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The design of a mill to treat a certain gold-silver ore by cyanidation

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SUBJECT

THE DESIGN OF A MILL TO TREAT A CERTAIN GOLD-SILVER ORE BY CYANIDATION

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MISSOURI SCHOOL OF MINES

1910

Approved. H. Copeland ...

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INTRODUCTION.

The problem under consideration is the design of a hundred-ton mill for treating silver ores by cyanidation. The analysis of the ore is as follows:

	Per Cent.
Copper	0.2
Iron	4.2
Zinc	1.4
Manganese	1.6
Lead	trace
Lime (CaO)	1.2
Sulphur	1.5
Insoluble (Al_2O_3-SiO_2) .	82.8
Undetermined	7.1
	100.0

	Oz. Per Ton.
Gold	0.20
Silver	8.60

The Sulphur is partly combined as Sulphide and partly as the Iron Sulphates, $FeSO_4$ and $Fe_2(SO_4)_3$. To determine the best method of procedure, preleminary tests were run on lots of 100 pounds each, this being crushed in a sampling grinder and classified into sand and slime.

The sand was leached in small tubes 18 inches in diameter and 18 inches deep and extremely erratic results were obtained. Slime tests were run in tubes of the same size fitted with stirrers, and the results were uniform. The acidity of the ore was determined, by agitating samples, in bottles, with a solution of sodium hydrate, and showed an average acidity equal to 7 pounds of lime per ton of ore. The cyanide consumption tests, showed a chemical loss of from 1.5 to 2.1 lbs. of KCN per ton of ore, provided the protective alkalinity did not drop below 0.02% CaO.

To determine the best method of collecting the sand and the extraction on a working scale 5 and 10 tons lots were crushed in a stamp-mill, the pulp run to a pit where the sand settled and the slime flowed over a gate whose height could be easily changed. The value and amounts of the various sized products are given below.

Screen Size.	Battery-Sample.		
	On Screen	VALUE	
		Gold	Silver
	Per Cent.	Oz. Per Ton	Oz. Per Ton
On 40	2.51	0.24	6.1
On 60	11.08	0.19	4.2
On 80	1.52	0.25	5.8
On 100	3.70	0.27	5.8
On 150	17.30	0.42	8.6
Through 150 . . .	50.10	0.61	14.1
Through 150, sand	16.50	1.10	19.2
Through 150 slime	33.60	0.37	11.7

	Sand-Sample.				
	On Screen	Heads		Tails	
		Gold	Silver	Gold	Silver.
	Per Cent.	Oz. Per Ton.	Oz. Per Ton.	Oz. Per Ton.	Oz. Per Ton.
On 40	3.9	0.30	6.2	....	2.5
On 60	20.0	0.29	5.4	....	1.6
On 80	21.7	0.30	7.2	....	1.2
On 100	5.8	0.29	7.4	....	0.8
On 150	28.1	0.50	11.4	....	1.2
Through 150	20.5	0.86	20.2	....	1.5
Through 150, sand	14.8	1.05	24.0		
Through 150, slime	5.7	0.19	10.0		

While the greatest values were carried by the sands finer than 40 mesh; a 60% extraction was the best obtainable on coarser than 40 mesh, while over 90% could be obtained from the slimes. It was therefore decided to slime everything thereby getting greater extraction, saving time and saving tanks, but necessitating agitation and forced filtration. The solution tests on slimes showed a good extraction of gold and silver, good precipitation, leaving a solution which could be used over again. Consumption 0.8 lbs. of zinc per ton of ore. The best strength of solution was one with 0.20% KCN. The gold recovery was 94%; the silver recovery 88%. The Best ration of solution to dry slime, was 4 of solution to 1 of slime by volume.

Concentration of the residue was tried but was found unprofitable as all values could be quickly dissolved in the cyanide treatment. The tests given above controlled the design of all portions of the mill.

General Outline of the Mill.

A general outline of the mill is given below. The mill is required to treat 100 tons of ore per day. The ore coming from the mine is stored in a bin of sufficient capacity to run the mill 48 hours. From the bin, the ore runs over a 1 1/2 in. grizzly, the oversize going to a No.2 Austin gyratory breaker where it is crushed to 1 in. The product from the gyratory together with the undersize from the grizzly is sent by gravity to an Allis Chalmers "B" Rolls, 14 in. by 30 in.diameter set to crush to 3/8 in. The product from the rolls falls onto a conveyor-elevator and is carried to a steel bin near the roof from which it is fed automatically to 14 in. by 30 in. diam. rigid rolls set to crush to 14 mesh. Into the launder carrying the feed to these rolls the solution is fed, just enough of it being used to keep the rolls clean. A launder carries the 14 mesh product to a 5 ft. tube mill 18 ft. long which crushes it to 150 mesh. The tube mill output is run into a tank and solution is added to make the pulp

