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HISTORICAL
COLLECTION

THESIS.

for the Degree of

Master of Science.

1910.

# O R E D R E S S I N G L A B O R A T O R Y

FOR THE MISSOURI SCHOOL OF MINES AND METALLURGY,

ROLLA, MISSOURI.

T218

DESIGN, DESCRIPTION, DRAWINGS FOR ERECTION,

BILLS OF MATERIAL, AND SPECIFICATIONS.

BY

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Missouri School of Mines and Metallurgy.

10921

TABLE OF CONTENTS.

Page



PART III, PURCHASING LISTS WITH SPECIFICATIONS.

Page

## PART IV, SPECIFICATIONS FOR ERECTION AND CONSTRUCTION.

## LIST OF DRAWINGS.

## PART I, INTRODUCTION.

The work of preparing suitable drawings and specifications for the construction of the new Ore Dressing Laboratory of the Missouri School of Mines and Metallurgy was begun about August 15, 1909. At that time general plans, as shown in drawings No. 1 and No. 2, were drawn up and submitted for approval. With certain minor alterations, to be mentioned under the section on specifications, these plans will be followed in the installation of machinery. Other detail drawings were made by the class in Ore Dressing Problems under the direction of the writer during the school term ending March 12, 1910.

It is not intended that this work shall contain such complete plans, specifications, and detail working drawings as would be necessary if the installation were to be made by outside contractors. The work of installation and construction will be conducted during the summer of 1910 by mechanics in the employ of the school and under the supervision of the writer, or under the direction of some one else equally familiar with the conditions at hand. On this account the specifications and working drawings are not complete in all details, as a few verbal instructions at the time of installation, from one familiar with the work, are frequently more useful to the mechanic than a sheet of detail drawings and pages of specifications.

Drawings 1, 2, and 3a, show the general arrangement of the laboratory together with all details of shafting and other iron work necessary for its construction. All of the other drawings were made by members of the class in Ore Dressing Problems, and show various pieces of apparatus, machinery, and sections of the mill in detail. Where the dimensions shown on any of these drawings differ from those mentioned in the specifications or in the directions for installation, the dimensions given in the specifications are to be considered as correct.

For convenience the following portion of this work is divided into three parts, numbered II, III, and IV respectively. Part II contains a general description of the laboratory, its arrangement, equipment, and operation. Part III contains bills of material and lists for buying, with the necessary specifications of all machines and supplies to be purchased for the laboratory. Part IV contains specifications for erection and construction of all parts of the laboratory, together with directions for the installation of the various machines.

PART II, DESCRIPTION.

The problems encountered in the design, equipment, arrangement, and operation of a testing laboratory for student use are in many ways different from those encountered in perfecting a commercial mill. The usual purpose of the commercial mill is to treat, at a profit, a certain class of ores, the characteristics of which are to a greater or less extent known. The operation of a testing laboratory in such a manner as to secure a profit from the ore actually treated is rarely possible. This is true because the very nature of the work necessitates much greater care in handling and treating the material, and a correspondingly greater expense than is the case in the commercial mill. The objects in erecting the new laboratory are to provide a convenient teaching place combined with a useful and practical testing plant. The instruction given the student during his few short weeks of work in the laboratory is not necessarily intended to make of him an expert in the manual operation of the machines that he uses. The object is rather to illustrate and to teach the principles of ore dressing, useful not only in the operation of the comparatively small number of machines that are available in the laboratory, useful not only for treating the particular ores with which the student happens to deal while in school, but useful in all cases and under all conditions; and furthermore to make plain to the mind of the student the fact that such principles are universally applicable.

The mill for treating ores on a practical scale, if it be of any size, or even tho it be of small capacity and happens to be situated where labor is not exceedingly cheap, must, for best working, possess certain mechanical devices for conveying the various products from place to place in the mill during the process of treatment, and for conveying the finished products to their proper destinations. The concentrate or valuable mineral must be conveyed to its storage bin and the tailing or refuse to its dumping ground. Such mechanical methods of conveying are also essential in the testing mill, not necessarily for reducing the cost of treatment of the small test samples of ore, but for the convenience of the operator and for making more accurate the tests that he performs. When the materials are carried by hand from one point in the plant to another and fed to the different machines in the uneven and unsystematic manner that is characteristic of hand feeding, the operation is usually productive of unreliable results.

Accurate sampling of the ores entering and of the products leaving the commercial mill is an exceedingly important item in the successful operation of such a plant. If correct results are desired from a test on a few tons of ore in the laboratory, correct sampling of the original ore and of the products resulting from its treatment is of even greater importance than in the case of the commercial mill. For, to learn the behavior of the ore when subjected to the particular method of treatment being used, it is necessary to know the analysis of each product that the ore yields; and since the best analyses are worthless unless they are performed on samples that accurately represent the substances from which they are taken, the truth of the above statement in regard to the importance of accurate sampling is readily apparent. There are two general methods of sampling, hand sampling and mechanical sampling. Hand sampling is frequently employed in small commercial mills, where only occasional samples are taken to check the operation of the mill. In the testing laboratory hand sampling is best avoided wherever possible, because it is too dependent upon the personal factor of the operator to yield as consistently uniform results as those secured with properly designed and properly operated mechanical samplers. For the foregoing reasons proper provision should be made for mechanical sampling devices at various points in the testing laboratory. Not only should samples be taken from the ore originally fed to the mill and from the tailing and concentrate produced, but also from the other products made by the mill in the process of concentrating the ore. Following the obtaining of a sample from any given product must come the cutting down or reduction of the sample to a proper size and degree of fineness suitable to chemical analysis. This necessitates a sample finishing room equipped with modern sample grinding machinery, which may be easily cleaned in order to prevent the 'salting' of one sample by others that have been previously crushed in the machines.

Since the arrangement of the commercial mill is largely determined by the characteristics of the ores to be concentrated, it is not necessary to make special provisions for rapidly changing the order or sequence of the various machines thru which the ore passes during its process of treatment. Such is not the case with the testing laboratory. The character of the ore treated today may be totally different from that of the ore treated yesterday, and for this reason it is impossible to adopt a predetermined and set arrangement of the crushing machines, of the preparatory machines, or of the concentrates. Therefore a certain elasticity in the arrangement of the testing plant is essential, so that it may be possible the ore from one point in the mill to another thru a certain series of machines and on short notice to change or even to reverse the order of treatment.

In order to meet the widely varying characteristics of the ores to be treated, adjustments of machinery are much more frequently necessary in the testing laboratory than in the mill. For this reason, wherever practicable, the machines in a school testing laboratory should be indppendently driven, so that the adjustments of any one machine may be changed without interfering with the operation of the other machines. The independent sources of power are preferably electric motors, whose speed may be varied, each motor driving a single machine or a single group of similiar machines.

Another point wherein the operation of the laboratory used by students differs from that of a commercial mill is in the number of men employed. A crew of thirty or forty men is ample for operating a large practical mill. It is not at all unusual, however, for thirty or forty students to be at work in the laboratory at one time. Provisions must be made for keeping such a large number busy. Especial precautions have to be taken in the design of the mill to make it as safe against accidents as is possible, for, as a rule, the average student is not more careful or intelligent in his handling of machinery than is the average laborer, and since there are many more students per square foot of floor space in the testing laboratory than there are laborers in the commercial mill the danger of accident is correspondingly increased.

The foregoing paragraphs outline to some extent the ideals that have governed the design of the laboratory. In many cases it has been impossible to conform exactly to these ideals, but, as will be seen in the subsequent description, they have, in all cases, been followed to as great an extent as possible.

The Metallurgy Building of the School of Mines stands at the southeast corner of the campus. In its present state of completion it consists of a central portion to which is attached two wings, one on the west side and the other on the east side. The central portion of the building contains the lecture rooms, a number of small laboratories for metallurgical research, and a large general laboratory used for chemical work. It also contains the general supply rooms and the heating plant, both of which serve the entire building. The west wing is the assay laboratory and is well equipped with furnaces, balances, and other apparatus necessary for the teaching of fire assaying. This wing also contains a coal-fired, reverberatory, roasting furnace and a water-jacketed cupola furnace.

