ANNUAL MILLING NUMBER

Engineering and Mining Journal

McGraw-Hill Co., Inc. New York, April 20, 1918

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Engineering and Mining Journal

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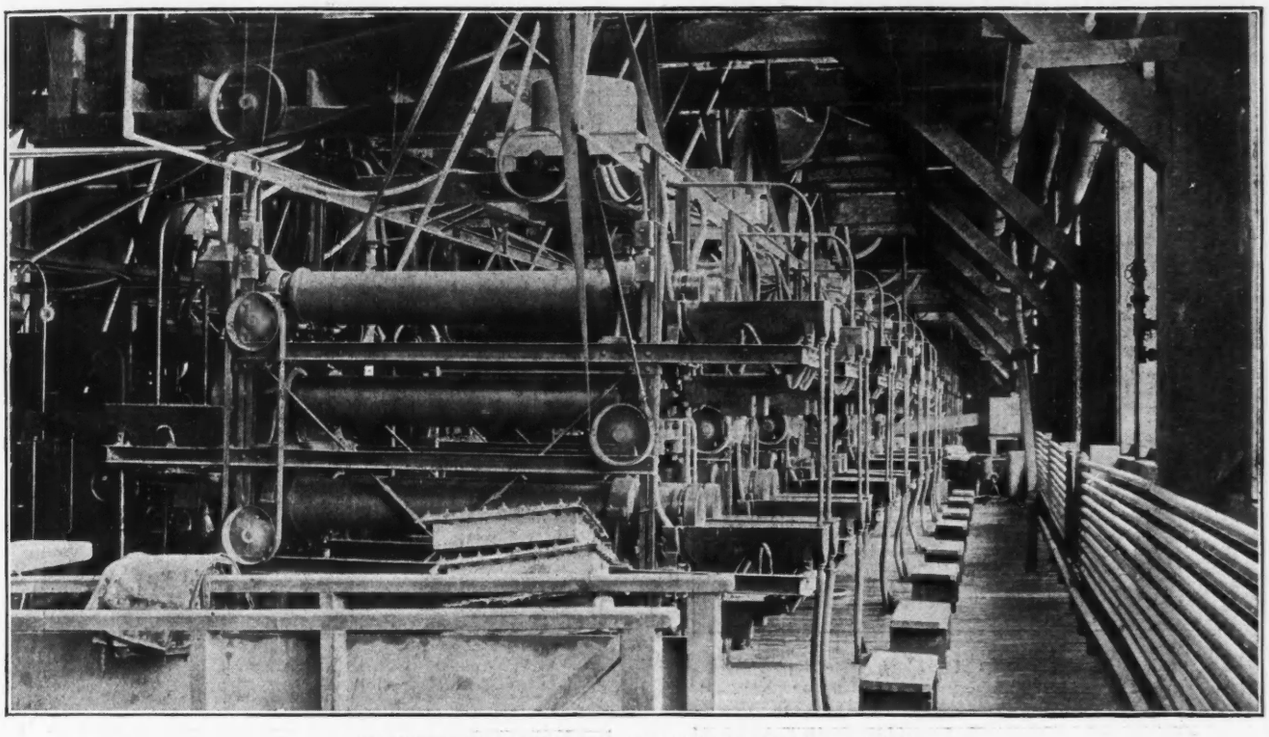
Volume 105 *Number* 16



MACQUISTEN TUBES AT THE MORNING NO. 1 MILL

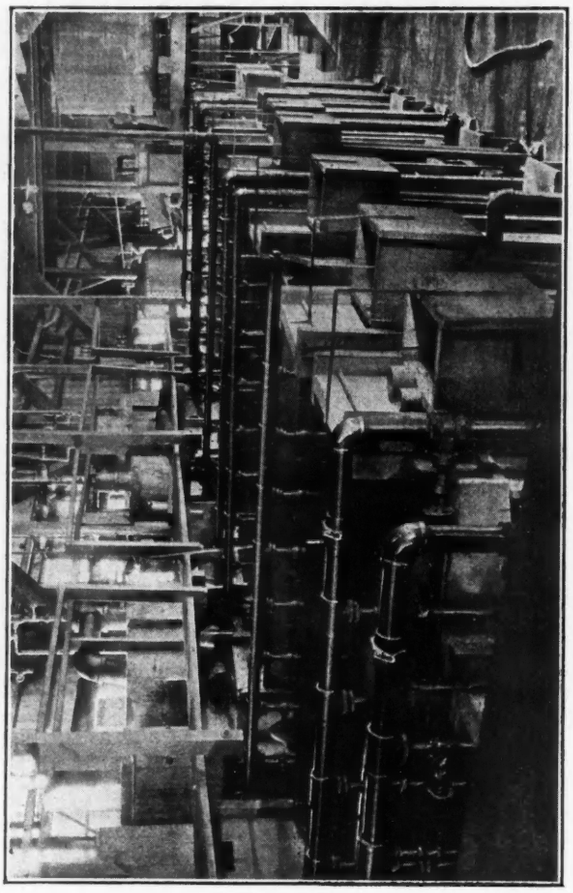
Flotation in the Coeur d'Alenes

BY CLAUDE T. RICE

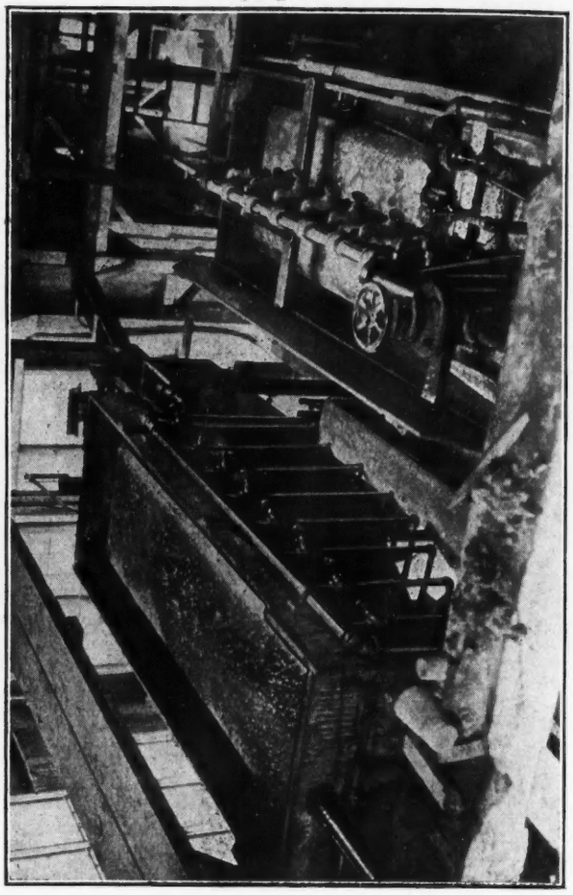
The treatment of the silver-lead and lead-zinc ores in the Coeur d'Alene district has followed the customary lines of ore-dressing practice. With the advent of the flotation process, use was made of this method for the treatment of the slime, which could not be satisfactorily handled by the appliances ordinarily available. Step by step the peculiar difficulties attendant upon the use of a new process were overcome, and a practice peculiar to this locality was developed. The flotation of galena and blende and the separation of blende from galena have been successfully accomplished in the treatment of the slime and finer portions of the mill pulp. Details of the method.

FLOTATION is now an integral part of the milling practice of the Cœur d'Alenes. This is true in the district, whether the ore is predominantly sphalerite or galena, or is one in which both sulphides are important; it does not matter whether sulphides occur disseminated in fine grains or in large-sized crystalline aggregates in the gangue (quartzite). Flotation, however, plays a relatively small part in the average flow sheet of the district, for the practice at present is to first obtain as much of the valuable mineral as possible by gravity concentration, after which the tails are retreated in frothing machines. At most of the mills even the finest slimes are first sent to tables or vanners before treatment by flotation, although the recovery by flotation of the galena in most ores of the district is high, especially if little siderite is present.

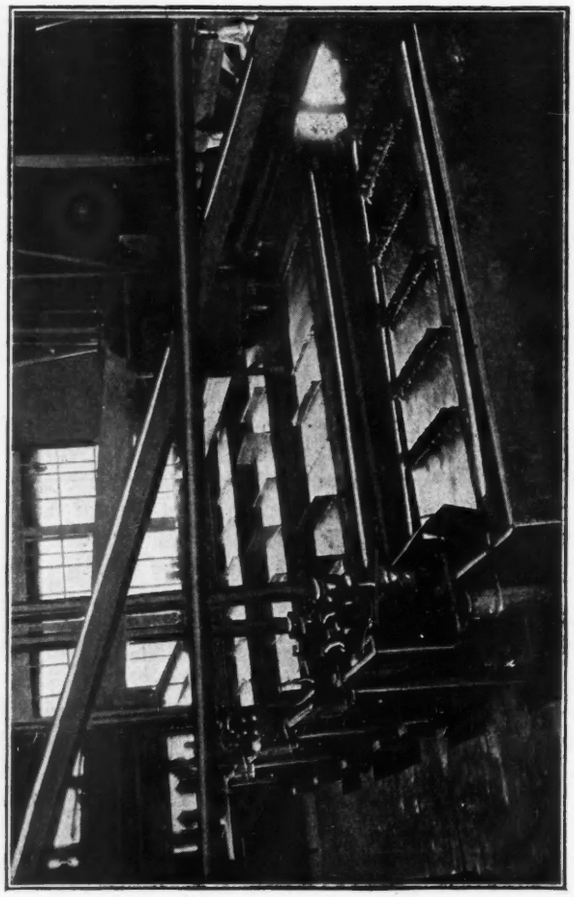
This supplementary application of the flotation process is due mainly to three causes: First, the uncertainty which now prevails in respect to the flotation patents; second, the lack of confidence which many of the millmen have in flotation, owing to the erratic results obtained in the district, which preclude sole reliance upon flotation; third, the instinctive realization of the importance of catching the valuable minerals as early in the milling process as possible. The last is by far the most important reason that more reliance is not placed at the present time upon flotation in milling Cœur d'Alene ores.



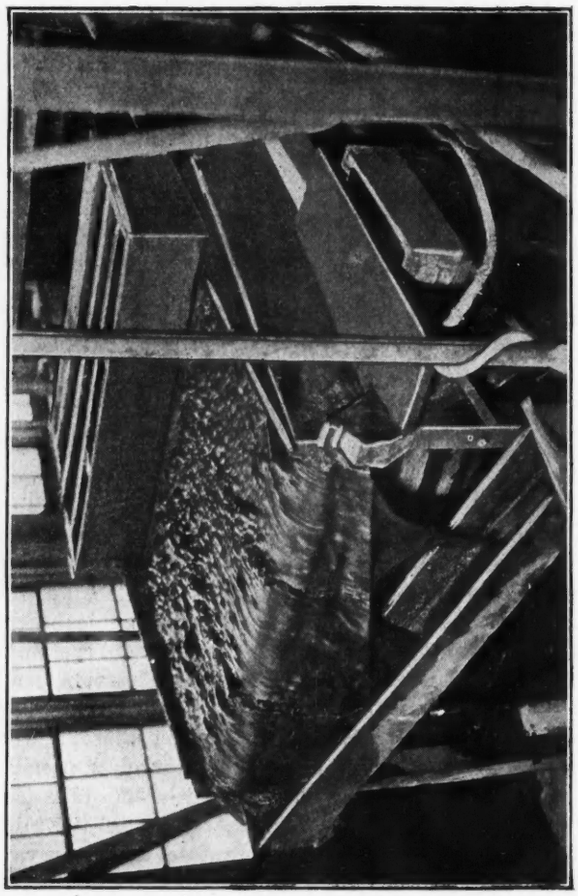
ZINC PNEUMATIC CELL, MORNING NO. 1 MILL



CALLOW PNEUMATIC CELLS IN OPERATION



CALLOW PNEUMATIC CELLS WITH PARTITIONS, NATIONAL MILL



ZEIGLER FLOTATION MACHINE, SUCCESS MILL

Cœur d'Alene milling practice is therefore still in a transitory stage in respect to flotation, and the relative importance of that method in the milling of the ores of the district depends mainly upon four factors: the royalties that may be demanded for the use of the process, the prices prevailing for silver, lead and zinc after the war, the progress which may be made in obtaining lower zinc in the lead "float" and lower lead in the zinc "float," especially after differential flotation, and, finally, the advances that may be made in the hydrometallurgy of lead and zinc. But whatever process is finally used in the treatment of the ores, it is reasonably certain that the greater part of the galena will be obtained by gravity concentration, since much of the lead is coarse and fully 80% of it can be saved on jigs and tables, the only exception to this condition being the fine-grained ores.

The saving of blende by gravity methods is not as good as that of galena. There is often siderite in the ore, as at the Morning mine, to prevent the recovery of the blende in marketable form by simple gravity methods. But even in the case of the finer-grained ores gravity methods will continue to play an important part in the mill treatment.

The flotation process will during the next few years increase considerably in importance in the milling methods of the district; for flotation, because of its so-called "selective action" upon the silver minerals and on account of its greater efficiency in the treatment of slimes, assists, even now, and will do more in the future in the treatment of Cœur d'Alene ores when it is better understood. Already many of the companies that are treating ores in which the valuable mineral occurs in coarse-grained aggregates are beginning to realize that by finer grinding of more of their table middlings and the treatment of the resulting slime in flotation machines they can make not only higher recoveries but also win a greater profit from their ores.

With an increase in the zinc content in the ore, flotation increases in importance in the milling scheme, since with such ores it becomes difficult to treat at a profit by gravity methods when the metals are at ordinary prices.

Selective Action of Flotation for Silver

In the Cœur d'Alenes much is said about the "selective action" of flotation for silver. This is because the proportion of silver to lead in the flotation froth is high as compared with other concentrates. But this is not so much because of selective action shown for silver minerals as it is that the flotation froth catches slime much better than does a table or vanner. In spite of the silver in the Bunker Hill & Sullivan ores appearing to be, to a considerable extent, associated with the iron minerals, in the case of the ores from Burke, Mullan and Nine Mile mines the silver is associated with the galena, and little if any of it with the pyrite, blende, pyrrhotite or siderite. In some of the ores, notably the Gold Hunter, a little chalcocite occurs that carries silver, but in spite of this the principal silver carrier is the galena. The silver occurs in the galena as an included mineral—probably argentite. This seems to be shown by the fact that the proportion of silver to lead is much higher in the coarse concentrates from the jigs than in those coming from the tables, while in the flotation concentrates the proportion is generally even higher than in the coarse concentrates. As the flotation froth will catch much finer mineral than will tables and vanners, this fine silver mineral is caught in the flotation machines, and as a consequence the flotation concentrates are enriched, and the table and vanner concentrates impoverished, in silver as compared to their lead content.

With silver at present prices, the increased extraction of silver obtained by flotation is important and justifies the use of the process in treating Cœur d'Alene ores. Fine-grinding of table middlings will also increase in importance throughout the district. In this field and in the treatment of the zinc-lead ores, flotation, following gravity concentration of the pulp, will become the established practice.

Flotation May Become of Primary Importance

In the event of a notable decline in lead and zinc prices, the future of several of the Cœur d'Alene properties will depend upon the successful application of the flotation process. This is especially true of properties producing ores in which the valuable minerals occur finely disseminated. For example, flotation has increased the recovery of the Gold Hunter mill 20% as compared to what it was with gravity concentration. Flotation has made it possible to profitably treat the fine-grained lead-zinc ore that now forms the bulk of the Morning mine's output. It was the great difficulty of treating the fine-grained lead-zinc ores from the last-mentioned property that caused flotation to be first tried in the district.

First Use of Flotation in the Cœur d'Alenes

Flotation in the Cœur d'Alenes began with the adoption of the Macquisten tube for separating blende from siderite in the granular table feed at the Morning mill. This was the first commercially successful flotation plant in the United States, although froth flotation had at that time been practiced in Australia for a number of years in the treatment of lead-zinc and copper ores. The Macquisten tube had been used several years earlier in a small way in Nevada, and it was the description of that installation in the *Journal* of Oct. 26, 1907, under the title of "Concentration Upside Down," which first caused the officers of the Federal company to think of using the Macquisten tube. At that time the Macquisten tube was of such a crude design mechanically that its efficiency in operation was such as to preclude the possibility of using it successfully on a commercial scale. At the Morning mill, where it was introduced in 1910, the Macquisten tube was developed into a successful appliance.

But the device will treat efficiently only a granular feed, and upon sizes smaller than 150-mesh it is not satisfactory, even when the sulphide particles are granular. Thus, while the adoption of the Macquisten tube made it possible for the Federal company to separate the greater part of its granular blende from the siderite in the middlings (obtained from the tables in the gravity treatment of the ore), much blende was still being lost, and it was the necessity of finding some method of satisfactorily treating this part of the ore that led the company to investigate froth flotation, and

finally caused other companies in the district to appreciate its possibilities in the treatment of the slimes from the lead ores.

Between 1911 and 1913, the Federal company tried out several froth-flotation methods upon the Morning mill slimes. The Potter-Delprat process, or one almost identical with it, under the name of the Wyman process, was first tried, but it did not succeed, because of the large acid consumption caused by the siderite gangue. The method was finally discarded, and the company then experimented with the froth-flotation process. In the experiments encouraging results were obtained, but the work was finally stopped. Early in 1914, at the invitation of H. A. Guess, T. M. Owen, who was one of the early workers in differential flotation, and had had experience with flotation in Australia, visited the Morning mill and conducted experiments upon the Morning ore. He showed that the slime portions could be treated by differential flotation and that the lead and zinc concentrates recovered were of marketable grade. In April, 1914, the application of differential flotation was undertaken by Mr. Guess.

Invention of the Callow Cell

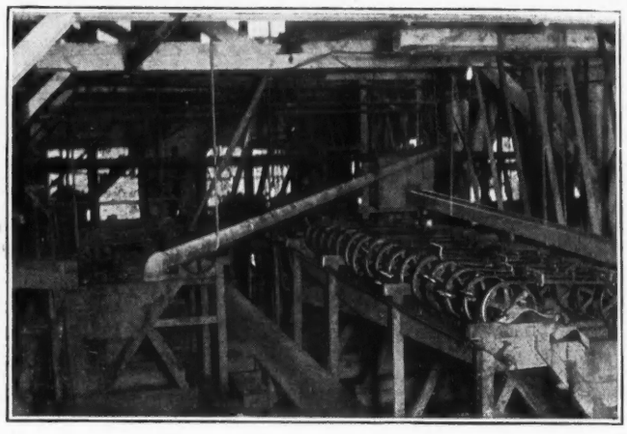
At the time the mill at the National mine near by was being built, and Callow pneumatic cells were being installed, J. M. Callow had found that excellent results could be obtained on that ore by using flotation, and so had devised his pneumatic cell for the work. The simplicity of the Callow cell appealed to Guess when he visited the National mill, and, after testing out the cell in a series of experiments in which it proved suitable for differential flotation, he installed Callow cells in both the Morning and the Greenhill-Cleveland mills.

The success of the Callow machine at the Morning, the Greenhill-Cleveland and the National mills caused the millmen at most of the nearby lead mines to consider the installation of flotation plants. By the fall of 1914 many of the lead mills of the district were using flotation for the treatment of the slime portion of their pulp. Naturally they installed Callow cells.

Introduction of the Janney Machine

Later, when it was found that the Callow cell not only would not give quite as high a grade of concentrate on some of the ores as would mechanical agitation appliances, other machines began to be introduced, and prominent among these was the Janney. The first of the Janney machines was installed at the Frisco mill by H. A. Guess, and soon afterward others were put in at the Greenhill-Cleveland and at the Morning mills, properties of the Federal company. These were all single-spitz Janney machines equipped with lifter pipes, but instead of scrapping these machines, as was done at several other places because the lifter pipes would not elevate anything except slime from the bottom of the cells, the Federal company remodeled its Janney machines along the lines suggested by Mr. Guess at the Federal mill at Flat River, Mo., took out the lifters and connected the spitz-boxes with the impeller chambers by 6-in. pipes. The pipes lead from the bottom of the spitz-box of each cell to a point directly under the impeller shaft of that compartment, at which point there is sufficient suction to draw any granular feed that is likely to get into a flotation machine. Some time later double-spitz Janney machines were added at the Hercules mill to handle the granular slime, and about a year ago the Janney pyramid machines were installed at the Interstate-Callahan mill near the head of Nine Mile canyon.

Since 1914 a number of flotation machines have been evolved in the district itself. At the Hercules mill a machine was devised with a series of small air-lifts that lead off from a central header over the top of the cell, a Callow box without the pneumatic bottom. At the end of this roughing cell is a small independent "cleaner" cell equipped with a Callow pan to produce the froth. Along this "cleaner" cell runs a longitudinal traveling belt having scrapers for skimming off the top of the froth as fast as it rises. This machine avoids the inconveniences that result from the blinding of the cloth on Callow pneumatic machines, and it also does away with the interference in the operation of the plant that occurs in a small installation when a machine has to be shut down to change bottoms. The "pipe" machine has the disadvantage that the adjustment of the air going to one of the pipes throws the whole set out and requires the readjustment of the other pipes. The work of the cell, as a consequence, depends upon having a conscientious and intelligent millman.



BUNKER HILL & SULLIVAN FLOTATION MACHINE

Callow Cells at Tailing Mills

At one of the Crerar-Hewitt tailing mills a Callow cell 2 ft. wide by 16 ft. long, with flat bottom and other modifications, is being used. At the Tamarack mill air-lift columns have been added to a spitz for a collector, and a machine of promise has been evolved. At the Bunker Hill & Sullivan mill the Bunker Hill machine is used. This machine consists of a spitz collecting chamber with 1½-in. centrifugal pumps connected to it and used to circulate the pulp through the cells into which the spitz or V-box is divided. The pumps are constructed with special bushings so as to minimize the wear on the shafts. The upkeep on this flotation machine is consequently not so large as might at first be thought. The machine has the advantage that it has a less violent and a more closely controllable action than have some of the others. The other distinguishing feature of the Bunker Hill machine is the use in each

cell of a traveling belt carrying scrapers that drag the top froth up an inclined lip in discharging it. This results in the production of a clean concentrate without close attention on the part of the attendant. The machine has also a positive regulation of the water level and an air-lift discharge of the tailings, so that there is not the trouble that is common with the spigot type of discharge.

The K. & K. machine has been tried at the Morning mine, but is no longer used, as it has not been found to offer any advantage over the modified Janney cells with which the mill is equipped for handling the granular part of the flotation feed. In one of the tailing mills owned by Crerar & Hewitt there is in use a machine of the K. & K. type so arranged as to circulate the pulp positively through the five cells into which the machine is divided. This machine is equipped with scrapers to remove the froth from the collecting chamber.

Zeigler Flotation Machine

The Zeigler machine remains to be mentioned. As it is attracting attention outside of the Cœur d'Alene district and is looked upon favorably in the district itself, I will describe it in greater detail than the others.

The Zeigler machine is a device resembling the K. & K. type. The impellers do not rotate in the body of the pulp itself. An air lift is used to raise the pulp and discharge it as a spray up into the impeller chamber, in which it is beaten into an exceedingly fine froth. The V-box collecting chamber is larger than in the K. & K. The Zeigler machine is divided into five cells, through which the pulp successively travels. In detail the action of the machine is as follows: The pulp enters through the feed opening, Fig. 1, near the bottom of the collecting chamber *A* of the first cell. An air lift *B* sprays the pulp into the chamber *D*, in which rotates a paddle wheel *E*, the axle of which serves as the axle for the impellers of the other cells and is carried at the ends in drip collars that drain back into the two end frothing chambers and prevent leakage. The impeller shaft rotates so as to discharge the aërated pulp into chamber *A* behind the baffle board *F*. There the froth collects and passes over the discharge lip, while the part of the pulp that does not float drops to the bottom and passes through opening *G* into chamber *A* of the next compartment, where the cycle is repeated. Above the baffle board is an opening *H*, through which the excess air in the froth escapes, so that only froth concentrates rise in the collecting chamber. Tailings pass through the discharge device *I*, Fig. 2, at the end of the machine, the water level in the agitation chamber being regulated positively by raising or lowering the end of the gooseneck overflow which swings on the nipple *J*. The greater part of the tailing discharges through the bottom spigot *K* of the regulating pipe, but this opening is adjusted so that a slight overflow ascends through the gooseneck. The discharge and feed ends can be reversed if desired, as the pulp moves equally well in either direction through the machine.