4 solution to 1 of dry ore. A 1 1/2 inch Traylor sand-pump sends the ore to a V-box settler where the sand settles and flows by gravity back to the tube mill. The overflow of the V-box goes to a tank which feeds another 1 1/2 in. Traylor sand pump which receives the pulp as fast as it comes from the tube mill, filling a tank in twelve hours. As soon as the tank is filled, agitation commences and lasts twelve hours during which time the pump fills tank No. 2. While No.2 is agitating No.3 is being filled and No. 1 is being emptied into the Oliver filters. This can be accomplished mostly by gravity but to drain the bottom five feet of the agitators a pump is provided. During the emptying period air from coils of pipes in the bottom keeps the slime from settling. Settling of the sands in the Oliver tanks is prevented in the same way. The filters are both of the same size: 11 ft. diam. by 8 ft. long and run at 1/5 R.P.M. The caked residue carrying 35% moisture is run off into a launder and goes to the dump. The solution from the filter goes into a gold solution tank which feeds the zinc boxes. The solution is drawn from this tank by floating pipes, thus allowing any sand which has come through the filter to settle and ~~thus~~ be kept out of the zinc boxes. The cake is washed away thru a launder

with a stream of water. The Zn. boxes, 4 in number, are arranged in parallel and the overflow from them runs by gravity to the sump where the necessary fresh KCN may be added to prepare the solution for use again. The precipitate from the zinc-boxes is removed by hand two or three times a month and then transferred to a special settling tank, known as the clean-up tank. This tank will be made of wood and lined with lead. The precipitate having been transferred to the clean-up tank, is allowed to settle as much as possible and the clean liquid drawn off. A 10% solution of H_2SO_4 is added in order to dissolve the Zn., the mixture being stirred by hand. The precipitate is forced into a filter press to remove as much of the moisture as possible and is then roasted in sheet iron trays. A mixture of 30 parts silica, 30 parts niter for 100 parts of precipitate is added to the trays with the moist precipitate in order to avoid the loss by dusting. The fusion is made in graphite crucibles holding 20 lbs. of dried precipitate. The flux best adapted for the present case is:

	Parts by Weight.
Precipitate	100
Borax Glass	20-40
Manganese Dioxide	20-40
Fluor Spar	5
Silica	15-40

Reference: E.H.Johnson & W.A.Caldecott, Trans. Chem. Met. Soc. of S.A., Vol. 3 , p. 51. (1902). This fusion is carried on in a pot furnace. The slag is retreated. The Au and Ag bullion is parted with sulphuric acid which dissolves the Ag as Ag_2SO_4. The Au is melted and cast into a bar. Ag is precipitated from Ag_2SO_4 solution by means of copper, the resulting silver is dried, melted, and cast into bars. The copper sulphate solution is passed over scrap iron the resultant cement copper being sacked and sold. All these operations of parting are to be carried out in the laboratory.

Mine Ore Bin.

The mine ore bin is 11 ft. wide, by 20 ft. long, by 25 ft. high, containing 5500 cu. ft., which is sufficiently large to store 220 tons of ore, considering 25 cu. ft. as equal to one ton. It was thought that 48 hours supply was ample storage as transportation facilities are of the best. The bin is made of 4 inch pine with 12in. by 12in. supports on the corners and with intermediate posts, 8in. by 8in. timber. Sway braces are used under the bin. With the present arrangement several more bins of the same capacity can be placed on either side of the present bin and a belt conveyor used to transport the ore to the grizzly. The bottom of the bin is level and is made of 4" planks supported every 5 ft. by 12in. by 12in. timbers.

Grizzly:- The grizzly is 4 ft. by 8 ft. long and has a 30 degree slope. Openings between the bars are 1 1/2 in. The upper end is attached to the bottom of the bin with 3/4 in. steel bars looped into eyes bolted through the bottom of the bin. The lower end is supported by 6in. by 6in. timbers resting on the concrete footings. It is not thought that the ore will run over the grizzly by gravity but will require the attention of the crusher-man. However if it is found that too much attention is required, a shaking device will be attached to this grizzly.

To catch the undersize from the grizzly a sheet iron chute is placed, which is curved to run around the gyratory and delivers into the rolls hopper. The slope of the chute is 60 degrees. See detail "A".

Preleminary Breaker:- A No. 1 1/2 Austin Gyratory driven by a 15 H.P. motor breaks the ore to 1 inch, and sends it by gravity to the rolls. The driving pulley of the breaker is 24 in. diam. and runs at 450 R. P. M. The motor runs at 1100 R. P. M. and therefore requires a 10 in. diam. pulley. A sheet iron chute of rectangular cross section and having a slope of 45 degrees carries the product to the rolls by gravity. The breaker is supported on a concrete foundation as shown in the Austin catalogue. The driving motor is placed on a platform made of 6 in. by 6 in. timbers. The width of belt was determined by the formula:

$$W. = \frac{H.\ P. \times 33000}{\text{Peripheral speed} \times 40}.$$

40 pounds per inch of width being used as safe strain on single leather belting.

$$W. = \frac{15 \times 33000 \times 7}{1100 \times 2 \times 22 \times 40} = 3.5 \text{ inches.}$$

Rolls:- A pair of Allis-Chalmers 14in. by 30in. diam. spring rolls takes the undersize from the grizzly and the product from the gyratory, reducing it to 3/8 in. These rolls are supported on 12in by 12in. timbers which are carried into a concrete wall at each end. Size of rolls was figured by the formula below.

$$\text{Cos.}\frac{N}{2} = \frac{D - S}{D - d}.$$

Or:

$$D = \frac{0.9636d - S.}{0.0364}$$

N. = Angle of Nip, = 31 degrees.
Cos. 1/2 N. = 0.9636
d. = size of max feed in inches.
S. = size of crushed product in inches.

