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Item 38

PRESENT DAY MILLING PLANTS ON THE COMSTOCK LODES

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There are a dozen mills operating on the Comstock Lode today; therefore for brevity's sake only a brief flow sheet of each mill will be given with a short description of the salient points of each.

It will become obvious that upon ores closely resembling each other, there is a wide difference in the metallurgical processes used at the different mills.

This fact immediately arouses the curiousity of the metallurgist, therefore comparative data will be given and discussed. In general, conclusions will be left for each metallurgist to draw for himself, in the hopes that his curiousity will first cause him to visit this interesting group of mills seeking more detailed information than here presented in this limited manuscript.

The list of mills with comparative data is as follows:

NO.	MILL	CAPACITY PER DAY	LOCATION	TYPE OF ORE	PROCESS USED
1.	Ariz ona Comstock	330 tons	Virginia City	Oxidized -Surface	Flotation Only
2..	Sierra Nevada	100 "	" "	Oxidized near surface	" "
3.	Bradley	120 tons	" "	Washoe-Pa n Tailing	" "
4.	Con-Chollar	135 "	Gold Hill	Old Mine Dumps	" "
5.	Sutro-Coalition	100 "	" "	Oxidiz ed near surface	Cyanide only (Be ing built)
6.	Overland	55 "	" "	Oxidized	Amal gamation a nd flotation
7.	Donovan	40 "	Silver City	Oxidiz ed	A malgamation a nd cyanide
8.	Trimble	35 "	" "	Oxidiz ed	A malgamatio n Only
9.	Recovery	50 "	" "	Oxidized	Amalgamation and flotation
10.	Clack	30 "	" "	Oxidiz ed	Amalgamtion with tables
11.	Esher	50 "	" "	Oxidized	Amalgamation with tables
12.	Hartford	50 "	" "	Oxidiz ed	Cyanide Only
13.	Dayton	130 "	" "	Oxidized	" "
		1205 Ton	About 900-100 Tons milled daily now.		

Each mill will be taken up in turn by first presenting its flow sheet followed by a discussion of its most interesting features.

FLOW SHEET- No. 1 ARIZONA COMSTOCK MILL

ORE-(330 tons by auto trucks)
to
BLAKE CRUSHER
To
GYRATORY CRUSHER (through 1¼ inch ring)
to
BIN
WATER

MARCY MILL
to
HYDRAULIC TRAP
to
DORR CLASSIFIER
(in closed circuit)
Overflow to

HARDINGE MILL
to
HYDRAULIC TRAP
to
DORR CLASSIFIER
(in closed circuit)
-to- Overflow

CONCENTRATE
to
Amalgamating Barrel
to

Tar Oil & Zanthate #8 -> AGITATOR <- Aero 25
to
EIGHT CELL FAHRENWALD FLOTATION UNIT.
giving

Concentrate
from
First three cells & Last five cells
to
Dorr Thickener
to
SETTLING BOXES
to
DRYING PANS (wood fired)
to (in bulk)
AUTO TRUCKS
To
SMELTER

First cell
to
AGITATOR <- Tar Oil
to <- Pine Oil
SIMPSON PNEUMATIC FLOTATION UNIT
(6 unit)
giving

Concentrate
to
Head of Fahrenwald
Unit.

Tailing
to
TABLE
(for test periods)
giving
Concentrate & Tailing
to
Storage for Future
Cyaniding

Tailing
To

MILL NO.1 -ARIZONA COMSTOCK

The ore for this mill is mined from an open cut on the outcrop of the Comstock Lode in the South end of Virginia City. It is a highly oxidized quartz ore, carrying considerable clay from gouge and altered country rock. The precious metal content of the ore per ton is about 0.10 oz. gold and 4.0 oz. silver; giving a ratio of 1 to 40 by weight, but close to 1 to 1 in value. The gold is mainly in a fine free state, and ~~like~~ the silver as both Chloride and Sulphide.

The ore is loaded by a 1½ cu.yd. gas shovel on to trucks hauling 10 ton loads to the mill less than a half mile away by down-hill road. For each ton of ore delivered to the mill about 1.8 tons of waste is removed to waste piles.

GRINDING

The Marcy was the original unit and the Hardinge was added later.

A single-unit flotation ~~cell~~ was first tried out at the end of one of the mills. This unit, while it extracted a good percentage of the values, gave trouble due to the coarseness of feed and the accumulation of metallic iron in it. The hydraulic traps recover less but with no difficulties and with as great overall extraction in the plant.

The ore is ground in a 3 to 1 pulp to a fineness of 5% on a 65 mesh screen, with 50% passing a 200 mesh screen, resulting in these two extreme products being of about equal value in the final tailing, and higher than the intermediate products.

