.



Electric Turbine Pumps

Suspended in the C & C shaft at the 2500-ft. level are two vertical turbine pumps which were manufactured by the Byron Jackson Co. and are driven by two General Electric 200-hp. 440-volt motors. Each unit has a capacity of 2200 gal. per minute. One of these units is in constant operation and the other is held as an auxiliary in case of accident to the operating unit. About 1500 gal. of water per minute is pumped from the 2500-ft. level to the 2310-ft. station.

The installation at this station consists of three horizontal turbine pumps. These pumps were manufactured by the Byron Jackson Co. and are driven by three General Electric 200-hp. 440-volt motors. Each unit has a capacity of 1500 gal. per minute. Two units are in constant operation and the third unit is an auxiliary to be used in case of accident to either of the other units. This station is pumping approximately 2100 gal. of water per minute to the Riedler station. Lubricating oil in motor and pump bearings varies from 150 to 160° Fahrenheit.

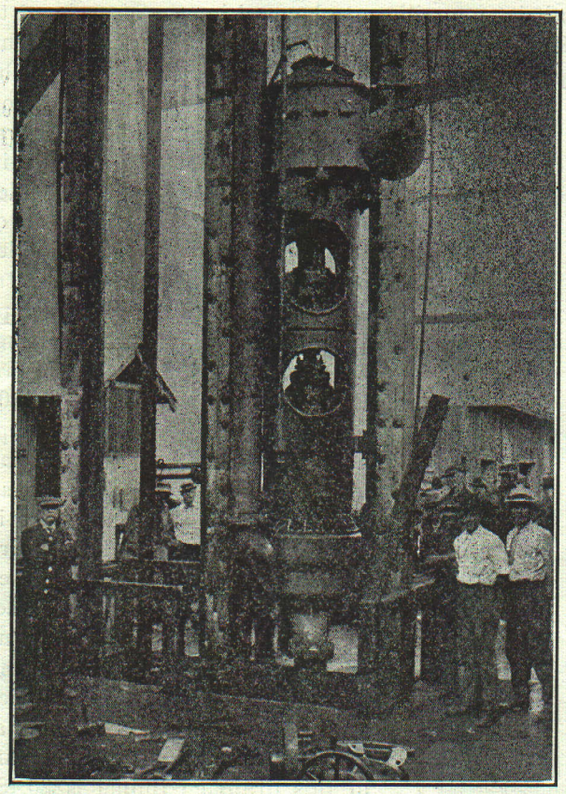
The installation on the Riedler station, 2000-ft. level, consists of three $6^{11}/_{16}$ by 24-in. Riedler pumps. They are the horizontal duplex double-acting plunger type and are driven by three Westinghouse 200-hp. 2200-volt motors. Each unit has a capacity of 1500 gal. per minute. These pumps were designed by Riedler and manufactured by the Allis-Chalmers company. Two units are in constant operation and the third unit is an auxiliary to be used in case of accident to the other units. This station is pumping approximately 2100 gal. per minute into the Sutro tunnel which connects with the C & C shaft at its 1600-ft. level. The main part of this drainage tunnel is 20,489 ft. long and cost $2,100,000, it being finished during 1879.

The diagram shows two 16-in. air-lifts immediately below the Riedler station. Under the former management the turbines at the 2310-ft. station pumped the water to the lower Riedler tank. The water was then pumped an additional 10 ft. to the upper Riedler tank with two 16-in. air-lifts. This has been rearranged so that the turbines at the 2310-ft. station pump directly to the upper Riedler tank which is the feed tank for the Riedler pumps. By this change the continuous use of these air-lifts has been eliminated and an economy affected thereby.

The scope of the work being done by the Pumping Association may be judged by the following weekly report. The Riedler pumps on the 2000-ft. station ran as follows: No. 1, 119 hours, 35 minutes; No. 2, 146 hours; No. 3, 59 hours, 50 minutes. The centrifugal pumps on the 2310-ft. station ran as follows: No. 1, 165½ hours; No. 2, 99¼ hours; No. 3, 65 hours. The shaft pumps on the 2500-ft. level ran as follows: No. 1, 56 hours; No. 2, 109 hours.