Air pressure of from four to five pounds per square inch raises the pulp through the air-lift boxes, and one horsepower is an ample allowance for supplying the air for a five-cell machine (30 to 50 cu.ft. of air is required per minute for a five-cell machine). The agitators or sprayers rotate at about 175 r.p.m. The five-cell machine has a capacity on most flotation pulps of from 75 to 100 tons per 24 hours. It requires from

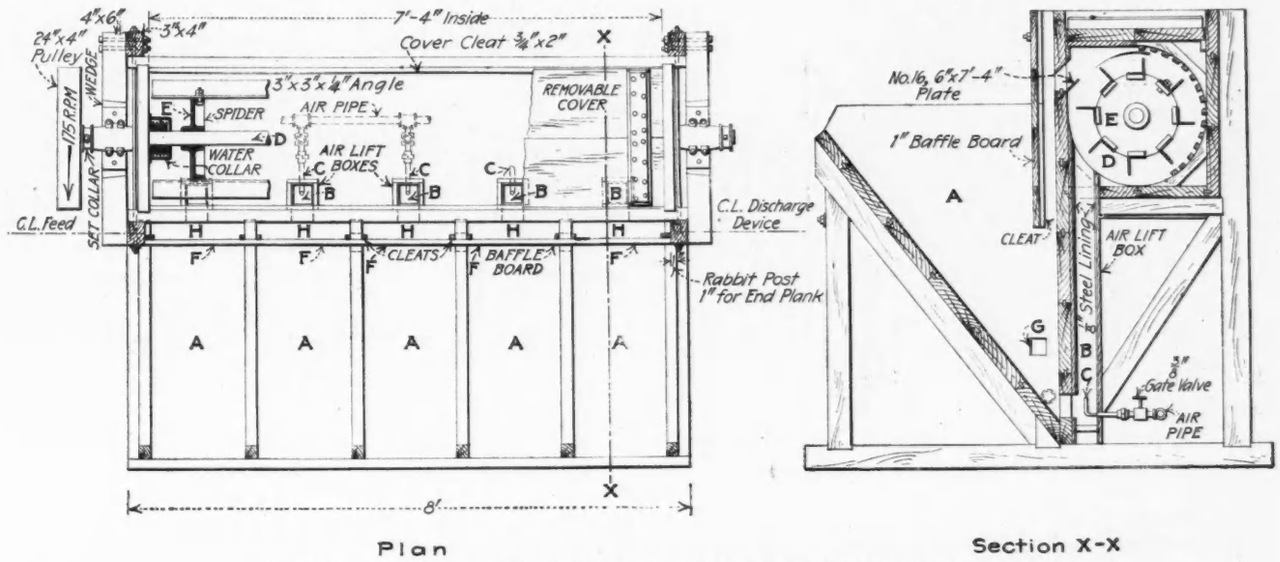


FIG. 1. PLAN AND SECTIONAL VIEW OF ZEIGLER FLOTATION MACHINE

The Zeigler machine can be operated either as a deep- or a shallow-froth machine. On slimes a froth bed eight inches deep is used as a maximum, while on granular pulps a froth bed as shallow as two inches is carried. The froth resembles that obtained on pneumatic machines. By changing the speed of the agitator shaft so as to get a quieter- and slower-discharging froth, the Zeigler machine can be made to serve as a "cleaner"; by running it faster and making the action more violent, it becomes a high-capacity "rougher." By operating the machine quietly, lead concentrates as high in grade as those obtained by the use of specially designed "cleaner" cells were won from an ore that, owing to the character of the gangue, under other conditions failed to yield a clean concentrate.

five to six horsepower to operate the machine. The only part that is likely to give trouble is the impeller shaft, and that rotates at a comparatively low speed. Several of the machines have been working more than a year without showing any pronounced weakness in design or construction.

In the Cœur d'Alenes, ores of the same general character often react differently with the same flotation agent, but most of the lead ores give good results with No. 5 G. N. S. pine oil. This is the only oil used at the Bunker Hill & Sullivan, the Hecla, and the Tamarack mills. At the Hercules it is also the only oil, with the exception of a small amount of hardwood creosote that is added at the "cleaner" cells of the Janneys which take the reground tailings from the tables (treating original feed and reground middlings). It is also the only oil that is used at the National mill to float the copper

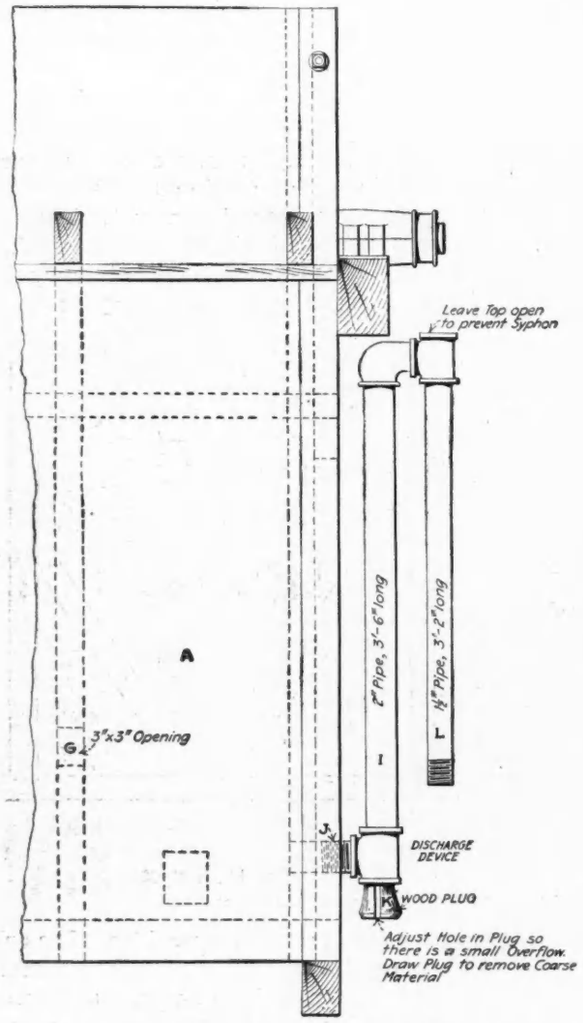


FIG. 2. PULP DISCHARGE END OF ZEIGLER FLOTATION MACHINE

minerals occurring as chalcocite, chalcopyrite and native copper.

No. 5 pine oil is used with other flotation agents in lifting the zinc mineral at the Interstate-Callahan and the Success mills. In one of the Crerar-Hewitt tailing plants it is used to float the lead and froth the pine-tar oil later used in lifting the zinc. On the other hand, the lead ore at the Gold Hunter mine will not float well with any of the several Southern pine oils, and tests have shown that hardwood creosotes (Cleveland-Cliffs No. 2 and oils of like nature) give much better results.

The next oil in importance in the district is a pine-tar oil of which a typical brand in use is No. 350 Pensacola. This oil is used at the Interstate-Callahan, the Success, and, to a certain extent, at the Morning mill, as well as at one of the Crerar-Hewitt tailing mills. It is mixed with No. 5 pine oil and acts as the collector in raising the zinc. In some of the mills coal-tar is added in small amount either to No. 5 pine oil or to No. 2 Cleveland-Cliffs, with the purpose of increasing the flotability of the galena, but great care has to be exercised in its use, or too much blende or gangue rises along with the galena. Where a coal-tar oil is used, it is one that is produced by the Spokane gasworks. No. 8 G. N. S. oil is used at the Morning mill rather than Pensacola 350, as it appears to lift the blende somewhat better than Pensacola. When the Morning No. 2 mill was being operated, Pensacola No. 400 in small amount was used instead of No. 350 whenever it was inconvenient to obtain No. 8 G. N. S. Pine-tar collector oils such as Nos. 8, 350 and 400 are used only at the mills where zinc is being floated, and none of them is used to lift lead.

Chemicals Used

The chemicals used in connection with froth flotation in the Cœur d'Alene mills are copper sulphate, sulphuric acid, sodium sulphide and lime, and these, with the exception of the lime, which is employed at the Hercules mill to settle the lead concentrates from flotation in the Dorr thickener that feeds the Oliver filters, are used almost entirely at the mills where zinc is being lifted. Copper sulphate is at present in use only at the Interstate-Callahan mill. It is expected that copper sulphate will be used at the Crerar-Hewitt tailing plant to bring up the blende with a minimum proportion of gangue. Until recently copper sulphate was also utilized at the Hercules mill for the purpose of obtaining a cleaner galena froth from the Janney machines (treating reground middlings). Sulphuric acid is employed at the Morning and Success mills, the object being to prevent siderite, white mica and other gangue minerals from being lifted with the zinc. Sodium sulphide is used at the Crerar-Hewitt and the Hayes tailing mills for sulphidizing the feed when oxidized minerals are present. Lime is used at the Hercules in settling the flotation concentrates in the Dorr thickener. At the other mills nothing is used at present to break down the flotation froth other than high-pressure water sprays or No. 5 pine oil in small quantities.

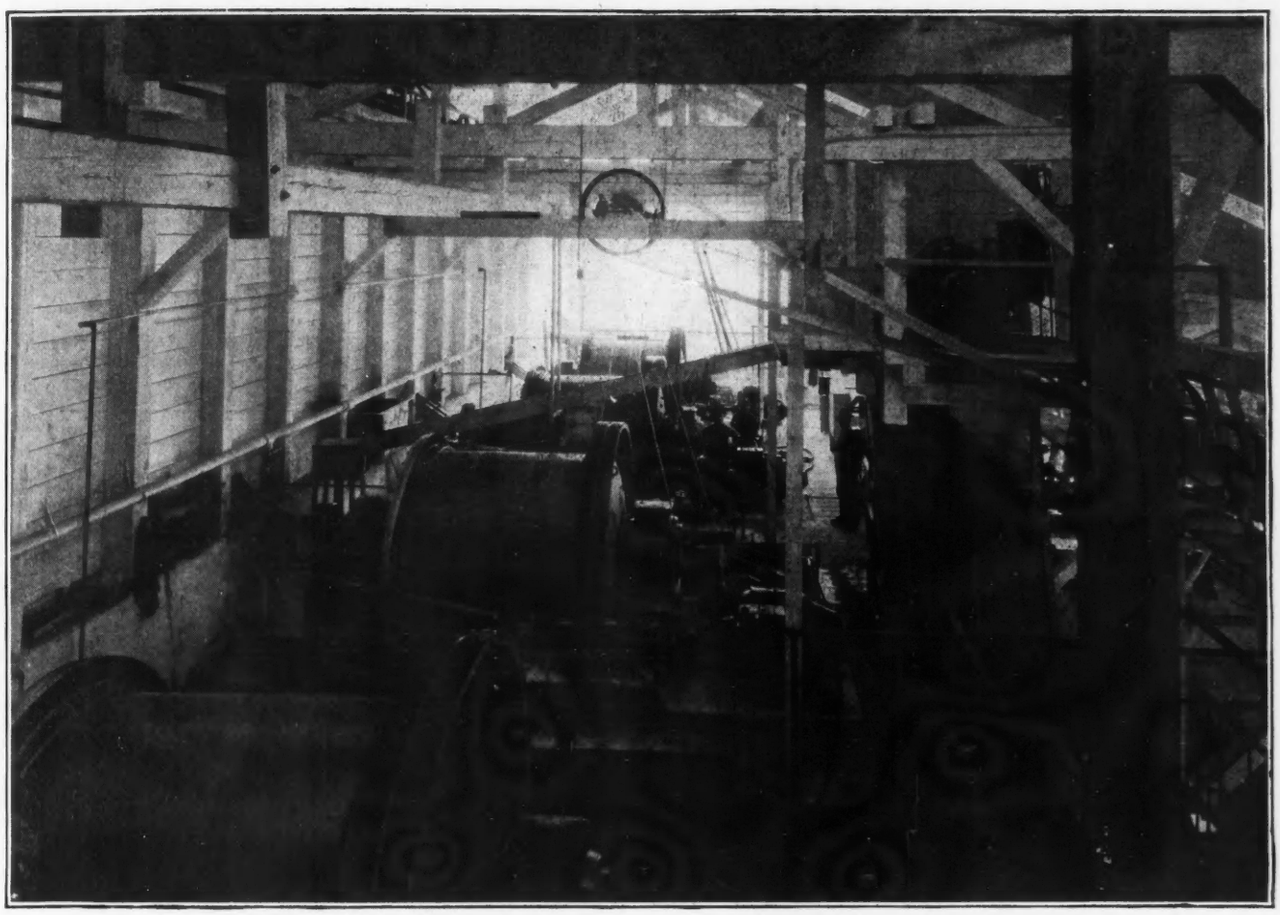
Fine-Crushing Increasing in the District

Flotation was first used in the lead mills of the district to secure the galena that escaped from the vanners and fine tables. This it has accomplished so well that many of the mills have discarded their vanners, and with the exception of the Bunker Hill & Sullivan mill, those that continue to use vanners are planning to discard them in the near future. At the Bunker Hill & Sullivan mill the mill pulp is closely classified, and granular material is treated upon tables and vanners, while the very fine slime pulp goes to flotation units.

At the other mills of the district there has been a steady increase in the amount of feed that has been sent to the flotation machines. There is a well-marked tendency to regrind the table middlings and to send the resulting product to the flotation units. For a while Hardinge conical mills usurped the fine-grinding field in

the district, as the first tube mills put in were equipped with smooth liners and did not operate satisfactorily. In the Hardinge mills, El Oro liners were used, and so a satisfactory crushing effect was obtained. The necessity of using rough liners in the ball- and tube-mills is now appreciated, and ball-mills are being used more and more in the district. Either white-iron or manganoid liners are used, according to the hardness of the ore that is being fed to the mills, and the crushing is done either with ordinary white iron balls, manganoid balls, or pebbles. Adamant blocks have been tried at the Morning mill with fairly satisfactory results, both in the Hardinge mills and in the tube-mill (now equipped with ribbed manganese liners, the conical lining once put in it having been taken out). Eucalyptus wood has been tried as a lining in a ball-mill in one of the mills and diluted by the return middlings to 3 to 1 before going to the flotation cells.

The standard size for the Dorr thickeners at the Hercules mill is 30 ft. in diameter by 6 to 10 ft deep. One of the Dorr thickeners, however, is 70 ft. in diameter. At the same mill some of the smaller Dorrs have been erected three high, one above the other, and at the Gold Hunter two Dorr thickeners have been placed one above the other. At the Morning mill an innovation in Dorr construction has been made by building a Dorr thickener 50 ft. in diameter directly upon the ground as a foundation, making the leveled-off ground the bottom of the thickener. No trouble has been experienced from seepage, and a considerable saving was made in the first cost of the tank. In the 60-ft. Dorr at the Hercules mill, instead of scrapers a revolving screw is



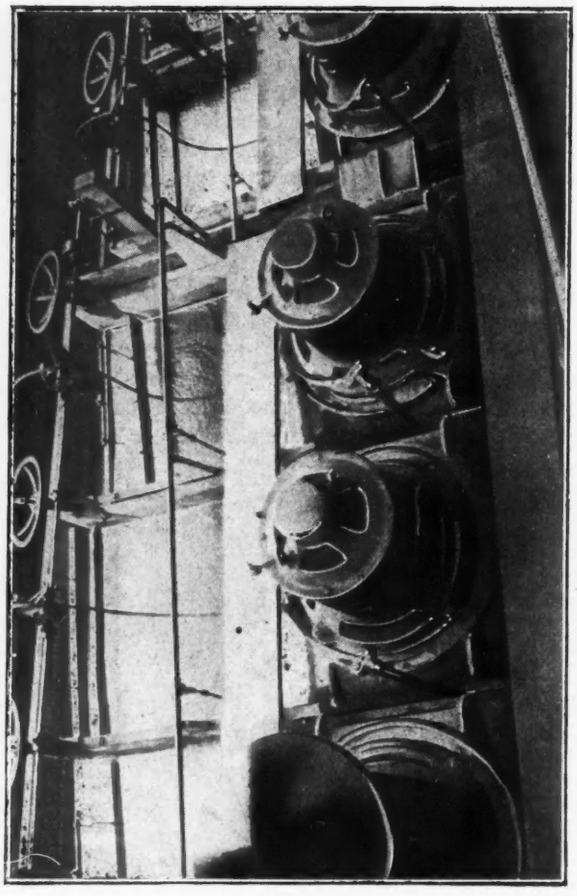
CHALMERS & WILLIAMS BALL-MILLS AT THE HERCULES MILL, WALLACE, IDAHO

of the district at the earnest solicitation of a dealer who handled that wood, but it wore out in six days.

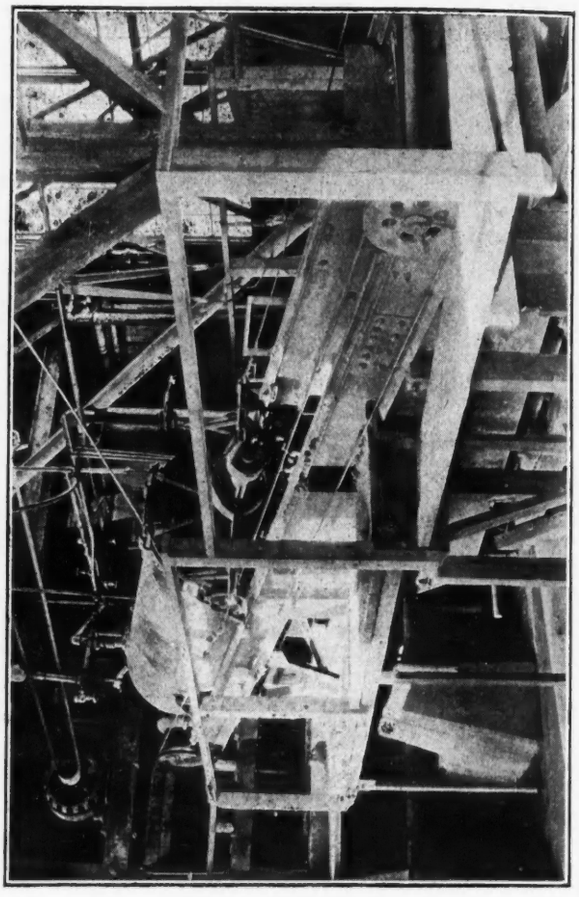
The ball- and tube-mills range in size from five to eight feet in diameter and from four to ten feet in length. One of the mills at the Hunter is 14 ft. long, and pebbles are used. The cylindrical mills are of Power and Mining Machinery, Chalmers & Williams and Marcy make. The pebble or ball-mills, whether cylindrical or conical, grind in closed circuit with the tables and drag classifiers. The overflow from the drag classifiers, after being tabled, goes to Callow cones or Dorr thickeners, where the pulp is settled and sent to the flotation machines at a dilution of 4 to 1. At the Bunker Hill & Sullivan the pulp is drawn off from the Dorrs at 1 to 1 used to feed the thickened pulp to the center, and this is carried by a small motor that travels on an inclined track supported by the top of the tank. The tank, which is built on a concrete bottom, was put up by erecting a form for carrying the metal lath reinforcement and the use of a cement gun to build the sides. This "gunite" thickening tank has been in use now for several months, and has rendered excellent service.

Where Flotation Agent Is Added

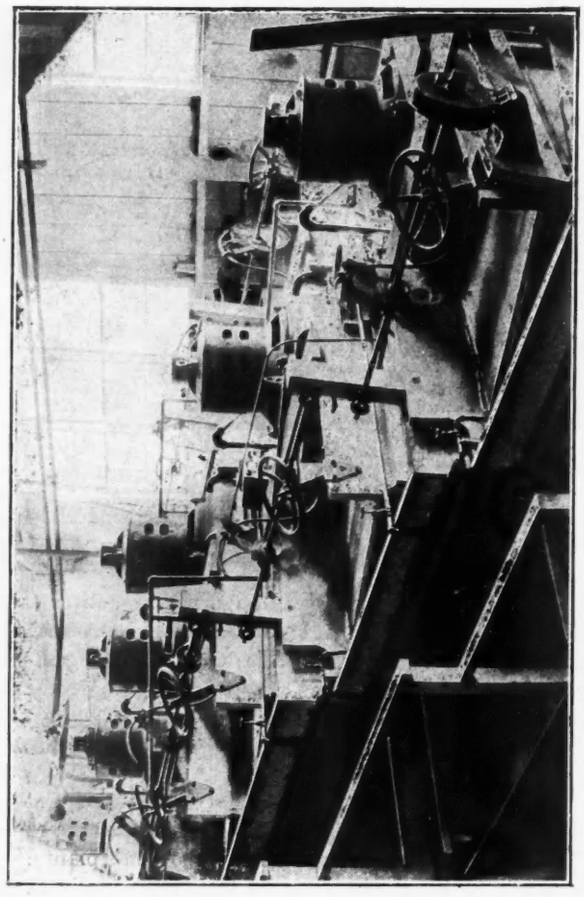
The oil is added to the pulp either at the centrifugal pump which takes the thickener pulp from the Dorrs or at the pachuca that is used at most of the plants. It is generally added at the pachuca and occasionally at



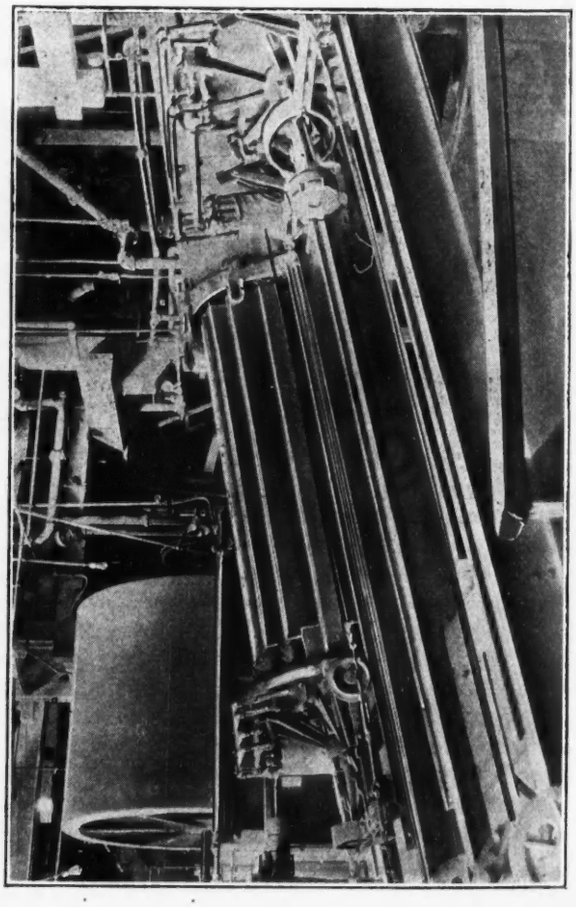
TOP VIEW 5-CELL DOUBLE-SPITZ JANNEY FLOTATION MACHINE, HERCULES MILL



KELLY FILTER AT THE NATIONAL MILL



DOUBLE-SPITZ JANNEY FLOTATION MACHINE, HERCULES MILL



KELLY AND OLIVER FILTERS, MORNING NO. 1 MILL

both points. Where the pulp goes to Janney machines, addition of the flotation agent is effected in the special cell with which each unit is equipped. At two of the mills in the district a froth is taken off at the pachuca. At one mill in the district, the Gold Hunter, where Callow machines are used, the flotation agent is added directly to the "rougher" cells through the return from the "cleaner" cells. Just as good extraction has thus been obtained as where the flotation agent was added to the feed in the pachuca. At the Bunker Hill & Sullivan mill oil is added to the pulp at the centrifugal pump that takes the pulp from the thickeners to the flotation machines, and the admixture is completed in larger Bunker Hill or Zeigler machines, while at the same time a high-grade froth is obtained. From the "rougher" mixing machines the pulp then goes to Callow cells for the roughing-off of a concentrate, which is later cleaned in an eight-cell Bunker Hill & Sullivan cleaner.

Number of Flotation Machines in Use

Of the several different machines favored in the district, the Callow cells are used principally for handling the slimes, while Janney machines are installed when there is much granular material in the flotation feed. There are nine Callow machines at the National, half of which are at present shut down, as only half of the mill is being run; 18 at the Morning, 12 at the Gold Hunter, eight at the Hercules, eight at the Bunker Hill & Sullivan, 18 at Morning No. 2, eight at the Greenhill-Cleveland, four at the Sweeney, and one each at the Hecla and the Hayes tailings mills at Pine Creek. At the Hercules there are 30 Janney cells, at the Morning No. 1, 20 cells; at the Ray-Jefferson six, at the Greenhill-Cleveland four, and at the Interstate-Callahan 16 cells. The only other machine that is used in more than one mill is the Zeigler, three of which are used at the Success mill, one at the Bunker Hill & Sullivan mill, one at the Hayes tailing mill and two at the Silverado mill (now closed down).

Details of Callow Cell

An eight-cell Callow machine, 10 ft. long by 2 ft. wide, will treat from 50 to 75 tons of slime in 24 hours under ordinary conditions, and requires from 150 to 175 cu.ft. of free air per minute per cell. The air is supplied by either Connellsville or Root blowers of small size and at pressures ranging from six to nine pounds per square inch. At the machines, an air pressure of about 2½ lb. per sq.in. at the head-end and 3½ lb. at the discharge end is found efficient.

The Janney Machine

The Janney machines require between six and seven horsepower per cell under ordinary conditions of pulp and load, and 400 tons of feed can be treated in a seven-cell rougher of the modified single-spitz form, such as is used at the Morning mill. A froth thickness of about one inch is carried on the "rougher" cells of the Janney machines and about eight inches upon the "cleaner" cells.

The froth carried on the Callow cells varies with the ore. In treating blende, a froth about 12 in. deep is used; in treating lead ores, the depth of froth used varies with the different ores, according to the readiness with which they can be cleaned. For example, at the Hercules mill a froth of only about four or five inches in thickness is carried, while at the Gold Hunter mill the froth is from 10 to 12 in. deep and at the Morning 12 to 14 in. Whenever siderite or siderite and blende occur in the ore, a deep froth must be carried in order to obtain a clean galena froth.