*****

$$\text{Capacity} = f(D \times R \times F \times S)$$

$$\text{Cap.}(ft^3/hr) = \frac{f(60 \times R \times D \times 3.1416 \times F \times S)}{1728}$$

$$\text{Cap.(Tons/day)} = f\,\frac{60 \times 24 \times R \times D \times 3.1416 \times F \times S.}{1728 \times 25}$$

D. = Diam in inches.
R. = Revs./minute.
F. = Width of face.
S. = Size of crushed product.

Solving for F. $$F. = f\,\frac{100 \times 1728 \times 25.}{R. \times D \times 3.1416 \times S.}$$

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% Yield = f(% Reduction)

% $\bar{Y}$ield = .6(125 - % Reduction)

f = 0.60

$$\%\ \text{Reduction} = \frac{d - S}{S}$$

*****

$$\text{Speed} = \frac{100 \log.\frac{16}{S}}{\log.\ 2}$$

$$P' = \frac{D''}{12} \times N$$

$$N = \frac{382 \log \frac{16}{S}}{D'' \log 2}$$

From the above formulas it was found that the rolls should be 14in. face by 30in. diam. and should be run at 100 R. P. M. Diameter of drive pulley is 3ft-4in. Diameter of motor pulley is 11 inches and motor runs at 400 R. P. M. From the same formulas used above the width of belt was calculated to be 4 inches. The rolls are placed below the floor so that gravity feed may be used, thus eliminating an elevator.

Elevator:- Running below the rolls is an endless conveyor-elevator upon which the ore drops as it leaves the rolls and is carried to a storage bin. This elevator has continuous 10in. by 8in. by 5in. buckets spaced 12" apart.

The capacity of the elevator is 100 tons/24 hours.

Or $\frac{100}{24}$ = 4.15 tons/hour.

It is desired to find the speed/minute, by Richar's formula:-

$$S = \frac{T \times d}{lw^2 \times 0.000475}$$

Where S.= Speed of the elevator in ft./Minute.
l = Lenght of bucket in inches.
w = Width.
d = Distance between buckets.
T = Capacity in tons/hour.
0.000475 = a constant.

$$S. = \frac{4.15 \times 12 \times 0.000475}{10 \times 64.} = 163.8 \text{ ft/minute.}$$

The speed of the head wheel which is 30" in diameter will be: $2 \times \frac{22}{7} \times \frac{15}{12} \times 164 = 21$ R. P. M.

Horse Power:- The power required to elevate the ore to the height of 43 ft. is, by calculation, 5 H. P. A back geared C. Q. general electric motor is to be used of the ratio 8:1 giving at motor shaft 125 R. P. M. Where a pinion 4 inches in diameter plays in a cog wheel of 24" diameter so as to obtain a speed ratio of 1/6 . The elevator is placed in a pit below the rolls and sufficient clearance is left between it and the concrete lining to allow workmen to do repairs. Emptying the buckets is accomplished by a tripper as furnished by the Link Belt people.

Crushed Ore Bin:- A secondary storage bin was thought necessary to keep the mill running in case of an accident to the coarse crushers. This is supplied by using a 60 ton steel bin with hopper bottom. In all bin computations it was considered that a ton of ore would occupy 25 cu.ft. Details of bin supports are shown in detail "B".

Roll Feeder:- The ore from bin No.2. passes into a sheet steel chute at the upper end of which is an automatic feeder shown in detail "B". This feeder is merely a cylinder 12in. wide on which are paddles 4 1/2 inches deep. To determine the speed of the feeder the capacity per revolution was calculated first

$\frac{1}{2}$ (6 x 3) x $\frac{12}{1728}$ x 4 = 0.25 cu.ft./revolution.

The mill is treating 100 tons/24 hours or 0.069 tons per minute. Estimating 25 cubic feet per ton of ore we have $\frac{0.069 \times 25}{0.25}$ = 7 R. P. M. of feeder.

A 2 Horse power D. C. General electric motor, running at 1000 R. P. M. is used. In order to decrease this speed to 7 R. P. M. two short shafts 8 ft. long, with bearings resting on vertical posts, and on a horizontal 12in. x 12in. guide post along the bottom of the bin, have to be used. These shafts carry a 24in. and a 4in. pulley attached as shown in detail "C". The speed was computed for the lower shaft at 166 R. P. M. and for the upper one connecting with the feeder driver at 27 R. P. M. The width of belting is 3in.

Secondary Rolls:- The second pair of rolls crush from 3/8 inch to 14 mesh. They are Allis-Chalmers' rigid rolls 14in. face and 30" diam and are run at 100 R. P. M. by a motor of 20 H. P. These rolls were figured like the other rolls but to make things uniform and in order not to have too many roll shells to be kept in stock it was thought advisable to use rolls of the same size as other although smaller rolls could do the work. Rolls and motor rest upon a platform as shown in detail "B". It was a question whether to use these rolls or a ball mill but the present course was decided upon because it was cheaper in first cost and in maintenance.

