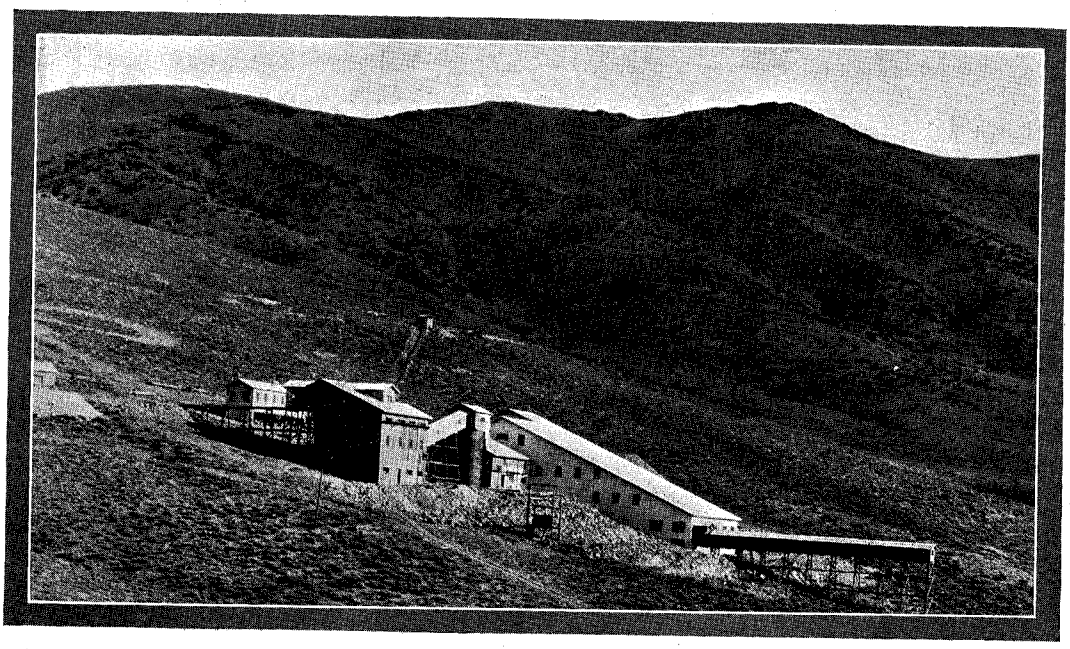


THE NEVADA-PACKARD MILL.

Construction and Operation of the Nevada Packard Mill

By Herbert G. Thomson

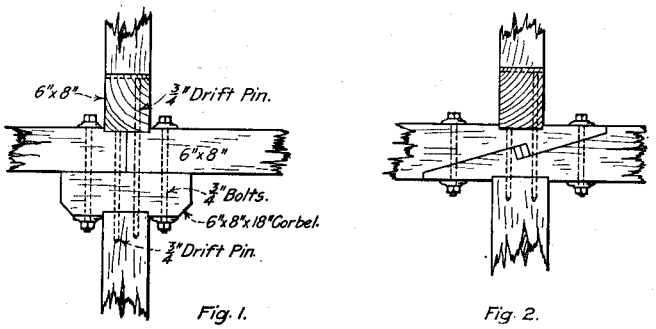
INTRODUCTORY. The cyanide plant of the Nevada Packard Mines Co. is situated at Packard, in Humboldt county, Nevada, four miles from Rochester and nine from Oreana, the nearest Southern Pacific railroad point. The Nevada Short Line narrow-gauge railroad runs within four miles of the property, but the combined rail and wagon transportation charges for supplies from Oreana are the same as the all-wagon haulage-rate from that point, $8.75 per ton.

The ore is a remarkable one. It is essentially a highly altered sericitized rhyolite, varying from a soft and friable talcose or schistose product to an extremely tough silicified variety. The rhyolite is traversed by occasional stringers of quartz. Cerargyrite is the valuable constituent of the ore. Sulphides occur sparingly, while sulph-antimonates or arsenates are extremely rare. The ratio of gold to silver is about 1:300. In places small quartz veinlets carry a much higher proportion of gold, giving a string of colors when panned. Preliminary tests showed the ore to be easily amenable to cyanidation. Briefly, the process consists of crushing dry in rolls, grinding in tube-mills, agitation, and modified counter-current decantation followed by filtration.

CONSTRUCTION. The mill was designed and erected by Knud Freitag, who remained as superintendent for several months after the completion of the plant. The mill is directly below the portal of the lowest adit. In order to allow sufficient room at the bottom for the disposal of tailing, it was necessary to house the tube-mills in an addition at the side of the main building. The slope of the mill-site is about 15°, allowing most of the pulp-transference to be done by gravity. The crushing-plant is situated 80 ft. from the mill. Construction of the mill started on August 12, 1915, at which time three-quarters of the excavation work was completed. Operations began on December 4, 1915. The usual 'tuning-up' process was conspicuous by its absence. In excavating for foundations, 5200 tons of material was removed, a large part being hard rhyolite, so that 1000 pounds of dynamite had to be used. All foundations are of concrete. The main building is 64 ft. wide by 144 ft. long. The tube-mill addition is 40 by 42 ft., and the crushing-plant 24 by 32 ft. In all, 220,000 ft. B.M. of lumber was used in the mill-construction. Oregon pine was used for the framing, while the roof and sides were built of 1-inch fir boards covered with J. M. asbestos roofing. The Oregon pine was furnished by the C. F. Smith Lumber Co., the siding, roof, and flooring by the Red River Lumber Co., and the heavy timbers for the crushing-plant by the Sierra Nevada Wood & Lumber Co. The asbestos covering has proved an excellent non-conductor of heat. With a temperature ranging from 10° below to 110° above zero, this becomes an important feature.