The new Ore Dressing Laboratory occupies the east wing of the building. The main floor of this wing, 50 feet by 80 feet, is connected to the central portion of the building by a neck, 16 feet by 50 feet. The available floor space thus provided is about 4800 square feet. Above the main floor is a secondary or mezzanine floor which provides an additional 1300 square feet of floor space. Under the north end of the wing is a basement, 16 feet by 50 feet, which is used as a storage room for ores and other supplies. The ore storage bins in the basement may be filled from the outside of the building, making it unnecessary for ore wagons to enter the laboratory. Except for conveying the ore from these basement bins to the crusher, the ore is mechanically handled and sampled thruout all mill tests.

On the main floor of the wing is a sample grinding room 16 feet square, which is equipped with a small Blake crusher, a disc grinder, a coffee mill, a light pair of rolls, an electric sample dryer, and a number of bucking-boards. A small chemical laboratory, in which the analyses may be performed that are necessary in connection with the various mill tests, occupies the west end of the mezzanine floor.

The lighting of the laboratory is a most excellent feature. A continuous row of windows fills the entire wall space and two large skylights furnish additional light to the mezzanine floor.

Since the drawings Nos. 1 and 2 were completed the concrete floor of the laboratory has been laid and a deviation made from the original plans, which is worthy of note. The floor, as constructed, slopes from the east and west walls of the laboratory to a central gutter, which begins at a point 16 feet north of the center of the south wall, runs north 32 feet from this point, thence northeast to the west side of the freight elevator. At the elevator the gutter ends in a 4-inch cast iron pipe, which conveys the material under the floor, into the basement, and out of the laboratory thru the north wall of the foundation. This method of draining the floor is considered more satisfactory than that of the original plan, which was to carry the central floor gutter due north and out of the laboratory thru the double doors of the north wall. The gutter has a uniform slope of ¼ inch to the foot which is sufficient to carry away all water used in the mill and deliver it, together with any sand that it may carry, to the concrete sump tanks on the outside of the mill.

The new machines for the laboratory were selected with a view of furnishing examples of the latest milling practice. In some few instances machines from the mill formerly used by the school have been used, but by far the greater amount of the equipment is entirely new. Nearly all of the machines are small in size with a consequent low capacity, which is an aid rather than a disadvantage since the usual mill test will be performed upon a ton or so of ore.

As previously outlined, the objects considered in installing the machines were as follows, to secure as great a variety of machines as possible, to so arrange them as to permit of a large number of mill schemes or processes, to provide ample working space and safety for large classes, and especially to facilitate the work of teaching. The general arrangement may be readily seen in the drawings No. 1 and No. 2, and the following is a brief summary showing the methods of handling material and concentrating ores on a laboratory scale.

From the storage bins for raw material in the basement the ore is raised in small cars by the platform elevator to a track, which is six feet above the concrete floor of the mill. The cars are then taken to the crushing floor where the ore is weighed and fed to the crusher, a No. 2 gyratory breaker. The crushed ore from the gyratory breaker is raised by a bucket elevator and thrown upon the upper of two plane, shaking screens arranged in series. The size of the holes in these screens may be readily varied to suit the particular ore by having a number of perforated plates to fit the frame of the screen. The oversize from the first (coarser) screen drops by gravity to a 5-inch by 7-inch Dodge crusher. The oversize from the second screen drops to a pair of 9-inch by 12-inch rolls. The products from both the Dodge breaker and the rolls fall to a conveyor belt, which carries them to the elevator and they are again thrown upon the screens. It is readily seen that, according to circumstances, graded crushing with screening may or may not be used. The ore may be crushed in the gyratory followed by either the rolls or the Dodge, without intermediate screening, by simply removing the perforated plates from the screen box or frame.

At the completion of the crushing operation the ore is sampled by two Vezin samplers. The rejected portion from the samplers is delivered by a bucket elevator to the conveyor serving the crushed-ore bins, from which it may be dropped into any one of these bins to remain there until wanted for concentration. The bin compartment at the east end of the row is used as a storage place for ores suited to stamp crushing and amalgamation. The stamps are fed by an automatic feeder of the Challenge type attached directly to the bins.

The remaining five bins are for the storage of crushed and sampled ores that are ready for concentration. Removal of the ore from these bins and conveying it to the concentrating machines is effected as follows: Each bin is provided with an automatic feeder by which the ore is drawn from the bin and dropped upon the conveyor running under the concentrating floor. This conveyor discharges the ore into that bucket elevator, which in crushing operations receives the reject from the samplers. The ore is elevated to the conveyors serving the bins, but in this case is tripped to the belt running to the trommels on the mezzanine floor. It is not necessary to use the bins at all, because the crushed and sampled ore may be carried direct from the samplers to the mezzanine floor by the method outlined. Without using the bins, however, the concentrating machines are dependent upon the uniformity of hand feeding of the gyratory breaker, which is usually not so satisfactory as the automatic feeding from the bins.

With the ore on the mezzanine floor any one of a number of treatment schemes may be quickly and easily arranged. The ore may be prepared for concentration by any one of the machines on this floor or by suitable combinations of them. The preparatory equipment consists of three trommel screens, one duplex Callow travelingbelt screen, one direct type Richards pulsator classifier, one five-spigot Richards vortex classifier, one deep pocket classifier consisting of three hydraulic cones, one small classifier of the Tamarack type, two 3½-foot Callow tanks, and two 5½-foot Callow tanks.

The various prepared products from the mezzanine floor may be distributed by gravity to any of the concentrating machines on the floor beneath. The concentrating machinery is as follows: As coarse concentrators there are three five-cell, differential motion, Harz jigs; one ten ton Richards pulsator jig; one six-foot Hancock jig; and a two-cell bull jig. As sand concentrators there are two laboratory size Wilfley tables, one laboratory Card table, one laboratory James table, and a full size Dunham table presented by The Braeckel Concentrator Company of Joplin, Mo. As fine or slime concentrators there is a four-foot Frue vanner, and a five-foot Sperry slimer; also the Parsons-Rittinger bumping-tables from the old mill will be used as canvas tables. A three-foot amalgamating-pan with a five-foot settler are used for amalgamating silver ores and for fine grinding.

Each machine used for concentration is individually driven by a three phase alternating current motor of proper size. This greatly facilitates experimental work by permitting the speed of any one machine to be readily changed without interrupting the operation of any other machine.

For regrinding middlings and for the fine crushing of ores previous to concentration a three and one-half foot Huntington mill is provided. The mill is driven by a seven and one-half horse power motor, and is so situated that it may receive by gravity the pulp from any of the concentrating machines. The crushed product from the mill is discharged into four small sump-tanks from which it is elevated for re-treatment by two motor-driven, direct-connected, centrifugal sand-pumps. From the receiving boxes above the mezzanine floor the re-elevated pulp may be distributed for re-treatment to any part of the mill.

A central launder is provided to carry tailing to the sump tank outside of the mill. The tailings pass thru an automatic sampler and in this way the hand sampling of such material is avoided.

The cyanide equipment consists of a leaching plant with all necessary tanks, a fourteen-inch Hendryx clay agitator, a sixteen-inch Hendryx combination agitator and filter, and a laboratory filter press.

Ores suited to magnetic separation are treated on a Knowles magnetic separator, and for the preparation of such ores there is provided a small cylindrical dryer and roaster, and a plane impact screen for dry sizing.

To conclude the description I may say that, while at present the laboratory may be far from the ideally perfect one, still it contains those features which in many ways are essential to the successful school laboratory and testing plant, namely, ample floor space for classes, independently driven machines, mechanical conveying and feeding of material, and mechanical sampling of all ores and the products resulting from their treatment. The standard types of machines now in use in practical mill work are represented. These, with the additions to the present equipment, which will be made from year to year in order to keep apace with the ever changing ore dressing practice, will ultimately constitute a laboratory of great value to the school and to the mining industry.