Tube Mill:- Following the best Mexican and U. S. practice, a tube mill 5ft. diam. by 18ft. long was used to slime everything instead of using grinding pans or other fine grinders. This mill is run by a 105 H.P. motor direct connected through gear and pinions to reduce the speed to 30 R. P. M. The mill and motor are supported by a concrete foundation.

Feed Tank:- The product from the tube mill flows by gravity to a steel tank 2ft. by 4ft. by 11ft. into which sufficient solution is run to make the pulp about 4 parts sol. to 1 part dry slime by volume.

Pump:- A 1 1/2 inch Traylor Centrifugal pump making 200 R. P. M. takes the pulp from the tank and carries it to a V-box settler. This pump is run by a direct connected motor of 2 H. P. having speed regulator. The lift is 13' and a 1 1/2 inch pipe is used. The H. P. was taken from Catalogue.

Settling Box:- To separate slime from the sand which is sent back to the tube mill for regrinding a V-box 4' wide by 6ft. long is provided. Two adjustable goose-neck pipe 5in. in diameter takes the settlings and returns it by gravity to the tube mill. The overflow runs into a wooden launder 6in. x 9ft:9in. which delivers the product into a pump supply tank 5ft. diam. by 3ft. high. Following this tank is another 1 1/2 inch Traylor Centrifugal pump lifting the pulp 30ft. to the top of the Brown Agitators. This pump is run by a direct connected motor of 5 H. P. at 1250 R. P. M. The settling box, tank, pump, and motor are carried on a platform 11 ft. above the floor supported by timbers 12" by 12in. and 6in. by 8in. with floor members of the same size.

Agitation Tanks:- There are three agitation tanks each provided with an air lift at the centre. Each tank is 12ft. diam.,(inside) by 45ft. high from the top of tank to tip of conical bottom. The air lift consists of an iron pipe 12in. diam. extending from 18in. above the bottom to 18in. below the top. Air enters at the bottom through a 2in. pipe carried through the side of the tank. The quantity of air can be regulated by a valve placed just outside of tank. The inside pipe is held in collars by steel bars riveted to the sides of tank. The tank itself is made of 1/2 inch steel, lap riveted, and is supported on a concrete foundation which forms the conical bottom. There is a 2in. discharge pipe provided. Each tank is large enough to hold 12 hours slimes (50 tons of ore), of a consistency of 3 parts solution to 1 part dry slime. The tanks are put through the following cycle of operations: filling continuously for 12 hours, agitation for 12 hours and emptying for 12 hours. The emptying is accomplished by gravity for the greater part but to drain the bottom 5 ft. a pump is provided. As the tank is to be emptied over a period of 12 hours it is necessary to prevent the settling of slimes and this is done with an agitation from coils of pipe in the conical bottom. These pipes are 1in. in diameter and have 1/8 in. holes spaced two inches apart. To drain the bottom of the tanks a 1 1/2 inch Traylor Centrifugal pump is used. It is driven by a direct connected motor of 2 H. P.

Oliver Filters:- Two Oliver filters, run in parallel, separate the solution from the slime. These filters are 11ft. diam. by 8' long. Above the filters is a platform supported by timbers 12in. x 12in. with 12in. x 12in. caps on which is placed a 10 H. P. motor, running at 500 R. P. M. The pulley is 8in. in diameter and drives a line shaft with a belt running to a pulley 5ft.:11in. in diameter. This gives to the line shaft a speed of 56 R. P. M. Motion is imparted to the filters by 6" pulleys running 4 inch quarter turn belts to the counter shafts upon which are keyed 14" driving wheels. This counter shaft has on its other end a worm gear which meshes with a pinion fastened to the shaft carrying the filter drum and turns it 1/5 R. P. M. The filter drum is divided into 24 compartments which are automatically connected to vacuum and to compression; 23 compartments being always under suction to filter the pulp and wash the cake. The other compartment connected to pressure is just in fromt of the scraper and helps to remove the washed cake from the drums. The filter tanks are built with hopper bottoms and are fitted with rows of perforated pipe into which compartment air is forced to prevent the settling of slime from the solution during the filtration. The water level is kept constant by an automatic floating valve.

Vacuum Tank or Gold Tank:- The tank to receive the gold solution, 6 ft. diameter and 6 ft. deep, is placed between the filter and the vacuum pump. The filter connection is run through the side of this tank to within a few inches of the bottom and is thus kept sealed and acts as a syphon. The solution is taken from near the top of the water level by a floating hose and is sent to the zinc boxes by means of an air jet acting as an injector. By this means the vacuum pump never has to pass any solution which may carry sand and quickly cut out the packing at the valves.