The entire mill-frame presents a neat and finished appearance, and the observer is highly impressed with the clean-cut and workmanlike manner in which attention

has been given to every detail of the construction. Due consideration has been given to the proper design of all members of the structure, without the use of an excess of material. There is a notable absence of useless or oversize timbers, without loss of the necessary strength and rigidity. Another feature is the use of butt-joints and corbel (Fig. 1) for joining stringers, instead of the usual splice-joint (Fig. 2). The use of this joint means a saving in labor, both in framing and erecting. The splice-joint, of course, is used in all trusses. The thickener and agitator mechanisms are suspended from the trusses, as well as the transmission machinery. Good clearances have been provided around all machinery and tanks, and every part is easily accessible. Floors are constructed around all tanks. Runways are built around and alongside all the mechanical appliances. Belts and transmission parts are overhead and well guarded in ac-



DETAILS OF BUTT AND SPLICE-JOINTS IN BUILDING.

cordance with safety-first ideas. Circular steel ore-bins furnished by the Western Pipe & Steel Co. were used instead of the ordinary wooden bins. The first cost of this type is about half of that of wooden bins of the same capacity. The entire equipment was selected with one object in view: to obtain the highest metallurgical as well as mechanical efficiency. All purchases were made from manufacturers of high-grade material on competitive bids based on complete detailed specifications submitted by the constructing engineer. No material was purchased because it was "good enough" or cheap, as experience has proved that this manner of selection means grief for the operators.

The selection of high-grade machinery does not necessarily mean high first cost of mill, as has been shown at Packard. However, it does mean low costs of operation and maintenance.

The original estimate furnished by Mr. Freitag called for $65,740. The final cost of the completed mill was $65,451.94 divided as follows:

Equipment (machinery, supplies, etc.)	$38,765.34
Grading (material, labor and teams)	4,213.05
Concrete (material and labor)	1,738.48
Framing (material and labor)	10,096.57
Construction (material and labor)	9,093.50
Engineering	1,545.00
Total	$65,451.94

As carefully segregated costs were not kept until the actual construction work began, more detailed figures are not available. However, the complete labor costs, exclusive of teaming, grading, and excavating, which work, as previously mentioned, was nearly completed when the erection of the mill started, may be of interest.

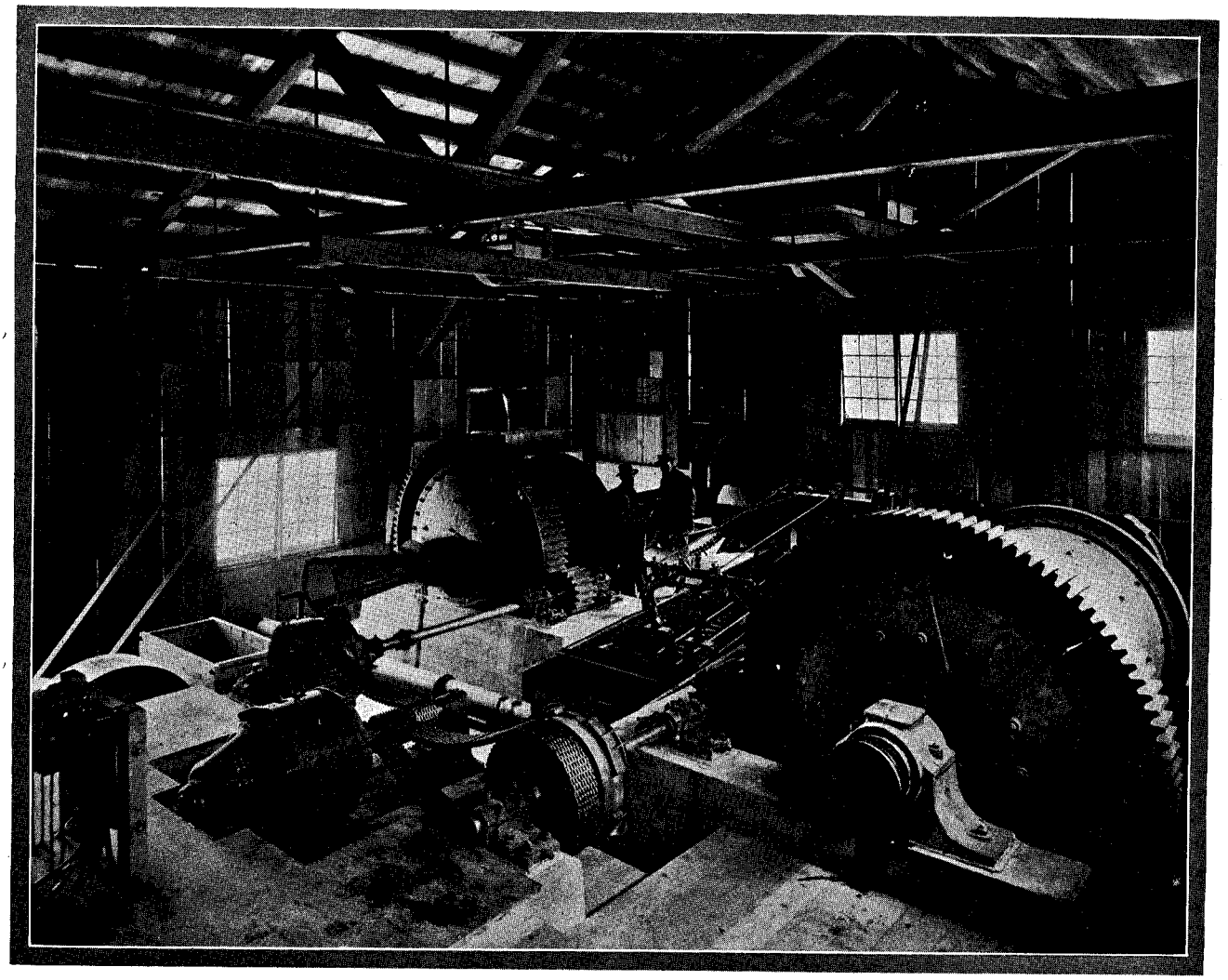
Mill construction (framing and erecting):		
305.5 shifts at $4	$1,222.00	
683.75 " " $5	3,418.75	
84 " " $6	504.00	
		$5,142.75
Pipe work:		
73.5 shifts at $4	$ 294.00	
43 " " $5	215.00	
		509.00
Crusher plant ore-bins:		
13 shifts at $4	$ 52.00	
6 " " $5	30.00	
		82.00
Mill ore-bins:		
9 shifts at $4	$ 36.00	
15 " " $5	75.00	
		111.00
Painting:		
9 shifts at $4	36.00	
		36.00
Concrete:		
58 shifts at $4	$ 232.00	
49.25 " " $5	246.25	
		478.25
Electrical equipment:		
31 shifts at $4	$ 124.00	
51.25 " " $5	256.25	
		380.25
Erecting tanks:		
22 shifts at $4	$ 88.00	
36 " " $5	180.00	
		268.00
Erecting Oliver filter:		
35.5 shifts at $4	$ 142.00	
27 " " $5	135.00	
		277.00
Installing machinery (not included under above headings):		
132.25 shifts at $4.00	$ 529.00	
24 " " $4.50	108.00	
195 " " $5.00	975.00	
		1,612.00
Watchman:		
94 shifts at $4	$ 376.00	
		376.00
Total		$9,272.25