FLOTATION

The flotation problem is that of treating a highly oxidized gold-silver ore. The original mill was designed to treat 110 tons a day of mine ore of mixed oxide and sulphide.

The gradual change to a large tonnage of lower-grade oxidized surface ores forced changes in the mill to meet the new conditions.

The pneumatic flotation unit was added to aid the mechanical type unit. Its concentrate recovery is low in amount and value, and is now returned to the head of the mechanical unit.

The concentrating table is run at times on a part of the flow as a check upon the flotation units. It yields a low value concentrate of tramp iron and partially oxidized pyrite.

The overall ratio of concentration is about 100 to 1, with a concentrate carrying an 85% clay content of minns 200 mesh, and yet of content about $400.00 gross value in gold nd silver per ton. The total value recovery in the concentrate is approximately 70% of the gold and 55% of the silver contained in the ore, or a combined value extraction of about 64%.

Many changes have been made in the flow sheet and the flotation reagents used, in a constant attempt to increase the extraction results, and the general conclusion is drawn that present results closely approximate the best possible under present plant conditions. It is true that designers of flotation units and flotation "experts" ache to try their hand at this problem. As it is they are probably saved many a bad headache.

DRYING OF THE CONCENTRATE

The use of an Oliver filter was abandoned on account of the extreme fineness and clay content of the concentrate, in favor of drying over wood fires to about 10% moisture.

SHIPMENT AND MARKETING OF THE CONCENTRATE

Although the loading platform is on a railroad spur the concentrate is hauled about 250 miles by auto truck to the smelter at Selby Calif. at less cost. The reason for this is that the trucking contractor does not base his hauling rate on the value of the product. He loads and delivers to the smelter for $9.00 a ton. Each load is sampled and an advance payment made. This feature of prompt shipment in small lots with prompt payment, is a great boon to the

operators of small flotation plants.

The sampling, assaying, and smelting charges will approximate $8.00 a ton. This with $9.00 for ha uling, equals 4½% on $400.00 concentrate. The total value deductions made by the smelter from the gold content at $35.00 an ounce and silver at 77.56 cents, figures out as 5%. Thus the total marketing cost of the concentrate becomes 9.25%. On the 64% value recovery at the mill in concentrate, the net value extraction at the mill becomes 90.75% of 64%, or 58% after the overall cost to market metallic gold and silver from the concentrate is deducted as an extraction item. Flotation simply makes a high-grade ore for further treatment at a smelter. A malgamation and cyanide after give a metal bar at the plant that requires less than 1% of its gross value to market.

The $1.00 a ton direct cost per ton milled by flotation at the Arizona Comstock is a low figure, but results in a high marketing cost on the shipping product made. If the additional cost to reduce the concentrate to the precious metals be added as an additional milling charge it would add 38.5 cts a ton more in this case to attain at 64% ~~recovery~~ as a net recovery.

FLOTATION TAILING AND TEST WORK

The flotation tailing is impounded below the mill for future treatment in a cyanide plant that is now partly constructed.

Cyaniding tests on this tailing, indicate the possibility of a total combined extraction on the mill heads of 97% of the gold and 89% of the silver. Cyaniding tests on the flotation concentrate indicate better than a 96% total value extraction upon 96 hrs. agitation.

The above test results check closely the excellent work of the 1000 ton Comstock Merger ~~Mill~~ in 1925 that treated a similiar oxidized ore by ball milling, table concentration, leaching of sands, and agitation of the slimes and of the reground concentrate, for a total value extraction of 97% at a direct cost of $1.22 a ton. Cyaniding tests on the ball mill product of the

Ariz ona Comstock without flotation, yielded but a total extraction 90% of the gold and 60% of the silver. Similiar ore treated in 1906 by Mr. Chas. Butlers in his stamps, tubemill, leaching and agitating plant, yielded a 90% value extraction, due probably to the finer grinding. In the Mexica n mill in 1912, Mr. Whitman Symmes treated a Comstock deep-level sulphide ore of twice the value by all-slime cyanidation for over 90% of the metal value.

ECONOMICS

The original 110 ton mill was built as a flotation mill out of second-hand equip ment, to keep the investment at a minimum with however an expected high extract ion by flotation based on laboratory tests that was not attained. Under extreme financial difficulties the new management has opened up a surp rising showing of ore as to tonnage and value, at sagebrush roots only a block off the main street of Virginia City, and has managed tom treble the ca p-acityof the flotation mill at a low expense. However the low extraction by flotation makes difficult the financing of the cyanide annex at the plant necessary to give satisfa ctory recovery and profit on the surface ores.