The 2500-ft. north drift, started from the winze

station at a point 565 ft. east from the shaft station, was cleaned out, and repaired a distance of 10 feet. Three tunnel sets of timbers were put in at the connection with the southwest drift. At this point the ground is badly caved, and must be thoroughly timbered before work can be continued. Total length in repair from the winze station is 455 ft., and the total distance from the shaft station is 1020 ft., the face being in caved ground. The ventilation of the 2500-ft. drift is greatly improved since the



VERTICAL TURBINE PUMP USED AT 2500-FT. LEVEL.

connection was made with the southwest drift. Water was held at all points.

Following is a statement of the cost of operation from December 1, 1912 to June 1, 1913:

Month.	Regular expense.	Extra expense.	Total expense.
December	$16,581	$3,138	$19,720
January	17,393	3,000	20,393
February	15,850	2,209	18,058
March	15,363	870	16,233
April	14,437	841	15,278
May	13,712	1,944	15,656

The items comprising the regular operating expenses include salaries, labor, supplies, power, water, hoisting, compressed air, all repairs on the pumps and the pumping system, and the general expense of maintaining the Association. All supplies used, with the exception of the ladders, which were taken from the Ward shaft, have been charged in the above account. The extraordinary and installation expenses comprise such items as the cost of the Mexican-Ophir winze winches, damages through personal injury, cost of removing hydraulic elevator, repairing and preparing the C & C shaft for the lowering of the 2500-ft. turbine pump, testing and installing this pump, repairing the 2500-ft. station and east drift, etc. The principal cause of the greatly reduced expense since my appointment on January 25, 1913, is the fact that the efficiency of labor has been raised and the work conducted with fewer men. Many changes have also been made in the operation of the pumps which were along the lines of economy.

Included in the statement of costs is a water bill which amounts to $2500 per month. The water contract gives the Association the use of 200 miners inches of water, which was consumed when the Association operated the Evans hydraulic elevators. As soon as the electrically driven turbine pumps were installed on the 2310 and 2500-ft. stations the operation of the elevators was discontinued, and there is no immediate use for this pressure water.

Progress at Panama

The grand total of canal excavation to July 1 was 203,383,539 cu. yd., leaving to be excavated 14,812,034 cubic yards.

The total excavation for the month of June was 2,659,424 cu. yd., as compared with 2,339,770 cu. yd. for the corresponding month last year, and 2,646,442 cu. yd. in June 1911. The dry excavation for the month amounted to 1,152,299 cu. yd., entirely by steam-shovels. The dredges removed 1,507,125 cu. yd., nearly attaining the total of the previous month, 1,525,493 cu. yd., which was the highest of record on the canal. In the Atlantic division, the total excavation was 814,980 cu. yd. Of this amount, all but 388 cu. yd. consisted of material dredged from the Atlantic entrance and approach to Gatun locks. The total excavation in Central division territory was 878,300 cu. yd., 57,274 cu. yd. of which consisted of hydraulic excavation, back of Gold hill, performed by the forces of the Fifth division. Central division shovels removed 821,026 cu. yd., as follows: 805,109 cu. yd., classified as primary excavation from Culebra cut; 13,017 cu. yd. charged to plant excavation, and 2900 cu. yd. from the drainage ditch between Empire and Culebra on the west bank. The total excavation from the Culebra cut section in June 1912 was 1,348,780 cu. yd. In the Pacific section, the total excavation was 966,144 cu. yd., 330,885 cu. yd. by steam-shovels, and 635,259 cu. yd. by dredges. The dry excavation consisted of 229,894 cu. yd. from the canal prism, south of Miraflores locks, and 100,991 cu. yd. from the terminal site. The wet excavation consisted of 604,080 cu. yd. from the Pacific entrance, between the dike and the sea, and 31,179 cu. yd. from the terminal basin.

H. D. Avis' patent for coating aluminum or its alloys for soldering is as follows: Chlorides of tin and zinc are mixed in the ratio of 2 to 3 parts of the former to 1 of the latter. The mixture is heated and excess of hydrochloric acid is expelled. On cooling, the mass becomes of a pasty consistence, after which a small amount of powdered tin is added. To tin the surface of the aluminum this paste is applied and the parts are heated below redness. When the proper temperature is reached, the aluminum is coated with the oxide of tin and zinc, which on removal with a brush or other means leaves a bright film of tin. The soldering is a simple matter.