Zinc Boxes:- There are four zinc boxes made of plate steel. Each box is 2 ft. high by 3 ft. wide by 25 ft. long and they are run in parallel. Julian and Smart state that 1.9 cu. ft. of zinc box is required for every ton of solution treated per day. It was figured that using 3 parts sol. to 1 part dry slime, by volume, there would be 229 tons of solution per day. $\left(\frac{100 \times 25 \times 62.5 \times 3}{2000} = 229 \text{ tons solution.}\right)$ Therefore the amount of cubic feet required in each box is 229 x 1.9 = 435 cu. ft. Each box is divided longitudinally into two troughs 18in. wide and each trough is divided into seven compartments 3' long leaving a 7" partition between compartments for the solution to run down into the next compartment coming up under the screen which supports the zinc shavings. From the zinc boxes the solution runs by gravity to a sump. The precipitate from zinc boxes is removed by hand and after separating all unreplaced zinc, is carried to the acid tank where it is treated with a 10% solution of Sulphuric acid. Decantation carries away the solution and the remaining residue is placed in a pan with proper fluxes and roasted to remove all volatile matter. After roasting the product it is fused in graphite crucibles holding 20 lbs. each, with the following flux.

	By Weight.
Precipitate	100
Borax Glass	20- 35
Manganese Dioxide	20- 40
Fluor-Spar	5
Sand	15- 40

The slag formed is retreated. The Au.,Ag., bullion is treated with sulphuric acid which takes all the silver into solution as Ag_2SO_4 and leaves the insoluble gold as a residue which is melted and cast into bars. The silver in the silver sulphate solution is precipitated by copper, dried, melted, and cast into bars. The $CuSO_4$ solution passes over scrap iron, the resultant cement Cu. being sacked and sold.

Sump:- The sump is 22 ft. square by 10 ft. high and is merely a concrete lined pit, the concrete being treated with a water-proofing compound. The sump solution is analyzed and enough KCN added every hour to keep the strenght of solution up to 0.2%. The solution from the sump is sent back to the crushing department with a 1 1/2 inch Traylor Centrifugal pump.

SPECIFICATIONS.

Where the figures in the written specifications differ from those in the drawings, the figures in the specifications are to be taken.

Breaker:- One Austin Gyratory rock breaker, size No. 2. Driving pulley, diameter 24 inches, face 8 inches. The driving pulley should be on the side opposite discharge. Approximate weight 10,000 lbs.

Rolls:- One Allis-Chalmers "B" spring rolls, 14 inch face by 30 inch diameter. The size of driving pulleys of each roll will be one of 40 in. and one 10 1/2 in. diameter. Weight with sheet steel housing 28500 lbs.

One Allis-Chalmers rigid rolls, 14 in. face by 30 in. diameter. The size of driving pulleys of each roll will be one of 40 in., and one 10 1/2 in. diameter. Weight with steel housing 28500 lbs.

Tube Mill:- One Allis-Chalmers or similar tube mill, 19 ft. long by 5 ft. outside diameter. It must be gear driven direct connected to the motor. Diameter of gear 18". Speed of the tube mill shall be 30 R. P. M. when driven with the motor herein after specified. The lining for the mill shall be of cast iron ribbed plate bolted to the shell so that the ribs forms continuous longitudinal channels. The feeder shall be of the spiral type. The discharge shall be of the closed type.

2, Oliver Filters;- Each 8 ft. long and diameter of the drum, 11 ft. They must run at 1/5 R. P. M., driving shaft 1" in diameter to which a pulley 14" in diameter by 6" face shall be attached.

4, Zinc Boxes:- Each made of plate steel each containing fourteen compartments, each compartment to have a capacity of 6 cu. ft. The outside dimensions of each of the four boxes shall be 2 ft. high by 4 ft. wide by 26 ft. long. Each compartment shall be provided with a diaphragm bolted to the side which shall provide a space of 7 inches between every two compartments to carry the solution from the top of one compartment to the bottom of the other compartment. A 10 mesh screen shall be placed along the bottom of the box to hold the zinc shavings. Plugs beneath the screen shall be plaved to run the precipitate into launders at each side of the zinc box.

1, 20 Horse Power Ingersol-Rand Air Compressor: size of cylinders 8" long by 13" diameter and 8" long by 7 1/2 in. diameter.

3, 20 H. P. General Electric Co., D. C. motor, of the type C. Q.- 15 to be run at 220 volts 900 R. P. M.

3, Starting rheostat for same.

1, 15 H. P. General Electric Co. D. C. motor of the type C. Q.- 10 to be run at 220 volts 660 R. P. M.

1, Starting rheostat for same.

1, 5 H. P. General Electric Co., D. C. Back geared motor of the type C. Q. - 5. Ratio 8:1 Speed at 220 volts, 137 R. P. M.

1, Starting rheostat for same.

1, 105 H. P. Allis-Chalmers motor of the type similar to General Electric C. L. B. Speed at 220 volts, 700 R. P. M. This motor must be direct connected to the tube mill, as specified.

1, Starting rheostat for same.

1, 10 H. P. General Electric Co. D. C. motor of the type C. Q.- 5 to be run at 220 volts, 1060 R. P. M.

1, Starting rheostat for same.

1, 2 H. P. General Electric Co. D. C. motor of the type C. Q. - 2 to be run at 220 volts and 1060 R. P. M.

1, Starting rheostat for same.