The usual practice is to regulate the water level on the Callow machines by means of a floating pan that controls a needle valve in the discharge, but more and more of the mills are adopting positive control of this important feature in the operation of the cells.

At a few of the mills the oil is dropped into the pulp by feeding devices, but usually, as the oils used are easy-flowing, such as No. 5 pine oil and No. 2 Cleveland-Cliffs creosote, a can with a stop-cock at its bottom drips the oil into the pulp.

Cleaning the Flotation Concentrate

The practice in the district is to lift a rough concentrate upon the first machines and then to send the float from two "rougher" machines to a "cleaner," the "rougher" machines making a tailing while the bottom discharge from the "cleaner" machines is returned to the "roughers" for retreatment. The lead tailings go from 0.5 to 0.7% lead where the fire assay is used and 1 to 1.2% lead at the mills where wet assays are made. The flotation feed varies in the different plants, but it ranges between 4 and 6% lead. The concentrates made on the Callow machines range between 40 and 45% lead and carry from 5 to 6% zinc. There is usually only 1% zinc in the mill feed. In the mills where there is much zinc in the ore, it is difficult to get galena concentrates from flotation that carry less than from 11 to 12% zinc, and often the zinc is higher. Whenever there is much zinc or siderite in the ore, the froth is drawn off from the Callows only along the last two feet of their sides. This gives the froth a better chance to stratify itself in the cell, and so causes a cleaner galena to come off.

Seldom is anything done to break down the froth between the "roughers" and "cleaners" other than to spray it with high-pressure water, but at a few of the mills No. 5 pine oil in small quantity is dripped in to accelerate the operation. In the "cleaners" the dilution is about seven to one, although this varies in the different mills. The principle followed in cleaning seems to be to lift the concentrate in a cleaner pulp, so as to get less entanglement of the gangue particles in the froth as well as less of the finer blende or galena (depending upon the making of a galena or a blende concentrate). At some of the mills the froth concentrates are sent to gravity tables to be cleaned as best they can, but little is usually accomplished by this tabling, owing to the fine-grained character of the feed.

The cleaning practice of the district seems crude to me. At the mills treating ore low in zinc, it is easy to keep within the zinc penalty, but at those where there is much zinc in the lead ore, where differential flotation is practiced, or where much lead or siderite occurs with the zinc, there is room remaining for improvement. The blende that rises in the lead froth and the galena and siderite particles that rise in the blende froth are usually extremely minute in size, and it would seem as though lower than 12% of either could be obtained by breaking down the froth completely before lifting it again.

The froth concentrates are settled to a consistency of from 50 to 60% moisture in either Callow tanks or Dorr thickeners, in most cases in Dorr thickeners, and then filtered. Considerable trouble is experienced with wood pulp in the ores, both at the Callow cells and especially at the Dorr thickeners, where the wood pulp causes trouble by stopping the spigots. At several of the mills this trouble is avoided, and the possibility of coarse sands reaching the flotation plant prevented, by sending the pulp through guard screens that range in size from 20 to 40 mesh. But this wise practice is not as generally followed in the district as it should be. Another method of avoiding the wood-pulp trouble at the Dorr thickeners is to use a large spigot and discharge intermittently by the automatic opening and closing of the valve, as is done at the Bunker Hill & Sullivan mill. When coal tar is added to the oil in order to lift the lead, some trouble is experienced in breaking the froth down at the Dorrs, but usually the froth will dissipate of its own accord as soon as it has reached a thickness of a foot or more. At the Gold Hunter mill a special device had to be put in to scrape the froth off the Dorr handling the froth concentrates. At the Hercules mill slacked lime is added to the thickener feed to break down the froth.

Filtering the Flotation Concentrates

The Oliver filter is extensively used. Almost all the Olivers are six by eight-foot machines. At the National and the Morning mills Kelly filters are used, but these require the attention of one man when they are running, and are not therefore economical in small installations where only 15 to 30 tons of concentrates are filtered in 24 hours. A vacuum of 22 in. is used on the Olivers, and a cake with from 8 to 11% moisture obtained. Some trouble has been experienced in keeping the heavy lead concentrates from choking up the pulp hopper when the filter has had to be shut down for any reason, but this has been overcome in several ingenious ways. One of the best of the methods has been developed at the Hercules mill. At this plant the agitator shaft is belted independently from the rest of the machine, and speeded up to 86 r.p.m. The agitator blades splash the concentrate pulp, which is carried low in the pulp hopper, up against the filter cloth.

The American Filter

Recently a new filter, the American, has been introduced into the district. This filter is used at the Hayes tailing mill near Pine Creek and is being subjected to a severe test, as the froth produced in the experimental work at that mill is difficult to filter. The filter consists of a series of vertical filter disks four feet in diameter, carried on a horizontal shaft. Each disk is divided into eight pie-shaped filter plates. The filter segments consist of a filter cloth loosely stretched over a pipe frame, a wire screen being used for keeping the two canvas filter surfaces apart while suction is on and the cake is being formed and dried. Each of the filter frames connects through a pipe with the control valve carried at the end of the shaft. As the shaft rotates, the frame is put under vacuum, thus forming the cake while submerged in the pulp hopper. The suction remains on, drying the cake as it emerges and until the scrapers for removing the cake are reached, when a pressure of a few pounds per inch is blown into the frame and the canvas bellied out against the scrapers, which knock the cake off, letting it drop into the cake hopper, which is under the overhang of the disks on the discharge side. A cake is formed on both sides of the filter leaves. The disks are placed at 12-in. centers along the horizontal shaft, and as many of them are mounted on the shaft as is necessary to give the machine the capacity desired. At the Hayes mill the machine has three disks.

Conclusion

There are two great flotation possibilities ahead in the district, the tailings piles at the Sweeney and Bunker Hill & Sullivan mills and the tailings that have been impounded just above Pine Creek and have accumulated during the last 15 years. The problem of treating the tailings is being attacked in an experimental mill, which is now treating from 30 or 40 tons per day, by the Hayes company, composed of some of the larger operators of the district. As yet the experiments are confined to floating the lead, and that is particularly difficult, as there is much wood pulp, sewage and flocculent matter in the feed. In addition, the tailing material has undergone oxidation. The wood pulp is so fine that it is almost impossible to screen it out of the feed going to the flotation machines, and when it comes in contact with the oils it appears to absorb them and causes much other trouble. It is thought that when the wood-pulp difficulties are solved, the rest of the problem will be comparatively easy. There is a large tonnage of imponded tailings, and their content is estimated to be 3% in lead and zinc.

It is difficult to say just what is the actual cost of flotation in the Cœur d'Alenes, but it costs between 15 and 20c. per ton of feed when floating one mineral, and about 25c. per ton of feed when floating two minerals differentially. This statement applies only to the thickening, floating and filtering, and does not include the cost of fine-grinding.

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Flotation in Arizona

BY RUDOLF GAHL*

The flotation treatment of copper ores of the disseminated type has grown to large proportions. Improvements of a mechanical nature are steadily being made, but the broadening of the field of flotation to include the treatment of mixed and oxidized ores is only slowly taking place. The article that follows is a review of the recent developments in flotation practice in Arizona. It covers mechanical improvements, the treatment of oxidized ores and leaching-flotation practice.

SINCE the Inspiration company in 1915 adopted a flow sheet for its copper concentrator in which flotation forms the backbone of the treatment and in which separation of the copper minerals according to their specific gravity plays only a secondary part, other Arizona copper producers have followed in its steps. At first a small company, the Stoddard Mining Co., erected a mill, with the assistance of H. Kenyon Burch, of Miami, Inspiration and Verde-Extension fame. Later the Miami Copper Co. remodeled several of its sections along similar lines, and the Phelps Dodge Corporation is considering the application of the Inspiration system in its Bisbee concentrator, now under design.

When Flotation Becomes Vexation

In the Inspiration flow sheet, tables were retained for the retreatment of the granular portion of the flotation tailings. Since then some optimists have gone so far as to recommend the omission of these tables in future installations, arguing that still finer grinding of the ore would make them unnecessary. On the other hand, there are some heretics among the conservative mill designers who are not converted from the opinion that flotation should be auxiliary to the time-honored gravity concentration, and I am inclined to think that, in spite of all the advantages pointed out in favor of the new system and the eminent success of the plants using it, many a mill superintendent who operates one of these modern plants has weak moments, especially when things go wrong, when he loses copper in the tailings, or puts gangue into the concentrates, and when he digs into the clever treatises that have been written on the theory of flotation and does not find anything to help him out. In such moments of weakness he often wishes he had means of removing a goodly fraction of the copper from the ore before turning it over to the beautifully simple, although, in spite of all that has been written about it, at times mysterious flotation process.

Flotation Equipment

Turning to the subject of flotation equipment, what has largely determined the choice of a flotation machine in the past, and is determining it now, is the attitude, of those who have to make the decision in the matter, toward the all-important question of flotation royalties. If they are of the opinion that the question of alleged infringement of the basic patent of Minerals Separation will ultimately be decided in favor of the defendants, they will probably install one of the machines of the pneumatic type that does not utilize mechanical agitation; that is, they will select a machine in which the subdivision of the injected air is accomplished by blowing it through a porous medium. The best-known representative of this type is the Callow machine, and this is largely on account of the publicity which it has received in the infringement suit of Minerals Separation against the Miami Copper Co. The larger copper mills apparently look favorably upon the Inspiration flotation machine, as appears to be proved by the installation of these machines or of machines of their general type in the plants of Ray-Consolidated, Chino, Miami and Utah Copper companies. The flotation machine designed by David Cole and characterized by the tubular shape of the air-injecting apparatus is in use at the plant of the Cananea Consolidated Copper Company.

Janney Machine Popular With Companies Contesting M. S. Claims

Companies which are contesting the basic patent rights of Minerals Separation have been reported to be using to a certain extent the Janney, a beater type machine, and, I understand, successfully. The installation of this machine in other plants is perhaps handicapped by the uncertainty that is attached by many to the outcome of the Hyde patent case in which this machine is involved.

In the other camp of the flotation controversy, considerable effort has been made to improve the machine construction. The Standard Minerals Separation machine is now designed to be operated with a low-pulp level. In the same type of machine the rate of pulp circulation has been materially increased. As the pulp circulates faster than it discharges from the machine, openings are provided now which permit the excess of the pulp to flow back to the preceding compartments.

The Hebbard type of flotation machine, being installed by Minerals Separation, has, so far, not attained the success in Arizona which it has in Australia. An Australian engineer, trained under Hebbard, is endeavoring to repeat in this country the Australian success of these machines.

Cascade Flotation Machines

Minerals Separation is also attaching much importance to the type of flotation machine which utilizes air bubbles that are drawn into the pulp wherever it drops to a lower level. Machines of this character are generally designated as "cascade" machines, and have been used and are being used in Arizona and elsewhere in America for the recovery of "float" that gets away from the regular flotation machines. Their principal merits are that they require no power, little supervision and are subject to a negligible amount of wear. A device of this kind was used in the operation of the

*Metallurgist, Inspiration Consolidated Copper Co.; Miami, Arizona.

Inspiration test mill. A larger one was installed at the plant of the Arizona Copper Co. and has been described by Arthur Crowfoot[1]. Nearly every one that operates flotation machines has contrived some scheme of this kind for his plant. Very likely, however, the engineers of Minerals Separation were the first inventors, having been early in the field. In Australia, the success of this scheme (a design of which is known as the Seale-Sellshear flotation machine) is reported to rival even that of the Hebbard type. As far as its application to the prevailing types of Arizona copper ores is concerned, I am inclined to be skeptical regarding its prospects of replacing types now in successful operation for the primary treatment of the ore, although its usefulness as a scavenger cannot be doubted. Conditions with ores that float easily are more favorable for the application of the machine as a primary concentrator, and there may be a field for it in preferential flotation.

Among the machines that are admittedly utilizing the principles granted in the patent to Minerals Separation, the Rork and K. & K. flotation machines, originated by employees of the Phelps Dodge Corporation and in operation at various plants of that concern, appear to have been measureably successful.

Treatment of Oxidized Ores by Flotation

The flotation process, since its introduction into Arizona, has been successful and has been adopted in a number of plants. Not only ores of copper are treated now by flotation, but also many others, such as rare-metal ores like those of molybdenum. Nevertheless, it must be admitted that not all of the sanguine hopes placed in the process have been realized, at least not at present. I am referring especially to the expectation, which had been entertained even by many of our most conservative metallurgists, that the flotation process would find as wide an application for the treatment of oxidized ores as it has found for sulphide ores.

It is true that it has been applied commercially to the treatment of a sulphidized lead carbonate ore by the Shattuck-Arizona Copper Co. at Bisbee. The Salt Lake Station of the Bureau of Mines deserves the credit for working out this problem and for detailing one of its student metallurgists, Glen L. Allen, to assist in applying the results obtained by small-scale tests, made under O. C. Ralston's direction, to a commercial scale. Mr. Allen is now mill superintendent of the Shattuck-Arizona Co.

It is also a fact that the Magma Copper Co. has used, and I suppose is still using, hydrogen sulphide gas for the purpose of producing a coating of copper sulphide on the oxidized copper minerals which they are recovering. J. M. Callow[2] has published figures indicating that the process is a commercial success.

Nevertheless, the process has not found as widespread application as it would have if more ores had been discovered that are suitable for this treatment. I am not well informed regarding the flotation treatment of lead carbonates, but from whatever experiments I have made, and from what I have seen otherwise regarding the application of the process to the treatment of oxidized copper ores, I would be inclined not to recommend its general application except under unusual conditions. In making this statement I am not referring to the addition of certain sulphur compounds to the mill pulp, a procedure that has been found decidedly beneficial in several cases, as I ascribe this influence rather to an action on the mill water than on the mineral contents of the gangue.

Effect of Lime in Mill Solutions

Flotation operators are familiar with the effect of lime contents of the mill solution on the flotation results, and some may be equally familiar with the fact that it can be counterbalanced either by converting the lime contained in such water into a sulphur compound or by adding a soluble sulphur compound of a certain kind; for example, sodium sulphide or even calcium sulphide. I assume that this or a similar action in many cases explains the beneficial effect of the addition of sulphur compounds.

Where experiments with the "filming" process have not promised success for large-scale operation, the "leaching-flotation" process has often been tried. It consists, as hardly needs mentioning, of adding sufficient sulphuric acid (perhaps acids of other kinds may be substituted in certain cases) to the ore pulp, with the object of dissolving the copper contents, as far as they are soluble in the acid. After solution has been completed, precipitation is accomplished by some one of the different methods available for the purpose; for instance, the introduction of a soluble sulphide, the passage of the pulp through a drum filled with iron shot (Miami-Chino method), or the addition of finely divided iron. Flotation to recover the copper sulphide precipitate or the cement copper, as the case may be, follows the precipitation treatment.

One Disadvantage in "Leach-Flotation"

Rickard and Ralston, by the way, in their valuable book on flotation, credit me with being the patentee of the leaching-flotation process, so far as it is concerned with the precipitation on iron. As a matter of fact, only a modification that appeared useful to me is covered by my patent, No. 1,217,437. Many investigators, not only in Arizona but elsewhere, are trying to adapt a process of this kind to special ores. It seems the acme of simplicity and requires little additional equipment in plants where flotation is already in use. It is, however, not without its drawbacks. Perhaps the principal one is that, after the copper is precipitated, the separation of the concentrates from the pulp still remains to be done. The flotation process may serve well in accomplishing this, but it is not as simple as it might be. The introduction of the leaching and the precipitating agent into the ore pulp causes a material contamination of the mill water, and, although the addition of foreign substances does not always interfere, in fact has been beneficial in certain cases, I believe that, as a rule, contaminations of any kind are objectionable.

The very simplicity of a leaching and flotation treatment entails another disadvantage. The manner in which the leaching agent is added to the pulp is not conducive to the best extraction by leaching. Modern leaching practice, at least as far as copper is concerned, realizes more and more, if I interpret things rightly, that the movement of the leaching solution and the

[1]Eng. and Min. Journ., Apr. 14, 1917, p. 665.
[2]Trans. A. I. M. E., Vol. 56 (1916) p. 88.

ore should be in opposite directions (counter-current) to obtain the best extraction. It is undoubtedly true, as has been pointed out repeatedly by a past master in the art,[3] that the solution of the metal is a relatively simple individual step in the operation of a commercial leaching process. Still, this must not be taken to mean that with the leaching agent in widest use for copper-leaching purposes, namely sulphuric acid, the degree of extraction obtained is not influenced materially by the mode of its application. I know that it is for the ores and tailings which I have tried to leach. The explanation is probably that what we have to deal with are not clearly defined copper carbonates, but more complex minerals. Furthermore, the copper silicates that predominate over the carbonates in the ores of certain Arizona copper mines, as, for instance the Inspiration, are much more difficult to dissolve than ordinary carbonates. For these reasons more than one Arizona copper metallurgist has, in spite of the alluring opportunities that flotation offers for the treatment of oxidized ores, decided to concentrate his efforts on leaching.

Leaching, in connection with flotation, is admittedly not without difficulties of its own. When it is carried out after flotation, the treatment of the tailings slime presents the biggest problem. The decantation process appears to be the only solution. Apparently the realization of the fact that it must be done at an extremely low cost, and with pulps that do not settle as well as might be wished, has so far prevented men like J. V. N. Dorr, who have done pioneer work in applying decantation methods to precious-metal ores, from applying their experience to the treatment of copper ores. On the reverse procedure, of leaching first and floating afterward, R. C. Canby, I believe, at one time conducted some experiments for the Miami Copper Co., and Frederick Laist, at Anaconda, has developed a method of this character with so much success on a small scale that it is, I understand, being considered or being tried out for the purpose of treating the ore from the Potrerillos orebody of the Andes Copper Co.

Advance in Flotation Methods

An advance in flotation methods is represented by the treatment of granular material, as practiced at Inspiration. Table middlings are, without regrinding, treated by flotation machines. While it is generally considered that ores, to be suitable for flotation in agitator or porous blanket machines, should contain a certain amount of slime, the treatment of de-slimed ores is foreshadowed in certain Minerals Separation patents.[4] I have, however, not heard that a practical application of the principle has been made elsewhere. Even de-slimed table tailings are treated in this manner at Inspiration in an experimental way.

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[3]L. D. Ricketts.

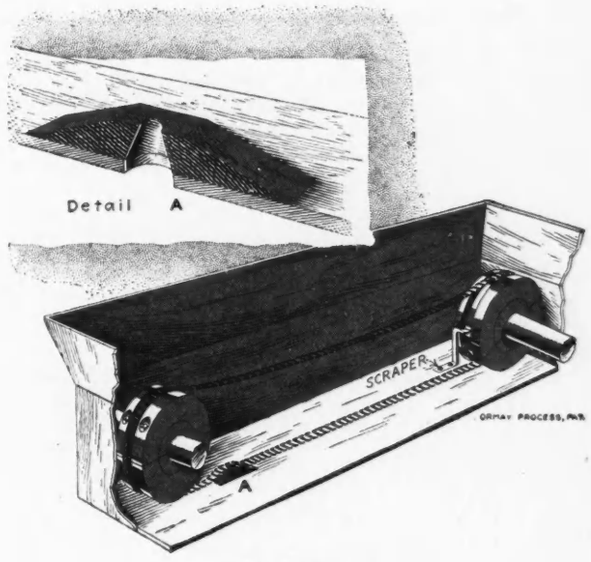
[4]A. H. Higgins, U S. Pat. Nos. 1,236,933 and 1,236,934.

A Convenient Soda Feeder

By Algernon Del Mar*

In flotation work an acid or neutral pulp must sometime be rendered alkaline to obtain the best results, and it has been found by experience (at least in some cases) that the reactions induced by soda in the solid form (powder) are more efficacious than an aqueous solution. As the soda should be added regularly, a simple feeder that any mill mechanic can make may interest those who may now be adding the chemical by hand.

Two wood pulleys 8 in. in diameter are mounted in a box and revolve at 10 to 20 r.p.m. On the pulleys is



SODA FEEDER

stretched what is known to the trade as a ladder chain, light and inexpensive. In the bottom of the box is a half-inch hole directly under the chain. Over this hole is tacked a strip of wood with a conical hole *A*. The chain scrapes on the wood and keeps the hole open. This precaution is necessary because when soda is exposed to air it absorbs moisture and will not run. A simple bucket elevator might be used for the purpose, but the bucket would fill up and so be inoperative. The feeder illustrated works well. It is necessary occasionally to stir the soda in the box. Against each pulley is an iron scraper to clear the groove on the pulleys so the chain will ride properly.

Correction for Feed Troubles with Janney Flotation Machines

At some mills using the Janney flotation machine, where there is much material of a granular nature in the feed, trouble from choking of the spitz boxes by failure of the lifter pipes to suck up the heavier particles along with the slime has been overcome by putting air-lift pipes into the lifters to act as boosters. A simpler remedy consists of conducting the pulp from the spitz to the impeller chamber through a 6-in. pipe leading from the bottom of the spitz and connecting with the impeller chamber directly under the impeller shaft, where there is a strong suction.

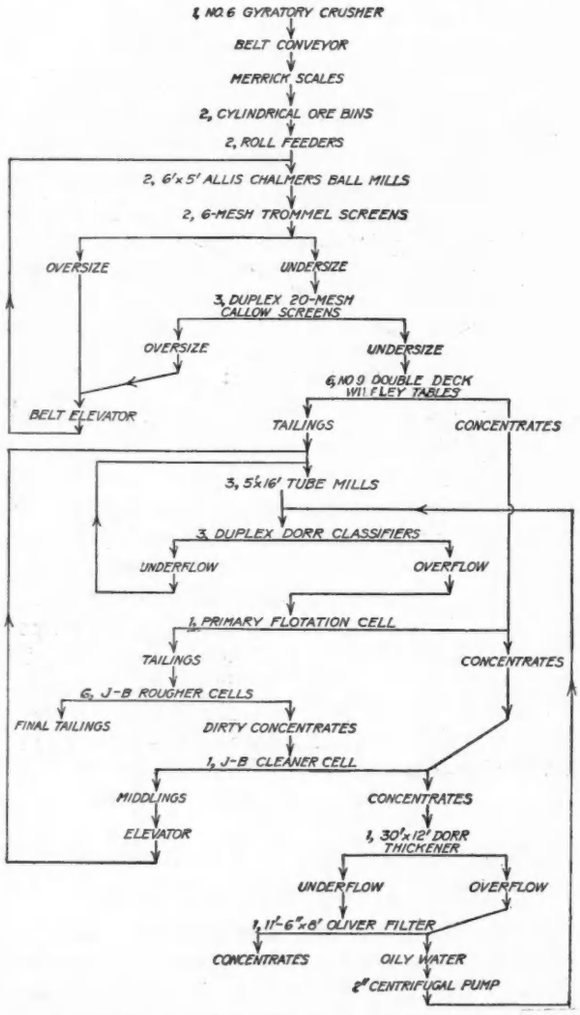
*Metallurgical engineer, Sandon, B. C.

Flotation at Belmont Surf Inlet Mines

BY A. H. JONES*

After prolonged tests to determine the proper flow sheet for the new mill at the Surf Inlet Mines of the Tonopah Belmont Development Co., a process was adopted involving gravity concentration followed by regrinding and flotation. The Jones-Belmont flotation cell was developed by Mr. Jones in the course of this work, and it is said that the device has given general satisfaction.

THE oil flotation process has called forth much discussion in regard to surface tension, critical contact area, electro-magnetic influence, chemical affinity, etc., and many of these matters will still be in controversy after the process has been superseded by something else. A thorough comprehension of all such detail, however, is not necessary to the operator, and I will confine myself to the subjects of the preliminary testing of the ore, the designing of a proper concentrating plant, methods and costs of operation, and the economical saving to be effected by the use of the flotation process.



FLOW SHEET AT BELMONT SURF INLET 300-TON MILL

It is only in rare instances that the total recovery attainable by gravity concentration cannot be increased by the use of oil flotation, either preceding or following the gravity concentration; and equally rare are the cases where the extraction by oil flotation cannot be improved by the use of gravity concentration at some stage in the milling process. Practical laboratory work, therefore, resolves itself into an effort to determine the highest economic recovery that can be obtained by gravity concentration, oil concentration, and a combination of both.

First, tests should be made on the ore by means of gravity concentration with stage crushing, to determine what recovery can be obtained by this method. Second, the ore should be ground very fine and treated by flotation, to ascertain the highest extraction obtainable and the oils most suited for the purpose. Third, many tests should be made to determine the most economical recovery that can be made with a combination of both methods. In arriving at a decision as to the best process to be used, the points to be considered are fineness of grinding required, ratio of concentration, costs of operation, installation, etc. In making such a comparison the fact should be borne in mind that it costs more to dewater and filter oil concentrates than gravity concentrates. The cost of installation will rarely be a deciding factor, because where the tonnage to be treated is large the difference in the cost of plants designed for any of the processes considered could hardly be great enough to warrant a cheaper installation when a more expensive one would insure a higher recovery.

In order to make this article entirely practical, from an operator's point of view, I will briefly discuss the laboratory experiments made on the ore from the Belmont Surf Inlet Mines, Surf Inlet, B. C., and the design and construction of the mill erected at that property.