OPERATION. From the mine, the ore is trammed in one-ton Matteson cars to the crushing-plant, where it is weighed on a Fairbanks recording-beam scale, and dumped into one of two circular steel ore-bins, having a combined capacity of 100 tons. Lime is added at this point, usually one shovelful to every four cars being sufficient to maintain the desired alkalinity. The steel bins are each 12 ft. diam. by 16 ft. deep, constructed in four courses, with $2\frac{1}{2}$ by $2\frac{1}{2}$ by $\frac{3}{8}$ angle-iron reinforcements at top and bottom. The two lower sections are of $\frac{1}{4}$-inch steel, and the upper two of $\frac{3}{16}$-inch. As far as the rigidity of the bins is concerned, $\frac{3}{16}$-in. steel would have been sufficient for all four courses, but $\frac{1}{4}$-in. was used on the lower two so as to withstand abrasion from the coarse ore. These bins have proved satisfactory, especially to

the mill-men, who are relieved of all ore-bin shoveling. The ore is drawn out through two standard 18 by 24-in. steel-plate rack-and-pinion ore-bin gates passing over two 20 by 45-in. grizzlies spaced 1½ inches and set on a 45° slope. The fine passes to the bucket-elevator and the coarse is fed to a No. 5 Superior McCully gyratory crusher set to 1½ inch. The crushed product is elevated in the 14-in. belt-and-bucket elevator to a 9-ft. by 30-in. trommel, constructed of No. 10 wire, 2 mesh, having ⅜-in. openings and making 20 r.p.m. The wear on these screens is heavy, the life of each being only about two months. The oversize passes to a set of 37½ by 15-in. Garfield rolls, and the undersize to the mill conveyor-belt. The rolls are set to ⅜-in. and readily handle the tough ore as well as an occasional drill-steel. Automatic feeding devices are not used, but in spite of the comparatively coarse feed, the roll-shells have not corrugated to any appreciable extent after seven months' run. The shells are of chrome-steel. The discharge from the rolls is returned by the elevator to the trommel for re-sizing. The trommel, elevator, and chutes are enclosed in a light, removable, dust-proof housing lined with sheet-iron. The conveyor is troughed and equipped with 14-in. Maxecon belt. It is 70.5 ft. centre to centre of pulleys, inclined at an angle of 18°, and running at a speed of 300 ft. per minute.

The crusher, rolls, trommel, and elevator are driven by a 60-hp. Westinghouse induction-motor. This motor, as well as all others in the mill, is equipped with automatic overload-relay and no-voltage release. Goodrich Pinnacle rubber belting is used for driving the rolls and crusher and is giving good service. The belt-conveyor discharges the ore into a 15 by 28 ft. 100-ton steel bin, similar in construction to those in the crusher plant. Head grab-samples are taken from the ascending stream of ore. These have checked fairly well with smelter-returns, but an automatic dip-sampler will soon be installed.

The grinding department in the Packard mill differs radically from standard practice by the introduction of stage-grinding in short tube-mills. The grinding is done in two short-length Power & Mining Machinery Co. tube-mills in closed circuit with a Dorr duplex classifier. The designer of the mill is an advocate of short-length tube-mills, and the work they do has borne out his contentions regarding their efficiency. In spite of the presence of some soft ore, there is enough of the extremely tough silicified rhyolite to give a run-of-mine ore similar



THIS PICTURE IS FULL OF INTEREST TO THE METALLURGICAL ENGINEER, SHOWING MOTOR AND CHAIN-DRIVEN SHORT TUBE-MILLS IN CLOSED-CIRCUIT WITH A CLASSIFIER.

to that of the average Californian Mother Lode mine.

Through a bin-gate the ore is drawn onto a 2 by 6-ft. Link-Belt steel apron-feeder, and discharged into the No. 1 tube-mill feed-box. This is, I believe, the first time that an apron-feeder has been used for this purpose in a cyanide plant. It has proved a thorough success. The regularity of the feed and the ease with which it can be adjusted are attractive features of the apron-feeder. The quantity of material fed to the tubes is regulated either by the speed of the feeder, controlled by an adjustable eccentric or by the amount that the ore-bin gate is opened. When once set, it needs no further attention.