3, 2 H. P. Traylor Machinery Co., D. C. motor, to run at 220 volts and 1000 R. P. M. Each one of these motors have to be direct connected to a Traylor Centrifugal pump.

3, Starting rheostat for same.

1, 5 H. P. Traylor Machinery Co., D. C. motor to run at 220 volts and 1250 R. P. M. This motor is to be direct connected to a Traylor centrifugal pump.

1, Starting rheostat for same.

3, 1 1/2 inch Traylor horizontal centrifugal sand pump, No. 1 1/2 - to be driven electrically by direct connection, at 1000 R. P. M.

1, 1 1/2 inch Traylor horizontal centrifugal sand pump No. 1 1/2 - to be driven electrically by direct connection at 1250 R. P. M.

1, Vacuum pump. One Ingersoll Rand Compound Compressor 10 in. by 14 in. by 16 in. direct connected to a General Electric Co. 12 H.P. D.C motor of the type "C.Q." to be run at 220 volts and 200 R.P.M.

1, Link Belt patent gravity discharge combination elevator and conveyor. No. 1821 with open-top pitch line buckets. See "Elevator drawing", Dimension of buckets 10" long by 8" high and 5" wide. The steel bucket will be attached by swivels to two strands of No. 1250 non-detachable tubular chain. In the conveyor portion 2 pairs of traction wheels 30 inches diameter will be used. At the extreme end a pair of chain wheels No. 550 36" in diam. will be placed. One pair Sprocket Idlers is placed in the middle of the 7'- 6" between the chain wheels and the higher of the two traction wheels of conveyor. See plan. The total lenght of the elevator and conveyor around the chain will be 110 ft. A pair of chain wheels No. 550, 30" in diameter shall be placed at top of elevator. This chain wheels shall be in a shaft 3 3/16 in. diam. to which a cog wheel 24" diameter shall be attached to play in a 4" pinion direct connected with a back geared motor. This wheels shall revolve at 20 R. P. M. giving to the elevator a velocity of 163 ft. per minute. One pair of Sproket Idlers shall be placed at 8' : 6" , 21' and 31' from the floor line respectively, and the first resting on the rigid rolls platform, the second on the lower support of the steel bin and the third in the guide, running across the bin.

1 Grizzly, 8' long by 4' wide, with 3 rests and bars 2" high, 3/4 in. width on top and 3/8 in. width on bottom. Bars shall be spaced 1 1/2 in. apart.

1 Rack and pinion ore bin grate, 48" wide by 48" high. It shall be made of steel plate, shall have steel shaft and cast iron guides, cast iron hand wheel, cast iron ratchet wheel and pawl, cast iron rack and pinion.

1 "S-A" Stephens-Adamson Co., automatic rotary feeder, 12" diameter from outside to outside of vane wheels. Vanes must be made of heavy steel plate and must be easily renewed when worn.

1 Curved, tapered, steel ore-chute 8' wide at top, 1' wide at bottom.

1 Straight steel ore-chute 11' long by 12" wide by 7" deep.

1 Curved, tapered, steel chute with hood over end to receive the ore from the conveyor 3' long

by 12" wide by 6" deep.

1 Straight, steel ore-chute 9 ft. long by 20 in wide by 8 in. deep.

1 Steel apron-distributor, V shaped, 6' l at base by 3 ft. high as shown in plan.

Ore Bin:- The crushed ore bin shall be 12' square by 9' high along the vertical edge with a hopper bottom sloping from each side at an angle of 45 degrees. The opening at the bottom shall be 12 inches square. This bin shall be made of 1/4 inch steel plate, all joints rivited with 5/8 inch rivets spaced 4 inches apart around the top of tank and along each side. Where the hopper bottom commences there shall be an angle iron, 4" by 2" by 3/8", rivited to the tank for the purpose of support.

Feed Tanks:- There are two pump-feed tanks for the purpose of keeping the liquid level always above the pump intake; one follows the tube mill and the other follows the V-box settler. The tank following the tube mill shall be made of 1/4" steel rivited so as to be water tight. It shall be 2' wide by 4' deep by 11' long and shall have an oval flange for a 1 1/2 inch. pipe rivited to the centre of the wide side. The tank following the settling box shall be 5 ft. inside diam. by 3ft. high and shall be made of 1/4" steel rivited so as to be water tight. On one side 12" from the bottom there shall be placed a connection for a 1 1/2" pipe.

Vacuum Tank:- One tank 6ft. diameter by 6 ft. high fitted with a conical top 1 ft. high and made of 1/4" steel will be required. This tank must be air tight and shall have provided three connections for 1 1/2" pipe: one shall be at the apex of conical top for the vacuum pipe; one shall be 3" from the top and the other shall be 2" from the bottom.

Acid Tank:- The acid tank shall be 4' diameter by 2' high, made of steel and lead lined with 5 lb. lead sheet.