Flow Sheet No. 2 SIERRA NEVADA MILL

ORE (50 tons a day)
to
JAW CRUSHER(16"by14")
to
ROLLS (14"by 26")
to
BIN
to
WATER ------> BALL MILL (tire and grate type) 4 ft diam.
to
HYDRAULIC TRAP --- Concentrate - to -amalgamating barrel/
to
DORR CLASSIFIER
in closed circuit
to
AGITATOR
to
FOUR CELL KRAUT FLOTATION UNIT.
<------- giving --------->

Concentrate
by pump
to
TWO CELL KRAUT FLOTATION CELL
<------giving-----> Tailing back to AGITATOR
Concentrate
to
SETTLING TANKS
to
PAN DRIER (oil fired)
to
SMELTER

Tailing
to
TWO PLATO TABLES
<---- giving ------>
Concentrate
to
SETTLING TANKS
to
PAN DRIER

Tailing
to
AUTOMATIC
SAMPLER
to
Waste Launder

MILL NO.2 SIERRA NEVADA

In the North end of Virginia City, the Sierra Nevada/00 ton flotation mill has been erected to treat an oxidized ore very similiar to that of the Arizona Comstock, and its flow sheet is quite similiar also. It has just been started up, and it will be interesting to compare the metallurgical results eventually obtained, with those of the Arizona Comstock.

FLOW SHEET No. 3 BRADLEY MILL

Water under 180 lb. pressure------> TAILING (120 tons a day)
to
TROMMEL SCREEN (16 mesh)
giving
Oversize and Undersize
to
BALL MILL(3'by5') to
to---------->
AGITATOR
to
PUMP(Centrifugal)

Zanthate----- ----> to
4 CELL KRAUT FLOTATION UNIT.
giving
Concentrate and Tailing
to
1 CELL KRAUT CLEANER to
giving
Concentrate & Middlings 2 CELL KRAUT
SCAVENGER UNIT
giving
Cresylic Acid
&Zanthate ------ return to AGITATOR
to CONCENTRATE & Tailing
to
SUN-DRYING BOXES to
with WEIGHT
CARPET BOTTOMS SAMPLER
to to
AUTO TRUCKS Waste
to
SMELTER

MILL NO.3- THE BRADLEY PLANT

This neat plant close to the Arizona Comstock was built to treat a pile of old Washoe-pan process tailing resulting from ore treated in the 60's. This particular tailing contains not only considerable weathered pyrite, but also many soluble salts, both from the treatment process and the years of weathering.

The tailing is sluiced to the plant by means of a monitor of double jointed pipe with nozzle and handle. By constant skillful manipulation of the cutting stream against the bank and the leather-like slime layers, a fairly steady flow of 1½ to 1 pulp is secured.

It was found necessary to install the ball mill to further pulp the tailing. The cleaning cells and scavenger cell were also added later.

Retorting of the concentrate was practiced last season to recover mercury, but has been discontinued as uneconomical.

Careful provision is made to determine the daily tonnage and value of both the concentrate made and the final tailing. A clever mechanical device has been installed to weight intermittently a large one/minute sample of the tailing stream to determine tonnage. Each day's flow of concentrate is directed to a separate drying box.