GRAVITY CONCENTRATION ALONE UNSATISFACTORY

The Surf Inlet ore is a hard white quartz, carrying gold as the important metal, with a small amount of silver and copper, with iron and copper sulphide. Metallurgical work on this ore was started in 1915, and the various tests made in connection therewith are described as follows:

1. Gravity concentration in all its phases: The recovery obtained by gravity concentration was not satisfactory. The extraction could have been increased by cyaniding the tailings, but unless the concentration was thorough enough to remove practically all of the copper content, the consumption of cyanide was excessive. This process was therefore rejected, because in actual mill work unavoidable irregularities in table operation would make the results erratic.

2. Amalgamation and gravity concentration: No economic increase in recovery was obtained by amalgamation.

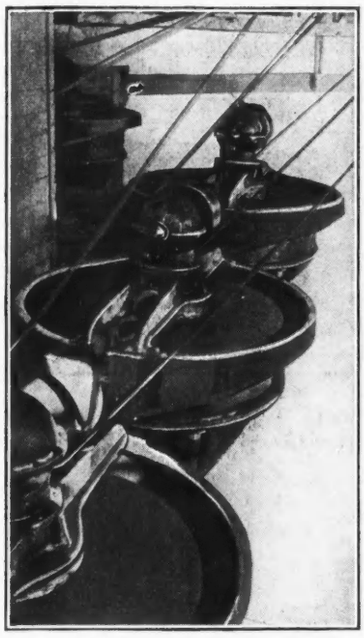
3. Roasting, leaching with acid, followed by cyanidation. The ore was roasted (sulphuric acid being made as a byproduct from the roaster gases), leached

*Superintendent of mills, Tonopah Belmont Development Co., Tonopah, Nevada.

with sulphuric acid to recover the copper content, and the residue treated by cyanide to recover the gold and silver. This treatment gave a satisfactory recovery, but was rejected on account of its complexity and because of the excessive cost of roasting at the remote site of the proposed plant.

4. Oil flotation: Flotation alone gave satisfactory recoveries and high-grade concentrates, but the percentage of recovery obtained from numerous tests made under identical working conditions was somewhat erratic.

5. Flotation followed by gravity concentration with one-stage grinding: The gravity concentrates made



EIGHT J-B FLOTATION MACHINES ARE USED

from the flotation residue were too low in grade to be shipped.

6. Gravity concentration at 20-mesh followed by regrinding to 70% minus 200-mesh and floating: Through this process was effected a satisfactory recovery, and consistent results were obtained from a great number of tests.

7. Gravity concentration at 20-mesh, regrinding to 70% minus 200-mesh and floating, followed by a second gravity concentration: This second concentration showed no economic increase in recovery over that obtained by process No. 6, as the product was too low grade to be handled

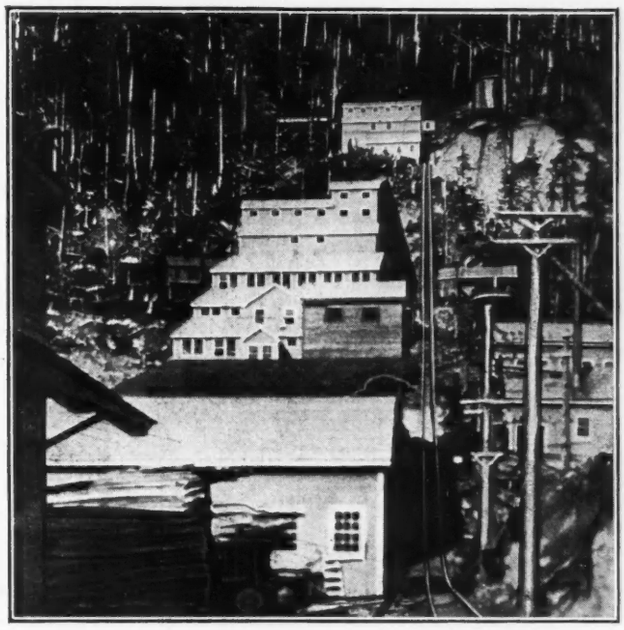
8. Selection of oils and other reagents: Final fixation of the flow sheet, in accordance with process No. 6, was followed by an exhaustive study of oils and other reagents. This investigation resulted in the decision to use 1¼ lb. of coal-tar mixture per ton of ore treated, this mixture being composed of 65% coal tar, 30% hardwood creosote, and 5% steam-distilled pine oil. It was also found that the use of approximately ¼ lb. of sodium sulphide per ton of ore treated would increase the recovery about one per cent.

Several long series of tests were then made, under conditions as nearly as possible like those to be expected in mill work, to determine whether or not the results indicated by the preliminary tests would be changed under actual working conditions. The residue from gravity concentration was reground for flotation in a small tube-mill, with oils and sodium sulphide added. The middlings from the cleaning of the flotation concentrates were added to pulp used in the following test, and the percentage of oily water that theoretically should be returned in mill operation was used over again in the succeeding test. These tests showed a remarkably constant extraction and indicated that return of the middlings made no appreciable increase in the value of the final tailings.

A great deal of experimental work was performed in an attempt to discover an economical method of recovering the bullion from the concentrates. Satisfactory results were obtained by subjecting the latter to a dead roast (making sulphuric acid as a byproduct from the roaster gases), leaching the roasted concentrates with sulphuric acid to extract the copper, and then treating the residue with cyanide to recover the gold and silver. Conditions, however, did not warrant the erection of this plant.

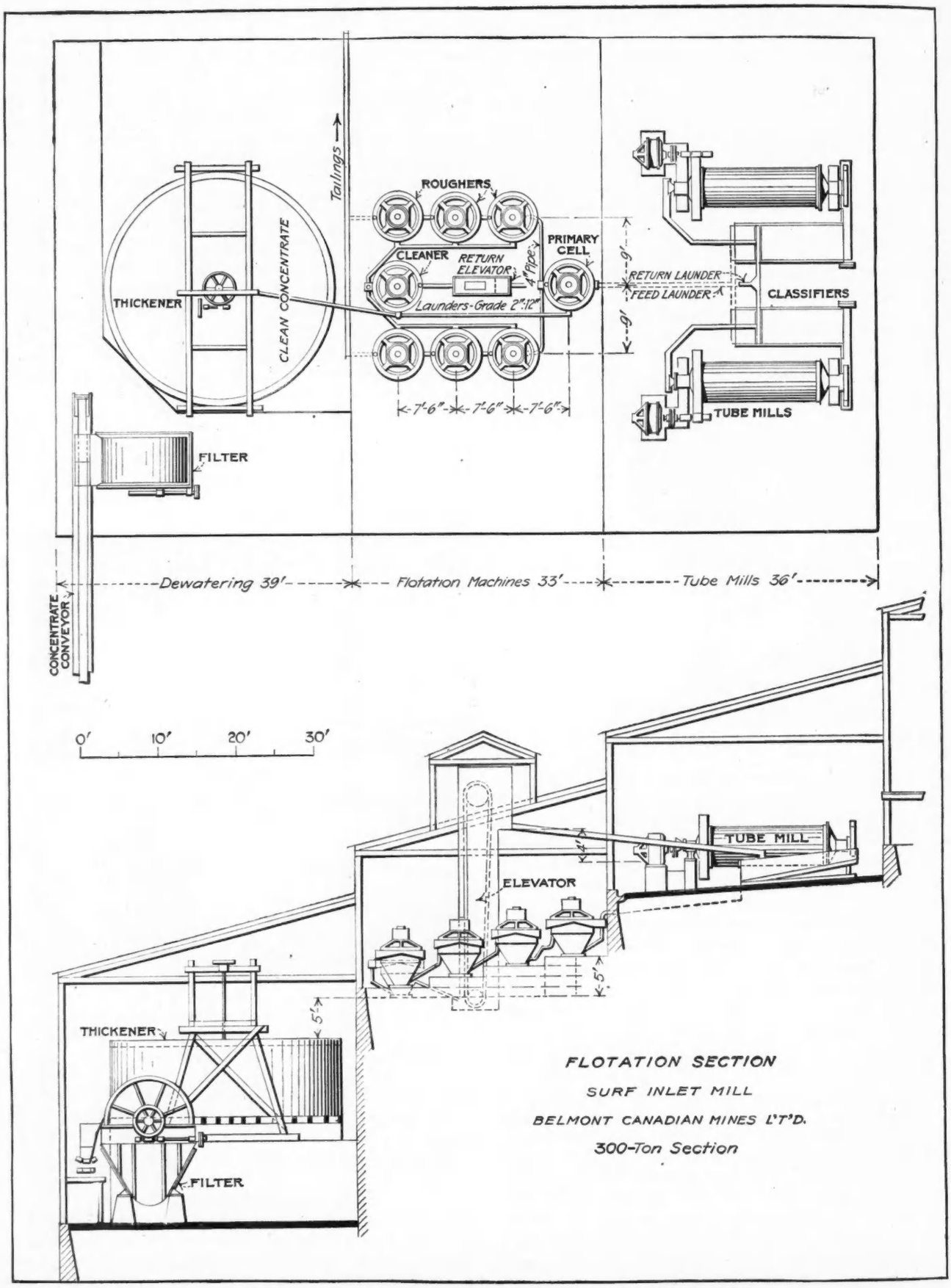
New Flotation Machine Designed for the Plant

As this Surf Inlet plant was to be the Tonopah Belmont Development Co.'s first installation of the flotation process, I made a tour of inspection of various flota-



MILL OF TONOPAH BELMONT DEVELOPMENT CO., AT SURF INLET MINES, BRITISH COLUMBIA

tion plants in Colorado, Utah, Nevada, and Arizona, from which I returned not entirely satisfied with the performance of any flotation appliance that I had seen. While each machine had some good points, it also had points of disadvantage. After careful consideration of all these appliances, it was decided to undertake the development of a machine that would eliminate as many as possible of the disadvantageous features and incorporate the advantageous characteristics of all the other machines. This endeavor resulted in the invention of a machine that was later patented under the name of the Jones-Belmont flotation cell. The performance of this cell at the Surf Inlet mill has been gratifying, as it gives a perfect circulation of the pulp



FLOTATION AND TUBE-MILL SECTION OF THE SURF INLET MILL

and a free delivery of the froth, with a very low power consumption, and requires practically no attention. At the present time the Tonopah Belmont Development Co. is making further installations of this machine in its 400-ton mill at Shawmut, Calif., and in its 300-ton Belmont Wagner mill at Telluride, Colorado.

The flow sheet finally adopted for the Belmont Surf Inlet mill is shown herewith. In accordance with this flow sheet, the mill was completed and operation started on Sept. 2, 1917.

Small Force Required for Operation

The entire mill operating force consists of two men on each 8-hour shift. One operator looks after two ball-mills and nine tables. The other operator, who also acts in the capacity of shift foreman, takes care of three tube-mills. eight flotation machines, one Dorr thickener, and one Oliver filter. These men assist each other in looking after adverse conditions that may arise in any part of the mill. Of course, this operating force is augmented by the usual indirect day force of repair crew, electrician, assayer, carpenter, blacksmith, etc., but a great deal of this labor is divided between the mine and the mill.

The following figures show the recoveries made by gravity concentration and flotation during actual operation: Head value gold, 0.6 oz.; gravity concentrates gold, 5.36 oz.; recovery by gravity, 47.8%; oil concentrates gold, 8.2 oz.; recovery by flotation, 44.4%; combined recovery 92.2%; insoluble 14%. The consumption and cost of supplies are detailed in the following table:

CONSUMPTION AND COST OF SUPPLIES AT SURF INLET MILL

		Quantity per Ton	Cost per Ton
Belting			$0.0006
Flotation	Pine oil	0.01 gal.	.007
	Coal tar	0.185 gal.	.053
	Creosote	0.105 gal.	.028
Steel balls		3.75 lb.	.36
Lining ball-mills			.085
Lining tube-mills (not yet determined)			
Pebbles		5.5 lb.	.125
Sodium sulphide		.15 lb.	.005

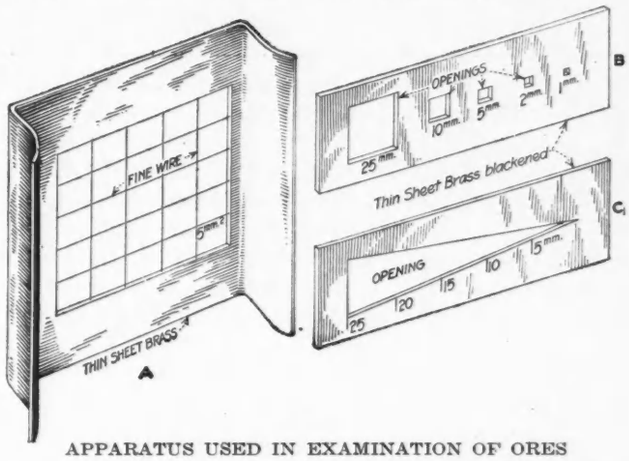
The ore treated is extremely hard, as shown by the high consumption of steel balls and flint pebbles, which makes the grinding cost unduly high, as compared with that of an average ore, not only in consumption of wearing parts but in cost of power and general maintenance.

Examination of Ores and Ore-Dressing Products

The superficial examination of ores and ore-dressing products requires only a few pieces of simple apparatus. For lumps of ore a coddington lense and either one or both of the brass plates shown in the figure (*B* & *C*) are convenient. The brass plate *B* is used for the determination of the size of the valuable mineral particles exposed on the surface of the ore. Plate *C* can be used for the same purpose, but is more useful for measuring the size of crushed particles of ore. A specific gravity balance, a magnet and a small blow-pipe outfit for determining minerals are accessories frequently required.

In making the examination, the different minerals are first identified, and next the size, shape and distribution of the valuable minerals are determined. The association of the different valuable minerals is studied in detail. The nature of the mineralization, whether massive, banded, fracture-plane, lamellar or disseminated, is noted. Determination of size and structure of the mineral aggregate is of importance. The identification and distribution of the different gangue minerals is next noted. This is repeated upon a sufficient number of selected specimens of the ore so that an average of the ore can be made. Where ore minerals are intimately associated, several surfaces are carefully polished and the mineral distribution is studied under a low-power microscope. Obscure minerals are etched.

Ore-dressing products invariably consist of broken particles of gangue and valuable mineral. With a given sample it is usually necessary to size the material and examine each size, although in the case of classified products already sized this may not be required. Dip samples taken by means of a small spatula are spread upon a glass plate and examined with a lense or, if they are coarse, with the unaided eye. A needle can be used to separate the different grains, middlings and clean



APPARATUS USED IN EXAMINATION OF ORES

gangue particles. By weighing each portion, the proportion to the whole can be determined. Separation by means of the needle is tedious and can be avoided by using the grating shown in *A*. In using the grating, a larger portion is taken and spread, by tapping the glass plate, in a uniform layer. The grating is laid upon the bed of grains. Several squares are examined, with a lense if necessary, and the number of different grains is noted. This is repeated upon several portions and an average struck which will give the approximate proportion of each differentiated product.

The method is effective for grains down to a millimeter in size. For finer grains, a microscope with an eyepiece grating is more suitable. The particles are examined by reflected light. In the absence of an eyepiece grating, a card ruled in 1 mm. or 2 mm. squares can be used. The grains are evenly spread and the ruled squares are usually visible. As in the previous case, the proportion is determined by counting the number of different grains in several squares and averaging the counts. The method is not as laborious as it sounds, and it is surprising how much valuable information of an approximate quantitative nature can be secured. A cheap dissecting microscope equipped with two coddington lenses, 19 and 33 mm. focal length, will answer for all physical examinations of this kind except when material finer than 80- or 100-mesh is to be examined. The work of jigs and tables can be readily checked up by an examination of the kind described. Chemical analysis of ore-dressing products can be avoided in a large measure by the method described.

Handling Flotation Concentrates at Utah Leasing Co.'s Plant

By H. H. ADAMS*

One of the details of the flotation process, the solution of which required considerable metallurgical skill, was the dewatering and drying of flotation concentrates. Crude devices were supplanted by equipment of recognized worth, and a practice was developed finally that satisfactorily accomplished the purpose. The article describes the installation and operation of a plant of this kind as applied to the treatment of cuperiferous tailings of low grade and limited quantity.

IN PREPARING flotation concentrates for filtering, the first essential is a suitable settling device. The Dorr tank is superior to anything so far devised for this purpose, especially where the concentrated product is of low specific gravity and contains considerable insoluble matter. In the case of ores the metallic content of which is in the form of galena or other mineral of high specific gravity, complete settlement may be obtained in tanks of square or rectangular shape, and by proper handling a shipping product containing 12 to 15% moisture may be obtained without recourse to mechanical filtering.

At the concentrator of the Utah Leasing Co., in southwestern Utah, where an ore containing only 14 lb. of copper to the ton is being treated by flotation, a filter plant as shown in the flow sheet below has been provided. An analysis of a recent lot sample of concentrates is as follows:

ANALYSIS OF CONCENTRATES, UTAH LEASING CO.

	Per Cent.
Copper	18.00
Iron	24.40
Sulphur	28.55
Insoluble	23.60
Lime	2.40
Alumina	1.30

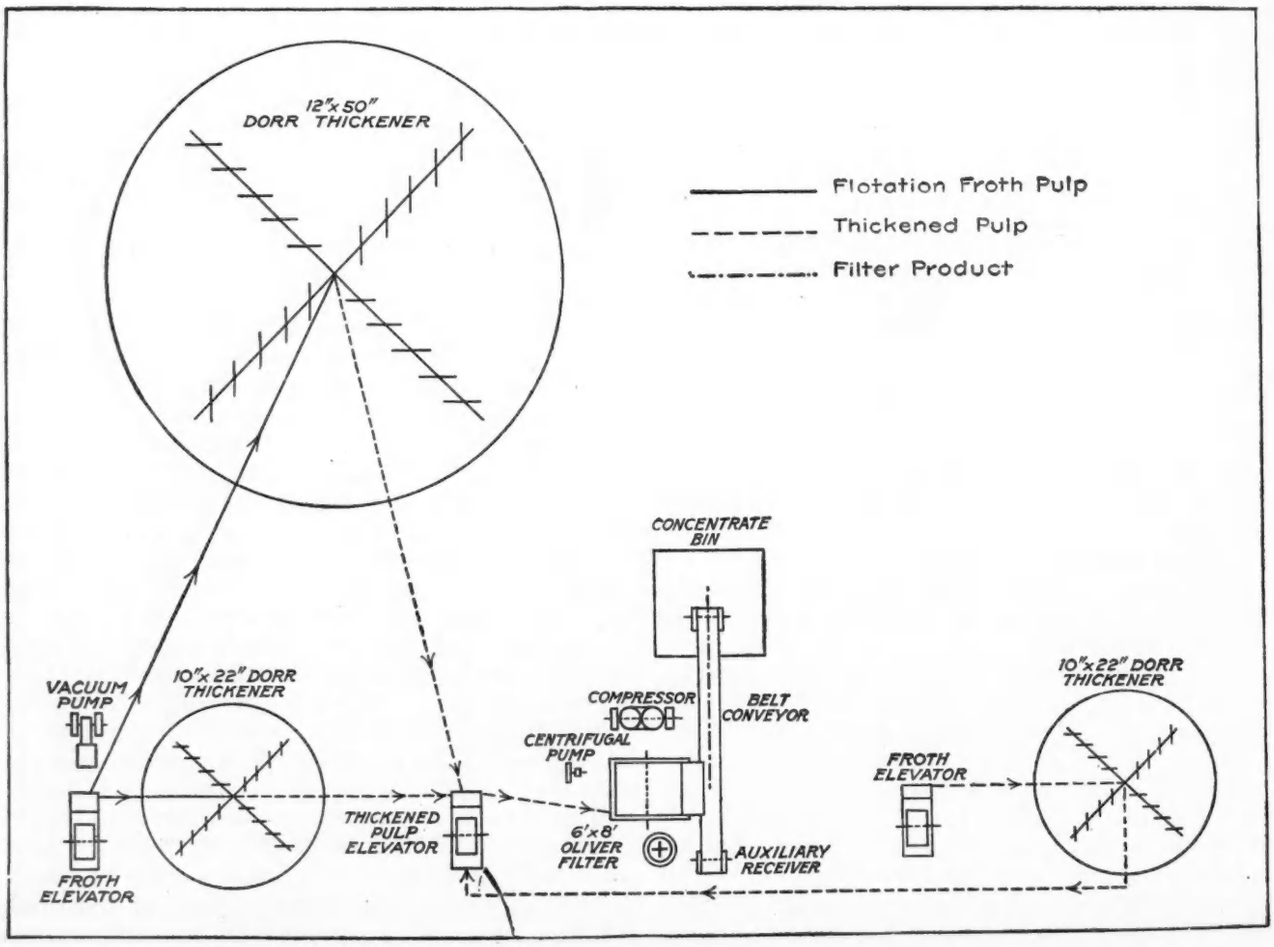
The screen analysis of a lot sample assaying 19.40% copper is given in the following table:

SCREEN ANALYSIS OF FLOTATION CONCENTRATE

Mesh	Per Cent. Product	Per Cent. Copper
+ 65	2	17.00
+ 80	4	19.60
+100	6	20.90
+150	4	21.70
+200	14	22.90
—200	68	17.90

It will be observed from the table that 68% of the

*Superintendent, Utah Leasing Co., Newhouse, Utah



CONCENTRATE SETTLING AND FILTRATION SYSTEM AT UTAH LEASING CO.'S MILL

concentrated product is minus 200-mesh, with a larger percentage of insoluable matter accompanying the fines than is shown to follow the plus 200-mesh product with the one exception of the plus 65-mesh material, of which there is only 2%. The entire difficulty of handling this concentrate, as concerns settling, thickening and filtering, varies with the per cent of minus 200-mesh insoluble material that it contains.

Arrangement of Equipment

From the flow sheet it will be noted that two 22 x 10 ft. Dorr tanks, installed in the mill building, and one 50 x 12 ft. Dorr tank, placed outside, have been provided for thickening the concentrates. This equipment is barely sufficient, at times, to give complete settlement, depending upon the character of the reagents used. The arrangement of settling tanks is such that concentrates from the flotation machine may readily be diverted from one to another, and the discharge from the three tanks is delivered to one bucket elevator and thence to an 8 x 6 ft. Oliver continuous filter. The thickening tanks are provided with baffles around the periphery extending from two to three feet below overflow and from one to three feet above. The froth becomes so heavy on the tanks indoors that it interferes with proper settlement, and it then becomes necessary to remove it with shovels. At times the froth will submerge in a heavy mass to a depth of five feet, with about 12 to 18 in. usually above the surface. It is necessary to use a spray at all times on the froth as it is discharged into the loading well of the thickener. In the tank outside, the froth breaks down readily from the action of the elements.

Bucket Elevators Not Fully Efficient With Thickened Flotation Concentrates

Operation has developed that the bucket elevator is not the most satisfactory appliance for elevating thickened flotation concentrates. Thickeners will discharge a product of such low moisture content that a bucket elevator will not handle it, and dilution with fresh water is necessary. At the same time it is self-evident that a dense pulp will filter more satisfactorily than a thin one. Thus, complying with one condition interferes with the other. It is evident that settling tanks should be so placed that their product will discharge into the filter tank by gravity, even at increased cost of installation.

In the operation of this plant the addition of unslacked lime to the pulp as it enters the filter tank is essential. It not only increases the capacity of the filter, but is also of beneficial effect in reducing the moisture in the cake. The amount of lime required varies widely and depends on the temperature of pulp, the density, and the percentage of insoluble material.

Heating the Pulp

Heating the pulp in the filter tank during the winter season by the introduction of live steam adds to the capacity of the filter and lowers the moisture content of the cake to a slight extent. A temperature ranging from 95 to 100° F. has been found most satisfactory. A variation of 10° from the figures mentioned has been found completely to nullify any good results. It has occurred to me that a satisfactory way to warm this pulp would be to set up a Callow cone and provide it with a series of steam coils extending from the discharge end half-way up the inside; the thickened product from the tanks to be discharged into the cone, and by the use of steam a warm pulp might be discharged continuously into the filter tank. Such an arrangement, however, would require more head room than is available in most plants.

Operation of Filter

In the actual operation of the filter, the observations that follow have been noted. A small hard wire, 15 or 16 gage, gives better service than a 10 or 12 gage wire for winding on cloth; it permits the scraper to ride closer to the cloth and thus to leave the outer surface of the cloth in better condition for the "blow." In handling a concentrate that is difficult to filter on account of the insoluble minus 200-mesh material, the best results can be obtained by setting the "blow" to begin approximately at the point of contact between the drum and the scraper. This will prevent any moisture remaining in the section of the filter from being forced back into the cake.

Use of Steam Advantageous

The application of steam for "blowing" the cloth is satisfactory and a pressure of 25 lb. is ample. The steam may be introduced at the same time as the air. The use of steam in connection with washing covers is of great aid. It is employed in connection with the "blow" as well as for heating the wash water in the filter tank. Soaps and washing powders for this purpose involve merely a waste of money. A quick wash, while the drum is turning, with a 10% solution of hydrochloric acid is satisfactory. This should be followed by an application of clear water, after which the cloth will generally be found in good condition. A wire scrubbing brush of medium stiffness is superior to a fibre brush.

