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Laboratory tests and design of plant for treatment of gold ore

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Julian Insco Prugh

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THESIS

FOR THE

Degree of Bachelor of Science

IN

MINE ENGINEERING.

♪ ♪

SUBJECT:

“Laboratory Tests and Design of Plant for Treatment of Gold Ore.”

♪ ♪

WILLIAM CHARLES WYMAN.

JULIAN INSCO PRUGH.

JUNE 9, 1905.

The Object of this work was to determine methods and design plants best adapted for the extraction of gold from a given ore in the most profitable manner. In the following sheets are given in detail the work carried out and our conclusions as to the best method of treating this particular ore.

Julian Insko Prugh

W.C.Wymann, Jr.

Character of Ore.

The Ore was a highly silicious ore supposed to contain free gold making a free milling proposition.

We completed the following tests and obtained the following results:

Cyanide Process - - - - -	78%
Cyanide and Amalgamation and Concentration. - - - - -	94 %
Barrel Chlorination - - - - -	39 %
Plattner Process - - - - -	41 %

The Cyanide Process in conjunction with Amalgamation and concentration as seen by the above table gave us the highest percent extraction hence we at once determined to use the last named process. The following is estimates on extraction by same:

Original ore ag 1.6087 Au 1.2162 - - - - -	\$24.32
300 gr of ore gave 4.5 grs. concentrates which ran \$42.92 per ton. One ton of ore will give thirty pounds of concentrates at \$42.92 per ton - - -	\$.65
Tailings from Amalgamation and concentration ran Au .3424 \$6.84 which gives an extraction by amalgamation - - - - -	\$16.83
This in turn leaving tailings worth as above stated \$6.84. These after the Cyanide process ran Au .06848 ^{oz} ^ \$1.20 giving an extraction of - - - - -	\$ 5.64.
Total value extracted - - - - -	\$23.12
Original ore - -	24.32
	<hr/>
	\$ 1.20

S P E C I F I C A T I O N S .

150 Ton Stamp Mill.

EXCAVATION:

The excavation shall be as per accompanying plans.

MASONRY WORK.

The masonry shall be done as per accompanying plans. The cement shall be a fine grade of Portland. The work shall be of crushed rock. The concrete shall be of the following proportions:

One part Portland Cement

Three Parts Sand

Six " Crushed Rock to pass a two inch ring,
free from fines.

The rock shall be obtained from the excavation. The crusher from the Stamp Mill will be temporarily installed for the work.

FRAME WORK.

COLUMNS.

The columns shall be of long leaf yellow pine or its equivalent in the opinion of the engineer in charge. They shall be 12" X 12" 8 feet apart from center to center in east and west direction and a distance as shown per accompanying plans in a north and south direction.

GIRDERS.

The girders shall be of same material as the columns.

3.

They shall consist of three 2" X 12" pieces bolted together to form a single girder and shall be placed as per accompanying plans.

BRACES.

The Braces shall be of same material and size as the members to which they are attached.

RAFTERS.

The rafters shall be of same material as columns. They shall be 2" X 4" set 18" apart as per accompanying plans.

SUPPORTS.

The supports for the roof of crusher bin shall be of same material as columns of mill. They shall be placed as shown per accompanying plan. They shall be 12" X 12".

GIRDERS.

The girders for support of roof of crusher bin shall be of same size as those of mill and of the same material. They shall rest upon the supports as per accompanying plans and shall meet to form an angle of ninety degrees as per accompanying plans.

SUPPORTS.

The supports for the tanks and crusher bin shall be of same material as columns of mill and shall be 12" X 12" and placed as per accompanying plans.

ROOFING.

The roofing shall consist of corrugated iron.

SIDING.

The siding shall be of same material as roofing and shall be supplied with braces consisting of 2" X 4" of good sound wood set four feet apart in a vertical direction.

TANKS.

The tanks shall be two in number, built of 2" tank lumber and banded with Lug Hoops. They shall be 14 feet inside diameter and 14 feet in height over all,

CRUSHER BIN.

The crusher bin shall be built as per accompanying plans. Its frame work shall be 12 X 12. The siding 2" X 12" and it shall be lined with sheet iron. It shall be hopper shaped, its sides making an angle of 38 degrees. The inside diameter shall be - Height 26'- Width (east and west) 23 feet. Depth (North and South) 20 feet. It shall be provided with an Ore Bin Gate 36" X 36".

GRIZZLEY.

The grizzley shall be of iron bars, sixteen in number 3/4" X 3" X 12' set 2" apart. Supported as per accompanying plan. It shall be set at an angle of forty five degrees.

CRUSHER.

The Crusher or Rock Breaker shall be a No. Five Gates as per catalogue.