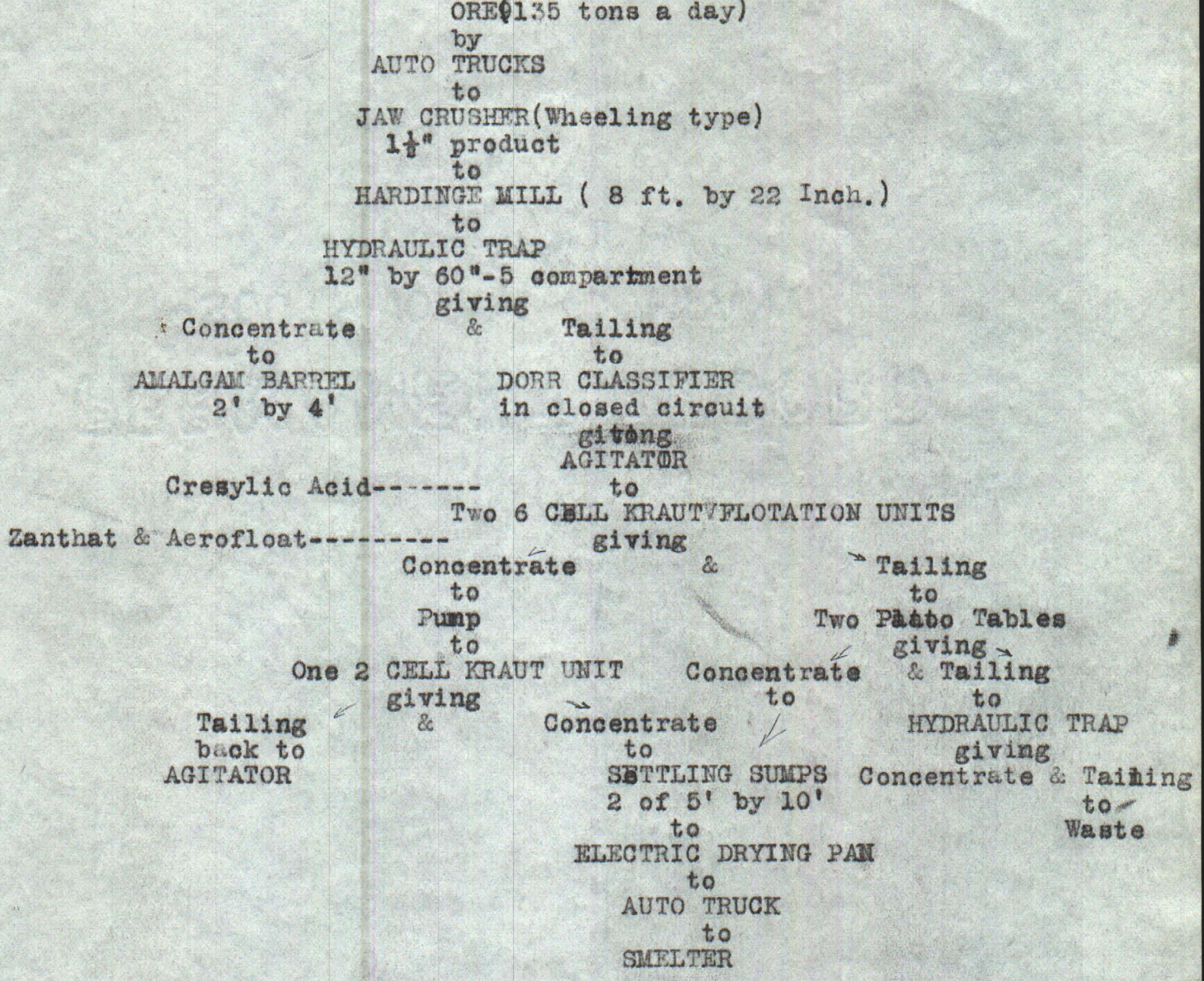
The history of the plant has been, that of skilled supervision versus a very tough product to treat.

ECONOMICS

The Washoe-pan process tailings from the old Comstock days have always been most intriguing to metallurgists because both on account of the attractive values contained there in, and the soluble salts that held guard over them! With the advent of cyaniding, many retreatment plants were erected with the general result that the costs exceeded the recovery.. Even such a skilled metallurgist as Charles Butters, after treating a quarter million tons, had only the consolation that his plant in Six Mile Canyon was famed for the successful development of the Butter's filter.

With the advent of flotation a group of San Francisco capitalists contributed the necessary capital to work a quarter-million tons known as the "Douglas Tailings" at the mouth of Six Mile Canyon, and to ascertain the fact that these same soluble salts in varying quantities caused such variable and unfavorable results in the flotation cells compared with laboratory tests that even a 50% gross extraction was much to be desired. Such good metallurgists as Alex Wise and George Fuerman in 1925, came to the same conclusion up Six Mile Canyon. The same conclusion holds true today after ten years improvement in the flotation process, but the present increased value of the precious metal content probably gives a favorable balance sheet. This same increased value of gold and silver encouraged Edmund Leaver and Jay Carpenter to construct, this summer, a 100 ton leaching plant on the "Douglas Tailings," to treat for a third time ore first treated by the Washoe-pan process and then by flotation. Their hope for successful treatment is based upon the flotation treatment having washed out the soluble salts along with the re-impounding of only the sandier content of the tailing.

FLOW SHEET No. 4 CON-CHOLLAR MILL



MILL NO.4-CON-CHOLLAR MILL

This mill is on the Comstock Lode in Gold Hill, just South of Virginia City.

The famous mines of Gold Hill yielded ore with a higher ratio of gold to silver than the Virginia City mines, and the mine dumps contain low grade mixed oxide and sulphide ore, that has been subjected to over 50 years of weathering.

The Con-Chollar mill is of interest because it is treating these old mine dumps by the flotation process.

This dump ore, from such old mines as the Belcher and Overman mines, is mined with a 3/8 cu. yd. gas shovel and hauled in 5 ton truck loads, an average distance of one-half mile for a contract price of 45¢ a ton.

This ore will probably average in content about0.08 oz. gold and 1.40 oz. silver, and with a flotation flow sheet somewhat similiar to the Arizona Comstock, a similiar recovery of about 2/3'ds of the value of the ore is made.

This low extraction is due probably to the urge for tonnage and the variable nature of the dump ore, as a day's test run at the rate of 100 tons a day is said to have given the 80% recovery expected from the experimental testing. The capacity of the plant is now being trebled by the addition of a Symons disc crusher, an 8 ft. by 6 ft. Marcy mill, with flotation units, concentrating tables, etc. to correspond, and lower costs and higher extraction are expected.