In winding wire on new covers an instance is recalled where the drum was operated at the usual speed, requiring the greater part of two days for winding. Provision should have been made for operating this at a greater speed. A drum 8 ft. in diameter may be operated safely at one revolution per 50 to 55 sec. In applying a new cover, after draining the filter tank, the chain driving agitator shaft should be taken off the sprockets in order to prevent tag-ends of wire from winding around the agitator shaft.

Filter Speed Must Be Determined by Trial

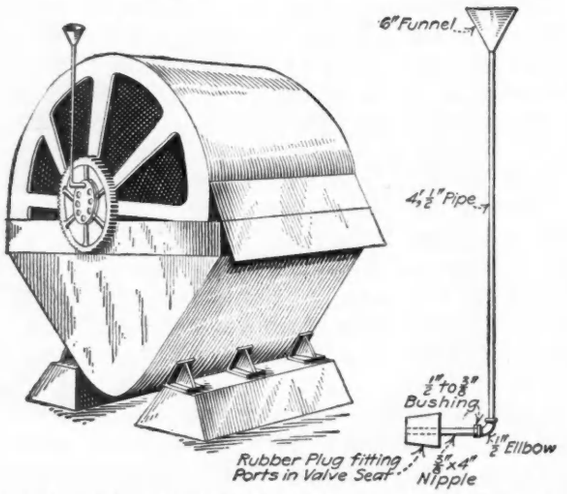
The proper speed at which the filter should be operated can be determined only by a trial. Where the pulp is granular and with a low insoluble content, an 8-ft. drum can be operated at a rate of one revolution in from three to four minutes. With a pulp that is plastic and high in insoluble material, the proper speed will be one revolution in from 10 to 12 minutes. This has been found essential in order that the action of the vacuum on the cake may be prolonged. The vacuum should be maintained at the highest possible point at all times.

The discharge from the thickening tanks should be at least 60% solids to insure good results from the filter. A certain classification takes place in a filter tank itself after pulp has been discharged into it, with the result that the colloidal material remains at or near the sur-

face and is subject to the first action of the vacuum, and the cloth blinds rapidly, necessitating frequent shut-downs for "blowing" and scrubbing.

Hydrochloric Solution Serviceable in Removing Deposition from Valves

The continued use of lime in the thickened pulp delivered to a filter will cause more or less deposition in the valves, valve connections and the piping. This can be removed by a 15 to 20% solution of hydrochloric acid. A method for applying the solution is shown in the accompanying illustration and is recommended by the Oliver executives. The air and vacuum lines are first disconnected and the valve is removed; a rubber plug with pipe and funnel attachment is inserted in the uppermost port leading to the vacuum pipes, and the solution is poured into the funnel until it rises through the vacuum pipes and shows on the canvas. The solution should not be allowed to stand in the pipes longer than one minute. The plug should then be removed and the acid solution drained out into a bucket and the drum turned until the next section shows at the top. The operation is repeated until all the pipes have been



DEVICE USED FOR INTRODUCING ACID INTO SECTIONS OF A DRUM FILTER

cleared. Usually about two treatments are required to clear the pipes. In laying out a filter installation, provision should be made for draining the filter tank into a bin so placed that the material can be shoveled into an elevator or other appliance and returned later to the filter tank. Filter tanks should always be drained when the drum and agitator stick because of sudden shut-downs and other troubles. As a matter of precaution, the manhole cover should be removed so that careful inspection can be made. A loose agitator on the shaft is a serious matter. At the time of installing the filter plant, the agitator was carefully keyed on the shaft and ⅜-in. holes were drilled through the shaft and each hub. Taper pins were then securely driven into these holes to prevent any possibility of the agitator becoming loose on the shaft.

Drying treatment of the filtered concentrate was contemplated at this plant, the Lowden dryer being considered, as well as other types. The reason for this was found in the fact that the moisture content of the filtered concentrate has never been considered satisfactory. It was decided that the limited life of operations would not justify the expenditure necessary to install such a plant.

Of the various drying schemes, following filtering, which have been worked out, few have merit. The old scheme of drying the concentrate on steam coils is expensive and unsatisfactory; wide variation in temperature causes pipe trouble, even when double strength material is used. The handling of the concentrate while in this process of final drying is expensive, and, even in small plants, requires continuous attendance. Some operators carry the drying process so far as to necessitate the sacking of the concentrated product in order to prevent a loss from dusting. An instance is recalled of a plant that produced a quantity of table concentrate which was filtered along with flotation concentrate and the product in turn dried on steam coils until it became necessary to sack it. Another instance is recalled of a table concentrate of good-grade galena being dried to a point that necessitated sacking to prevent excessive losses from dusting, and this notwithstanding that the haul to the railroad was short and the distance to the smelter was less than 200 miles.

Operating Costs

The accompanying table gives the cost of operating the filter plant for the year 1917, and other data directly concerned with the operations:

COST OF FILTRATION AND HANDLING OF FLOTATION CONCENTRATE

	Amount		Per Ton	
Operating labor	$408.00		$0.056	
Repairs to filter	24.90		.003	
Repairs to air compressor	22.70		.003	
Repairs to vacuum pump	18.40		.003	
Repairs to thickeners	171.30		.022	
Constructing lime crusher	176.40		.023	
Crushing lime	56.85		.005	
Oils, waste and grease	119.70		.016	
Repair parts for vacuum pump	6.25		.000	
Repair parts for air compressor	30.60		.004	
Miscellaneous supplies	29.60		.004	
Covers for filter	144.00		.027	
Wire and tacks	63.60		.008	
Lime	1,959.40		.275	
Power	1,080.00	$4,311.70	.149	$0.598
Hauling concentrate	$4,325.10		$0.600	
Reclaiming concentrate	419.85		.060	
Storing concentrate	31.80		.003	
Conveyor repairs	21.90	4,798.65	.002	.665
Totals		$9,110.35		$1.263
Wet concentrate, pounds			14,417,010	
Dry concentrate, pounds			11,227,740	
Moisture, pounds			3,189,270	
Per cent. of moisture			22.12	
Cost of filtering, per ton of ore milled			.0347c.	

The item of the cost of "reclaiming concentrate" covers the expense of handling the overflow from the two 22-ft. tanks, before the 50-ft. tank was installed. Complete settlement could not be secured in these tanks, and it became necessary to run the overflow into ponds outside, where the product was allowed to settle and dry out sufficiently for shipment. The item of cost of "storing concentrate" covers the expense of stacking concentrate on the platform at the railroad track for a short period in July and August, when an embargo was placed on the shipments to the smelter.

The filter plant as constructed was designed by O. B. Hofstrand.*

Sulphur wasted as SO_2 in roasting Sudbury ores is estimated by the Royal Ontario Nickel Commission at not less than 300,000 tons annually, which would produce 1,000,000 tons of sulphuric acid.

*Metallurgical engineer, Salt Lake City, Utah.

Milling Practice and Operating Costs In The Joplin District*

By H. W. KITSON

A standard milling practice has been evolved in the Joplin district, consisting of coarse crushing in jaw breakers and rolls, followed by roughing and cleaning of coarse concentrates in Cooley jigs. The finer particles are roughly classified for table concentration, and a few plants are introducing regrinding and flotation to the minus 2 mm. product. The Netta 1500-ton mill is treating 100 tons per day by flotation, frothing first in a "rougher" and then a "cleaner" unit. A 500-ton mill can be built for $60,000 and the mine developed to the productive stage for $40,000. The average mining and milling operating cost is $1.295 per ton, of which milling is 25%, and to which the addition of royalty, depletion and depreciation charges makes the total cost $1.536 per ton of ore, or a total average cost per ton for concentrates at Joplin mines, $64.40; at Webb City, $65.30; and at the Oklahoma mines, $54.80.

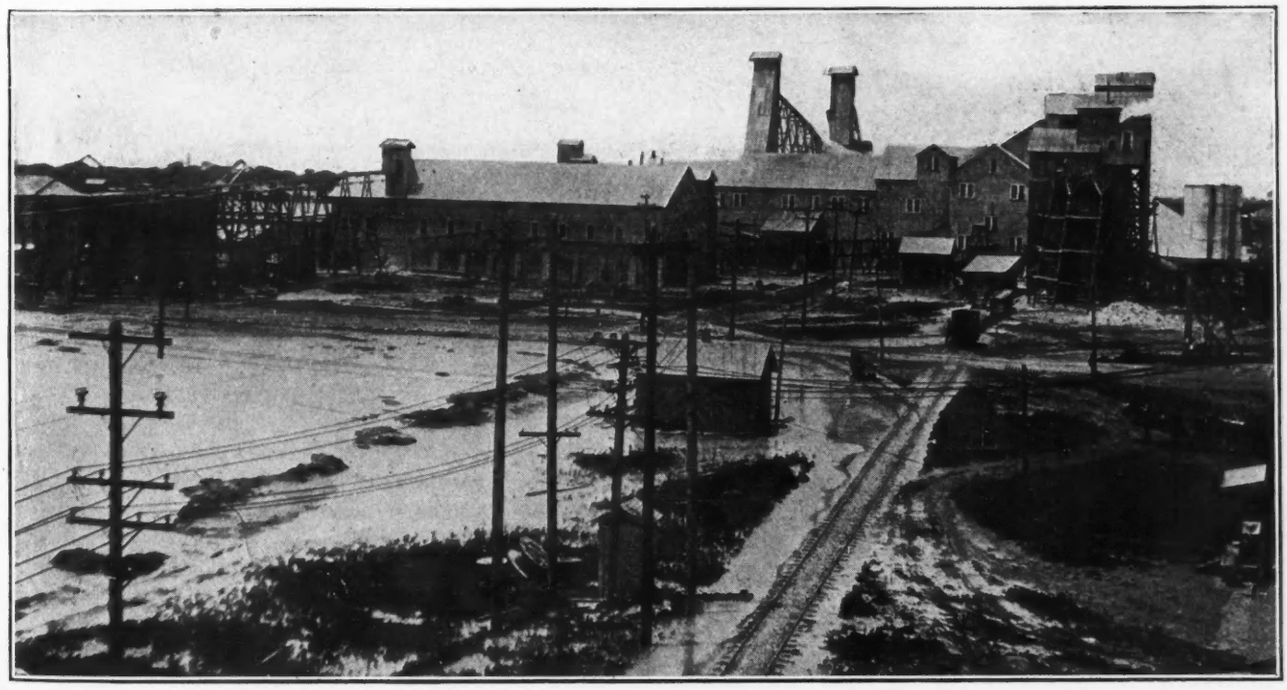
MILLING problems, as solved in the Joplin district for the hundreds of mills in operation and in course of construction, have led to a standardization of flow sheets and mechanical equipment, exhibiting at the various mills about the same degree of uniformity in practice as described of mining methods. This has been made possible by the similarity in structure, texture and composition of ores in all mines producing zinc-lead sulphides. Rosin blend, rosin jack and both white jack and yellow blend are the chief varieties of sphalerite, while black jack is extremely rare in occurrence. Galena is a byproduct of concentration, and small amounts of marcasite, chalcopyrite and cadmium are present as impurities.

*Continued from Mar. 2, 1918: "The Mining Districts of Joplin and Southeast Missouri—III."

Joplin Ores Have High Ratio of Concentration

The gangue is composed mainly of jasperoid flint and chert, with variations locally in the relative quantities of limestone, shale, dolomite, calcite and clay. Gold and silver are practically absent, and although a few rare metals have been recognized, no attempt to recover them on a commercial scale has as yet been made. Cadmium, which is present in small quantities only, enters mostly into the lead concentrates, and the rarer metals are neutral in the process of concentration.

The only variations in ores from different parts of the district that are of importance in milling are those due to differences in grade and relative proportions of lead to zinc. In rare instances some zinc ores, as at the Montreal mine, are sufficiently high to smelt without other concentration than ore sorting at the mine; but the zinc ores of the Joplin district in general have a high ratio of concentration and yield high-grade concentrates of both zinc and lead. Differences due to grade, however, affect the flow sheet in degree rather than in kind, and although flotation is being applied as a supplementary process at some of the larger plants treating higher-grade ores, with resulting higher mill extractions, it has not as yet been generally adopted. Preliminary crushing, sizing, jigging and table con-



EAGLE-PICHER LEAD CO.'S 1500-TON NETTA MILL; 100-TON FLOTATION UNIT IN FOREGROUND

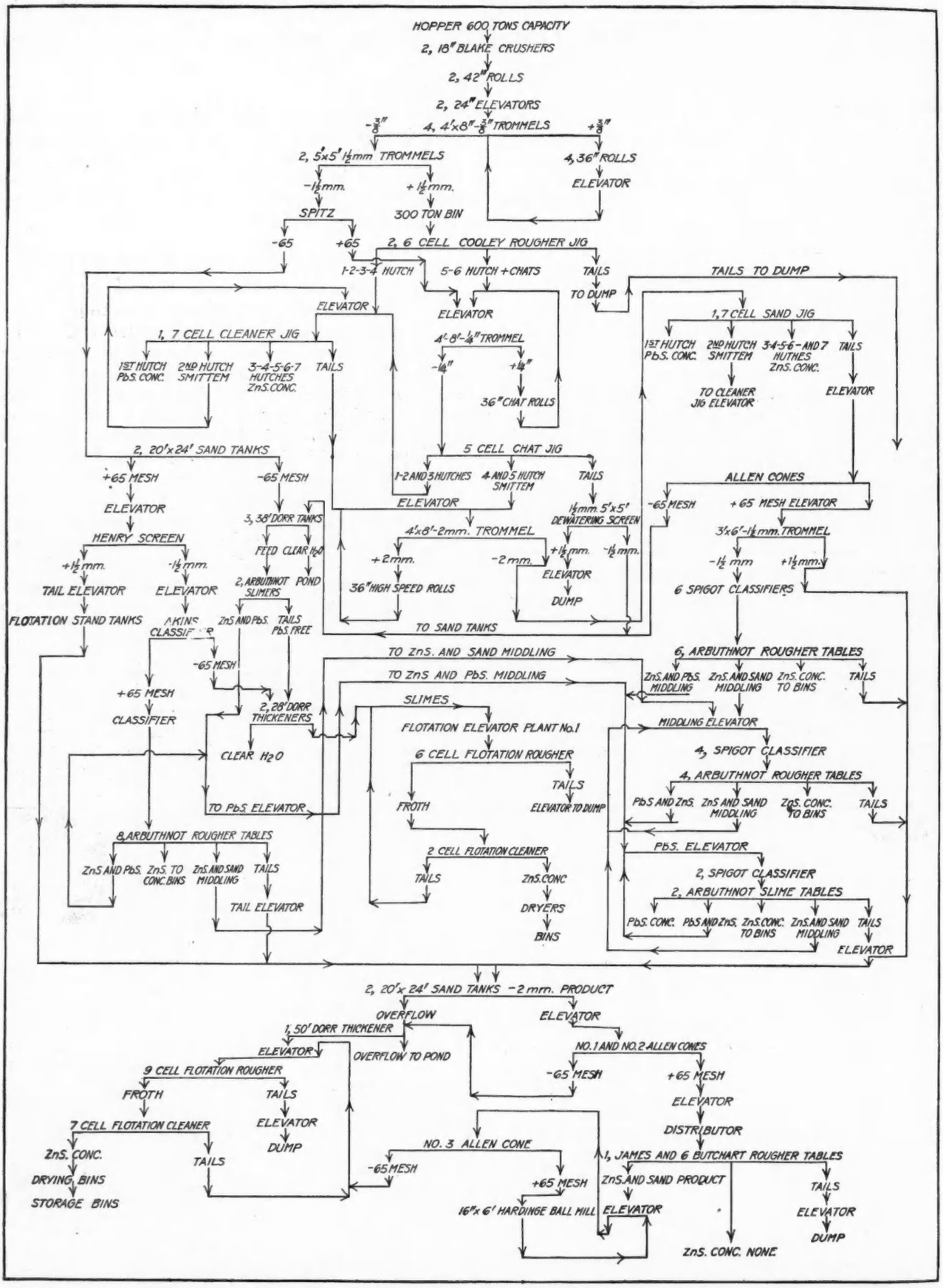


FIG. 1. FLOW SHEET OF THE EAGLE-PICHER LEAD CO.'S 1500-TON MILL

centration methods, where flotation is used, conform in general to the prevailing practice of the district.

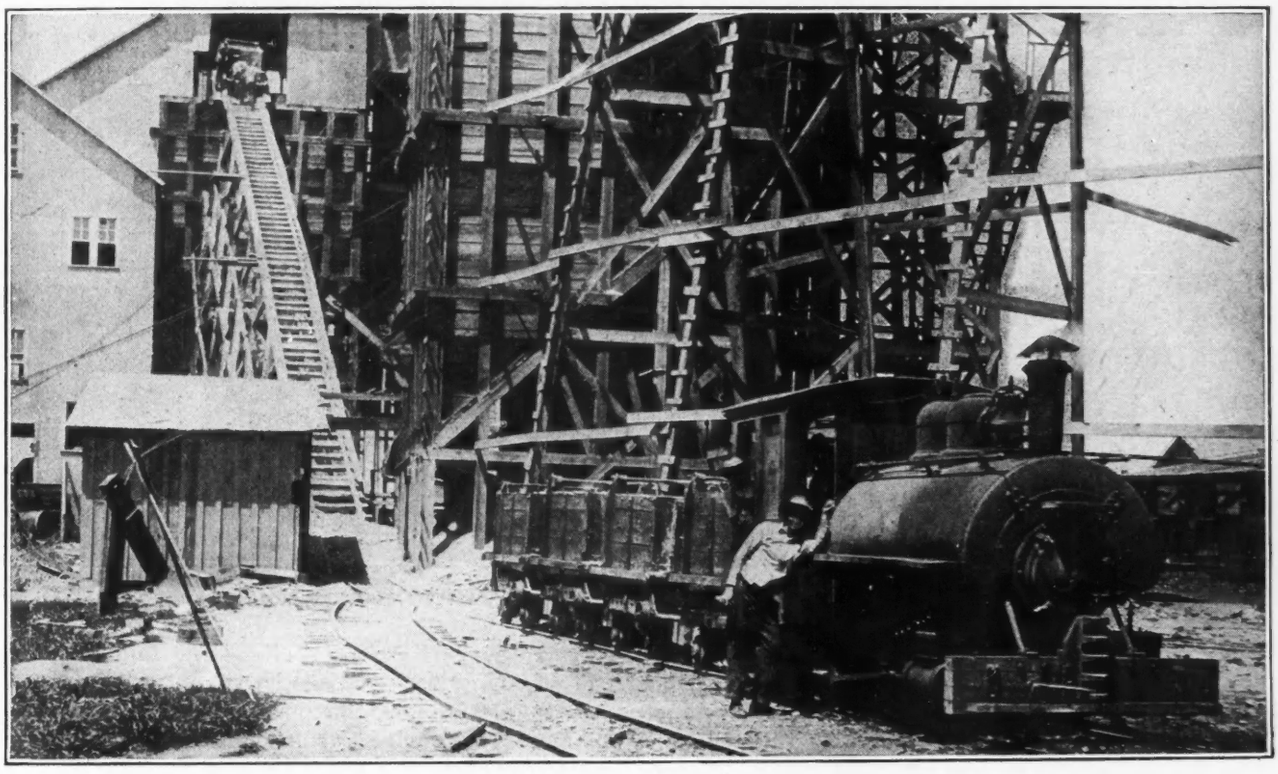
A close inspection of coarse and fine concentrates shows that the sphalerite is hard and well crystallized, and crushes along cleavage planes into similar smaller fragments. Galena and chalcopyrite similarly retain their crystalline form when reduced by crushing, and marcasite becomes roughly spherical. Excellent data of Joplin ores and concentrates analyses have been presented in a recent paper[1] by W. G. Waring. According to Waring the chert and jasperoid flint makes up more than 90% of the crude ore in the sheet-ground mines and splits up into concoidal chips and flakes that are especially adapted to jig work, facilitating a rapid and clean separation of sulphides.

The grade of sheet-ground ores is low. At present ores yielding 2% combined recoverable sulphides are close to the line of demarkation between ore and waste; and, as shown in Table II, the average recovery in Missouri mills is under 4%, but in the Oklahoma and Kansas sections the grades are prevailingly higher, and a number of mills are treating ores from which are made recoveries of 5, 10 and 15% combined sulphides, with a probable average of 8%. The proportion of lead to zinc in the sheet-ground ores is prevailing low, as can be seen in Table II, compared with the relative amounts in ores of Oklahoma mines, which in rare instances, as at the Laclede mine, consist of almost pure galena in large cubes, with small quantities of marcasite and little or no zinc.

On account of the custom of leasing in small tracts, as previously described, a mill is required for each lease, and mill buildings, ore bins and hoisting derricks or head frames are built together as one integral unit. Under such conditions, the mill capacity is usually limited by the hoisting capacity from one single or one two-compartment shaft, which in turn is governed by the size of buckets used. At a few of the newer and larger properties holding land in fee, two or more shafts have been made tributary to a central mill, and the ore is hauled in trains by locomotives from the outlying shafts to the foot of an incline hoistway leading to the mill bins.

Mills Work Three Eight-Hour Shifts

The average capacity of mill units is from 200 to 500 tons per day of three eight-hour shifts, as shown in Table II, although some mills in the district have capacities ranging from 1000 to as high as 2000 tons per day. The capacity of mill bins at the smaller plants is usually slight, though some of the larger units have 500-ton bins. Bin capacity is largely a matter of height of derrick, as the buckets are dumped directly over grizzlies into the hoppers, and provision is seldom made for lateral distribution. Grizzlies are customarily heavy rails or bars spaced from four to five inches apart. The oversize is broken up by spalling, and a small percentage of waste is sorted at the grizzlies and trammed to the dump in cars.



SURFACE HAULAGE AT THE EAGLE-PICHER LEAD CO.'S BINGHAM MILL, PICHER, OKLA.

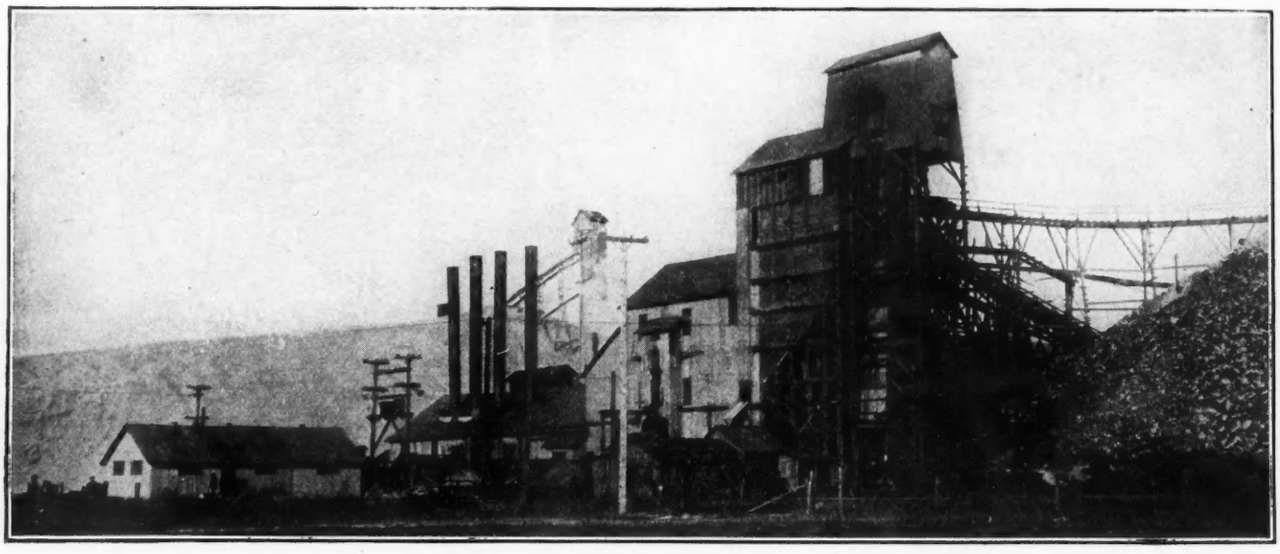
Ore Reduced in Blake Crushers and Rolls

The crushing, jig and table practice in general is so similar at all the mills of the district that a description of any one might with small changes in detail apply to all. Flotation, however, has lately found a field in some of the larger plants, and the results are being watched with unusual interest by millmen in all parts of the district. The 1500-ton Eagle-Picher Lead Co.'s Netta mill, at Picher, Okla., is of recent con-

[1] "The Zinc Ores of the Joplin District: Their Composition and Character." Bull. 129, A. I. M. E.; and in abstract Eng. and Min. Journ, Feb. 9, 1918.

struction, and as it typifies the most advanced practice in the district, a description of it, up to the point of flotation treatment, with exceptions noted, will well indicate the milling practice of the district.