BELT CONVEYOR.

The Belt Conveyor shall be of four ply rubber 2 1/2' X 85'. It shall be supplied with Carns 3' apart and returns 5' apart.

FEED BINS.

The Feed Bins shall be in all respects similar to Crusher Bin with the exception that frame work shall be of 6" X 6" and siding 12" X 1". Their inside dimensions shall be 14' vertical- 11' wide and 14' deep. Directions taken same as Crusher Bin. They shall be five in number each provided with a 24" - 28" Ore Bin Gate.

AUTOMATIC FEEDERS.

The automatic feeders shall be feeders known as Challenge, Alles-Chalmers Co. Mfgr. They shall be ten in number, each to feed five stamps.

STAMPS.

The Stamps shall be the Alles Chalmer "1000 lb." Stamp. Fifty in number of five to battery. Run at rate of 100 drops per minute (see pullys and belting). Provided with sixty mesh screens.

AMALGAM PLATES.

The Amalgam plates shall be silvered copper. Ten in number 5' X 15' provided with mercury well at each end and planed as shown per accompanying plans.

LAUNDERS.

The Launderers shall be ten in number built of 6" X $\frac{1}{2}$ " material and constructed as per accompanying plans.

FRUE VANNERS.

The Frue Vanners shall be twenty in number and placed as per accompanying plans. They shall be provided with a four ply rubber belt and shall have the following dimensions: 12' X 4' X 4' in height (Fr number of vibrations pulleys and belting). There shall be provided beneath the vanner nearest the south end of mill a wooden tank - 40' X 5' X 2 $\frac{1}{2}$ ' to receive tailings. See accompanying plans.

CLEAN UP PANS.

There shall be two 5' clean up pans. See accompanying plans.

ASSAY FURNACES.

There shall be two Assay Furnaces having 18" muffles.

See accompanying plans.

POT FURNACES.

There shall be two pot furnaces having an area of 2' X 1½'.

PIPING.

There shall be a 2" pipe connected to the two tanks and running along east side of Mill. See accompanying plans. It shall be provided with valves-at tank- stamp and vanners. There shall be an inch pipe connected to this and running along back of stamp., provided with ten elbows and valves for same to feed stamp. See accompanying plans. There shall also be inch pipes running to Frue Vanners, each provided with valves. See accompanying plans. There shall be a 3" pipe leading from tailing tank to Cyanide Mill through which tailings are pumped.

POWER FOR CRUSHER.

Power for Crusher shall be furnished by Westinghaus thirty-six Horse Power Motor.

POWER FOR BELT CONVEYOR.

Power for Belt Conveyor shall be furnished by a Westinghaus Five Horse Power Motor.

POWER FOR STAMP.

Power for Stamp shall be a Westinghaus One hundred and eighteen Horse Power Motor.

POWER FOR FRUE VANNERS.

Power for Frue Vanners shall be furnished by two Westinghaus Six Horse Power Motors.

POWER FOR PANS.

The Power for Pans shall be two Westinghaus Six Horse Power motors.

SHAFTING.

Shafting for Stamp $2\frac{1}{2}$ " steel

" " Vanners $1\frac{1}{2}$ " "

PULLEYS AND BELTING.

The pulleys in the Stamp shall be 71" diameter. On the motor 12" connected by endless leather belt. This will give the stamp 100 drop per minute. The pulley faces shall be 2'.

The pulleys on the Vanner shall be 12" in diameter and on the motors running them 9" in diameter 4" face. This will give the Vanner 200 vibrations per minute. They shall be connected by endless leather belt.

The pans shall be provided with a 16" pulley the motor running them -8- This will give them 150 revolutions per minute. Connected by 8" leather endless belt.

TRANSFORMER.

Transformer shall be placed as per accompanying plans. The power shall be supplied by the Power Company. Transformed from 20000 volts to 220. Transformer(Westinghaus) should be so designed as not to exceed fifty degrees F. where motors are running at maximum capacity for two hours.

Building sight on a slope of 15 degrees.

COSTS.

50 stamp mill.

EXCAVATION.

2063 cu yds @ \$1.50 per cu yd \$ 3094.50

CONCRETE.

276 bbls Portland Cement @ \$1.75 bbl 483.00

Timbers

12" X 12"
56.086 Thousand feet @ \$22. per m 1232.40

6" X 6"
3.42 " " " " " " 75.24

2" X 4"
4.786 " " " " " " 105.30

2" X 12"
11.668 " " " " " " 256.70

TANKS.