## PART III, PURCHASING LISTS WITH SPECIFICATIONS.

This section contains complete lists with the necessary specifications of milling machinery, materials for erection and construction, power transmission machinery, belting, etc., excepting nails and other small supplies, which may be purchased from the local dealers as needed.

### CRUSHING EQUIPMENT.

Number

1 NO. 2 gyratory breaker. This breaker is to have an extended drive shaft with all necessary bearings for its support, the drive shaft to be diametrically opposite the discharge spout for crushed ore. The distance of the outside of the drive pulley on the above mentioned shaft from the central axis of the breaker is to be 8 feet 6 inches.

1 Set of spring rolls, diameter 12 inches and face 9 inches. Each roll is to be driven by a pulley attached directly to the roll shaft.

1 Three and one-half foot Huntington mill, mounted upon a timber base.

1 Double jar mill, manufactured by The Alsing Engineering Co., New York.

### SAMPLERS.

1 Vezin sampler, diameter across the cutting seg-

Number

ments to be 2 feet 9 inches.

1 Vezin sampler, diameter across the cutting segments to be 2 feet.

The above samplers are to be mounted on a steel frame in the relative positions shown in drawing 1 and 2. The first or larger sampler is to receive the undersize from the shaking screen, and to deliver its sample to the second or smaller sampler by way of a shaking chute actuated by an eccentric. The reject from both samplers is to pass to the bucket elevator by which it is delivered to the conveyor serving the crushed ore bins. The steel frame and shaking chute, together with all necessary driving mechanisms such as shafts, bearings, gears, pulleys, eccentric, etc., are to be provided with the samplers; and the entire unit is to be complete and ready for installation.

1 Scobey tailings sampler, manufactured by The Mine and Smelter Supply Co., Denver, Colo.

FEEDERS.

1 Automatic Challenge feeder of the suspended type for stamps. The feeder is to be attached directly to the bin and is to have as small a feed hopper as possible. If the feeder may be

Number

successfully operated by attaching directly to the bin chute, the feed hopper may be entirely omitted.

5 Automatic feeders to remove fine ore from the crushed ore bins. These feeders are to be of the type described in catalog 15 of The Mine and Smelter Supply Co., Denver, Colo. as Figure 238. Each feeder is to be driven by an individual eccentric bored and key seated for 1-15/16-inch shafting. One eccentric with rod 1 foot 8 inches long is to accompany each feeder.

ORE BIN GATES.

13 Ore bin gates of the downward closing arc type, to fit an ore chute 16 inches wide by 14 inches deep.

CONVEYORS.

21 Conveyor belt carriers for 10 inch belt. These carriers are to be of the 2-pulley troughing type with single base, similiar to that shown in Plate 3a, drawing U.

21 Return idlers for 10 inch belt of the type shown in Plate 3a, drawing U.

Neither the conveyor belt carriers nor the return idlers are to be mounted on boards as shown

Number

in the drawing.

For the other materials necessary for the completion of the belt conveyors, namely, shafting, pulleys, and belting refer to the separate lists of these materials, to be found on pages 38, 41, and 43 respectively.

ELEVATORS.

1 Bucket elevator complete as follows: The buckets are to be 6 inches wide and of No. 10 steel. The belt is to be of 4 ply rubber of proper width to carry the 6 inch buckets, and the buckets are to be spaced 18 inches apart on the belt. The boot of the elevator is to be of cast or sheet iron and to contain a cleanout door, placed at or near the bottom, for cleaning the boot. The lower drum is to be 24 inches in diameter and of proper width to carry the belt. The bearings of the drum shaft are to be fastened to the boot, and are to be of the adjustable takeup type for regulating the tension of the elevator belt. The head piece of the elevator is to consist of a drum 24 inches in diameter of proper width to carry the elevator belt, and a drive pulley 36 inches in diameter with 6 inch face. Both

Number

the drum and drive pulley are to be mounted on a shaft of suitable diameter, which is to be provided with two bearings of the standard rigid pillow block type. The distance from the center of the bottom drum to the center of the top drum is to be 14 feet 10 inches. The elevator belt is to be made of proper length to conform to the above specified distance between the centers of the drums.

1 Bucket elevator to conform in all details to the above specifications, except that the distance between the centers of the drums is to be 14 feet.

BELT CONVEYOR TRIPPER.

1 Hand propelled conveyor tripper for a 10 inch belt, to be constructed as follows: The tripper is to consist of two iron drums or pulleys mounted on a strongly constructed steel frame. The pulleys are to be so placed that the conveyor belt travels over the upper pulley then down and under the lower one, discharging the material from the top pulley into a sheet steel hopper from which it may be dropped to either or both sides of the belt. The steel frame is to be carried

Number

by four single flange wheels upon a double rail track of 30-inch gage, and to be provided with a clamp for fastening the tripper at any point on the track. The lower pulley is to be placed at such an elevation that, when the track is supported upon the boards or beams that support the troughing conveyor carriers, the pulley with its bearings will clear the carriers. The total height of the tripper is not to exceed 2 feet 10 inches.

## TROMMEL SCREENS.

3 Cylindrical trommel screens 2 feet in diameter by 4 feet long as described below. The screen frame of each is to consist of a shaft, bearings for the same, two spiders and hoops, and a punched steel plate screening surface. The holes in the screening surfaces are to be round and 3 mm., 5 mm., and 9 mm. in diameter for the three screens respectively. Each screen is to be provided with a water tight housing of No. 12 sheet steel to receive the undersize and oversize products from the screen. The slope of the bottom of each housing is to be 15 degrees from the horizontal when the trommel shaft is hung at an

Number

angle of 5 degrees from the horizontal. The screens are to be so constructed as to admit of being mounted and driven as shown in drawings 1 and 2. The oversize from the first or 5 mm. trommel is to flow by gravity to the 9 mm. trommel, and the undersize form the 5 mm. trommel is to flow by gravity to the 3 mm. trommel. The construction of each screen is to be such that the screening surfaces may be readily changed. The diameter of the shaft of each screen is to be 1-3/16 inches. The shaft of the 9 mm. trommel is to be provided , outside of the bearing on its lower end, with a standard key seat for fastening the drive gear to the shaft. The upper end of the same shaft is to carry, between the upper end of the housing and the upper bearing, two sprocket wheels from which the other two trommels are to be driven. The 3 mm. and 5 mm. screens are to be provided with a sprocket wheel of the same diameter and number of teeth as the wheel mentioned above. The sprocket wheel on the 3 mm. trommel is to be fastened to its shaft between the upper end of the housing and the upper shaft bearing. The sprocket wheel of

Number

5 m.m. trommel is to be fastened to its shaft on the outside of the lower shaft bearing. Set screws are to be used in fastening the sprocket wheels to the shafts. Fifteen feet of link steel chain to fit the above sprocket wheels is to be furnished with the trommels.

CLASSIFIERS.

1 Richards five spigot vortex tank classifier. This classifier is to be made similiar in all ways to the commercial machine which is manufactured by Allis-Chalmers Co., except that it is to be a small machine having a capacity of about one ton of sand per hour.

3 Classifying cones complete as follows: The cones are to be of cast iron or sheet steel, and to be 12 inches, 15 inches, and 18 inches in diameter respectively. Each cone is to be provided with a lip on one side of the rim for carrying the overflow. Each is to be provided with an hydraulic sorting column, the sorting column of the 12 inch cone to be 1¼ inches in diameter, and the sorting columns of the 15 inch and 18 inch cones/to be 1½ indhcs in diameter. Hydraulic water is to be admitted to each sorting column

Number

thru a regulating valve provided with a dial and pointer. The valves with their dials and pointers are to be provided with the cones.

1 Double cone hydraulic classifiers 12 inches in diameter. The classifier is to be the same as, or the equivalent of, the one described on page 206 of Catalog 15 of The Mine and Smelter Supply Co., Denver, Colo.

1 Richards pulsator classifier, direct type, capacity 25 tons per day.

2 Callow settling cones, 5 feet 9 inches in diameter, to be used as settling tanks. Each cone is to be provided with a goose neck syphon casting for discharging the settled pulp.