The stages of the process may be divided into coarse crushing, coarse concentration, fines or table concentration, and regrinding and flotation treatment of the fines made in coarse crushing. Referring to the flow sheet in Fig. 1, preliminary coarse crushing is effected entirely with jaw crushers of the Blake type, which receive a minus grizzly-size product, reducing it to minus two inches. According to variations in practice, the ore from the bins may be fed to the crusher either entirely over a slide, or by sluicing over a shaking screen perforated either with ⅜- or ½-in. holes. Secondary crushing is effected in either open or closed rolls of local standard pattern, and the product from the crushers reduced to minus ⅜- or ½-in. size. This reduction is accomplished in a closed circuit with a ⅜- or ½-in. perforated trommel and two sets of rolls. The primary set or sets receives the product from the crusher directly at the discharge, and the ⅜- or ½-in. product joins the undersize from the shaking screen at the boot of a belt-bucket elevator which discharges the wet pulp into the trommel. The oversize then goes to the secondary set or sets of rolls, and the product is returned to the trommel at the elevator boot.



ATHLETIC PLANT AT DUENWEG, MO. CAPACITY, 750 TONS IN 20 HOURS

Concentration in "Rougher" and "Cleaner" Jigs

At most mills, mixed jig and table feed is produced at the trommel, and the entire undersize passes to one or two "rougher" Cooley jigs of the Harz fixed-sieve separate plunger-compartment type having five or six cells per unit. The first four hutch products from the "rougher" jigs will vary in grade from 10 to 25% zinc, and, together with the bed products of the first two or three cells, is sent to a 6- to 7-cell "cleaner" set of Cooley jigs having reduced grate areas, for further concentration. At the Netta, the minus ⅜-in. undersize from the trommel is passed to a second trommel sizing to 1.5 mm. The oversize only goes to the "rougher" jigs, and the 1.5-mm. undersize goes to a spitzkasten, where the pulp is roughly classified into plus 65- and minus 65-mesh products, the latter going directly to a set of sand tanks.

The product from the first four hutches of the "rougher" jigs—"smittem" as it is locally called—is elevated to the "cleaner" jig, and the tailings are discharged at the ends. The tailings then pass over the outer circumference of a 1.5- to 2-mm. dewatering trommel and thence to the dump elevator, the undersize flowing to settling tanks. The "chats"—spigot products of the last two cells and the bed products from the last three cells of the "rougher" jig—are joined by the plus 65-mesh spitzkasten product at the boot of an elevator and discharged into a ¼-in. trommel. The oversize from this trommel is reduced in a third set of rolls called "chat" rolls, and returned in closed circuit to the ¼-in. trommel, the undersize from which feeds to a 5-cell "chat" jig.

At the Netta, the hutch product of the first three cells of the "chat" jig joins the product from the first four cells of the "rougher" jig, at the boot of an elevator serving the 7-cell "cleaner" jig. The tailings at the end of the "chat" jig discharge on a 1.5-mm. dewatering screen, and the oversize goes to the dump elevator. The "sludge," or undersize from the dewatering screen, flows to a set of three 38-ft. Dorr thickener tanks. The fourth and fifth hutch "smittem" from the "chat" jig is elevated to a 2-mm. trommel, the undersize going to a 7-cell sand jig and the oversize to 36-in. high-speed rolls and thence back in closed circuit with the 2-mm. trommel elevator.

The hutch product from the first cell of the sand jig yields galena concentrates, the second cell hutch product, "smittem," goes to the "cleaner" jig elevator, the third-, fourth-, fifth-, sixth- and seventh-hutch products yield zinc concentrates, and the end discharge is elevated to Allen cones.

The Allen cones overflow a minus 65-mesh "sludge" that flows to the Dorr thickener tanks, and the plus 65-mesh product is elevated to a 1.5-mm. trommel. The oversize from this trommel is elevated to a second set of sand tanks, and the undersize flows to a 6-spigot classifier serving six Arbuthnot "rougher" tables.

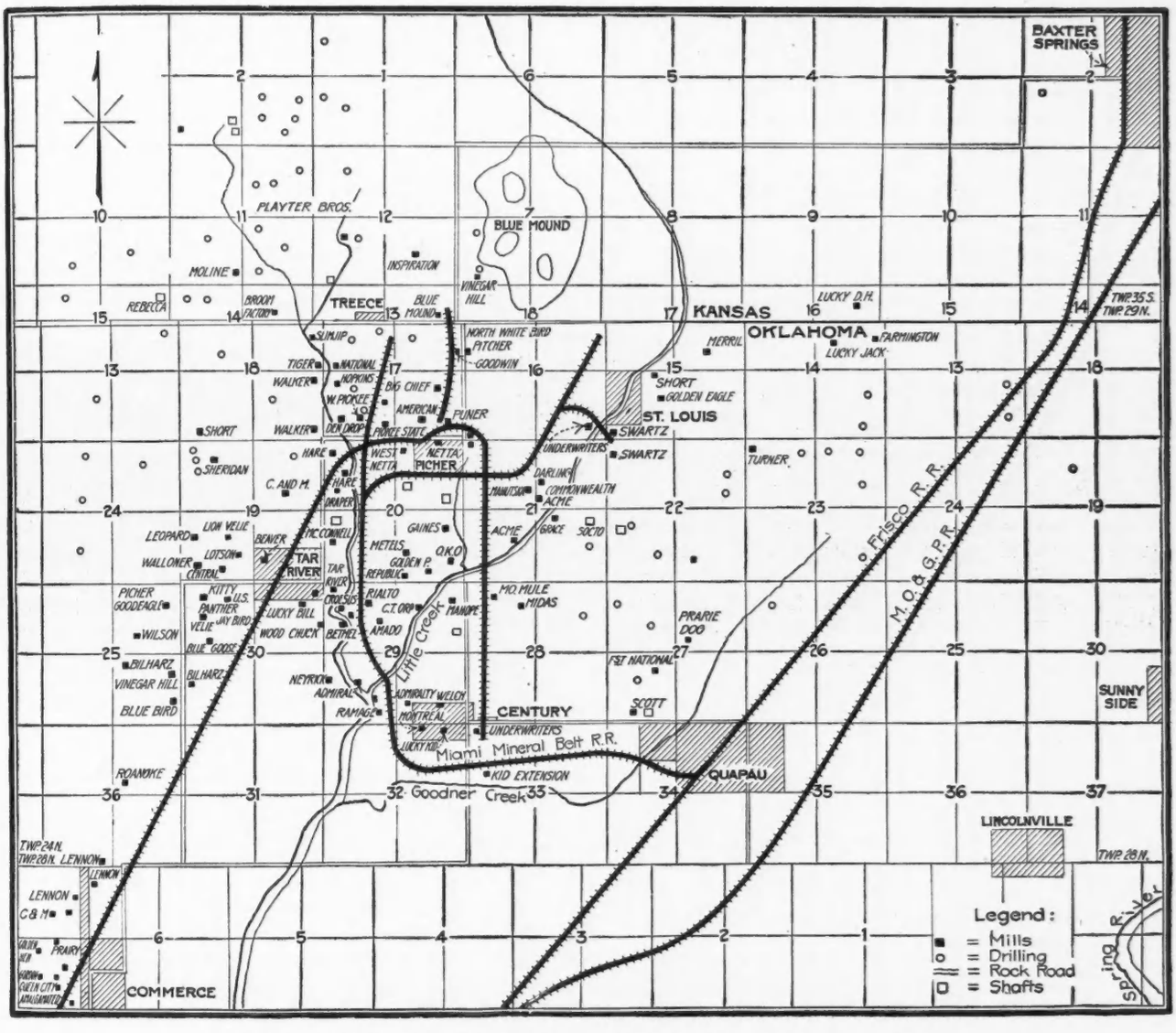
The retreatment of "chats" by regrinding is com-

monly the practice of the district, but the use of "chat" jigs is uncommon, and most of the mills return the reground "chats" to the "rougher"-jig feed. This, as pointed out in a recent and comprehensive paper by C. A. Wright,[2] is a serious mistake, as the feed to the "rougher" jig is considerably less in grade than the enriched "chats," which with a 1.5 to 3% zinc ore will contain from 4% to 8% zinc.

Tails from "Cleaner" and "Smittem" from "Chat" Jigs Reground in High-Speed Rolls

The "cleaner" jig is to be found in all mills of the district retreating the hutch product from the first few cells of one or two "rougher" jigs. At the Netta, the inclusive, yield zinc concentrates, and the end discharge produces tails, which are elevated and screened in the 2-mm. trommel, and reground in the high-speed rolls, along with the screened oversize from the "chat" jig "smittem."

The Netta flow sheet has now been followed to the completion of coarse concentration, and both finished zinc and lead coarse concentrates have been made from the "cleaner" jig and sand jig. The roughly classified minus 65-mesh pulp from the spitzkasten has been sent to the first set of sand tanks, and a minus 65-mesh "sludge" from the Allen cones and a minus 1.5-mm. tailings from the dewatering screens have been collected in Dorr thickeners. Also six classified products



MAP OF THE OKLAHOMA-KANSAS SECTION OF THE JOPLIN DISTRICT

"cleaner," as shown, receives the first four hutch products of the "rougher," the first three hutch products of the "chat" jig, and the second-hutch "smittem" of the sand jig. Four products are made by the "cleaner" jig: The first hutch yields galena concentrates, the second hutch produces "smittem," which is returned to the "cleaner" feed; the third to the seventh hutches, of the minus 1.5-mm. sand-jig tails have been sent to Arbuthnot tables, and a minus 2-mm. plus 1.5-mm. tail product from the sand jig has been sent to the second set of sand tanks.

The table treatment of fines or "sludge" at the Netta begins at this point. The first set of sand tanks overflow or minus 65-mesh "sludge" flows to the three 38-ft. Dorr thickener tanks, from which the clear-water overflow goes to the pond and the thickened pulp to two

[2] "Ore-Dressing Practice in the Joplin District," Bull. 130. A. I. M. E.

Arbuthnot slime tables. The plus 65-mesh product from the sand tanks is elevated to a 1.5-mm. flat screen, a local product, known as the Henry, from which the oversize is elevated to the second set of sand tanks, and the undersize is elevated to an Akins classifier. The minus 65-mesh product from the classifier flows to two 28-ft. Dorr thickening tanks, from which the thickened slimes flow to flotation plant No. 1 elevator. The plus 65-mesh product from the Akins classifier is further classified and distributed to eight Arbuthnot roughing tables.

The six Arbuthnot roughing tables treating the classified product from the sand-jig tails produce a finished zinc concentrate, a zinc-lead middling, a zinc-sand middling, and a tails product which is elevated to the second set of sand tanks. The zinc-sand middling is elevated to a four-spigot classifier, and the products are distributed to four Arbuthnot roughing tables, which produce finished zinc concentrates, a zinc-sand middling that is returned in circuit to the four-spigot classifier, and a zinc-lead middling that is elevated to a two-spigot classifier along with the zinc-lead middlings from the six "rougher" tables. Table tails are elevated to the second set of sand tanks. The two-spigot classifier serves two Arbuthnot slime tables, which make finished zinc concentrates and finished lead concentrates. The tails are similarly elevated to the second set of sand tanks, and zinc-lead and zinc-sand middlings are returned in circuit respectively to the two-spigot and four-spigot classifiers.

TABLE I. ESTIMATED COST OF 500-TON MINE AND MILL EQUIPMENT IN JOPLIN DISTRICT

Churn drill holes, per ft.	$1.50
Two shafts, each 250 ft. deep	$6,000
Mining equipment, compressors, hoists, etc.	15,000
Mill complete	60,000
Mine development	10,000
Engineering and incidentals	9,000
Total, exclusive of pumping, premium on lease, etc.	$100,000

The plus and minus classified products from the first two sand tanks were followed respectively to a set of eight Arbuthnot roughing tables and a pair of Arbuthnot slime tables. The "rougher" tables make a finished zinc concentrate, a zinc-lead middling, that is elevated to the two-spigot classifier, and zinc-sand middlings which are elevated to the four-spigot classifier serving the four roughing tables treating the "sludge" from the sand-jig tails. The tailings from the set of eight roughing tables are elevated to the second set of sand tanks. The two Arbuthnot slime tables treating the thickened slime from the 38-ft. Dorr tanks make lead-free tails which go to the 28-ft. Dorr thickeners, and zinc-lead middlings that are combined with the zinc-lead middlings from the roughing tables.

The practice at most mills of the district is to table the "sludge" from the various jig-tail screens, dewatered in sloped bottom rectangular settling tanks and classified in hydraulic V-boxes arranged in series with connecting launders. The introduction of Dorr thickeners and Akins and other classifiers is comparatively recent, and screening is mostly effected in trommels.

Thickened Slimes Go to Flotation Plant No. 1

The final stage of the process at the Netta is the treatment of the thickened slimes from the two 28-ft. Dorr tanks by flotation in plant No. 1, and the roughing on tables, regrinding and frothing of the product contained in the second set of sand tanks.

At flotation plant No. 1, Minerals Separation frothing units are used, treating the pulp first in a 6-cell "rougher," the tails going straight to the dump, and the froth to a two-cell "cleaner." The tails from the "cleaner" are returned directly in circuit to the "rougher" unit, and the frothed zinc concentrates are dried and placed in bins.

The second set of sand tanks have received the plus 1.5-mm. product from the Henry screen, the plus 1.5-mm. screened oversize from the cone-classified sand-jig tails and the tails from all the roughing and slime tables, excepting the pair of slimers between the Dorr

TABLE II. COST, GRADE AND TONNAGE DATA OF JOPLIN DISTRICT

Holding Acreage	Camp	No. of Shafts	No. of Mills	Mill Capacity, Tons Ore per Day	Output of Concentrates, Tons		Grade Zinc in Concentrates per Cent.	Mining and Milling Cost per Ton Ore	Cost per Ton Concentrates	Concentrates Recovery per Ton Ore, per Cent.
					Zinc	Lead				
Missouri										
30	Joplin	2	1	150	5.0	...	61.0	$1.46	$83.20	1.8
190	Joplin	5	4	1,100	22.0	6.0	62.0	1.30	.....	2.0
15	Joplin	2	1	250	5.0	...	61.0	1.45	60.50	2.0
40	Joplin	14	1	250	6.0	...	57.0	1.50	50.00	3.0
40	Joplin	1	1	100	12.0	...	63.0	2.24	50.00	12.0
40	Joplin	3	1	150	6.0	...	59.0	1.68	53.50	4.0
40	Joplin	2	1	350	9.0	1.0	60.0	1.37	72.37	2.6
30	Joplin	2	1	700	10.0	3.0	60.0	1.12	63.00	1.8
20	Joplin	1	1	150	4.0	...	55.0	1.40	60.00	2.6
40	Joplin	2	1	300	15.0	...	63.0	1.50	.....	5.0
40	Joplin	3	1	800	8.0	2.0	61.0	1.14	88.32	1.2
40	Joplin	3	1	300	9.0	1.0	60.0	1.38	70.94	3.3
Kansas										
40	Webb City	1	1	350	3.0	0.75	60.0	1.10	60.00	1.5
70	Webb City	3	1	650	15.0	5.00	60.0	1.32	75.67	3.0
40	Webb City	1	1	300	9.0	1.75	62.5	1.34	65.50	3.0
200	Webb City	10	3	3,000	50.0	25.00	58.3	1.15	65.00	2.5
40	Carterville	3	1	800	8.0	2.0	61.0	1.14	88.32	1.2
70	Webb City	4	2	600	18.0	1.0	60.4	1.34	62.00	2.14
215	Duenweg	8	1	300	7.0	1.0	60.5	1.36	78.75	2.0
60	Webb City	2	1	300	7.0	2.0	60.0	1.12	63.00	3.0
.....	Webb City	2	1	200	4.0	...	58.0	.....	60.0	2.0
27	Carterville	1	1	250	7.0	3.0	57.0	1.10	60.0	2.0
60	Prosperity	5	1	1,000	13.0	5.0	60.0	1.37	76.50	2.0
40	Prosperity	1	1	300	.....	.....	.....	1.50	75.21	2.0
40	Webb City	2	1	420	6.5	1.5	57.5	1.27	68.00	2.0
50	Webb City	2	1	300	7.0	1.5	60.0	0.98	56.00	2.5
30	Prosperity	2	1	350	4.5	1.5	60.0	1.37	74.16	1.7
125	Oronogo	3	1	700	23.0	8.0	58.0	1.59	59.72	4.0
110	Wentworth	2	1	250	25.0	.....	38.0	.....	20.00	10.0
310	Wentworth	4	1	300	12.5	1.5	.....	.....	60.00	6.0
6	Granby	3	1	150	4.0	.....	52.0	.....	34.43	2.7
250	Aurora	12	2	300	15.0	.....	45.0	1.15	23.00	5.0
60	Neosho	2	1	150	3.0	.....	60.0	.....	60.00	2.0
26,800	Granby	8	2	600	15.0	.....	55.0	1.12	.....	2.5
50	Galena	3	1	100	5.0	...	56.0	1.75	.....	5.0
20	Galena	1	1	65	2.0	...	58.0	2.00	50.00	3.0
40	Galena	3	1	400	5.0	3.0	51.0	1.50	60.00	2.0
320	Galena	6	1	200	10.0	...	61.0	1.40	.....	5.0
57	Galena	1	1	300	5.0	1.0	59.0	1.50	42.00	2.0
Oklahoma										
20	Tar River	2	1	500	.....	.....	62.5	2.55	.....	6.3
160	Tar River	6	3	1,250	70.0	15.0	61.8	1.78	30.00	7.0
140	Douthat	9	3	1,000	40.0	15.0	62.5	2.40	38.00	5.5
180	Picher	2	1	700	40.0	20.0	60.0	2.00	30.00	8.5
60	Tar River	3	1	200	10.0	2.0	59.0	1.40	30.00	6.0
100	Tar River	5	1	225	5.0	2.0	60.0	1.81	55.00	3.1
200	Douthat	10	3	700	50.0	.....	61.5	1.75	28.00	7.0
40	Commerce	6	2	300	14.0	8.0	56.0	1.40	34.00	7.0
124	Picher	2	1	200	6.0	.....	58.0	1.75	.....	3.0
60	Picher	2	1	200	15.0	10.0	55.8	1.50	33.50	7.0
40	Baxter	2	1	30	3.0	3.0	40.0	2.40	50.00	....

tanks. This material is therefore all minus 2 mm. The overflow from these sand tanks passes to a 50-ft. Dorr thickener and the sands are elevated to two Allen cones. A minus 65-mesh overflow goes to the Dorr thickener, and the plus 65-mesh "sludge" is elevated and distributed to one James and six Butchart roughing tables.

Two products only are made on these tables, a zinc-sand head product, and tailings which are sent to the dump. The zinc-sand heads are elevated to a third Allen cone, and the plus 65-mesh spigot product is reground in a Hardinge ball-mill. The reground material is discharged in closed circuit with the third Allen cone. The minus 65-mesh cone overflow joins the thickened slime from the 50-ft. Dorr thickener and feeds a 9-cell M. S. flotation "rougher." The "rougher" tails go to the dump, and the froth is cleaned in a 7-cell frothing

unit making finished zinc concentrates and tails that are returned to the "rougher" as in Plant No. 1. The combined capacity of both flotation plants is about 100 tons of "sludge" per day, and the flotation extraction is about 85%, making the total mill extraction 70% or better. At the Bingham mill, operated by the Eagle-Picher Lead Co. on an adjoining tract, the flotation feed had not at the time of this visit been made lead free, as at the Netta, and the flotation concentrates were retabled to reduce the lead content to under 0.3 per cent.

Frothing Agent a Hardwood Creosote

Both lead and zinc sulphides in Joplin ores are easily floated, and a hardwood creosote is the frothing agent used. The main problem lies in the proper degree of crushing and regrinding necessary to free the sulphides from the gangue. The average extraction obtained in Joplin mills is estimated at 60 to 65%, without the use of flotation. Much of the finer material that is run to waste in mills not using flotation would be available under a proper system of classifying, and in many mills a small amount of regrinding might be demonstrated to be economically practicable. The future will undoubtedly witness many additions of the flotation process to the standard practice of the Joplin district.

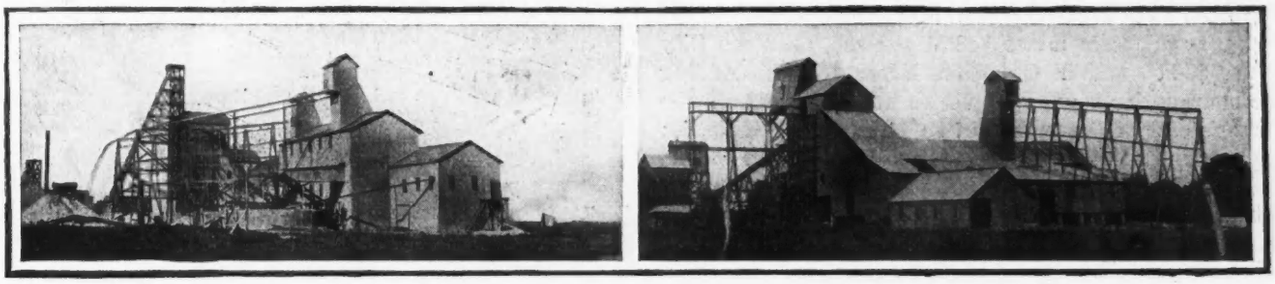
Experimentation with coal-tar, pine and other oils and mixtures has been conducted with varying degrees of success; and the cleaning of sulphides with acid varies with different ores. As the process develops in its applicability to the Joplin flow sheets, changes from the present method of treatment may be expected. By the present system of roughing and cleaning, high-grade concentrates are obtained; and on account of the ore-buying system that prevails in the district, the grade of all concentrates, jig, table or flotation, is of prime importance, and the degree of extraction a secondary consideration. In this connection it would seem that when the base market price of zinc concentrates is below $60 per ton, it is to the millman's advantage to aim at grades of 60% zinc or over, since the base value per unit is less than the bonus of $1 per unit for all zinc over 60%, which for all base prices is constant; but with the market basic price over $60 per ton, the receipts for bonus zinc per unit become proportionately less than the base price per unit offered for a 60% grade, and a higher price per unit for the excess over a 60% zinc would be obtained by throwing this excess, if practicable, into additional tonnage of cencentrates.

The disposal of mill tailings in the Joplin district is effected by piling in mounds in stages by the use of 60-ft. high belt-bucket elevators and launders, locally called "dummy" elevators, as shown in the illustrations and in surface views of the district presented in previous installments. Samples taken of some of these tailings or "chat" piles in the sheet-ground district are said to average 0.75% zinc, although at the more modern mills 0.5% zinc and 0.1% lead is representative. The "chats" offer a hard regrinding problem, and it is doubtful if a contained value of less than 1% zinc would make regrinding profitable. The greatest losses undoubtedly occur in the "sludge" tails.

The water for milling purposes is supplied from mine drainage, and the amount of water necessary to pump at most properties is about equal to mill requirements. In the newer orebodies opening up in the Oklahoma fields, the water pumped varies at different mines, depending largely upon the relative depth of the different "runs," or ore horizons. This condition, however, is equalized by the distribution of water from those properties pumping amounts in excess of their mill requirements, to those properties having an insufficient supply.

Standard 500-Ton Mills Cost $60,000.

A standard 500-ton mill can be built and equipped ready for operation in under four months' time, and, together with power plant, offices and shops, will cost approximately $60,000. An estimate of complete capital investment for such a plant is given in Table I.



THE ANNA BEAVER AND LACLEDE MILLS IN THE OKLAHOMA SECTION

The Empire District Electric Co. supplied power at an average cost, in the fall of 1917, of 1¼c. per kilowatt hour. Most of the larger plants, however, find it good policy to maintain auxiliary power plants to insure themselves against the frequent break-downs that have occurred in the last two years at the power companies' plants. Kansas coal can be obtained at a cost varying from $3 to $7 per ton, and Oklahoma fuel oil, and natural gas piped into the district, are suitable for use either under boilers or in internal-combustion engines. Fuel oil costs about $2 per bbl. of 42 gal., and gas for use under boilers 12½c. and engine gas 25c. per 1000 ft. The gas supply has not been satisfactory, however, on account of the occurrence of frequent and sudden drops in pressure. The Empire District Electric Co. has an hydroelectric plant below the point of confluence of Spring River and Shoal Creek near the Kansas border, and another in Taney County, Mo., on the White River, with an auxiliary three-turbine coal-steam electric generating plant near the Kansas dam site. The combined capacity of these plants is 45,000 kilowatts, or sufficient to supply power for a production of 12,000 tons of concentrates per week, although, on account of poor equipment and consequent break-drowns, only about 8000 tons per week is averaged.

Operating costs for mining and milling, as reported

by 12 Joplin-camp properties, were from $1.12 to $2.24 per ton of ore, averaging $1.46 per ton. The range of costs from 15 Webb City properties was from $0.98 to $1.50 per ton, with an average of $1.27 per ton. In Oklahoma the costs are somewhat higher, on account of higher wages and supplies, and ranged from $1.40 to $2.55 per ton, with an average of $1.89 per ton. Labor roughly constitutes 50% of the total cost, supplies 30%, power 15%, and general expense 5%. Of the total mining and milling costs, milling amounts to about 25%. To the operating costs, royalty, depletion and depreciation changes must be added accordingly.