In No. 1 tube-mill box the ore first comes in contact with the cyanide solution. Sufficient solution from the stock-tank is added to bring the moisture content up to 40%. The first tube-mill is six feet in diameter by five feet in length. At the discharge end, sufficient stock-solution for proper classification is added; and the pulp flows by gravity to the feed-box of the classifier. This machine does its usual excellent work. The classifier-discharge is transferred to the second tube-mill, 6 ft. diam. by 10 ft. long, by a 10 ft. by 8 in. screw-conveyor, chain-driven from the classifier-shaft. Solution is again added to bring the moisture up to 40%. The tube-mill discharge is again returned to the classifier.

No. 1 mill was designed for use as a ball-mill, but in the first test made with silex pebbles it did such satisfactory work that the change to a ball-mill will soon be made. It is probable that Campbell & Kelly liners and balls manufactured at Tonopah will be used. They have proved satisfactory in the Tonopah and Manhattan mills. Both mills are at present lined with Forbes white-iron liners. These are similar to the El Oro. They are spaced so as to allow for the removal of single sections when worn, thus obtaining maximum life for each liner. An average life of about eight months is indicated. The mills were started with silex pebble-loads, but selected rhyolite has largely replaced the Danish pebbles. Although the rhyolite is tough and silicified, it still retains enough of its granular structure to 'sand' somewhat, and it is evident that the capacity of the mills would be reduced below 90 tons daily if rhyolite entirely were used. However, as the rhyolite 'pebbles' contain sufficient gold and silver to pay for all handling, the use of them has proved economical, especially during the present scarcity and high price of the silex. No account is kept of the quantity added, as the amount about compensates for the moisture contained in the ore, no reduction for which is made in computing tonnage. The discharge-screens are 4 ft. diam., made in two sections. Being strongly ribbed on the discharge side, the ribs act as lifters assisting in a rapid discharge. The use of reverse-screw discharges was considered, but the reduction of discharge-area and capacity consequent upon their use would more than outweigh any advantage. The main bearings are 16 by 16 in. The scoop-feeds are of special design, having removable plates on the outer faces, allowing inspection of the spirals. They are also fitted with white-iron digging-lips, bolted to the frames, taking the heaviest wear from the scoops. These lips last about six months and are easily and cheaply replaceable. The mills are driven by a single 100-hp. Westinghouse slip-ring induction motor. For this motor, a rheostatic controller is used. The motor is connected to the tube-mill gear-shaft by silent chain-drives and Hill clutches. These clutches are rarely used, the mills starting from rest on slow speed. The following screen-tests show the work being done in the grinding department.

Mesh	Screen aperture, In.	Heading %	No. 1 tube-mill discharge %	Classifier discharge	No 2 tube-mill discharge	Classifier overflow
+ 4	0.185	33.9	0.2	0.2	...	...
+ 10	0.065	21.7	0.9	2.5	...	...
+ 20	0.034	9.8	2.3	3.9	...	...
+ 40	0.015	5.6	11.4	17.8	1.6	...
+ 60	0.0087	2.9	10.4	22.8	11.8	0.4
+ 100	0.0055	2.5	6.4	20.2	17.8	3.7
+ 150	0.0041	2.7	6.9	12.9	16.2	6.8
+ 200	0.0029	0.9	2.6	3.5	5.8	5.2
— 200	.....	19.6	57.8	15.9	46.2	83.3
		99.6	98.9	99.7	99.4	99.4

Of the *minus* 200 classifier-overflow product, 5.2% is sand and 94.8% slime. These screen-tests are not exceptional, but the averages of all tests made, the majority of them having been made while the pebble-load consisted of about 50% each of rhyolite and silex. A short while ago it was noted that a heavy concentrate was collecting in the feed and discharge boxes of the tube-mills and classifier; after removing the iron with a magnet, an assay of the residue showed $2300 gold and $180 silver per ton. An examination of the coarser particles proved the presence of flakes of a coated gold-silver alloy. As has been previously observed in many Mexican cyanide-plants where tube-mills were used, the fragments of copper and brass from caps, wire, etc., were heavily plated with silver. Careful tests on the tailing showed