6 Callow settling cones, 3 feet 9 inches in diameter, to be used as settling tanks. Each is to be provided with a goose neck syphon casting for discharging the settled pulp.

2 Callow settling cones, 3 feet 3 inches in diameter. Each cone is to be provided with a straight spigot discharge casting and a brass, or bronze, stop-cock.

CENTRIFUGAL PUMP.

1 Direct-connected, motor-driven, centrifugal

Number

sand-pump. The pump is to have a 2 inch discharge and to be properly constructed to handle sandy water. It is to be direct connected to a 220-volt, three-phase, alternating-current motor of proper size to elevate the material to a height of 35 feet.

CONCENTRATORS.

1 Richards pulsator jig, 10 ton size.

1 Model Hancock jig, This jig is to be complete in every detail and in all ways similiar to the commercial machine, which is manufactured by Allis-Chalmers Co. The bed of the jig is to be 6 feet long by 11 inches wide. The depth of the screen frame is to be the same as that of the standard jig. The movement of the screen is to be the same, both in character and amount, as the movement of the screen of the standard jig.

2 Standard Wilfley table head motions.

CYANIDE EQUIPMENT.

1 Laboratory filter press of 6 leaves, with montejus for charging, built by D. M. Sperry, Batavia, Ills.

1 Hendryx 16-inch clay agitator.

1 Hendryx 14-inch combination agitator and filter.

Number

1 Set of laboratory leaching-tanks made by The Pacific Tank Co., San Francisco, Calif.

PUNCHED METAL PLATES.

All of the following plates are to be of No. 4 sheet steel, 4 feet long by 2½ feet wide. The plates are to be punched with round holes, and a blank margin 1½ inches wide is to be left on all four edges.

1 Plate, 9 mm. holes 9/16 inches between centers.

1 Plate, 12½ mm. holes, ¾ inch between centers.

1 Plate, 15 mm. holes, ⅞ inch between centers.

1 Plate, 20 mm. holes, 1⅛ inches between centers.

1 Plate, 25 mm. holes, 1½ inches between centers.

1 Plate, 40 mm. holes, 2⅛ inches between centers.

All of the following ~~xxx~~ plates are to be of No. 22 sheet steel, 6 feet long by 3 feet wide. The plates are to be punched with oblong holes of the specified size. The holes are to be punched to hit and miss endways.

1 Plate, holes 3/32-inch by ¼-inch, distance

Number

between centers 3/16-inch.

1 Plate, holes 1/8-inch by 1/8-inch, distance between centers 1/4-inch.

1 Plate, holes 3/16-inch by 1/4-inch, distance between centers 3/8 inch.

1 Plate, holes 1/4-inch by 1-inch, distance between centers 7/16-inch.

## SCREEN CLOTH.

1 Piece of double-crimped, square-mesh screen-cloth, 3 feet by 5 feet, to be made of No. 26 steel wire, and to have 24 meshes per linear inch.

1 Piece of double-crimped, square-mesh screen cloth, 3 feet by 5 feet, to be made of No. 28 steel wire, and to have 30 meshes per linear inch.

1 Piece double-crimped, square-mesh screen-cloth, 3 feet by 5 feet, to be made of No. 17 steel wire and to have 8 meshes per linear inch.

1 Piece, 3 feet by 5 feet, of each of the screen-cloths manufactured by W. S. Tyler, Cleveland, Ohio, and sold as No. 42, No. 54, No. 93, No. 108, and No. 145.

## SHEET STEEL.

1 Piece of No. 4 sheet steel, 4 feet 9 inches by 2 feet 6 inches.

Number

1 Piece of No. 4 sheet steel, 4 feet 9 inches by 3 feet.

1 Piece of No. 4 sheet steel, 3 feet by 3 feet.

3 Pieces of No. 8 sheet steel, 4 feet by 10 feet

## ANGLE IRONS.

3 Pieces, 20 feet long, of standard 2-inch by 2-inch steel angle iron.

1 Piece, 20 feet long, of standard 4-inch by 4-inch steel angle iron.

4 Pieces, 1 foot long, of standard 6-inch by 6-inch angle iron.

## TIE-RODS.

All of the following tie-rods are to be complete with threads, nuts, and washers at both ends.

14 Tie-rods, 7 feet long by ½-inch diameter.

18 Tie-rods, 5 feet 4 inches long by ½-inch diameter.

4 Tie-rods, 3 feet 4 inches long by ½-inch diameter.

## LAG SCREWS.

All of the following lag screws are to be provided with steel washers.

100 Lag screws, with square heads and gimlet points,

Number

6½ inches long by ½ inch in diameter.

100 Lag screws, with square heads and gimlet points, 9 inches long by ½-inch diameter.

## LUMBER.

This list contains the dimensions and amount of all lumber necessary for the construction of floors, partitions, bins, frameworks, machine foundations, and all other parts of the mill which are to be constructed of wood, excepting the heavy timbers for the concentrating floor for which short pieces from the old mill room may be used.

The following lumber is to be grade No. 1, clear yellow pine, finished smooth on four sides:

| No. Pieces | Size" | Length. |
|---|---|---|
| 6 | 8 x 8 | 16 feet |
| 10 | 8 x 8 | 14 feet |
| 10 | 8 x 8 | 12 feet |
| 2 | 6 x 6 | 24 feet |
| 10 | 6 x 6 | 18 feet |
| 30 | 6 x 6 | 16 feet |
| 30 | 6 x 6 | 14 feet |
| 4 | 6 x 8 | 18 feet |
| 35 | 4 x 4 | 16 feet |

| No. Pieces | Size | Length |
|---|---|---|
| 20 | 4 x 4 | 14 feet |
| 50 | 4 x 4 | 12 " |
| 30 | 2 x 14 | 12 " |
| 75 | 2 x 12 | 18 " |
| 50 | 2 x 6 | 20 " |
| 80 | 2 x 6 | 18 " |
| 160 | 2 x 6 | 16 " |
| 40 | 2 x 4 | 16 " |
| 3 | 3 x 15 | 12 " |

Flooring:- The following lumber is to be best yellow pine, vertical-grain, matched flooring in the quantities and sizes shown:

| Quantity | Size | Length |
|---|---|---|
| 1500 sq. ft. | 7/8 inch by 3¼ inch | Commercial |
| 750 " " | 1 " by 4 " | " |

The following is to be best grade Oregon fir, free from knots and other imperfections, smooth on four sides.

| No. Pieces | Size" | Length |
|---|---|---|
| 40 | 2 x 8 | 16 feet |

Ceiling:- The following is to be best grade, beaded, yellow pine, matched ceiling about 3¼-inch face:

1200 sq. ft. in commercial lengths.

Redwood:- The following lumber is to be best grade of clear redwood, smooth on one side:

| No. Pieces | Size" | Length |
|---|---|---|
| 20 | 1½ x 8 | 12 feet |

DOORS AND WINDOW FRAMES.

Number

2 Swinging doors with hinges, each to be 3 feet by 7 feet, and to have a glass pane in the upper half.

2 Window frames 6 feet high by 5½ feet wide, to contain panes of glass of convenient commercial size.

1 Window frame 5 feet high by 15 feet wide, to contain panes of glass of convenient commercial size.

1 Window frame 6 feet high by 12 feet long, to contain panes of glass of convenient commercial size.

3 Window frames 60 inches high by 36 inches wide complete with double, sliding sash and weights

2 Door frames for swinging doors 3 feet by 7 feet.

BEVEL GEARS.

1 Gear wheel, 64 teeth, 1 inch pitch, 2½ inch

Number

face, bored and key seated to fit 1-3/16-inch shaft. The gear is to be purchased from The Dodge Manufacturing Co. whose pattern number for the same is 0014570.

1 Gear wheel, 14 teeth, 1½-inch pitch, 2½-inch face, key-seated and bored to fit 1-11/16-inch shaft. The gear is to be purchased from The Dodge Manufacturing Co., whose pattern number for the same is 001457CP.