Years ago a large tonnage of similiar dump ore was treated in a mill, using Kinkaed mills with amalgamation followed by concentration on Johnson vanners, for a total extraction of 57%, according to the old mill records.

In the 20's the Comstock Merger cyanide plant, (already described) treated large tonnages from the Gold Hill mines from old stoped areas for a total extraction of over 95%.

The concentration ratio of the flotation cells in the Con-Chollar mill is a little over 100 to 1 in a heavy sulphide concentrate of about

$250.00 per ton value. The tables take out but 3% of the total concentrate having a value of $75.00 a ton or less.

The hydraulic trap at the end of the ball mill recovers over 10% of the value of the ore, mainly in gold and in a small bulk easily concentrated and amalgamated. In this case it is a valuable adjunct to flotation extraction and costs, by removing coarse gold quickly from the ball mill circuit. Provision is made also to recover at intervals the coarse gold from the ore below the classifier rakes by concentrating this product over one of the tables. A simiiliar treatment of the product from behind the ball mill liners yields a high return. Even a hydraulic trap is placed in the final tailing launder. One months bullion, assaying 400 fine in gold and 270 fine in silver, represented 13.2% of the value of the ore treated. It would be interesting, but probably slightly unprofitable, to find out what the extraction results would be with all conditions the same except for the elimination of the hydraulic trap.

The total cost of milling is about $1.25 a ton of which 10¢ is for water, and 31¢ for power. The marketing is expressed as an additional cost of 30¢ a ton, which amount to about 7½% of the value of the ore.

In the case of starting on an uncertain or a narrow margin mining venture, the high cost of an all-agitation cyanide plant in order to make the highest net extraction is often not advisable or possible to finance. The lower expected extraction results of a flotation plant may be balanced in great part by lower operating costs and lower overall depreciation charges. It is often a case of less capital ventured for a less expected profit.

12a followed by 12b

FLOW SHEET No. 5 SUTRO-COALITION MILL. Under construction

ORE (100 tons a day)
to
JAW CRUSHER(Wheeling-type)
(1½" product)
to
BALL MILL (Size ?)
to
DORR CLASSIFIER(in closed circuit to 100 mesh)
to
No 1 THICKENER
giving

Underflow & Overflow
to
Zinc Dust Precipitation

both to
No. 1 AGITATOR & No. 2 AGITATOR
both to
No.2 THICKENER
both to
No.3 AGITATOR & No.4 AGITATOR
both to
NO. 3 THICKENER
to
FILTER
to
PULPING TANK
to
Waste

126 followed by 13

MILL No. 5 SUTRO COALITION

This mill is being constructed through the financial aid of an R.F.C. loan, to work the upper levels of the Crown Point mine. The ore is an oxidzed ore of an average content of 0.20 oz. gold and 5.8 oz. silver.

In the early plans for this mill the flotation process was favored by the property owners. In seeking a government loan detailed test work was carreid out. On a series of flotation tests, when the grinding was finer than 100 mesh, the extraction on the gold reached 83% and on the silver 71 to 77%, with a concentrating ratio from 20 to 1 to 40 to 1.

On another test, grinding to 30 mesh, the slime content was treated by flotation, and the sand content by cyanidation. On another test the ore was first treated by flotation and the concentrate reground and added to the tailing for cyanidation. The resulting extraction on these tests were also comparatively low in contrast to straight cyanidation.

Cyaniding tests were made on the ore variously ground from 30 mesh to 200 mesh. The 30 mesh and 48 mesh grinding was followed by separation into sands for leaching and slimes for agitation giving for the 30 mesh grind a value recovery of 90%, and for the 48 mesh grind, 92.2%. Finer grinding to approximately 100 mesh with agitation gave an extraction of 97.5% of the gold and 88.0% of the silver,, or a value extraction of 94.5%. Finer grinding than this did not increase the extraction.

Since the mill is to be but a 100 ton unit, it was recommended that the simpler flow sheet of all-agitation plant be adopted along with 100 mesh grinding as the extra cost of grinding to this mesh is repaid in higher extraction. Since extraction results were so excellent with this simple flow sheet, tests were not made combining cyanidation with amalgamation, hydraulic traps, or corduroy. The last two could be added later without much inconvenience to the plant if there is evidence of considerable coarse gold in the classifier circuit.

Flotation results in practice in the mills on the Comstock Lode have failed generally to equal the extraction indicated by laboratory test work. It will be interesting to see how closely the cyanide test work and the mill results check in this new mill.