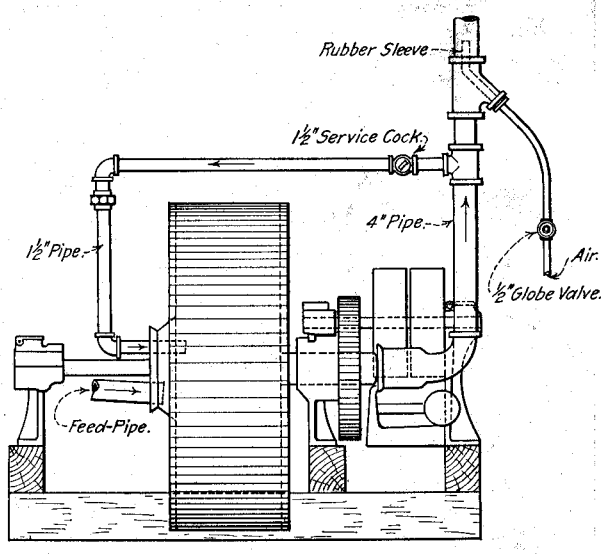


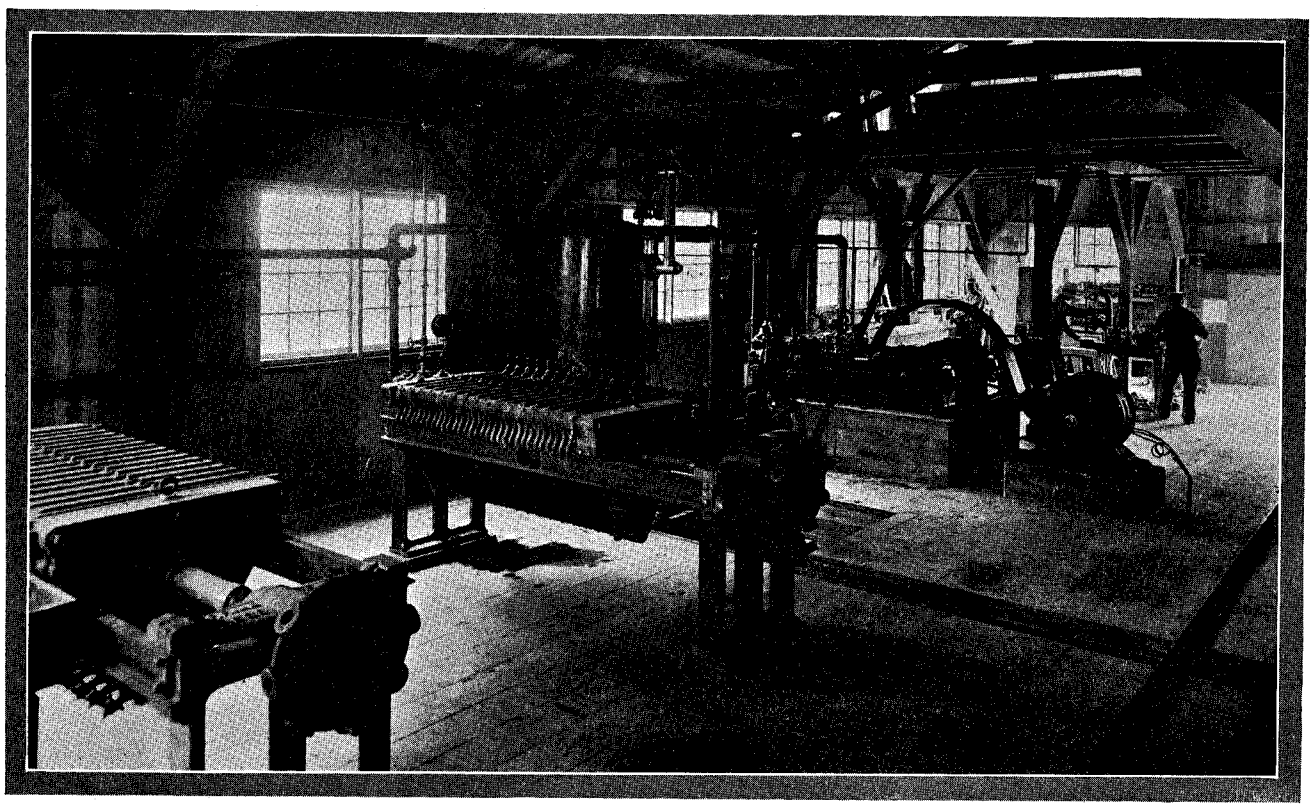
Fig.3.

FRENIER PUMP ARRANGEMENT.

that the classifier acted as an effective barrier to the passage of this concentrate farther into the mill-circuit.

The classifier-overflow, diluted to about 7:1, is elevated by a No. 1 Abbé-Frenier spiral pump to No. 1 Dorr thickener. The lift is about 23 ft., and as the maximum height to which a Frenier will elevate this material is about 20 ft., an air connection was made to the riser. Merely 'cracking' the valve admits enough air, acting on the air-lift principle, to overcome the difference. When first installed, the pump showed a disconcerting tendency to slop over under slight provocation. By returning a portion of the pulp through a by-pass as shown in the accompanying sketch, this trouble was entirely remedied. I believe that everyone who has seen the work done here by the Frenier will agree that it is far superior to the bucket-elevator or straight air-lift. However, when the manufacturer's catalogue naively states that "it is impossible to have the wheel elevate all the liquid without having some of the liquid overflow at times and when starting and stopping, so that it is absolutely necessary to provide a sump to receive the overflow," the prospective user may be pardoned for maintaining the Missourian attitude.

The Dorr classifier, Frenier apron-feeder and screw-conveyor, as well as the crushing-plant conveyor-belt, are driven by a 10-hp. motor. Discharge from the Frenier flows into a 28 by 10-ft. Dorr thickener (No. 1). So far, no trouble has been experienced from foaming in any part of the thickeners. They are all equipped with the simplified type of lifters, and with electric-bell overload-alarms. The solution overflows to a 12 by 10-ft. clarifying-tank in which sixteen 5 by 8-ft. Butters-type canvas leaves are suspended. The clear solution is drawn through these leaves by a 2-in. Gould rotary pump, and discharged into a 12 by 10-ft. pregnant solution-tank. This clarified solution is pumped through one of two 16-frame 36-in. Merrill precipitation-presses by a 5¼ by 6 Deane triplex-plunger pump. The two presses are used alternately, clean-ups being made every 12 to 15 days. Single cloths of No. 10 canvas only are used, safely withstanding a pressure of 35 lb., which is reached just before a clean-up. The same cloths are used several times. From 5 to 6 tons of solution per ton of ore is precipitated. The standard Merrill zinc-dust screw-feeder and emulsifier are used. The zinc is added to the pregnant solution at the pump intake, and is in contact with it through about 30 ft. of pipe, before entering the presses. At the Packard mill this has proved a sufficient length of contact for satisfactory precipitation. No attempt is made to obtain complete precipitation, the aim being rather to procure a high-grade product. The pregnant solution has averaged $1.37 and the barren effluent 7 cents.* By testing the effluent frequently with 10% sodium sulphide solution, the mill-men keep the silver content within a few cents of the latter figure, except for a short time after 'cutting in' a new press, when the barren solution usually runs slightly higher. This method of testing the effluent is in use in many cyanide-plants treating silver ores, yet it does not seem to be generally known.