Average Operating Costs

The reports of 32 properties compiled by the Metals Committee of the Southwest Mine Safety and Sanitation Association showed an average operating cost of $1.295 per ton of ore mined. Royalty, depletion and depreciation added, brought the total cost to $1.536 per ton. Royalties vary considerably in different parts of the district, as already stated, but probably average 10% of the selling price of concentrates. Depletion charges in Joplin may be specified at $4 per ton of concentrates, in Webb City at $3 per ton, and in Oklahoma at $6 per ton. Depreciation of plant and equipment may be figured in all camps at $4 per ton. Operating costs for mining and milling are given in Table II. The cost of concentrates for operation alone averages at Joplin mines $48.91 per ton, at Webb City mines $50.80 and in Oklahoma mines $37.87. Adding the charges for royalty, depletion and depreciation, the average cost of concentrates; as given in the table, is: Joplin mines, $64.40 per ton; Webb City Mines, $65.30, and Oklahoma mines, $54.80. These costs will vary somewhat with the price of concentrates, on account of the sliding scale of wages and the rise in cost of supplies that is usually coincident, but with the October, 1917, price of concentrates, $75 per ton, a ready comparison of relative profit per ton of concentrates can be obtained for each section of the district.

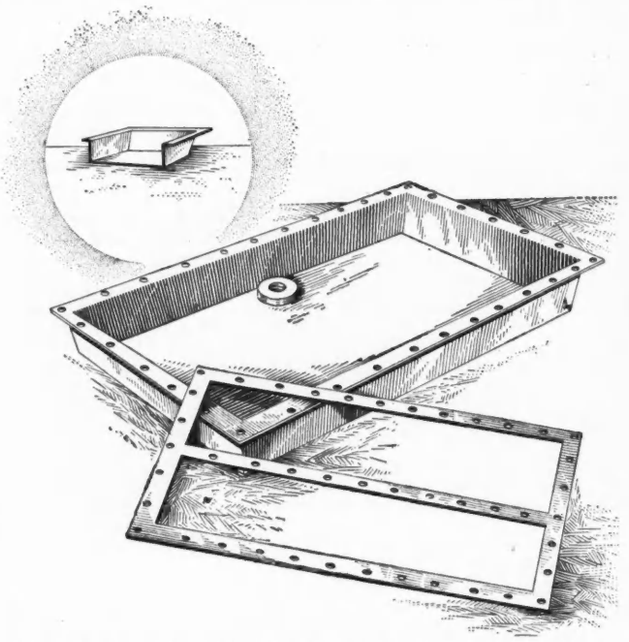
Joplin Practice Efficient

Notwithstanding the tendency toward criticisms of the mining and milling methods that characterize the Joplin district, it is noteworthy that in the matter of low costs Joplin practice leaves little to be desired. At the St. Louis meeting of the American Institute of Mining Engineers in October, 1917, pamphlets containing concise and interesting cost data were distributed, and some of that cost data I present herein with acknowledgment to Luther V. Rice, of Robert W. Hunt & Co., for the data in Table I, and to the War Minerals Committee, which collected the data given in Table II. More segregated costs of both mining and milling, together with much valuable technical data on ores and metallurgical results and conclusions, are given in the papers to which reference has been made in footnotes and to which I make acknowledgment for many figures and facts embodied in this general description of the district.

War Risk Insurance amounting to more than $12,000,000,000 has been written on the lives of American soldiers, sailors and nurses. Up to Mar. 7, 1,392,324 applications had been received at the Bureau of War Risk Insurance. The average amount applied for is $8,085. The maximum permitted is $10,000 and the minimum is $1000.

Callow-Cell Pneumatic-Bottom Pans

The sketch shows the type of individual cast-iron bottom pan used in the Cœur d'Alenes for each cell in the Callow pneumatic frothing machines. This pan was originated at the Gold Hunter mill, and is used there at present. It is made by the Union Iron Works, of Spokane, Wash. The pan is rectangular in sectional opening and has relatively shallow sides. It has an extended rim and is bored to receive the bolts that fasten the open cover-plate frame. The canvas is cut and punched to match and is held in place over the pan by the cover plate. Generally no outside reinforcing screen is used to keep the canvas from bulging with the air pressure from within, as was formerly the practice; instead, the use of three or four layers of canvas is sufficient. As soon as the top canvas becomes choked, it is removed and a new one substituted at the bottom,



DETAILS OF PNEUMATIC BOTTOM PANS FOR CALLOW FLOTATION CELLS

the second canvas thereby coming to the top. Several of these unit pans fit on the bottom of the Callow cell tank, and each is held in place by an air-pipe fitting which connects through the tank bottom to a nipple screwed into the bottom of each pan, gaskets being used to make a tight joint. At some of the mills these pans are made of wood. Instead of having the air-feed opening near the bottom, it is centrally placed.

For some reason the Gold Hunter mill had trouble in getting an even air flow through the canvas mats when individual pans were used, and a ½-in. iron bar was bolted to the cover below the canvas to divide the upward air current. In some of the pans the reinforcing rib of the cover plate is across instead of along the pan. Generally a bolt is sufficient in every hole to secure the canvas mat tightly, but it is well to have the holes bored around the rim and cover close together so that additional bolts can be used if necessary. Ears are generally bolted to the shorter sides of the cover plates to aid in lifting when canvases have to be changed. At the Bunker Hill & Sullivan mill, canvas mats are calked into grooves in the rim of the pans with rope.

Troubles in Flotation

By OLIVER C. RALSTON*

One of the most interesting subjects in the application of the flotation process is that which relates to operating troubles. The need for an exhaustive research of the chemical and physical factors involved in flotation should be apparent to all who carefully read the article that follows:

NO ONE knows milling troubles better than does the flotation man. When two flotation men meet, they don't talk much about the success each is having, but inquire rather anxiously about the troubles that have appeared and how they have been dealt with. It is strange that there have been so few papers on this subject. Jackson A. Pierce[1] is about the only millman who has frankly written about his tribulations and confessed his ignorance of why he finally succeeded. It is time that some of the rest of us gained courage to join him.

The history of many flotation mills gives the same kind of perplexing difficulties, especially at the beginning of operations, and there have been instances where work done by flotation machines has been so unprofitable that the process was finally abandoned in spite of the encouraging indications given in the laboratory with small test machines. The process of flotation is so easily disturbed that any hostile plotter who happens to be versed in its vagaries can completely upset the operation of a flotation mill. Even without any hostile conspiracy, everything may be going well when suddenly the froth will change in appearance, "mineral" will cease to be floated and the froth may die entirely.

Up to Operator to Correct Disturbances

It is always "up to the operator" to restore normal operation quickly, for the pulp is constantly passing through the flotation machines and money is being rapidly lost. This may occur several times in every 24 hours, and much valuable pulp may escape into the tail-race. The machine operators generally run first to the oil-feeder, to see if it is giving the regular amount of flotation oil. Then they will try adding a little more of the oil to see if they have been underoiling the pulp. That failing, they will cut down the oil-feed, and if they are still unsuccessful they will probably add some rather expensive oil not normally used. If this still brings no results, and if the disturbing influence has not already passed, they try looking over the mechanical parts of the machine and turning on more or less air or speeding up the agitators. The idea is to change everything that can be thought of, trusting that the unknown disturbing factor will be righted. Many times these passing troubles are adjusted without any one knowing their real cause. If the trouble persists so that operation is either seriously handicapped or even prevented, the work is either dropped entirely or the disturbing influence definitely ascertained and eliminated.

I have already mentioned the difficulties of Jackson A. Pierce, whose mill at Idaho Springs, Colo., gave indications of never being a success. It was impossible to get any metallurgical froth for a long time. Then the trouble disappeared, and satisfactory results ensued. I do not know all the conditions that surrounded his case, but I do know that the mill had been remodeled from an old cyanide mill. It is a well-known fact that cyanides are deleterious to flotation under ordinary conditions, so that his first period of unsuccessful operation may have been during the time that all traces of cyanide were being flushed out of the system.

Copper Salts Remedy Trouble at Mascot

One of the best-known examples of troubles successfully mastered is that at Mascot, Tenn., where a sphalerite of exceptional purity is being concentrated from a disseminated ore. When this plant was started, it was impossible to duplicate the work done in the laboratory, and an immense amount of work on the plant was of no avail until the conditions of laboratory testing and plant operation were compared. The testing in a bronze machine gave excellent results, while operation in a wood and iron one was discouraging. A plate of copper, hung in the spitzkasten of the plant machines, solved the difficulty and led to the further discovery that a small amount of a solution of copper sulphate added to the pulp accomplished the same end. The manner in which this trouble was mastered does great credit to the staff at the mill. Just why a pure sphalerite requires modification by reaction with copper sulphate or other soluble salts of copper is not easy to explain, but the point is that the successful conditions of operation were found.

One of the most common troubles in a flotation plant is over-oiling. As already mentioned, one of the first things the usual operator will do when he is trying to right a trouble in operation is to try adding more oil. This usually results in a somewhat poorer grade of concentrate, because the excess of oil often makes a tougher froth, so that more gangue is carried into the concentrate. Too much oil fed all at once will usually kill the froth, due to the well-known "raw-oil" effect. After stirring the excess oil into the pulp, the froth comes back. If the froth is tough, less agitation may be wanted.

"Over-Electrolyte" Another Source of Grief

Closely allied to this trouble is that coming from "over-electrolyte." Presence of an excess of almost any electrolyte usually causes poor "selection." In strong brines, a lower grade concentrate is obtained than in pure water. If it were not for this, it is probable that the water in the Great Salt Lake might now be in use for flotation work. Likewise, an excess of sulphuric acid in plants using it is likely to cause trouble. The remedy for troubles of this kind is to prevent the entrance of excess electrolyte into the pulp wherever possible. Reducing the amount of oil used will sometimes improve conditions. At an experimental flotation mill belonging to the Ohio Copper Co. mine water

*Metallurgist, Hooker Electrochemical Co., Niagara Falls, N. Y.
[1] "Min. and Sci. Press," Sept. 16, 1916.

containing considerable amounts of dissolved material was used, and caused endless trouble. Only about 10% extraction of the copper seemed possible. Iron and copper sulphates were present in the water. After trying every addition agent mentioned in the tests, experiments with various chemicals available in the local analytical laboratory proved that a small amount of potassium cyanide rectified most of the trouble. Immediately the extraction increased to 65%, in spite of bad conditions of fluctuating feed, dilutions of pulp, etc.

This result is all the more curious considering the fact that copper sulphate and cyanides had opposite effects in the cases mentioned before. In this case, it is almost certain that the cyanide could not exist long in the solution, but that it would immediately combine with the compounds already present to form complexes like ferrocyanides, cuprocyanides, etc., whose effects on flotation are not known to be so deleterious. Dr. Gahl informs me that a small amount of cyanide improves the flotation at the Inspiration mill. E. J. Atckison has also informed me of similar results in treating the silver ore at the Amparo mines, in Mexico, finding, however, that a slight increase in the amount of cyanide used is objectionable. This latter observation is important in that it suggests a possible critical amount of each electrolyte. In general, the best thing that can be done is to remove the excess of undesirable electrolyte. For example, before the pulp enters the flotation machines lime could be added to remove iron sulphates from the solution.

Oil and Organic Agents

Lubricating oil, dripping into the mill pulp from bearings, often creates trouble, causing either dirty froth or sometimes an apparent over-oil effect. Hence, it is well to look after the oil cups and arrange catches to prevent any dripping oil getting into the pulp. The Minerals Separation machines often drip oil into the pulp, and should be so constructed that lubricating oil cannot run down the shafts of the impellers.

Organic agents are often effective in their action on flotation. If the water in the mill feed comes from a swamp, it contains tannin extracts and other materials which prevent good flotation. Many of these things cause a copious foam, but it is white and does not carry "mineral." If roots gets into the mill feed their plant juices will be crushed out of them and usually cause similar trouble. This happens at the plants of the Midvale Minerals Co., at Midvale, Utah, and at the Prince Consolidated Mining Co., at Pioche, Nev. Such plants and weeds should be screened out.

Tobacco juice, glue and similar substances cause like troubles, and if a mill becomes contaminated with them it is sometimes necessary to drain out all the pulp and scrub the inside of the flotation machines. One tale is told of an apparently well-built wooden machine, constructed by a ship's carpenter, in which no one could obtain successful flotation. It was found that the joints of the machine were filled with glue, which had to be removed before normal flotation could be obtained.

In another case which came to my personal experience a batch of ore was being crushed in a pebble-mill for use in small laboratory tests. The outlet of the mill was plugged with a "gunny" sack to prevent the pulp from splashing out during the grinding. The sack fell into the mill and was ground up with the ore. This ore would not float, although subsequent crushing of another batch in the same mill gave material that caused no trouble. The effects of most organic materials are hard to counteract, and the best thing that can be done is to eliminate them at their sources.

Variability in Flotation Agents

Variable oil shipments have often been blamed for trouble, and there is no doubt that there are cases where the manufacturers have been unable to duplicate their previous shipments and yet have not informed the purchasers. In many cases trouble has started the moment a new shipment of oil was introduced into the mill. However, most of the larger dealers in flotation oils have now taken steps to remedy this difficulty. In other cases, variation of the oil has been caused by deliberate attempts to adulterate an expensive oil with cheaper products.

I have also heard of cases where trouble arose from allowing barrels of oil to stand open in the warm sun for some time before being used. The freshly opened barrels had been tested before acceptance and found satisfactory, but before the supply was exhausted the last portions of the oil left in the barrels were found of almost no flotative value. Supposedly the valuable constituents of the oil were the most volatile parts, and these evaporated, leaving a worthless residue. So many factors can cause trouble that the oil is usually blamed if no other explanation is at hand.

Change in Water Supply Affects Process

Water supply is another thing which can change and cause trouble in flotation. If the mineral salts dissolved in the water are different at different times, it is probable that the best oils for different conditions will have to be kept on hand and used as needed. In fact, it often happens that the preliminary test work on an ore will be done in a distant laboratory and with different water than that which is to be used in the mill. On that account, some particular type of oil may be chosen which later proves unsatisfactory. This was the case when the National Mill at Mullen, Idaho, failed to work well with turpentine, which had been chosen as the best oil in the laboratory. In line with these experiences is the fact observed at Mascot, Tenn., and Miami, Ariz., that after a hard rain flotation was poor. It was not easy to see how the rain water had a chemical composition which would be prejudicial. An explanation was wanting for some time, until it was found that the fine sediment carried into the mill water by the unusual surface run-off was the real cause of the trouble, and that after settling out the sediment the water was as good as ever for flotation work. These clay-like materials sometimes exist in the ore itself, and have been called the "primary slimes" at Miami and Inspiration to distinguish them from the "secondary slimes" formed during the grinding of the ore. At Inspiration, Dr. Gahl found that their effect could be remedied by introducing a proper proportion of granular matter or iron filings when the presence of a large proportion of primary slimes endangered success.

Grinding is closely related to the subject. One thing which caused ball-mills to be chosen in the design of the Inspiration mill was the fact that finely divided iron

had been found to be beneficial in the presence of the primary slime. There is no doubt that there is often considerable difference in the flotation work upon pulp made in ball-mills as compared with that upon pulp from pebble-mills.

Tales are told of the change from one to the other methods of grinding, with resulting improvements in the flotation.

There are so many things involved in the change that it is difficult to explain just how the supposed improvements were effected. There is doubt as to the most suitable size of one particle for flotation, but the opinion is fairly unanimous that sized material does not give good results, and a mixture of all sizes is best. I mentioned before the fact that a definite ratio of "granular" to "colloidal" material seems to be necessary, and too much of either results in unsatisfactory flotation.

Miscellaneous Troubles

Tough froth, which is hard to break down, has also caused difficulties. Stories of mill floors flooded with tough leathery froth are common. At the Butte and Superior mill there is a housing over the concentrate bins. High up on the windows of this housing I once saw marks showing the level attained on one occasion by a tough froth. Many a millman has had to wade into froth knee-deep or more. Tough froth is often due to too much oil, but more often to the wrong mixture of oils. Some mixtures of oils can be obtained that form froth so tough that it will support a penny.

In the Minerals Separation-Miami suit one story was told of a froth so tough that it supported a shovel laid on it. I have noticed several ores in which the addition of coal-creosote to a pulp already oiled with pine oil formed a very tough froth. The remedy for such cases is, of course, to change the oil mixture or its method of application. Sometimes these tough froths happen to be the best metallurgically, and then special froth-breakers have to be devised. The most successful one usually have jets of water impinging sharply into the froth launders or other containers.

Cement, or the soluble portions thereof, is also known to have caused trouble just after newly made concrete was allowed to come in contact with the mill pulp—according to Clayton, of the Missouri School of Mines.

Fluctuating feed, both as to percentage of mineral present and the density of the pulp, causes poor extractions more often than anything else that I know of. At one time not enough froth will overflow from a flotation machine (adjusted for average conditions), and the next minute too much froth will be overflowing. Machines designed to take fluctuating feed are being evolved, but up to the present I know of no better way of increasing the extraction and bettering the grade of concentrate than by providing a constant feed. When this has been done, a minimum of attention will be required. At the Inspiration mill changes of pulp density are prevented by a floating hydrometer placed in the tube-mill discharge and actuating the inlet valve on the water line. Thickeners usually make satisfactory devices for providing a constant feed.

Filtering and shipping difficulties are encountered after the installation of new plants. Some plants try to use small concentrate settling bins without filtering appliances; as a consequence much flotation concentrate is lost, and such wet material is shipped that the smelter exacts a penalty. The usual procedure is to improve the settling and thickening capacity and to install a filter.

Every flotation machine has a certain capacity for each type of material, at which it will give satisfactory results, and usually it has a much lower capacity for sand than for slime. As R. C. Canby has so ably expressed it, one can easily conceive of passing a hundred tons of granulated lead through certain machines, but to conceive of passing the same weight of feathers through the same machines is difficult. Hence, an increase in the proportion of fine material in the pulp feeding a machine may overload it and cause poor work.

The foregoing are some of the most obvious troubles that are experienced in flotation, and I have no doubt that a discussion of this paper would bring forth similar perplexities. Some mills are afflicted only to a mild degree with the troubles described, so that their operators are not familiar with them unless discussion of this kind brings the subject to their attention.

Groch Centrifugal Flotation Machine*

In addition to the Callow pneumatic installations at Cobalt, Ont., there are several Groch centrifugal flotation machines at various mills in the district. This machine is the invention of Frank Groch, of the Grodwards Co., Cobalt, and may briefly be described as follows: It consists of a V-shaped box divided into compartments, in each of which operates a specially designed impeller having the combined functions of atomizing the oil, agitating the pulp centrifugally, and sucking the air into the mass during the agitation. The impeller is a vertical hollow shaft, with a contrivance at its lower extremity resembling a duplex centrifugal pump, or a turbine divided horizontally by a disk. The full-sized machine in operation has six impellers, and on the fine slime from Cobalt silver ore has a capacity of 25 tons per day. With fine sand the capacity will be much larger.

In action the pulp enters the first compartment of the V-box at the bottom, is sucked up by the lower portion of the duplex centrifugal impeller, and discharged in such a manner as to cause a tendency for the impeller to be thrust upward, its weight thus being reduced on its bearing and lessening the power consumption. The oil and air enter the pulp through the impeller, by passing down the hollow shaft and being discharged at the periphery of the impeller, thus being brought into contact with the sulphides of the pulp under conditions for successful flotation. The rest of the operation is similar to that of any other flotation machine. The oiled sulphides rise to the surface, and flow over the lips of the V-box, while the pulp, thus impoverished, settles and slides down the inclined planes into the first compartments, to be sucked up into the impeller of compartment No. 2, and the operation completed.

The following mills have Groch machine installation: Coniagas, Trethewey, McKinley-Darragh, Northern Customs Concentrator, Beaver, Miller Independence, and the Metals Chemical Company, Welland.

*Twenty-sixth Annual Report of the Ontario Bureau of Mines, 1917.

Flotation in Relation to Gangue Minerals

BY JAMES M. McCLAVE*

The influence of gangue minerals upon the successful flotation of sulphide minerals has attracted little attention hitherto. That it is important and worthy of scientific study is shown by the field and laboratory experience that form the substance of the article presented herewith.

RECENT investigations to determine the solubility of oils and their peculiar behavior when mixed with water led to a series of tests of oiled water on gangues. The oiled-water solutions were prepared by mixing pine oils and coal-tar creosotes with water, using 1% of the oil mixture to 2000 lb. of water. The oiled water was allowed to stand 24 hours and then filtered through filter paper. The filtrate in many cases was almost as clear as distilled water. The filtered oiled water was used to secure comparative data with oil mixes introduced directly into the pulp.

DETAILS OF TREATMENT

Two ores similar in character and composition were taken. No. 1 had been tested with pine oil and creosote without previous mixing and filtering. No. 2 was treated with the oiled-water mixture. The results were so radically different that I concluded that the difference was due to the oiled-water mixture. After a careful investigation it was found that the oiled water was not the cause of the difference. The gangues were analyzed. No. 1 sample proved to be a quartz-porphyry and sample No. 2 white quartz with schist and limestone. The flotation tests on No. 1 sample were satisfactory with almost any kind of pine oil or oiled-water mixtures. The tests on No. 2 sample were anything but satisfactory. This naturally led to the conclusion that the limestone had something to do with the poor results. Acid was used to neutralize the limestone, but this did not improve matters.

In former treatment table-dressing had been used on both ores. Small table tests were made on 60- to 100-mesh size with a view of making high-grade concentrates and clean tailings, and in order to secure these products it was necessary to discard the middlings. The table concentrate from No. 1 was mixed with the table tailing of No. 2 and the table concentrates from No. 2 was mixed with the tailing of No. 1. Interesting tests were made on the "double-crossed" ores. No. 1 sample with No. 2 gangue showed practically the same discouraging results with the various oil mixtures that were manifested in the first tests. Sample No. 2, with the well-behaved gangue, gave practically the same results that were shown in test No. 1 before the gangues had been changed.

Field experience on a number of ore-dressing problems has convinced me that it is important to make a special study of the gangue materials before designing a flotation plant. The following examples of mill practice will give a general idea of the importance of oils in relation to gangues.

*Metallurgical engineer, 922-18th St., Denver, Colo.

In testing a complex ore to determine the best combination of oils, it was found that a combination of crude petroleum coal-tar creosote and steam-distilled pine oil gave the best results. The assay of the ore was as follows: Gold, 0.05 oz.; silver, 5.0 oz.; lead, 7%; zinc, 20%; iron, 16.4%; insolubles, 23.5%. In a short time after the above tests were completed, another ore was received at the laboratory from a different mining district. The second sample was similar in appearance and had the same general structure. The second sample analyzed gold, 0.02 oz.; silver, 8.4 oz.; lead, 6%; zinc, 18.6%; iron, 19.3%; insolubles, 24.4%. The oil data that gave the best results on the first ore were tried on the second sample, with poor results. The oil combination worked out for the first ore which produced such clean concentrate and tailing products gave a dirty concentrate on the second sample. Finally, a combination of coal tar and hardwood creosotes gave a clean concentrate and tailing. The question naturally arises why such a marked difference in the frothing properties of the two ores.

The gangues had been analyzed only for insolubles, and, carrying the investigation further, it was found that the first sample contained 7% of lime and the second sample 0.5% lime. The difference in the lime contents of the ores undoubtedly produced the great difference in frothing conditions, as was proved later by removing the lime in the first sample and adding this lime to the second sample; it was found that the oil combinations had to be reversed.

CHANGES CAUSED BY VARIATION IN ORE

In testing a heavy sulphide ore containing 7% lime and 20% silica, an oil mixture was found that gave a clean froth concentrate and a high recovery. A mill was designed to treat the ore directly by flotation, on account of the ore requiring reduction to 50-mesh in order to liberate the valuable particles. The mill operated successfully for two years, making a good recovery by direct flotation. With depth, the ore changed, the sulphide crystals became larger and table concentration was introduced, followed by regrinding and the treatment of the tailings by flotation.

The same oil mixture was used that gave such good results before. This mixture proved a failure. The froth was siliceous and tailings contained both lead and iron sulphides. Other oil mixtures were hastily prepared and tried out, with little encouragement. In looking over the remodeled mill, it was found that there was a back-wash on the tables that was cut out as waste material and was not returned to the flotation department. This product was diverted to the flotation machines, and every one connected with the mill received an agreeable surprise, as the old oil mixture worked perfectly and the flotation department gave no further trouble. But why? The table back-wash was analyzed and found to contain a small percentage of metals and a high percentage of lime. In this case the lime was the missing factor.

In another case flotation tests on a silver-lead ore indicated clean products and high recovery with pine oil.

The mill products showed some improvement by using hardwood creosote. The mining company acquired the adjoining property across the gulch. The ore in this mine was of the same general character, and so close was the resemblance in looks and value that the superintendent thought he was taking no chances, and sent 500 tons of ore from the new mine to the mill. As soon as the ore reached the flotation department, it was evident that there was something wrong. Many quick changes were made with oils, but without any improvement in the froth.

The mill was closed down and the ore sent to the laboratory for a thorough investigation. The analysis showed a small amount of manganese present in the form of rhodochrocite. A mixture of pine oil and crude petroleum made a positive metal-bearing froth. In mill practice, kerosene was used instead of the crude petroleum. Comparative tests were run on ores from both properties. Samples from the old property treated with the oil mixture used on ore from the new property would not produce a mineral froth. Later tests and investigations proved conclusively that the manganese mineral was the cause of the flotation troubles.