14 X 14 Circular

2 @ \$76.80 each 153.60

I RECTANGULAR 25.00

4' X 5' X 2½'

CORRUGATED IRON

16411 sq. ft. @ \$2.35 per 100 sq. ft. 385.65

SHEET IRON LINING FOR BINS

2572.5 sq. ft. @ \$2. per 100 sq. ft. 51.45

TIMBERS FOR STAMPS

20 - 36" X 40" X 10' @ \$48 each 960.00

ORE BIN GATES

1 - 36" X 36" 29.75

5 - 24" X 28" @ \$15.30 76.50

Forward Balance \$ 6934.09

Amount brought forward \$6934.09

GRIZZLEY

1 - 12' X 5' (See specifications) @ 8¢ et 100.00

GATES CRUSHER

5 as per catalogue 2500.00

AUTOMATIC FEEDERS.

5 Challenge @ \$50 each 250.00

STAMPS.

Alles-Chalmers 50 167.500 lbs. Complete 9750.00

MERCURY TABLES

10 - 15' X 5' Silvered Cu. @ 350 each 3500.00

FRUE VANNERS

20 - 12' X 4' each @ \$400 8000.00

AMALGAM PANS

2 @ 5' each \$450 900.00

ASSAY FURNACES

2 @ \$75 150.00

POT FURNACES.

2 @ \$150 each 300.00

PIPING AND VALVES.

150' 3" pipe 34.50

4 valves for same @ \$6 each 24.00

170' 2" pipe 18.70

4 valves for same 10.00

150' 1" pipe 7.50

36 valves for same 27.00

Forward Balance

27.00
\$32505.79

10.

Amount brought forward \$32505.79

BELT CONVEYORS.

2½ X 85' 720.00

CARNS FOR SAME

450.00

Returns for same

230.00

BELTING. Oak tanned leather

72' - 2' @ 2.50 per foot 180.00

300' -4" @ 35¢ " " 105.00

SHAFTING.

180' - 1"/16" shafting 35 per foot 63.00

PULLEYS.

20- 9" diameter 4" face \$2.60 each 52.00

1 - 12" " 2' " \$27. 27.00

MOTORS

Crusher

1 - 36 H.P. Westinghuas Motor 720.00

STAMPS

1 118 H.P. " " 3360.00

VANNERS

2- 6 H.P. " " each \$120 240.00

BELT CONVEYORS

1 - 5 H.P. " " 100.00

AMALGAM PANS

2 - 5 H.P. " " \$120 240.00

TRANSFORMER

Westinghuas Cap 138 K.W. 1104.00

Total cost of mill

Cost of erection. Lumber frame work 758.00

Grand Total \$40,854.79.

S P E C I F I C A T I O N S .

150 Ton Cyanide Plant.

EXCAVATION,

The excavation shall be as per accompanying sketch.

MASONRY WORK.

The masonry work shall be done as per accompanying plans. The cement shall be a fine grade of Portland . The foundation shall be of crushed rock. The concrete shall be of the following proportions.

1 part of Portland Cement

3 parts Sand

6 " Crushed rock, to pass 2" ring, free from fines.

The rock will be obtained from the same source as in the stamp mill.

FRAME WORK OF MILL BUILDING.

The posts, supports and beams are of long leaf Y.P. (12" X 12" set 8' apart.

The roof girders shall be made of 3 - 2" X 12" bolted together and shall be placed 8' apart.

The roof shall be supported by steel tie rods every 8'

The rafters shall be 2" X 4" set 18" apart. The roofing shall be of corrugated iron sheeting.

The siding shall be the same as roofing. Bracing consisting of 2" X 4" shall be placed every 4" on sides.

All lumber shall be of long leaf yellow pine.

The flooring of the vat room shall be of 2" X 12" planks.

All piping shall be of wrought iron in the following sizes:

Water pipes	3"
Pulp	4"
Sol.	2 $\frac{1}{2}$ "
Au Sol.	1 $\frac{1}{2}$ "
Sump return pipe	3"
Alkaline Sump Pipe	3"
Vacuum Pump	1 $\frac{1}{2}$ "

Valves shall be iron body valves, of globe pattern, Joints shall also be of cast iron.

The rubber connections shall be of five ply 2 $\frac{1}{2}$ " rubber hose.

The machinery shall consist of 1 - 50 H.P. 220V Westinghaus Induction Motor whose power shall come from transformer station at Au mill to which power is delivered as prescribed on long distance transmitters.

Shafting and pulleys shall be chilled steel and sized as per list.

Belting shall be of oak tanned leather sized according to accompanying list.