PRECIPITATION-PRESSES AND MOTOR-DRIVEN COMPRESSOR.

*Wherever assay-values are given in this article, they will be on the basis of 50-cent silver.

The pregnant solution entering the presses averages 1.6 KCN and 0.8 P. A. The effluent titrates 1.95 KCN and 0.7 P. A. A re-generation of 0.35 lb. KCN per ton on a 2-lb. solution is remarkable, but it has been repeatedly checked by different operators. The advantages of zinc-dust over shaving, except in smaller mills, have been too frequently mentioned to warrant repetition. The survival of the obsolete zinc-boxes shows tortoise tendencies.

The precipitate is dried to less than 14% moisture and shipped to the smelter. A refinery will be erected soon. A representative, though incomplete, analysis of the product follows:

	%		%
Ag	69.9	$Al_2O_3 + Fe_2O_3$	0.89
Au	0.022	Insoluble:	
Zn	15.50	Al_2O_3, SiO_2, etc. 1.61	2.03
$CaCO_3$	3.35	Cu	trace
CaO	0.82	Pb	none
Na_2CO_3	0.80		

Returning to the mill-circuit: The underflow from No. 1 thickener, having a specific gravity of about 1.45, is discharged into the first of two Dorr agitators, each 28 by 16 ft., where it is diluted to a gravity of 1.3, with stock solution. Most of the cyanide and lead acetate are added in this agitator, the remainder being dissolved in the stock-tank. The cyanide strength is kept around 2 lb. KCN and the protective alkalinity at 0.8 lb. CaO per ton. Sodium cyanide in the 'cyan-egg' form is used, but following general custom, the silver nitrate solution is standardized to KCN. An analysis of the solution showed the following constituents:

	%		%
$K_2Zn(CN)_4$	0.15	CaO	0.038*
NaCN (free)	0.07	$Al_2(SO_4)_3$	0.069
$NaAg(CN)_2$	0.009	$K_4Fe(CN)_6$	trace
SiO_2	0.004		

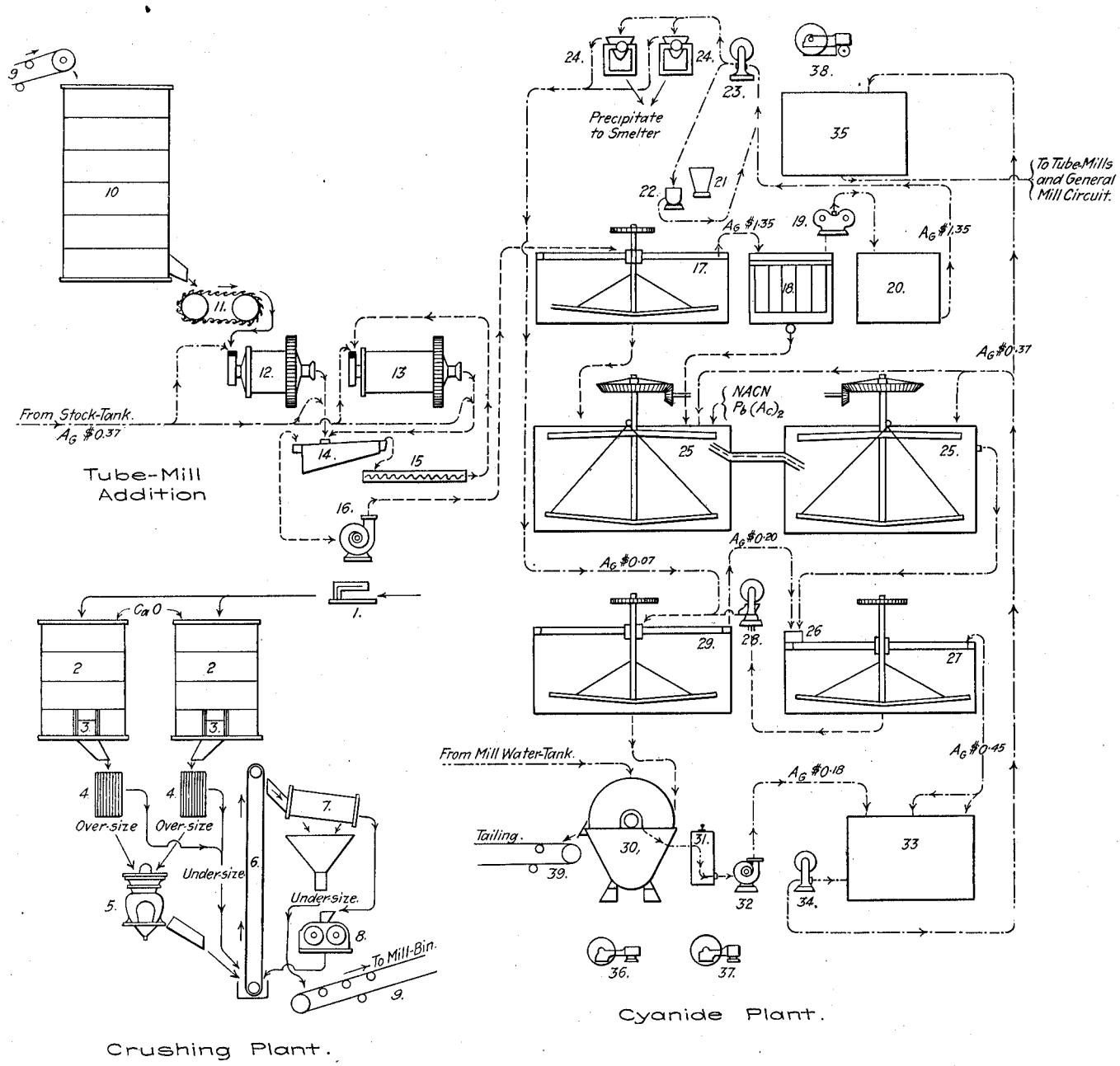
*By analysis, 0.05 by P. A. determination.
Total solids at 110° = 0.359%.
Total cyanogen = 2.06 lb. per ton in terms of KCN.