BEARINGS.

5 Adjustable, ring-oiling pillow-blocks for 2-11/16-inch shafting, to be provided with bolts, nuts, and washers for fastening to 8-inch timbers. See Plate 3a, drawing A.

8 Heavy, rigid post-bearings, wick-oiling, for 1-15/16-inch shafting, with bolts, nuts, and washers for 6-inch timbers. See Plate 3a, B.

2 Heavy, rigid post-bearings, capillary-oiling, for 1-15/16-inch shafting, with bolts, nuts, and washers for 8-inch timbers. See Plate 3a, C.

2 Solid, cast iron flat-boxes for 1-11/16-inch shafting, with 16½-inch bolts. See Plate 3a, C.

2 Heavy, rigid post-bearings, ring-oiling, for 1-15/16-inch shafting, with bolts, nuts, and wash-

Number

ers for 8-inch timbers. See Plate 3a, E.

1 Rigid pillow-block, wick-oiling for 1-15/16-inch shafting, with bolts, nuts, and washers for 6-inch timber. See Plate 3a, E.

3 Rigid pillow-blocks, wick-oiling, for 1-15/16-inch shafting, with bolts, nuts, and washers for 4-inch timbers. See Plate 3a, F.

2 Rigid pillow-blocks, wick-oiling, for 1-11/16-inch shafting, with bolts, nuts, and washers for 4-inch timbers. See Plate 3a, G.

2 Rigid pillow-blocks, wick-oiling for 1-15/16-inch shafting, with bolts, nuts, and washers for 8-inch timbers. See Plate 3 a, H.

2 Take-up bearings, push or pull type, 18-inch movement, for 1-15/16-inch shafting, with bolts, nuts, and washers for 8-inch timbers. See Plate 3a, I.

4 Take-up bearings, push or pull type, 18-inch movement, for 1-15/16-inch shafting, with bolts, nuts, and washers for 4-inch timbers. See Plate 3a, J.

2 Take-up bearings, push or pull type, 12-inch movement, for 1-11/16-inch shafting, with bolts, nuts, and washers for 4-inch timbers. See Plate 3a, K.

| Number | |
|---|---|
| 2 | Wall brackets with 12-inch extension from wall to center of shaft, each carrying one standard, rigid pillow-block for 2-11/16-inch shafting, the brackets to be provided with bolts, nuts, and washers for fastening to 6-inch timbers. See Plate 3a, L. |
| 1 | Wall bracket with 12-inch extension from wall to center of shaft, carrying one standard, rigid pillow-block for 2-3/16-inch shafting, with bolts, nuts, and washers for 6-inch timbers. See Plate 3a, M. |
| 3 | Standard, rigid pillow-blocks for 2-3/16-inch shafting, with bolts, nuts, and washers for 6-inch timbers. See Plate 3a, M and N. |
| 2 | Adjustable drop-hangers, drop to center of shaft 16 inches, each carrying a capillary-oiled bearing for 1-7/16-inch shafting, with bolts, nuts, and washers for 4-inch timbers. See Plate 3a, P. |
| 3 | Adjustable post hangers, wick-oiling, for 1-11/16-inch shafting, with bolts, nuts, and washers for 8-inch timbers. See Plate 3a, O. |
| 6 | Standard, rigid pillow-blocks for 1-3/16-inch shafting, with bolts, nuts, and washers for 4-inch |

Number

timbers. See Plate 3a, R.

2 Heavy, standard, rigid post-bearings for 1-15/16-inch shafting, with bolts, nuts, and washers for 6-inch timbers. See Plate 3a, Q.

2 Standard, rigid pillow-blocks for 1-11/16-inch shafting, with bolts, nuts, and washers for 6-inch timbers. See Plate 3a, Q.

3 Common flat-boxes for 1-3/16-inch shafting, with bolts, nuts, and washers for 4-inch timbers.

10 Side journal post-bearings for 1-3/16-inch shafting, with bolts, nuts, and washers for 4-inch timbers.

6 Common flat-boxes for 1-15/16-inch shafting, with bolts, nuts, and washers for 4-inch timbers.

4 Adjustable drop-hangers with standard-oiling bearings, for 1-3/16-inch shafting, 12-inch drop to center of shaft.

## COLLARS.

All of the collars in this list are to be solid and to be of the safety type, having no projecting set screws or knobs of any description.

6 Collars for 2-11/16-inch shafting.

4 Collars for 2-3/16-inch shafting.

28 Collars for 1-15/16-inch shafting.

10 Collars for 1-11/16-inch shafting.

Number

2 Collars for 1-7/16-inch shafting.

24 Collars for 1-3/16-inch shafting.

## COUPLINGS.

1 Dodge-Collins, compression coupling or equivalent for 2-11/16-inch shaft.

1 Keyless, compression, flange coupling for 1-15/16-inch shaft.

## ECCENTRICS.

2 Pain eccentrics with 3-inch travel, bored and key seated to fit 1-15/16-inch shafting. The eccentric-rods are to be 1¼ inches in diameter and 7 feet 6 inches in length from the center of the eccentric to the center of the eccentric-rod end. The rods are to be fastened to the eccentric by two hexagonal nuts, and the eccentric-rod end is to be bored, ~~and~~ key seated, and provided with a set screw to fit 1-11/16-inch shafting. The construction of the eccentric-rod end is to be as shown in the detail drawing on Plate 3a, D.

2 Adjustable eccentrics with 2½-inch to 6-inch travel, to be bored and key seated for 1-15/16-inch shafting. The eccentric-rod is to be 1¼ inches in diameter and 3 feet 6 inches in length from the center of the eccentric to the end of

Number

the rod. The eccentric-rod is to be fastened to the eccentric by two hexagonal nuts, and at the loose end it is to be threaded to a distance of 8 inches from the end and provided with two extra hexagonal nuts.

## PULLEYS.

Unless otherwise specified all pulleys in the following list are to be of solid cast iron with single arms. All are to be finished and accurately bored to shaft size. In the table the following abbreviations have been used: C. means crowned face; F. means flat face; K.S.K. means key seated and provided with key; S.S. means provided with set screws. D.B. means double belt. S.B. means single belt. Unless otherwise specified all key seats are to be of standard cross section, and all set screws are to be on the keys.

The first column in the table refers to the drawing on Plate 3a for which the pulley is intended. The second column gives the number of pulleys of each size that are needed.

| | No. | Diam" | Face" | Bore" | Description. | | | |
|---|---|---|---|---|---|---|---|---|
| A | 1 | [illegible] | 12 | 2-11/16 | C. | K.S.K. | S.S. | |
| A | 1 | 38 | 8 | 2-11/16 | C. | K.S.K. | S.S. | |
| A | 1 | 6 | 6 | 2-11/16 | C. | K.S.K. | S.S. | Wood |
| A | 1 | 15 | 9 | 2-11/16 | F. | K.S.K. | S.S. | |

| | No. | Diam" | Face" | Bore" | Description. | | |
|---|---|---|---|---|---|---|---|
| A | 1 | 20 | 6 | 2-11/16 | C. | K.S.K. | S.S. |
| A | 1 | 10 | 6 | 2-11/16 | " | " | " |
| B | 1 | 25 | 8 | 1-15/16 | " | " | " |
| D | 1 | 17 | 6 | 1-15/16 | " | " | " |
| B | 1 | 12 | 6 | 1-15/16 | " | " | " |
| E | 1 | 18 | 12 | 1-15/16 | " | " | " |
| E | 1 | 18 | 6 | 1-15/16 | " | " | " |
| F | 1 | 18 | 12 | 1-15/16 | " | " | " |
| F | 1 | 18 | 6 | 1-15/16 | " | " | " |
| G | 1 | 12 | 12 | 1-11/16 | " | " | " |
| G | 1 | 12 | 6 | 1-11/16 | " | " | |
| H | 1 | 18 | 12 | 1-15/16 | " | " | S.S. |
| H | 1 | 24 | 6 | 1-15/16 | " | " | " |
| I | 1 | 18 | 12 | 1-15/16 | " | " | " |
| J | 2 | 18 | 12 | 1-15/16 | " | " | " |
| K | 1 | 12 | 12 | 1-11/16 | " | " | " |
| L | 1 | 24 | 7 | 2-11/16 | " | " | " |
| L | 1 | 13 | 4 | 2-11/16 | " | " | " |
| L | 1 | 26 | 6 | 2-11/16 | F. | " | " |
| L | 1 | 14 | 5 | 2-11/16 | C | " | " |
| L | 2 | 11 | 4 | 2-11/16 | " | " | " |
| M | 1 | 24 | 7 | 2-3/16 | " | " | " |
| M | 1 | 8 | 8 | 2-3/16 | " | " | " |
| N | 1 | 36 | 7 | 2-3/16 | " | " | " |