FLOW SHEET No. 6 OVERLAND MILL

ORE(35 tons a day)
to
JAW CRUSHER
1½" product
to
10 STAMPS
(1200 lb- 100 drops of 5 inch. each- 40 mesh screen
3½ inch discharge- inside plates
giving
Tailing ← & → Amalgam (60% of amalgam values) to a bar to the U.S.Mint.
over
16 FT. of PLATES
giving
Tailing ← & → Amalgam
to
GRINDING PAN(5ft.by 2½ft)
giving
Tailing ← & → Amalgam(mostly silver)
to
AGITATOR9(5 to 1 pulp)
to
FIVE CELL FLOTATION UNIT.
giving
Concentrate ← & → Tailing
(All taken from 1st cell) to Waste.
to Drier
to
Smelter.

MILL NO.6 OVERLAND MILL

The gold-silver ore treated by this mill near Gold Hill is an oxidized ore carrying but a small per-cent of sulphides, and with most of its values in free gold. This ore would yield a high extraction by all cyaniding, and flotation adherents would probably claim the same for flotation. Since over 70% of the gold would amalgamate, the original mill was an amalgamating mill. To treat the tailing, from amalgamation, instead of cyaniding as at the Donovan mill, a flotation annex was added, resulting in an overall extraction of 90%. The stamps are followed by a grinding pan and every effort is made to recover the maximum gold by amalgamation. The ratio of concentration by flotation is 400 to 1, giving, in a $400.00 concentrate, a 2/3ds value of extraction of the amalgamation tailing. A cyanide plant would have been more costly to construct and operate and might not have compensated by a higher net recovery.

FLOW SHEET No.7 DONOVAN MILL

ORE(40 tons a day)
to
JAW CRUSHER
to
Water and Mercury---- 10 STAMPS
to
PLATES2(4.5ft. by 9.0 ft.)
giving ----- - - Amalgam
to
GRINDING PANS (2-5ft Diam) to Amalgam Barrel
giving Amalgam (giving 65 to 85% of the gold and 10% of the silver
to
Tailing from Trimble Mill---- DORR BOWL CLASSIFIER
giving

Sand
to
FRENIER PUMP
to
BUTTERS&MEIN DISTRIBUTOR
to
4 LEACHING TANKS(8 ft. depth charge)
giving

Tailing to Waste

Solution to ZINC BOXES giving Precipitate to REFINERY

Overflow to SETTLING PONDS giving

Sands to CLAM SHELL EXCAVATOR to DRYING & FARMING AREA to HORSE SCRAPERS to LEACHING TANKS (3 ft. depth charge) giving

Tailing to Waste

Solution to ZINC BOXES

Slimes to PUMP to AGITATORS for agitation & decantation giving Tailing & Solution to ZINC BOXES

Overflow Water for sluicing

MILL NO.7 THE DONOVAN MILL

The Donovan Mill is in Silver City, which is about 2 miles south of Gold Hill, and on the "Comstock Lode." Odd to relate, the ores of Silver City are gold ores, carrying some silver, and are highly oxidized. There are many small mines in the district and for over 70 years, the many small mills of the district have been ~~small~~ stamp mills followed only by plates. The 10 stamp Donovan mill erected in 1890, was of this type, making an extraction of 70% to 80% by amalgamation only. In 1900, with the introduction of cyaniding, leaching vats were added to treat the sandy portion of the amalgamation tailing. As a consequence there was an urge to treat as slimy a sand product as possible, and in time there evolved the practice which is still followed of recovering a slimy sand product from settling ponds with a clam shell excavator, and after draining, to spread it over a flat area for drying and "farming" it with team and harrows to hasten drying and to break up slimy lumps. The dried tailing is then loaded by scrapers into the leaching tanks.

Due to the high slime content the leaching rate of the charge is but ½" to 3/4" per hour, and a nine day treatment is given to get the maximum recovery on the silver content.

For many years the entire 40 mesh product from the battery, with 60% minus 200 mesh, was successfully treated in this manner. The successful leaching of such a product is due to the slime entering the tanks mixed with some sand in hard little sun-baked lumps that act much like sand particles for a considerable period of time before breaking down. It is claimed that the lumps remaining in the charge at the finish, assay as low as the balance of the charge. This is an excellent illustration in this highly mechanical age of what can be accomplished by a simple leaching plant.

Now that the Donovan plant is also treating the tailing of the Trimble Mill the procedure is followed of feeding the combined amalgamation tailing to a Dorr bowl classifier, where the coarser sand is removed, and then elevated by a Frenier pump to a Butters and Mein distributor, feeding a new line of four 20 feet diameter leaching tanks, holding 100 tons each in an 8 foot charge.

Each charge is allowed to drain for 24 hours and then first treated with a 6 lb. cyanide solution, followed in time with weaker solutions. The leaching rate is held back to 1 inch an hour. The cyanide consumption is low, and much stress is placed upon the extra extraction of the silver obtained by using this strong first solution.