The reducing power of the solution is remarkably low, being equivalent to $\frac{9}{10}$ cc. N/10 $KMnO_4$ on a 10 cc. sample (with 2 cc. 1:1 H_2SO_4).

In the use of lead salts, we had the usual experience. Knowing that sulphides were practically absent, it was hoped that lead would not have to be used, though a supply was kept on hand. For the first three weeks the extraction remained near 95%, and then dropped gradually. Immediately upon the addition of lead acetate, the extraction returned to normal. Frequent tests with both nitro-prusside and lead carbonate have failed to show a trace of alkaline sulphides in any part of the mill-circuit. Ten pounds of lead acetate only are added daily.

The two agitators are connected in series by a straight pipe. The agitating mechanism is suspended from the roof-trusses. A unique feature is the use of one right and one left-hand drive. Besides the more symmetrical arrangement, there is a saving of one bent in the mill-framing. The air is—or was—admitted at the bottom of the tanks, through ball-check air-inlet valves. Soon after beginning operations, one valve snapped off, and was found reposing in one of the launder-arms. The agitator worked as well as ever, so the valve was never replaced. The Dorr machines work well on low air-pressures, require practically no attention and little power. Although a development of the last few years, they have already sent many of the weird and wonderful devices that went by the name of agitators to the scrap-heap. The two agitators, thickener, zinc-dust feeder, triplex and rotary pumps are driven by a 10-hp. motor.

From the agitators the pulp flows by gravity to the feed-box of No. 2 Dorr thickener—the first of two counter-current decantation tanks. It is diluted in the box by the overflow from No. 3 thickener and flows down a staggered riffle mixing-launder to the feed-well of No. 2 thickener. The clear solution flows to the sump-tank. The discharge is transferred by a No. 4 Colorado Iron Works diaphragm pump to No. 3 thickener, where it is diluted with the barren solution discharged from the Merrill presses. No. 2 thickener is 28 ft. diam. by 1 ft. deep. No. 3 thickener has the same diameter but is 12 ft. deep, giving a fall of two feet between them for allowing the decanted solution to flow from the third to the second tank. The increase in the depth of this tank provides additional storage-room for pulp during shut-downs of the filter. The underflow, having a specific gravity of about 1.5, is discharged into an 11½ by 12-ft. Oliver filter. The vacuum is maintained at 22 in. by a 10 by 12 in. Doak dry-vacuum pump connected with a receiver fitted with the usual float-valve release. The pipe connecting the receiver and dry-vacuum pump is run to the upper mill-floor and back, giving an effective rise of nearly 50 ft. It is not always remembered in installing dry-vacuum pumps for filtration that the combined air-lift action and vacuum will raise the solution many feet above the theoretical 30, if the float valve fails to release. The solution is handled by a 2-in. Krogh centrifugal pump, discharging into the 20 by 12 ft. sump-tank. External air-lifts as well as mechanical agitators are used to keep the pulp from settling. The filter-canvas will have a probable lift of 10 months. Water only is used for washing and is sprayed on both the ascending and descending sides by vermorel sprays. It is interesting to note that giving the cake practically the limit of water-wash just holds the amount of solution constant in the mill-circuit. In many of the Californian mills, an all-water wash would make the 'wasting' of solution necessary in a very short time. The explanation of the difference lies, of course, in the low moisture-content of the ore treated and the excessive evaporation of mill-solution due to the dry atmosphere. The cake is discharged with a moisture-content of 21.4%. Daily determinations of the soluble loss were made for the period of one month, and averaged slightly over 5 cents per ton. This low loss is due to the reduction in value of the solution by counter-current wash in the thickeners and the heavy water-wash on the drum. All soluble-loss assays are made by determining the moisture-content of the sample, agitating thoroughly with a measured volume of water



1. Fairbanks Recording Beam-Scale.
2. 12'x 16' Steel Ore-Bins.
3. 18"x 24" Steel Ore-Bin Gates.
4. 20"x45" Grizzlies, 1½" spaces.
5. Nº5 McCully Gyratory Crusher, Superior Type.
6. 14" Belt and Bucket-Elevator, 12"x 6" Mall. Buckets.
7. 30"x 9'3" Trommel, 2-mesh, Nº 10 Wire Screen.
8. 15½"x 37" Garfield Rolls.
9. 14" Conveyor-Belt.
10. 15'x 28' Steel Ore-Bin.
11. 2'x 6' Steel Apron-Feeder.
12. 5'x 6' Tube-Mill.
13. 6'x 10' Tube-Mill
14. Dorr Duplex Classifier.
15. 8"x 9' Screw-Conveyor.
16. Nº 1 Frenier Pump
17. 10'x 28' Dorr Thickener.
18. 10'x 12' Clarifying Tank - 16 - 5'x 8' Butters' Leaves.
19. 2" Rotary Force-Pump, "Gould."
20. 10'x 12' Pregnant Solution Tank.
21. Merrill Zinc-Dust Feeder.
22. Zinc-Dust Emulsifier
23. 5½"x 6" Deane Triplex-Pump.
24. 36" Merrill Precipitating-Presses, 16 Frame.
25. 16'x 28' Dorr Agitators.
26. Feed-Box.
27. 10'x 28' Dorr Thickener.
28. Nº4 Diaphragm Pump, Colorado Iron Works Type.
29. 12'x 28' Dorr Thickener.
30. 11'6"x 12' Oliver Filter.
31. Vacuum-Receiver
32. 2" Krogh Centrifugal Pump.
33. 12'x 20' Sump-Tank
34. 5½"x 6" Deane Triplex Pump.
35. 12'x 18' Stock-Tank
36. 14"x 12" Dry Vacuum-Pump.
37. 12'x 8' Ingersoll-Rand Air-Compressor, Low Pressure.
38. 13" & 7½"x 12" Ingersoll-Rand Air-Compressor, for Mine.
39. 12" Belt-Conveyor.