| | No. | Diam" | Face" | Bore" | Description. | | |
|---|---|---|---|---|---|---|---|
| N | 1 | 12 | 8 | 2-3/16 | C. | K.S.K. | S.S. |
| O | 1 | 10 | 6 | 1-11/16 | " | " | " |
| O | 1 | 12 | 6 | 1-11/16 | " | " | " |
| P | 1 | 30 | 5 | 1-7/16 | " | " | " |
| P | 1 | 9 | 10 | 1-7/16 | " | " | " |
| Q | 1 | 36 | 7 | 1-15/16 | " | " | " |
| Q | 1 | 7 | 6 | 1-15/16 | " | " | " |
| Q | 1 | 8 | 5 | 1-15/16 | " | " | " |
| Q | 1 | 16 | 5 | 1-11/16 | " | " | " |
| R | 2 | 25 | 5 | 1-3/16 | " | " | " |
| R | 2 | 5 | 3 | 1-3/16 | " | " | " |
| | 2 | 6 | 3 | 1-3/16 | " | " | " |
| | 2 | 4 | 3 | 1-3/16 | " | " | " |
| | 2 | 7 | 3 | 1-3/16 | " | " | " |
| | 3 | 11 | 4 | 1-3/16 | " | " | " |
| | 3 | 8 | 4 | 1-3/16 | " | " | " |
| | 6 | 6 | 4 | 1-3/16 | " | " | " |
| | 3 | 12 | 4 | 1-3/16 | " | " | " |
| | 3 | 7 | 4 | 1-3/16 | " | " | " |
| | 2 | 14 | 4 | 1-3/16 | " | " | " |
| | 3 | 12 | 4 | 1-15/16 | " | " | " |
| | 2 | 10 | 4 | 1-15/16 | " | " | " |

SHAFTING.

All of the following shafting is to be cold rolled mild steel, key seated as specified.

| No. pieces. | Length | Diameter" | Key seated according to | | |
|---|---|---|---|---|---|
| 2 | 15' 00" | 2-11/16 | Plate 3a, | drawing | A |
| 2 | 24' 00" | 1-15/16 | " | " | B |
| 1 | 4' 10" | 1-15/16 | " | " | C |
| 1 | 3' 03" | 1-11/16 | " | " | " |
| 1 | 6' 00" | 1-15/16 | " | " | E |
| 1 | 9' 06" | 1-15/16 | " | " | F |
| 1 | 3' 07" | 1-11/16 | " | " | G |
| 1 | 5' 00" | 1-15/16 | " | " | H |
| 1 | 3' 06" | 1-15/16 | " | " | I |
| 2 | 3' 03" | 1-15/16 | " | " | J |
| 1 | 3' 00" | 1-11/16 | " | " | K |
| 1 | 16' 00" | 2-11/16 | " | " | L |
| 1 | 12' 00" | 2-3/16 | " | " | M |
| 1 | 4' 06" | 2-3/16 | " | " | N |
| 1 | 9' 06" | 1-11/16 | " | " | O |
| 1 | 5' 00" | 1-7/16 | " | " | P |
| 1 | 10' 00" | 1-15/16 | " | " | Q |
| 1 | 9' 00" | 1-11/16 | " | " | Q |
| 3 | 3' 03" | 1-3/16 | " | " | R |
| 2 | 20' 00" | 1-3/16 | Not key seated | | |
| 1 | 16' 00" | 1-15/16 | " | | |

ROPE SHEAVES.

All of the following are to be iron sheaves for $\frac{7}{8}$ inch Manilla rope.

| Number | No. grooves | Diam" | Bore" | Description. | |
|---|---|---|---|---|---|
| 1 | 1 | 24 | 2-11/16 | K.S.K. | S.S. |
| 1 | 2 | 24 | 1-15/16 | K.S.K. | S.S. |
| 1 | 1 | 72 | 1-15/16 | K.S.K. | |
| 1 | 3 | 40 | 1-15/16 | K.S.K. | S.S. |
| 2 | 2 | 24 | 1-3/16 | | S.S. |
| 4 | 1 | 24 | 1-3/16 | | S.S. |

TENSION CARRIAGES.

Number

1 Vertical tension carriage, complete with 100 pound weights and a 24 inch single strand sheave for $\frac{7}{8}$ inch Manilla rope. The carriage is to be Dodge style O or equivalent.

1 Adjustable horizontal tension carriage, complete with 100 pound weight and a 24 inch single strand rope sheave for $\frac{7}{8}$ inch Manilla rope. The carriage is to be Dodge style M or its equivalent, with a travel of 8 feet.

## BELTING.

The following is to be best grade of rubber belting for power transmission in the lengths, widths, and weights specified:

| No. pieces. | Length. | Width" | Ply. |
|---|---|---|---|
| 2 | 100 feet | 3 | 3 |
| 1 | 150 " | 4 | 3 |
| 2 | 100 " | 5 | 4 |
| 1 | 100 " | 6 | 4 |
| 1 | 60 " | 7 | 4 |
| 1 | 50 " | 10 | 4 |

The following is to be best grade of rubber belting for conveyors, having an extra layer of rubber ⅛ inch thick on one side:

| No. pieces. | Length. | Width" | Ply. |
|---|---|---|---|
| 1 | 110 feet | 10 | 3 |
| 1 | 100 " | 10 | 3 |
| 1 | 80 " | 10 | 3 |

## BELT LACING.

| Number. | |
|---|---|
| 200 | Feet of ¼ inch cut leather belt lacing. |

## BELT CLAMP.

1 Belt clamp for holding and tightening belts from 2 inches to 10 inches in width while being laced.

Number

TRANSMISSION ROPE.

200 Feet of $\frac{7}{8}$ inch Dodge Blue Strand Manilla rope, for power transmission.

SPECIAL CASTINGS.

4 Castings of steel to be made according to Plate 3a, drawings S. The surface for carrying the floating roller is to be finished smooth and true.

4 Castings of steel to be made according to Plate 3a, drawing T, and finished same as the above castings.

4 Rollers as shown in Plate 3a, drawing T. The rollers are to be turned from a solid piece of mild steel.

## PART IV, SPECIFICATIONS FOR ERECTION AND CONSTRUCTION.

### CONCENTRATING FLOOR.

This floor, for the support of the various concentrating machines, is to be placed upon the concrete floor of the laboratory in the position shown in drawings 1 and 2. The floor is to be 36 feet from north to south by 32 feet from east to west. The elevation at the south end is to be 5 feet 4 inches above the center line of the concrete floor, and at the north end the elevation is to be 4 feet 7 inches above the same line. The floor is to slope uniformly from the south edge to the north edge.

The construction of the floor is to be as follows: Lay 8-inch by 8-inch timbers east and west on the concrete floor. These are to serve as sills and are to be placed 9 feet between centers, measuring north and south. On these sills place posts of the proper length to bring the top of the floor to the proper elevation, as above specified. On these posts lay 8-inch by 8-inch caps running east and west. The caps are to carry the joists, which are to be 2-inch by 12-inch yellow pine on edge, spaced 12 inches between centers. Cover the joists by securely nailing 2-inch by 6-inch yellow pine planks to their top edges. The planking is to be covered by $\frac{7}{8}$ inch vertical grain matched flooring running north and south. Steps from the concrete floor to the wood floor are to be constructed at convenient points.