The tanks and vats shall be as follows and shall be placed as per plans:

2 wooden sump tanks	15' diam X 8' high
2 solution tanks(wood)	20' " X 10' "
5 steel leaching vats	35' X 8' "
1 stock tank (wood)	12' X 5' "
1 Alkalie tank	15' X 8' "

There shall be three sets of Zn boxes (12" - 18" X 24") each containing 6 compartments with screens. The pulp which comes through other plant shall be distributed throughout vats, by means

of an automatic distributor. There shall also be another automatic distributor to discharge the solution into vats.

The distributors shall run on a suspended train above vats and be raised and lowered by means of a Harrington Chain Hoist.

The following rubber connections shall be made.

From vat outlets to vacuum tanks and from tanks to gold solution tanks. From gold solution tanks to zinc boxes. From zinc boxes to sump. From sump to centrifugal pump which returns solution to solution tanks and from main pipe leading from centrifugal pump which pumps alkaline solution from vat to the leaching. A rubber connection shall be made from Vat outlet to Alkaline tank for the return of solution to said tank.

There shall be two centrifugal pumps for above named purpose each with a capacity of 265 gallons.

There shall be also two vacuum pumps (Gould & Co.) for above named purpose.

Valves shall be placed on entrance or outlet to every vat or tank on any permanent piping.

This mill is designed to concentrate the pulp tailings from a 150 ton stamp mill situated 75' above on same hill of slope of 15 degrees.

14.

150 ton Cyanide Plant.

COSTS.

EXCAVATION

For piers and foundation 1482 cu yds

@ \$1.50 per cu yd.

\$2223.00

MASONRY

Cost only for cement and construction

Rock comes from excavation and as in

stamp mill crushed on spot

Total masonry 47823.45 cu ft.

Cement as in specifications 1-3-6 is

1/10' 4782.345 cu ft cement @ 60¢/sq.ft

1396.50

LUMBER

12" X 12"	7167 ft	86004 linear ft	@ \$22 a 1000	1892.09
6" X 12"	54 "	162 "	" " " "	3.57
2" X 12"	7757 "	15514 "	" " " "	341.31
2" X 4 "	12451 "	8301 "	" " " "	182.63

ROOFING AND SIDING

As in specifications plant is roofed and sided with corrugated iron. Actual space to cover is 25891.2 sq. ft. or 25900 sq. ft @ \$2.35 / hundred

608.65

RODING FOR ROOF SUPPORT.

780' of 1 1/2" steel rods @ 30¢

234.00

PIPING

3" piping valves and joints			
1689' pipe @ 23¢/ft			129.49
12 elbows" 38¢			4.56
2 #5 " " 41¢			.82
9 tees " 50¢			4.50
1 cross " 90¢			.90
16 valves" 3.75			60.00

4" piping, valves and joints

206' pipe @ 32½¢	66.90
4 tees @ 60¢	2.40
5 valves @ 5.70	28.50

2½" piping, valves and joints

207' pipe @ 17½¢	36.23
5 tees " 33¢	1.65
6 valves @ 2.70	16.20

1½" piping, valves and joints

209' piping @ 8½¢	18.62
11 elbows " 10	1.10
7 valves " 1.50	10.50

RUBBER TUBE CONNECTIONS

312 feet 2½" 5 ply rubber hose @ \$1.04	324.48
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IRON PULLEYS.

2 - 4' diam 4" face @ \$12.70	25.40
2 2' " 3" " 5.30	10.60
1 2' " 6" " 7.75	7.75

SHAFTING.

28' of 1 15/16" diam steel shafting @ 49¢ /ft	13.75
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BELTING

40' of 4" Oak tanned leather @ 35¢/ft	14.00
20' of 6" " " " " 53¢/"	10.60
36' " 3" " " " " 26¢/"	9.36

MACHINERY.

1 50H.P. 220V Westinghaus Ind. motor	1000.00
2 265 gal centrifugal pumps @ \$57.00	114.00
2 Gould & Co. Vacuum pumps @ \$80.00	160.00
2 Harrington chain hoists to lift 599# a dist of 8' @ \$22.50	45.00
2 Trucks for automatic distributors running on rail tram @ \$10.	20.00

Steel Tracks

372' of 1" steel track @ 30¢/ ft	101.60
3 sets of wooden zinc boxes containing compartments and screens @ \$52.00	156.00
2 Automatic distributors @ \$96.00	192.00
2 Wooden Sump tanks @ \$112.00 15' diam.X 8' high	224.00
1 Alkali Tank (wood) 15' X 8'	112.00
2 Solution Tanks 20' dia X 10' @ \$260	520.00
1 Stock Tank 12' diam X 5'	88.00
5 Leaching Vats(steel) with launders at top for self settling @ \$960.00	1920.00
For building we estimate	<u>1500.00</u>
Estimate of costs	\$13832.66
Stamp Mill.	<u>40,854.79</u>
Cost of Plant	\$54,687.45