Pachucah Tanks:- Three agitator tanks of the following description are needed. Each tank shall be 12 ft. diameter by 39 ft. high, on the bottom of which shall be rivited a conical bottom having a slope of 45 degrees terminating in a 1 1/2" pipe connection. These tanks shall be made of 1/2" steel, rivited at all joints so as to be absolutely water tight. At the line of union between the cylindrical and conical parts there shall be rivited a 5" x 5" x 1" angle iron running all around the tank which angle iron shall be in turn rivited to a 1in. by 2in. steel ring. The tank shall be supported by a concrete foundation running down to hard-pan rock or to firm ground. In case rock is not reached the bearing power of the soil shall be determined and the foundation given sufficient area to insure stability. Inside the tank a 12in. air lift shall be installed. This shall be supported by four 1in. by 3in. steel bars running from a collar rivited to the pipe to a steel ring rivited to the conical bottom of the tank.

There shall be two openings in the bottom of the tank: one for a 2in. air pipe, and the other for a 1 1/2in. air pipe. Agitation is to be maintained by air from this 2in. air pipe which passes the 12in. air lift pipe and terminates in a fine nozzle. To prevent settling of the slime during emptying there shall be four concentric 1in. pipes held 1in. above the bottom by means of stirrups rivited to the bottom. These auxiliary agitation pipes shall have 1/8in. holes spaced 3in. apart on their lower sides. Each tank shall have a ladder on both the inside and the outside, extending from the bottom to the top. On the top of each tank there shall be a 12in. flange.

BUILDING TIMBER.

All lumber shall be free from knotts, well seasoned and otherwise in good condition.

Posts Timber.

	Ft. B. M.	
4 pcs. 12 in. x 12 in. x 24 ft.	1152.	
4 pcs. 12 in. x 12 in. x 22 ft.	1056.	
42 pcs. 12 in. x 12 in. x 20 ft.	10080.	
1 pcs. 12 in. x 12 in. x 16 ft.	192.	
32 pcs. 12 in. x 12 in. x 14 ft.	5376.	
12 pcs. 12 in. x 12 in. x 12 ft.	1728.	
6 pcs. 8 in. x 8 in. x 20 ft.	637.	
8 pcs. 8 in. x 8 in. x 24 ft.	1024.	21245

Sides, Bins & Platforms.

32 pcs. 2 in. x 6 in. x 12 ft.	384.	
10 pcs. 4 in. x 6 in. x 10 ft.	100.	
25 pcs. 4 in. x 6 in. x 12 ft.	360.	
10 pcs. 4 in. x 6 in. x 10 ft.	200.	
24 pcs. 2 in. x 12 in. x 14 ft.	612.	
48 pcs. 2 in. x 12 in. x 12 ft.	1152.	
26 pcs. 2 in. x 12 in. x 10 ft.	520.	
100 pcs. 3 in. x 12 in. x 10 ft.	3000.	
6 pcs. 6 in. x 6 in. x 10 ft.	180.	6568
		27813

BUILDING TIMBER, continued.

Roof Trusses.

	Ft. B. M.	
40 pcs. 4 in. x 8 in. x 12 ft.	1280.	27813.
24 pcs. 4 in. x 8 in. x 20 ft.	768.	
8 pcs. 4 in. x 8 in. x 18 ft.	384.	
16 pcs. 4 in. x 6 in. x 16 ft.	512.	
9 pcs. 4 in. x 8 in. x 10 ft.	240.	
10 pcs. 4 in. x 6 in. x 18 ft.	360.	
36 pcs. 4 in. x 6 in. x 14 ft.	1008.	
132 pcs. 3 in. x 3 in. x 12 ft.	1188.	5740.
Total Ft.B.M.		33553

Corrugated Sheet Iron (Galvanized)

20 gage 9725 sq. ft. , , ... = 22,400 lb.

Iron Bars threaded on each end with washers and nuts.

5, 1 in. by 10 ft. 6 in.long round.

10, 1 in. by 7 ft. 6 in.long "

10, 1 in. by 4 ft. 6 in.long "

12, 1 in. by 7 ft. 0 in.long "

24, 1 in. by 4 ft. 0 in.long "

Total weight Wrought Iron = 814 lb.

43 Windows, 3 ft. by 6 ft. with 12 lights each 10 in. by 16 in.

516 panes window glass 10 in. by 16 in.

4 Doors, 36 in. by 78 in.

Pipe & Pipe Fittings.

785 ft. 1 1/2 in. black, wrot-iron pipe.

206 ft. 1 in. " " " " .

39 Elbows.

34 Tees.

10 Unions.

4 Crosses.

30 1 1/2 in. Iron plug-cocks.

Concrete.

1203 Bags cement.

401 Yds. broken stone. (Crusher run).

100 Yds. Sand.

Wire.

1500 ft. # 10 rubber covered copper wire.

1000 ft. # 10 " " " " .

50 ft. # 12 flexible lamp cord.

50 ft. 16 C. P. 220 V. Incandescent lamps.