## SAMPLING ROOM.

The sample finishing room is to occupy the south third of the neck that connects the main laboratory with the central building. It is to be approximately 16 feet square and is to contain a Blake crusher, a pair of sampling rolls, a disc grinder, a coffee mill, an electric sample dryer, and a sufficient number of bucking-boards. Each grinding machine is to be supported upon a strongly made wooden base at the south side of the room. Power is to be furnished by a 7½ horse-power motor, belt connected to a line shaft, for details of which see Plate 3a, drawing L. The line shaft is to be supported on the south side of the room, at a safe distance above the floor, by two iron wall brackets carrying the shaft bearings. The brackets are to be fastened by bolts to 6 inch by 8 inch timbers, which run from floor to roof on the south wall of the room, and which are securely fastened to the wall by lag screws or bolts.

The partition on the east side of the room is to run from the concrete floor to the roof of the building. It is to contain a window frame 15 feet long by 5 feet high made up of glass panes of convenient commercial size. The bottom of the window frame is to be 5 feet above the concrete floor. The north wall of the room is to project from the concrete floor to the roof of the building, and is to contain two window frames each 6 feet high by 5½ feet long with glass panes of convenient size. These frames are to be placed one on each side of a swinging door, 7 feet high by 3 feet wide, which is to have a glass window in its upper half. All portions of the partitions other than the windows are to be framed with 2-inch by 4-inch lumber, and covered with beaded yellow pine ceiling both on the inside and the outside of the room.

## CHEMICAL LABORATORY.

The chemical laboratory is to be placed on the west end of the mezzanine floor. It is to be 16 feet by 12 feet and completely equipped with tables, desks, hoods, water, air, and gas. The south wall will be the upper portion of the north wall of the sample room. The north wall of the laboratory is to contain a swinging door, 3 feet by 7 feet, the upper half of which is to contain a pane of glass, the door being placed at the extreme east end of the wall. That portion of the wall west of the swinging door is to contain a window frame 12 feet long by 6 feet high, with glass panes of convenient size. The bottom of the window frame is to be placed about 30 inches above the floor. The east wall of the laboratory is to contain three windows, each of which is to consist of a frame, 60 inches by 36 inches, holding double sliding window sash. The bottoms of the windows are to be placed 30 inches above the floor. All portions of the partitions other than the windows are to be framed with 2-inch by 4-inch lumber, and covered with beaded yellow pine ceiling both on the inside and outside of the room.

BASEMENT STORAGE BINS.

These bins for ore storage are to be erected along the north wall of the basement. They are to be constructed substantially as shown in drawing 8. Sills may be used under the posts instead of the floor bolts and concrete piers as shown in the drawing. The frame work is to be of 6-inch by 6-inch lumber, and the lining is to be of 2-inch by 6-inch planking. The sills are to be fastened to the concrete floor by drilling holes in the floor and setting ½-inch bolts at proper points. Each section of the bin is to be provided with an ore chute, 16 inches wide by 14 inches deep, sloping at an angle of 45 degrees, and extending down to a point a few inches above the ore cars. Each chute is to be fitted with an iron gate of the downward closing arc type.

## CRUSHED ORE STORAGE BINS.

These bins are to be constructed along the south wall of the laboratory, substantially as shown in drawings 6 and 7. The frames are to be of 6-inch by 6-inch lumber. The ore compartments are to be lined with 2-inch by 6-inch planking, which is in turn to be lined with 1-inch by 4-inch matched flooring. Each section of the bin is to be provided with an ore chute 16 inches wide by 14 inches deep, and a gate of the downward closing arc type. The front of each section is to carry a bracket of 4-inch by 4-inch lumber for holding the automatic feeder. Each post in front of the bin is to carry a wick oiling rigid pillow block for holding the automatic feeder line shaft. Details of all of the above mentioned items are shown in drawings 6 and 7.

## ORE-CAR TRACK.

The car track upon which ore is to be carried from the freight elevator to the crushing floor is to be supported as follows: Frames of 4-inch by-4 inch lumber, consisting of one sill, two posts, and one cap are to be placed at regular intervals between the freight elevator and the crushing floor, the posts being 2 feet 6 inches between centers. The frames are to be braced so as to render them rigid. Upon the caps of these frames two 4-inch by-4 inch stringers are to be laid at a distance between centers equal to the gage of the track. On each side of these stringers a 2-inch by-4 inch stringer is to be laid on edge directly over each post of the supporting frames. Cover these stringers with 2-inch by 6-inch boards 3 feet long. The rails ~~fxx~~ to carry the ore cars are to be spiked directly to the above 2-inch by 6-inch boards, the spikes passing thru the boards and entering the 4-inch by 4-inch stringers. The gage of the track is to be that of the ore cars, and the total height of the track above the concrete floor is to be the same as that of the floor surrounding the crusher.

## CRUSHING DEPARTMENT.

The crushing department is to contain a No. 2 gyratory crusher, a Dodge crusher, a pair of rolls, a bucket elevator, and two plane, shaking screens. All of the machinery is to be arranged and driven as shown in drawings 1 and 2 and in the detail drawing No. 5, except that the shaking screen is to be driven by rope instead of by bevel gear. The framework for the support of shafting and floors is to be constructed by 8-inch by 8-inch timbers securely mortised at the various joints. The floor surrounding the crusher is to be constructed as follows: Timbers 8 inches by 8 inches running east and west are to support the joists, which are to be of 2-inch by 14-

inch yellow pine laid on edge, 12 inches between centers. On these joists is to be securely nailed 2-inch by 6-inch planking, which in turn is to be covered with $\frac{7}{8}$-inch vertical grain, yellow pine flooring. The elevation of the floor above that of the concrete floor is to be 6 feet and 3 inches.

The floor surrounding the Dodge crusher and rolls is to be constructed similiarly to that just described. Its elevation above the concrete floor is to be 4 feet 4 inches. A flight of steps is to be provided from the crusher floor to the roll floor.

Each machine is to be driven by a belt from the line-shaft, which is to run north and south and to be driven by a 35 horse power motor. For details of the line-shaft and its equipment see Plate 3a, drawing A.

## SHAKING SCREENS.

The shaking screens for use in connection with the crushing department are to be constructed substantially as shown in drawings 3 and 4. The screen is to be supported upon a frame-work of 8-inch by 8-inch timbers. Upon the caps of this frame work are to be placed the special castings, shown in detail in Plate 3a, drawings S and T.

The screen frame is to be made of 3-inch by 15-inch lumber securely bound together at the ends with suitable iron tie-rods. Inside of the frame 2-inch by 2-inch angle irons are to be placed in proper positions to support the punched metal screens. Under each punched metal plate is to be placed a sheet of No. 4 steel to receive the undersize from the screens. The plate under the first screen is to deliver the ore to the second screen, and the plate under the second screen is to deliver the ore to the automatic samplers. The oversize from each screen is to be dropped thru the steel plate below the screen by a chute constructed of sheet iron and angle iron, and placed in the position shown in the drawings. The entire screen frame is to be shaken by two eccentrics fastened to a revolving shaft at the north end of the supporting frame. The shaft is to be driven from the main-shaft of the crushing department by a ⅞-inch Manilla rope. For details of the shaft and its equipment see Plate 3a, drawing C.

STAMP BATTERY.

The mortar and moving parts of the three stamp battery now standing in the old mill room are to be reframed and placed in front of the extreme east section of the crushed-ore storage bins. The frame is to be constructed of timbers from the old mill according to drawing No. 10. The stamps are to be placed as shown in the drawing and fed with a Challenge feeder. Power is to be supplied by a five horse-power motor supported above the bin and belt-connected to a counter-shaft according to the drawing. For details of the shaft and its equipment see Plate 3a, drawing M.

In front of the battery is to be placed a table for the support of the amalgamated plate. The table is to be so constructed that the slope of the plate may be xx-readily adjusted.