Dry Ore
Pulp.
Solution.
Water.

FLOW-SHEET OF NEVADA PACKARD MILL.

and assaying the filtered solution. It need scarcely be remarked that the unwashed-*minus*-washed tailing method does not give accurate results. The cyanide loss in the tailing is under 0.2 lb. per ton. It is a safe prediction that the counter-current decantation method is going to play a large part in future cyanidation. It is an equally safe prediction, however, that except in the case of low-grade ore treated with low-content cyanide solutions, continuous vacuum-filtration will follow the decantation step in the process.

The following table gives the extraction throughout the mill:

	Assay-value	Cumulative extraction, %
Headings	$7.06	...
Washed No. 1 tube-mill discharge	3.16	55.3
Washed classifier-discharge	3.31	53.1
Washed No. 2 tube-mill discharge	2.07	70.0
Washed classifier overflow	1.45	79.5
Washed No. 1 thickener discharge	1.38	80.4
Washed No. 2 agitator discharge	0.56	92.1
Washed No. 2 thickener discharge	0.49	93.0
Washed No. 3 thickener discharge (filter-feed)	0.46	93.5
Washed filter-tailing	0.38	94.6
Unwashed filter-tailing	0.44	93.8

The above are the averages of a number of assays run on consecutive days. The high extraction in the tube-mill circuit and the low extraction in the thickeners are interesting. The tailing is conveyed to the dump by a 12-in. Goodrich conveyor-belt, only sufficient water being added to keep the discharge-chute wet. A 5-hp. motor direct-geared to the head pulley drives the tailing-conveyor. A 30-hp. motor furnishes power for driving the two lower thickeners, diaphragm-pump, Oliver filter, transfer-pump, air-compressor, and Deane triplex pump. The latter, equipped with the usual by-pass, returns the solution from the sump-tank to the stock-tank at the head of the mill.

The power-line of the Nevada Valleys Power Co. delivers the current to the transformers at 6600 volts, and is there stepped down to 440 volts for the motors, and to 120 volts for the lighting circuit. 250-watt nitrogen lamps are used for illuminating the tube-mill floor, and 60-watt tungsten-filament lamps elsewhere. In order to balance the power-load, the crusher and rolls are run on graveyard shift while the compressor at the mine is shut-down.

The entire crew in the mill consists of three solution-men, three solution-helpers, a repair-man and a roustabout. The solution-helpers run the crusher. As the mine-compressor is in the mill-building, and is looked after by the mill-crew, the time of one man daily is charged to mine-account. The wages paid are probably as high as any in Nevada.

Solution-men	$5.00	Roustabout	$4.00
Solution-helpers	4.50	Repair-man	5.00

The cost per ton milled, on a basis of 2796 tons per month (the average since starting) is $1.265 per ton distributed as follows:

	Consumption per ton of ore milled, Lb.	Price per lb., Cents	Cost per ton, Cents	%
Cyanide	0.316	25	7.9	6.3
Lead acetate	0.118	13.7	1.7	1.4
Zinc	0.747	29	21.8	17.2
Pebbles (exclusive of mine-rock)	2.29	7.5	4.0	3.1
Hydrochloric acid	0.029	7.5	0.2	0.1
Lime	2.36	1.1	2.6	2.1
Power, 1.425 hp. at 26.5c. per hp.-day			38.0	29.9
Assaying (73% labor)			3.3	2.8
Miscellaneous chemicals			0.2	0.1
Labor			31.5	24.9
Supervision			2.9	2.3
Maintenance and repairs (90% labor)			3.9	3.0
Miscellaneous supplies			8.5	6.7
Total			$1.265	100.0

The extraction, based on smelter-returns, has averaged 94.9% since the beginning of operations.

In conclusion, a few words may be added regarding what Gelasio Caetani has called "the psychology of milling." The mill is well lighted and arranged so that all parts are easily accessible. The company furnishes the unmarried men on shift-work with cabins, while the bunkhouses of the miners are divided into rooms, two men sharing a room. The boarding-house is run at cost, and high wages are paid. A total mining, milling, and development cost of a few cents over $4 per ton, and an extraction of 95% of the precious metals in the ore strengthens the belief of the management that successful mining and low wages are not synonyms.

I am indebted to Mr. Freitag for many of the data given in this article, and also to J. W. Wilkey, superintendent, and B. B. Hall, accountant, of the Nevada Packard Mines Co. for aid given in its preparation.

THE TURN in the zinc market as a consequence of War conditions is indicated by the record of the Consolidated Interstate-Callahan mine in the Coeur d'Alene. Previous to the War, the company was losing money. For the year ended June 30, 1914, the operating loss was $99,314. During the year ended June 30, 1915, this debt was paid, dividends of $697,597 were distributed, and in addition there remained a surplus of $1,094,862. A single dividend in August, 1915, was $960,000, and the dividends during 1915 totaled $2,530,000. During the first six months of 1916, the Interstate-Callahan paid dividends of $1,394,970.

A TIN-CONCENTRATING AND SMELTING PLANT for the An-Yuan mines in Hunan province, southern China, is shortly to be placed in commission by the Wah Chang Mining & Smelting Co., which will offer this product for sale at New York and through agencies in Europe. These mines are in the Ichanghsien district, and contain both oxide and sulphide ores occurring as chimneys in limestone, marmorized by granite and intruded by a later granite dike along the course of which the ore-chimneys are found.