Also much stress is placed upon the way the lime is added, and the alkalinity maintained. One hundred pounds of dry slaked lime is added near the bottom of the tank to assure a protective alkalinity of the effluent solution. Another one hundred pounds is added near the top of the charge. By pH control, only enough lime is added to keep the solutions about neutral, and this method of alkalinity control is credited with giving a well-marked increase in extraction of 25% upon the silver content and 2.5% on the gold content in the leaching tanks. This pH control is also used in the older leaching plant and in the agitating department, and is credited with a saving of 75% over the quick lime used when a higher protective alkalinity was carried. The benefits extend also to a saving in zinc used, and to producing a higher grade bullion.

The over-flow from the Dorr bowl classifier flows to the old settling ponds, where the sandier content is removed as before for farming and leaching. The slime at the lower end of the pond is pumped in turn to 3 large tanks, fitted with Deveraux agitators. After settling and decantation of the water, the slime is agitated in a 1.0 lb. cyanide solution. Then follows

periods of decantation and agitation with final dumping in a 0.2 lb. cyanide solution.

The over-flow from the ponds,(under pump pressure) is used for sluicing the sands from the leaching vats.

Thus this plant has had much of the same metallurgical history as the plants on the South African Rand, that started with amalgamation only, then to leaching of the maximum sands, and then to additional treatment of the slimes by agitation and decantation.

It might be suggested that the installation of filters would bring this mill up-to-date with the Rand mills, but the owner's regret is that the narrow confines of the gulch did not allow expanding the farming area sufficient to allow in turn the simple leaching of the entire product of the two mills! As it is, it is the only plant on the Comstock today to use sand leaching as a part of the extraction process.

An over-all extraction is made of 90% or better, and all the bullion is sent direct to the U. S. Mint, thus securing the full price and content of the precious metals. The total shipment and treatment charge on the amalgam bullion is but 0.6% while on the cyanide bullion, averaging 35 parts gold to 935 parts silver, it is under 1.0%.

This partly custom mill, (with its own mine) has the distinction of being individually owned, with the ownership having passed from father to son.

FLOW SHEET No. 8 TRIMBLE MILL

ORE (35 tons a day)
to
CRUSHER
to
Water and Mercury---- 10 STAMPS-(108 drops Of 5.5 inch.)
High discharge-35 mesh screens
giving --- Amalgam
to
Plates@ 4 ft. by 16ft.)
giving Amalgam
to
GRINDING PANS
giving Amalgam
and
Tailing
to
Donovan's Pàant.

The Trimble Mill is one of the old time straight stamp-amalgamating mills running on custom ore. The milling charge ,about as at the Donovan Mill, is from $2.00 to $2.50 per ton depending on the size of the lot milled and the customer receives all the values recovered in amalgam. The tailing in turn is purchased on a simple basis of subtratting $2.00 from its assay value and paying the customer half of the balance.

These two custom mills have been a boon to the small mine owners and leasers in Silver City, whomhave maintained a steady production for many decades in contrast to Virginia City's periods of high and low production.

F1
FLOW SHEET No.9(

RECOVERY MILL
ORE (70 tons a day)
to
JAW CRUSHER-(driven by a Pelton wheel)
to
ROLLS
to
VEZEN SAMPLER
to
Water ------> BALL MILL- (4½ ft. by 4½ ft)
to
HYDRAULIC TRAP -removing a concentrate.
to
CLASSIFIER
in closed circuit
giving
Overflow - through 60 mesh.
to
Mercury----> GIBSON AMALGAMATOR giving Amalgam
to
Mercury--> PLATES- 8 ft. long., giving Amalgam
to
Pine Oil &Zanthate-- 6 CELL KRAUT FLOTATION UNIT
giving
Concentrate & Tailing
Taken from 1st cell to
to PLATO TABLE -as scavenger
TWO 8 Ft. CONES giving
to Concentrate & Tailing
OIL BURNING DRYER to
to Waste.
SMELTER

This mill in Silver City is a more recent mill,and like the Overland Mill it is a combination amalgamation and flotation mill. It is fitted with Vezin samplers,and has purchased ores based on paying 80% of the head sample with a $3.00 milling charge.

FLOW SHEET No. 10 CLACK MILL

ORE (30 tons a day)
to
CRUSHER
to
Water & Mercury-- 10 FT. LANE SLOW SPEED MILL
(Wier discharge giving a 30 mesh product
with 70% minus 100 mesh)
giving
Tailing & Amalgam
to
Mercury -- PLATES (12 ft. in lenght)
giving
Tailing & Amalgam
to
6Ft. AMALGAMATING PAN
giving
Tailing & Amalgam
to
TRAP
to
3 CONCENTRATING TABLES
giving
Concentrate & Tailing
back to
AMALGAMATING PAN
for regrind.