## TROMMEL-SCREEN FRAMES.

Trommel-screen frames for the support of the three screens are to be constructed of 6-inch by 6-inch lumber, and placed on the messanine floor in the position shown in drawings 1 and 2. The frames are to be so constructed that the trommels, which are 2 feet in diameter by 4 feet long, may hang at a slope of 5 degrees from the horizontal. The screens are to be supported on their frames in such a manner that the upper (middle size) screen shall receive its feed from the belt conveyor at as great an elevation as possible. This screen is to deliver its oversize to the screen having the largest holes and its undersize to the screen having the smallest holes. The undersize products from the housings of the two latter trommels are to be discharged at an elevation at least 2 feet 6 inches above the messanine floor, or at a greater elevation if possible. The east trommel of the lower pair is to be driven by a bevel gear, and it in turn is to drive the other two trommels by means of sprocket wheels and chains. Two shafts are to be mounted upon the trommel frame approximately in the positions shown in drawings 1 and 2. For details of these shafts see Plate 3a, drawing Q.

SETTLING-TANKS.

Four Callow settling-cones are to be suspended from the messanine floor in the positions shown in drawings 1 and 2. The two smaller cones are to be placed with their tops level with the floor, while the two larger cones are to be suspended at a proper elevation to receive the overflow from the smaller cones.

From the roof of the building above the messanine floor two Callow settling-cones, each 3 feet 3 inches in diameter, are to be suspended. One is to be supported at as great an elevation as possible with the other sufficiently low to receive the overflow from the first. These two cones are to be properly placed to receive the elevated pulp from the centrifugal pump.

Under the concentrating floor four small Callow settling-cones are to be mounted on portable frames in such a manner that they may be conveniently moved from place to place as the conditions demand.

At the north end of the concentrating floor a sump tank having four hopper-bottomed compartments is to be constructed of wood. Detail drawings of this tank are to be furnished later. The tank is to be made of sufficiently heavy material to support above it the motor-driven centrifugal pump, which is to serve as an elevator for fine material.

BULL JIG.

A bull jig of two compartments is to be constructed according to drawings which will be furnished later.

HARZ JIGS.

The three five-cell Harz jigs are to be mounted on frames constructed of 4-inch by 4-inch timbers according to drawing No. 11. In front of each jig and at the tail end settling-tanks are to be constructed for receiving the various products discharged from the jig. The position of these small settling-tanks with respect to the jig and its supporting frame is shown in the drawing. Mounted on each jig frame in the position shown in the drawing is to be a two horse-power motor. The motor is to be belt connected to a counter-shaft fastened to the frame of the jig, and the jig is to be driven by a belt from a pulley on the counter-shaft. For details of the counter-shaft and its equipment See Plate 3a, drawing R.

LABORATORY TABLES.

The laboratory Card table is to be mounted on a frame of 4-inch by 4-inch timbers carrying a counter-shaft and two horse-power motor as shown in drawing 13.

Two laboratory tables are to be constructed according to instructions from the writer. Each is to be supported on a frame similiar to that of the Card table, and each is to be driven with a two horse-power motor. Standard Wilfley table head-motions are to be used for shaking the decks of the tables.

FRUE VANNER.

The 4-foot Frue vanner is to be placed in the position shown in drawings 1 and 2, with its head end to the west and the tailings end to the east. It is to be driven from a counter-shaft supported from the joists of the mezzanine floor, the counter-shaft being driven by a three horse-power motor hung from the joists of the floor. The counter-shaft is to be so placed that the vanner may be driven by a quarter-twist belt, this being the customary manner of driving in commercial mills. For details of the vanner counter-shaft see Plate 3a, drawing P.

SPERRY SLIMER.

The five-foot Sperry slimer is to be placed on the concentrating floor in the position shown by drawings 1 and 2. It is to be driven by a shaft supported near the edge of the concentrating floor, the shaft being driven from a second shaft supported from the joists of the mezzanine floor. This last shaft is to be driven by a three horse power motor hung from the lower side of the floor joists. Details for this shafting are not shown in the drawings as the shafting will be fitted and assembled in the shop at the time of installation.

## AMALGAMATING-PAN AND STTLER.

The [redacted] amalgamating-pan and the settler from the old mill room are to be placed in the position shown in drawings 1 and 2. The settler must be at a sufficient elevation that pulp may be discharged from it to the wooden sump tanks previously described. These tanks will probably be about three feet high. The supporting frames for the pan and the settler from the old mill may be used. The shafts of the machines are to project on the east side of each, and are to be driven from a counter shaft which is in turn driven by a five horse power motor.

## BELT CONVEYORS.

The belt conveyor running under the rolls is to be made longer at its south end than is shown in the general plans. The south drum is to be placed above and sufficiently close to the conveyor running in front of the crushed ore storage bins that it may deliver its product to the latter conveyor. The conveyor under the rolls is to be driven by a pulley on the shaft of the south drum. The pulley is to be driven by a belt from a counter shaft which is to be supported on the south posts of the shaking screen frame, This shaft is driven in turn by a belt from the shaft carrying the eccentrics of the shaking screens. For details of the head and tail shafts of the conveyor and for the above mentioned counter shafts see Plate 3a, drawings G, K, O, and C.

The conveyor serving the crushed-ore storage bins is to be constructed with an inclined flight similiar to that shown in drawing 12. It is to be driven by means of a ¾-inch Manilla rope from the line-shaft of the crushed-ore feeders. The conveyor belt is to be supported by carriers placed on the cap posts of the bins and by return idlers suspended under each cap . On each side of the conveyor belt a light track-rail is to be laid for carrying the conveyor tripper. The gage of the track is to be 30 inches. The west drum of the conveyor is to be mounted in the west compartment of the crushed-ore storage bin. For details of the head and tail shafts of this conveyor see Plate 3a, drawing B and J.

The conveyor north of the crushed-ore storage bins, which is to receive the ore from these bins and carry it to the bucket elevator, is to be placed in the position shown in drawings 1 and 2. The conveyor belt is to be supported on a frame-work of 4-inch by 4-inch timbers, upon which the troughing carriers and return idlers are to be fastened at intervals of 5 feet. It is to be driven by a pulley on the shaft of the east drum, the pulley being driven by a belt from the drive shaft of the conveyor serving the crushed ore bins. For details of the head and tail shafts of this conveyor see Plate 3a, drawings F and J.

The conveyor serving the trommels on the mezzanine floor is to be supported by troughing rollers and idlers placed at intervals of 5 feet, which are to be fastened to two beams each 6 inches by 8 inches in section. It is to receive ore from the conveyor serving the storage bins and deliver it to the topmost trommel. The conveyor must be so situated with respect to the above mentioned trommel that it will deliver the ore to the trommel without injury to the shaft or to the bearing of the trommel. The conveyor is to be driven by a pulley attached to its upper drum-shaft, the pulley being driven by a belt from the counter-shaft shown in Plate 3a, drawing Q. For details of the head and tail shafts of the conveyor see Plate 3a, drawing H and I.

## ELEVATORS.

The boot of the bucket elevator, which is to deliver the products from the breaker, the Dodge crusher, and the rolls, to the shaking screen, is to be so situated that it may receive the product from the breaker by gravity and the products from the rolls and Dodge crusher by means of the conveyor belt. The drums of the elevator are to be placed in a vertical line 14 feet 10 inches between centers. The elevator is to be driven by a pulley on the shaft of the top drum, the pulley being driven by a belt from the crushing plant line shaft.

The bucket elevator, that is to receive the reject from the automatic samplers and to receive the crushed ore from the storage bins and deliver these materials to the conveyor serving the bins, is to be placed approximately as shown in drawings 1 and 2. It is to be so situated with respect to the automatic samplers, with respect to the conveyor running north of the crushed ore bins, and with respect to the conveyor serving these bins, that it may fulfill the purpose outlined above. The drums are to be mounted in a vertical line with their centers 14 feet apart. The elevator is to be driven by a pulley on the shaft of the top drum, the pulley being driven by a belt from the line shaft operating the crushed-ore feeders.

INDEX.

Page