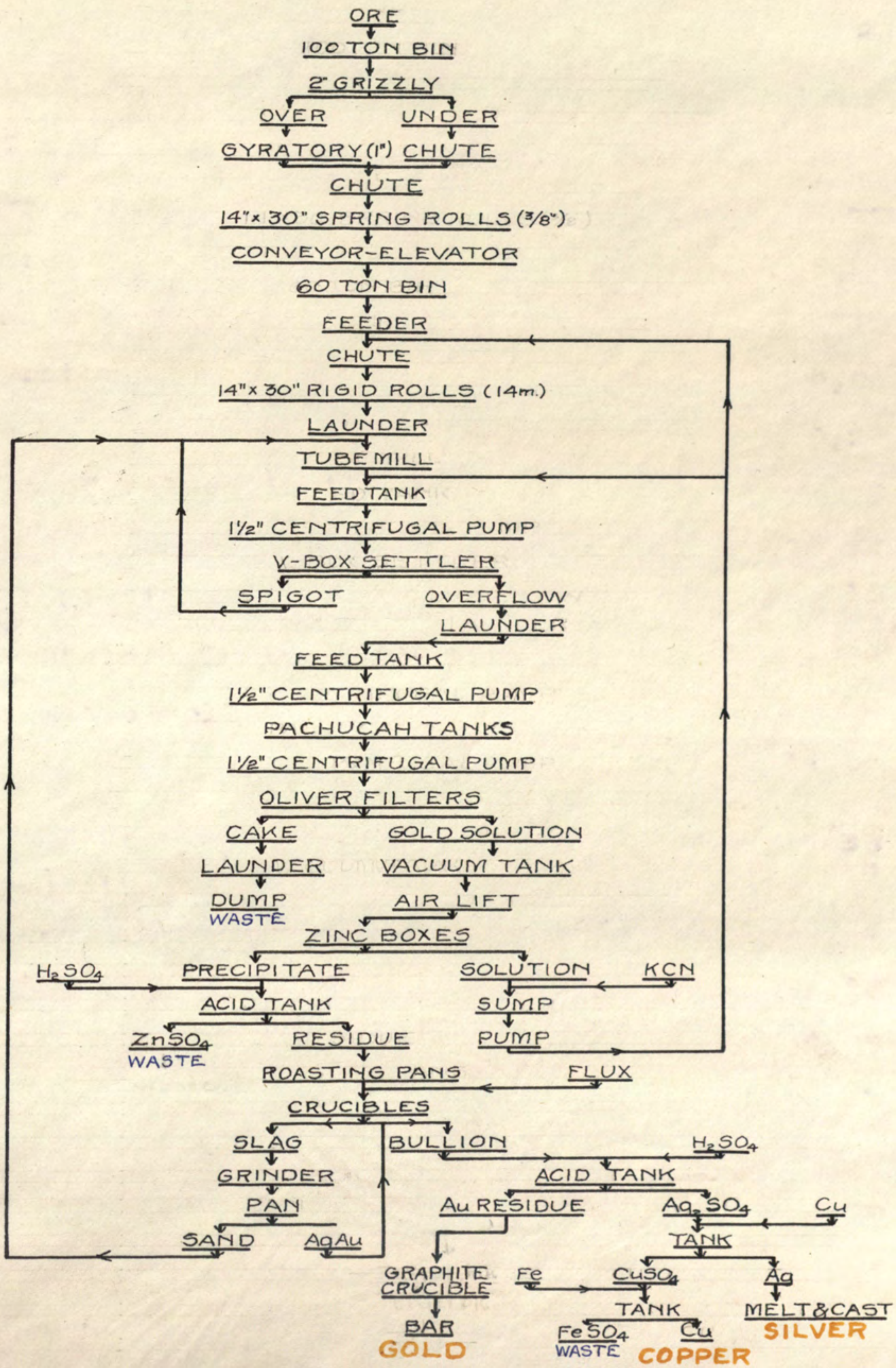
50 Lamp sockets. (rapper) .

100 Cleats (porcelain).

200 Percelain knobs 2 in. diameter.

50 Rosettes with fuse plugs.

FLOW SHEET.


ORE
100 TON BIN
2" GRIZZLY
OVER
UNDER
GYRATORY (1")
CHUTE
CHUTE
14"x 30" SPRING ROLLS (3/8")
CONVEYOR-ELEVATOR
60 TON BIN
FEEDER
CHUTE
14"x 30" RIGID ROLLS (14m.)
LAUNDER
TUBE MILL
FEED TANK
1½" CENTRIFUGAL PUMP
V-BOX SETTLER
SPIGOT
OVERFLOW
LAUNDER
FEED TANK
1½" CENTRIFUGAL PUMP
PACHUCAH TANKS
1½" CENTRIFUGAL PUMP
OLIVER FILTERS
CAKE
GOLD SOLUTION
LAUNDER
VACUUM TANK
DUMP
WASTE
AIR LIFT
ZINC BOXES
H_2SO_4
PRECIPITATE
SOLUTION
KCN
ACID TANK
SUMP
$ZnSO_4$
WASTE
RESIDUE
PUMP
ROASTING PANS
FLUX
CRUCIBLES
SLAG
BULLION
H_2SO_4
GRINDER
ACID TANK
PAN
Au RESIDUE
Ag_2SO_4
Cu
SAND
AgAu
TANK
GRAPHITE CRUCIBLE
Fe
$CuSO_4$
Ag
TANK
MELT & CAST
BAR
$FeSO_4$
Cu
SILVER
GOLD
WASTE
COPPER

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