This mill is also fitted for custom milling, but with the returns depending on the values amalgamated. Of a recovery of 75% by amalgamation , 75% of this in turn is recovered in the Lane slow speed mill, 20% on the plates and 5% in the grinding pan.

The concentrating tables are used as an adjunct to amalgamation. The further grinding of the pyrite concentrate releases gold for amalgamation

16d followed by 16e

FLOW SHEET No.11 ESHER MILL

ORE (50 tons a day capacity)
to
CRUSHER
to
Water---- BALL MILL (5ft. by 5 ft.)
to
CLASSIFIER
in closed circuit
to
Mercury added--- PLATES-8ft in lenght
giving
Tailing & Amalgam
to
DOUBLE DECK TABLES
giving
Concentrate & Tailing
to Smelter

This mill runs intermittently. It was built with flotation cells following amalgamation but the cells were replaced with tables.

FLOW SHEET No. 12 HARTFORD MILL?

ORE (50 tons a day)
by
AUTO TRUCK
to
JAW CRUSHER
to
Cyanide solution- BALL MILL -6ft by 4 ft.
to
CLASSIFIER
in closed circuit
to
THICKENER
giving
Underflow Overflow
to to
3 DEVERAUX AGITATORS ZINC BOXES
to
2 THICKENERS
to
OLIVER FILTER
to
Waste

This all-cyanide and all-agitation mill was apparently built without sufficient settling capacity in the thickeners, which with other troubles has prevented steady running.

16e followed by 17

FLOW SHEET No. 13 DAYTON MILL

ORE (130 tons a day)
to
JAW CRUSHER (new)
to
GYRATORY (new)
to
SAMPLER
to
Cyanide solution---> BALL MILL (5 ft. by 6 ft.)
to
CLASSIFIER
in closed circuit
gving 30 mesh product
to
FRENIER PUMP
to
CLASSIFIER
in closed circuit
with
TUBE MILL (5 ft. by 22ft).
giving
60 mesh product
to
THICKENER
giving

Underflow & Overflow

Underflow: to 3 DEVERAUX AGITATORS to THICKENER to 2 OLIVER FILTERS to MIXER to Waste

Water----->

Overflow: to SETTLING TANKS with excelsior to CLARIFYING PRESS to ZINC DUST PRECIPITATION

MILL NO. 13 THE DAYTON MILL

The ore for this mill in Silver City is an oxidized gold quartz ore. It is true, the ratio of gold to silver is about 1 to 5 by weight, but this by value becomes 10 to 1, and the silver is of minor consideration metallurgically. It is similiar to the ores treated in the other Silver City mills by the method of amalgamation followed by either cyanidation or flotation of about a 40 mesh product. However in this case, finer grinding was adopted to allow treatment in an all-agitation all-cyanidation plant. One factor favoring this choice was the ownership of the Flowery Mill, operated so efficiently by Alex Wise for several years. This mill was rapidly and cheaply moved over and set up, using the same units and flow sheet, and has given excellent service in low costs and high extraction. On a quarter ounce gold ore, grounded to pass 65 mesh, and, in total contact with 1.5 lb cyanide solution for 72 hours, the extraction of gold is 95 %, and of the silver 75% with 60% of the gold values dissolved in the grinding circuit. The cyanide consumption is approximately 0.4~~6~~ 16. per ton, while the lime reaches 10 lb. in order to obtain the necessary setting. The direct cost for milling is around $1.50 a ton, and the bullion is shipped direct to the U. S. Mint.

CONCLUSIONS

In many mining districts the mills are very similiar to each other in process, flow sheet, and units used, but on the Comstock there is a most interesting variation in all particulars.

If an analytical attempt is made to ascertain if such a variation of processes is ~~metallurgically~~ justifiable, or if one process would not be best fit all cases, one meets the baffling assertion in each case that the peculiar variation of the ore in question justified the process used. There is, of course, much truth in such a statement, but probably often as deciding a factor was the wide variation in the peculiarities, experiences, and convictions of the metallurgists designing the plants. Often too, financial considerations dictate the type of plant to be erected, or even the whim of the company officers! It is natural that the resulting plant is loyally supported by those responsible for its design and construction.

Our general conclusion is that the use of flotation alone on Comstock ores has not, to date, justified the faith and hope placed in it, and that often amalgamation alone, and usually cyanidation alone are its proven economic superiors, and of these two, cyaniding alone will give nearly complete extraction, but at a greater installation and operating cost.

Combinations of amalgamation, table concentration, flotation and cyanidation may be superior to cyanidation alone, where the daily tonnage justifies a more complex plant.

It is interesting to note that no plant has been installed using the combination of corduroy or blankets with cyaniding as is the latest Rand practice in South Africa. The high assay value of the classifier sands