Necessity for Careful Sampling

Tests were made on a zinc-lead-copper ore that proved to be about the simplest flotation problem that ever came into the laboratory, as almost any kind of a pine oil would give a good froth. The mill was overhauled and a flotation unit installed after the tables to treat the middlings and tailings. When the flotation machines were started, it was expected that froth would readily form, but no froth appeared. Then followed a series of rapid oil changes, but still no froth. The manager became desperate and cleaned house by discharging the entire mill crew, and even this drastic measure did not help to make a froth.

The mill was closed down and I came in for his share of abuse on account of the complete failure. The laboratory work was reviewed and fresh samples were brought in for tests. The new samples were similar to those used in the first tests, but no oil combination would produce a clean metal froth. The old samples were unearthed, and comparative tests were made, showing a wide difference in frothing conditions. To the eye the ores were identical, and assays showed similar metal values. Microscopic examinations of the ore showed a gangue containing epidote. The engineer who sampled the mine was interviewed, and he soon cleared up the mystery. All samples were cut down at the property to small pulps except ore from the new vein, which had been recently opened up by a crosscut tunnel. The large samples were left at the president's office, and these had been presented for the flotation tests.

Writers and experimenters have featured the use of oils and reagents and their relation to minerals and have had little to say about their troubles with gangue minerals, and it is the object of this article to encourage others to give their experience along this line.

Sixteen million buttons are to be given to subscribers of the Liberty Loan Bonds of the third issue, whether of a $50 bond or a $10,000 one. The buttons, which have a border of brilliant red, and a blue field with a liberty bell, and the words "Third Liberty Loan" in white, are now ready for delivery when subscriptions are made.

Selective Flotation in Australia

By Guy C. Riddell*

Preferential flotation of lead and zinc at Broken Hill, Australia, is being watched with considerable interest in this country. The successful operation of the Bradford SO_2 process among the heavy producers there has attracted comment in many quarters. Several of the large mining companies at Broken Hill have used the process for over a year, and the Australian rights were purchased in 1917 by a combination of four of the heaviest producers, namely, Amalgamated Zinc, Broken Hill South, Sulphide Corporation, and Zinc Corporation. In addition to these, the Broken Hill Proprietary, Ltd., under the auspices of which the process was evolved by the inventor, Leslie Bradford, has been treating large tonnages at the new Bradford mill for a considerable time.

The 65th half-yearly report of the last-named company for the six months ended Nov. 30, 1917, discloses the fact that the company's operations are improving and expanding. Its lead and zinc interests continue heavy. The new Bradford SO_2 selective flotation mill presents a feature of interest to American flotation operators. Slimes to the extent of 50,248 tons were handled by the process during the six-month period, yielding 5592 tons lead concentrates of 61.6% Pb and 83.2 oz. Ag and 13,407 tons of zinc concentrates. Since the re-flotation section of the mill was started, the average grade of the zinc concentrates produced has been 49.54% Zn, 4.34 Pb, and 14.47 oz. Ag per ton. This zinc product of the Bradford SO_2 process is the highest grade of zinc concentrates produced on the Barrier lode.

It is my understanding that the treatment, on Broken Hill Proprietary ores, emulsifies by the use of nitre cake instead of oil. The selective agent is SO_2 gas in acidulated solution. Both the galena and the blende become thoroughly wetted in the process and sink, the galena then coming to the surface, while the blende is kept in the wetted condition by the continued action of the gas, to which it is more susceptible than galena. Pyrites come up with the galena, separation between iron and zinc being fully as well-defined as between the lead and zinc. The Broken Hill crude ores on which the process is used run approximately 15% Pb, 15% Zn, and 14 oz. silver.

Several refractory lead, zinc, and copper ores from the United States, Canada and Mexico have been sent over to the Broken Hill mill for testing by selective flotation, and preliminary reports recently returned indicate the success of the Bradford SO_2 treatment on them. The Bradford selective-flotation processes are patented in all the principal countries of the world. I am Mr. Bradford's representative in America, and recently returned to New York from Australia.

Liberty and Labor

The hope of labor lies in the opportunities for freedom; military domination, supervision, checks, bondage, lie in Prussian rule.

It is not through a German régime but through democracy that labor is to receive adequate recognition and its realization of its rightful place in the world.

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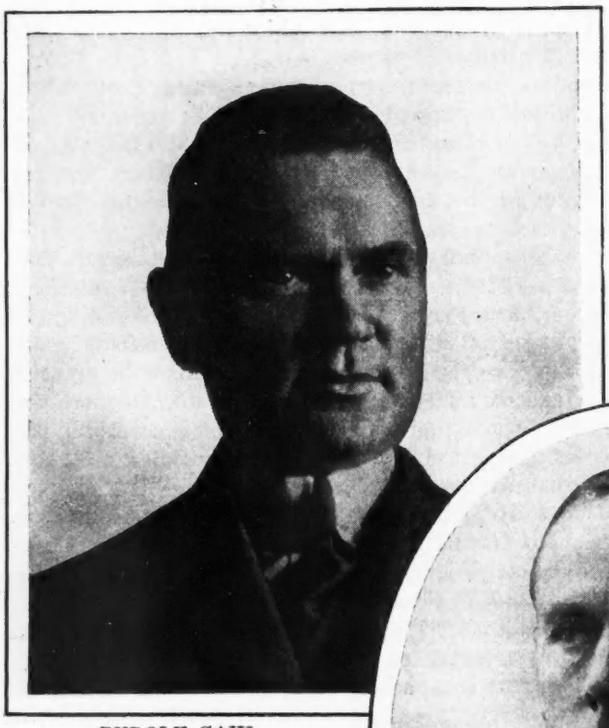
*Metallurgical engineer, 29 Broadway, New York.

Prominent Mill Superintendents



RUDOLF GAHL
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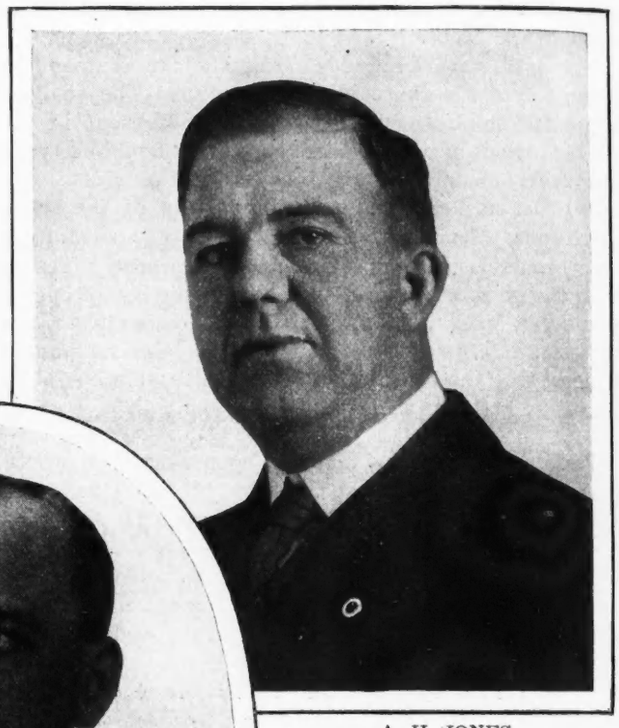
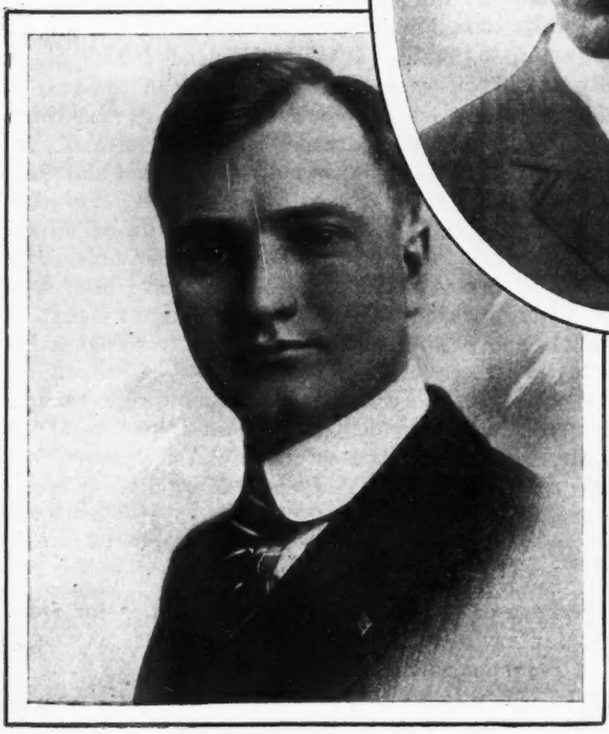


A. H. JONES
Tonopah Belmont Development Co



ALBERT E. WIGGIN
Anaconda Copper Mining Co.

ARTHUR CROWFOOT
Arizona Copper Co.

J. T. SHIMMIN
Butte & Superior Mining Co.

Differential Flotation of Lead and Zinc

By W. L. ZEIGLER*

The separation of blende and galena is still an important metallurgical problem. Separation by differential flotation is being practiced in the milling plants of the Coeur d'Alenes, Idaho, and a fair degree of success has been attained. The paper offers a review of the methods practiced.

NEARLY all flotation oils, when used in small quantity, show a marked tendency to float galena in preference to sphalerite and pyrite. This is especially true when the so-called "frothing" oils are used. The greater part of the clean galena ores in the Cœur d'Alene district float easily, with a good recovery, by the use of steam-distilled pine oil or wood cresote, which are good frothing agents but poor collectors, while, with possibly one exception, the sphalerite ores require a "collector" to obtain a good extraction. Much work has been done in this district to separate the galena and blende in the mill slimes by flotation, and at present this is being accomplished in several mills and tailings plants.

Pneumatic Cell Successfully Used

The general method used at present is to float the galena first from the thickened mill slimes in pneumatic

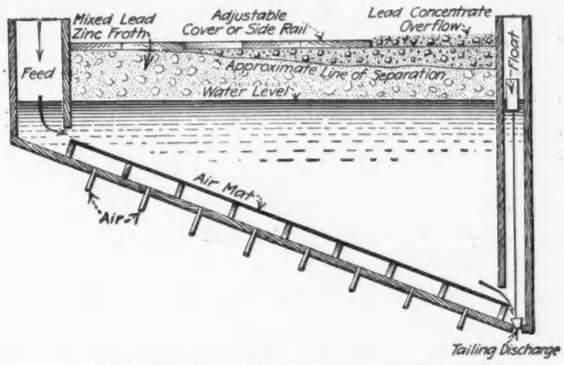


FIG. 1. LONGITUDINAL SECTION OF PNEUMATIC CELL

cells by the use of a small quantity of a frothing oil. The tailing from the lead cells is then sent to zinc cells, where the sphalerite is floated from the gangue by using a suitable quantity of a "collector" oil and reagents.

In this method, the type of flotation machine employed probably has as much to do with the success of the process as have the differential properties of the oils used. The pneumatic cell is particularly adapted to this work, as the agitation is by no means violent and can be readily adjusted to meet different conditions by simply supplying more or less air under the air mats. Mechanical agitation will invariably tend to raise the finer particles of sphalerite with the galena, and as froth produced in this manner is much more persistent and difficult to break down than that made by the pneumatic cell, there is little mechanical separation of the two sulphides in the froth bed.

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When using wood creosote or pine oil, blende forms a more friable froth than galena; hence, in a deep bed, the froth breaks down, permitting most of the zinc to go back into the pulp, while the greater part of the lead remains in suspension, as illustrated in Fig. 1. This condition is obtained when using a small quantity of air in the pneumatic cell and is further adjustable by placing boards over the top or side rails on the overflow edges to hinder the flow of the froth, thus giving the zinc in the froth a chance to drop back into the pulp.

Predominance of Metals Governs Concentrates

The greatest disadvantage is that there is no sharp end-point between the flow of the lead and zinc froths, and it depends to a large extent upon the skill of the operator. However, where conditions are regular, better results are obtained than one would naturally expect. The amount of zinc that is contained in the lead concentrate and the amount of lead that is left in the zinc concentrate depend greatly upon the percentages of the two minerals in the feed. That is, if the galena predominates in the feed, it is easier to make a high-grade lead concentrate which will carry a small percentage of zinc than it is to obtain a zinc concentrate that will carry a small percentage of lead, and the lower the proportion of lead is to that of zinc, the more difficult it is to obtain a clean lead concentrate and a high extraction of galena.

Several combinations of "roughers" and "cleaners" may be used, according to the values and characteristics of the ore, the extreme case being a "rougher" and "cleaner" for both the lead and zinc concentrate and tailings. After the lead is taken off, there is no objection to using mechanical agitation for extracting the zinc, and it is sometimes used on the tailing from the zinc cells to obtain a better extraction.

The general mill practice is to carry out ordinary concentration as far as possible, and to remove both a lead and zinc concentrate as coarse as can be separated, depending upon the characteristics of the ore. The greater part of the lead, and in some cases of the zinc, are removed in this manner, and flotation is used only for material that is too fine or which cannot be separated on tables and vanners.

Initial Preparation of Pulp

The initial preparation of the pulp plays an important part in differential flotation. Probably the most difficult separation to make is when both sands and slimes of the different minerals are present. This is due to the fact that the finer the mineral particles are, the less oil and agitation it requires to float them; hence, it is hard to differentiate between the fine particles of sphalerite and the coarse grains of galena. The ideal condition is when all the galena is slime and all the sphalerite is in the granular form. This condition could never be attained in practice, but it can be approached by subjecting the feed to hydraulic classification, and especially on most ores where the lead slimes badly and the zinc does not. The curve shown in Fig. 2 illustrates this clearly and was plotted from screen-

size assays of a pulp hydraulically classified in the mill

Ordinarily this pulp is tabled, making both a galena and blende concentrate, while the tailings are thickened and sent to the flotation unit. Differential flotation may be used on this feed with the following results:

	Per Cent. Lead	Per Cent. Zinc
Table lead concentrate	76.0	3.1
D. F. lead concentrate	79.4	3.0
Table zinc concentrate	2.9	38.4
D. F. zinc concentrate	3.9	42.3
Table tailing	1.6	4.3
D. F. tailing	0.3	2.4

D. F. = Differential flotation

By thickening and treating the table tailings by flotation, the following results are obtained:

	Per Cent. Lead	Per Cent. Zinc
Lead concentrate	50.0	10.0
Zinc concentrate	8.0	40.0
Tailing	0.2	0.9

Plotted on Fig. 3 are curves of the screen-size assays. As there is a quantity of a low-grade magnetic mar-

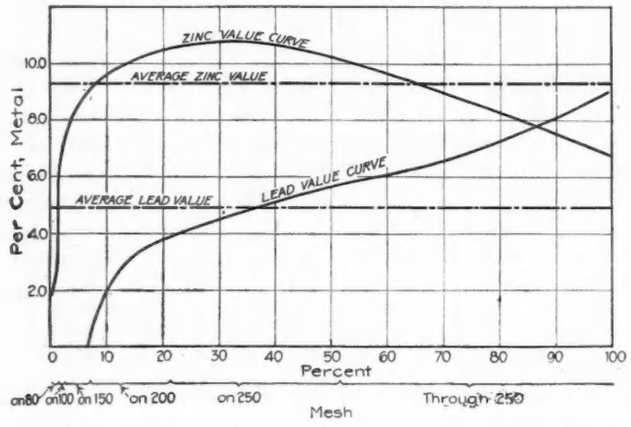

FIG. 2. SCREEN ANALYSIS—VALVE CURVES OF PULP PREPARED BY HYDRAULIC CLASSIFICATION

matite in this ore which does not yield to flotation, tabling followed by flotation proves the most economical, and better results are obtained than in following flotation with tables.

Use of Chemicals

A light coal-tar distillate made soluble in a strong caustic soda solution will cause the lead to float almost entirely free from zinc, and requires a combination of mechanical and air agitation. This may be carried on until no more lead floats and the remaining froth is white in appearance. Adding copper sulphate and No. 350 pine oil will then raise the zinc, with a good extraction and a clean concentrate. A very small amount of eucalyptus oil dissolved in a relatively large quantity of wood alcohol will also give good results, but when sufficient quantity is added to get a good extraction of the lead the colloidal zinc tends to raise, there being no definite dividing line. Both common salt and sodium carbonate tend to differentiate between galena and blende, and have been used experimentally, but the number of ores to which they are applicable is limited.

After both minerals are floated as a combined concentrate, the Horwood process seems to be the only solution for their separation, although potassium permanganate, potassium dichromate and other chemicals have been used experimentally. Even if successful, their cost would be prohibitive.

Unfortunately the zinc blende in the ores of the Cœur d'Alene district is not high grade, and carries combined iron ranging from 5 to 20%. Under the present market conditions, it is better to take the penalty on zinc in the lead concentrate than to sacrifice the extraction of the lead. The low price paid for zinc slimes leaves the margin of profit so narrow that expensive treatment is out of the question.

Horwood Process

T. J. Hoover, who was among the earliest writers on flotation, said in 1912, regarding the separation of sulphides:[1]

Up to the present, these methods have not with complete success solved the problem of the separation of the sulphides from each other. The Horwood process is a step in this direction, but little has been heard of it recently, and on economic grounds it is doubtful if in the present form the idea is commercially feasible.

The sulphides of the base metal have the quality of oil and gas adhesion in varying magnitudes, as can be easily demonstrated, but the range of this variability is much smaller than between gangue and sulphides. No one dare say, however, that even this minute variability does not have in it the basis of a commercial separation. Horwood accomplishes the result by going to the expense of a preliminary slight roast. . . . Some oils cause a better froth-

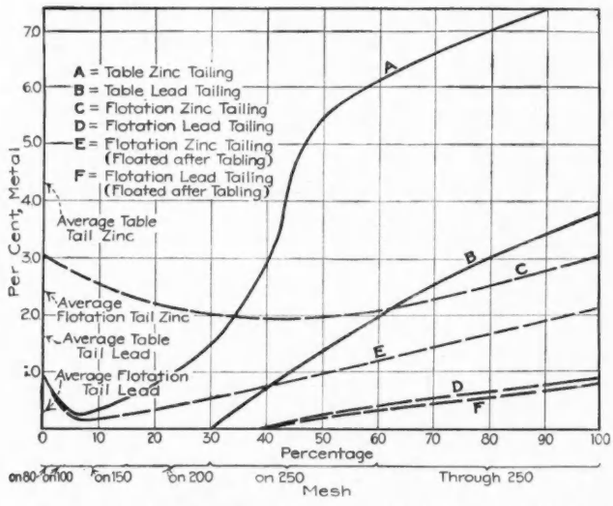

FIG. 3. COMPARATIVE VALUE CURVES OF TABLE AND FLOTATION TAILING

ing of the blende than of the galena; some temperatures are better for the frothing of certain sulphides than of others. . . . The above factors and others, which are available for working in conjunction, conceivably contain the secret of a revolutionary process for solving the longstanding problem of separating completely and commercially mixed sulphides of copper, zinc and lead. I am inclined to think, however, that the solution of this vexed problem lies within the realm of the chemical industry.

Evidently, if we may expect as much of an advance in the next six years as there has been in the last, sulphides will be separated from one another as completely as they now are from their gangue.

Mineral Production of British South Africa in the last quarter of 1917, as reported by the vice consul at Johannesburg, was as follows: Gold, 2,197,773 oz.; coal, 2,588,025 tons; tin, 510; copper, 8053; asbestos, 1450 tons; silver in gold bullion, 224,113 oz.; corundum 1094 tons. Transvaal's share of this output was: Gold, 2,197,771 oz.; coal, 1,717,710 tons; tin, 503; copper, 3926; asbestos, 702 tons; silver in gold bullion, 224,113 oz.; corundum, 1094 tons.

[1] "Concentrating Ores by Flotation," by Theodore J. Hoover, July 4, 1912.

Flotation vs. Cyanidation

G. H. CLEVENGER*

The applicability of the flotation process to the treatment of gold and silver ores is determined by the extraction, the cost and the practicability of disposing of the flotation concentrate, as compared with the extraction and cost by some other suitable method. This paper presents a comparison of flotation and cyanidation and shows that cyanidation often has advantage in net return.

SOON after it was discovered that certain gold and silver ores could be treated by flotation, many assumed that flotation would bring about the same revolution in the treatment of precious-metal ores that it had brought in the metallurgy of the base metals—zinc, copper and lead. The more optimistic predicted that it would displace the cyanide process, and, in many cases, amalgamation, while even the more conservative were prepared to admit a considerable field for flotation in the treatment of gold and silver ores.

Flotation Not Invariably the Preferred Practice

It is now common knowledge that flotation has not accomplished all that was expected of it in the treatment of precious-metal ores, and this has been the more difficult to understand in the light of the economic results attained in the treatment of zinc, copper and lead ores. Comparison of the state of the art at the time that flotation was successfully introduced, in respect to the treatment of low-grade base-metal ores having a light gangue (concentrating ores), and low-grade gold and silver ores having a light gangue and no interfering base metals (cyaniding ores), will clearly show that a direct analogy between the two problems cannot be made.

Flotation was first applied commercially in a large way to the treatment of zinc ores, and even before its complete development it achieved considerable favor on account of the high losses by other methods of concentration. The application of the process to the treatment of copper ores was less rapid, but once it was clearly demonstrated that the extraction made upon low-grade concentrating ores could be considerably increased, its general adoption followed. Similarly with lead ores, its suitability for the treatment of certain products which could not be handled by water concentration quickly led to its use in this field. In the case of the three ores named, there was a distinct need for such a process, as the losses by all methods of concentration formerly in use were, in most cases, excessive. In short, the processes for the mechanical concentration of base-metal ores were imperfect, extractions from 50% to 70% only being realized. Moreover, the product obtained by flotation was similar to that which had previously been obtained by water concentration, so that, aside from difficulties which arose through the extreme subdivision of the concentrate, no special methods were required for its treatment other than the smelting processes previously used for the recovery of the zinc, copper or lead from the concentrate of older methods of concentration.

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Briefly, then, in the case of the base metals, the extraction was increased by flotation at a reasonable cost, and from the concentrate the metal could be obtained by the same methods that were previously used. On the other hand, the cyanide process which had been developed for the treatment of siliceous gold and silver ores was giving extractions of from 90 to 99% and, in addition, the precious metals were produced in the form of bullion, which could be readily disposed of.

The possibility of treating precious-metal ores by flotation was not seriously considered until the process had been firmly established, but when it was adopted its development was rapid.

Application of the Process to Concentration of the Precious Metals

There at once arose the problem of realizing upon the concentrates. Local treatment or shipment to a smelter were possibilities, but in some cases the former could not be accomplished, and in any event, either procedure was at a distinct disadvantage as compared with the direct production of bullion. Thus flotation, in the case of the precious metals, has had to compete with a highly developed existent process with little or no opportunity for improvement in extraction, and with the distinct disadvantage that it produces a crude product (concentrate), and not bullion.

Many years ago metallurgy was defined as the art of making money from ores, and although there have been radical changes in metallurgical practice, the definition still holds. It is a truism that intelligent operators are endeavoring to make the highest net recovery from their ores. This does not necessarily mean the selection of the process showing the highest extraction, for there are other factors entering into the problem. Net recovery in the case of gold and silver ores may be defined as the total value of the gold and silver contained in the ore minus the losses of gold and silver occurring during treatment, the cost of treatment, the cost of marketing (either bullion or concentrate), and royalty, if a royalty has to be paid upon the process used; it being assumed that all items of expense or loss are included under some one or other of these heads.

Metal Losses Occurring in Flotation and Cyanidation

The losses which may occur in the cyanide process are through undissolved and dissolved gold and silver contained in the tailings discharged from the plant plus whatever other loses may occur during treatment, such, for example, as wasted solution, loss of precipitate in handling, etc. Theoretical extraction is the amount of gold and silver indicated by the product of the difference between the assay of the original ore and the assay of the tailing and the tonnage treated, while actual extraction is represented by the value of the bullion produced. Formerly, the discrepancy between theoretical and actual extraction was large. At present, such discrepancies in well-operated plants are small, and in some cases the actual recovery is more than the theoretical extraction. This is explained, where the ore is weighed, care-

fully sampled and proper deductions made for moisture, by the fact that the fire assay for gold and silver is not, as has been popularly supposed, a perfect operation. In other words, losses occurring in the fire assay may more than compensate for plant losses other than those represented in the tailings discharged from the mill. A gain in extraction is more likely to occur with the silver than with the gold, on account of the higher correction for the former in the fire assay as ordinarily done.

In flotation, it has not been so clearly demonstrated, in the case of gold and silver ores, that theoretical and actual extraction will agree closely. Flotation has the advantage that a lower-grade product is produced and, therefore, there is less chance for loss if carefully handled. On the other hand, if the concentrate is shipped to an outside plant for treatment, there is the added danger of loss during transit, and errors in moisture determinations, as well as loss through the failure of the buyer to make corrected assays upon the product purchased. Furthermore, if the concentrate is treated locally, there is the tailing loss, plus whatever other losses there may be inherent to the process used. On the whole, I consider it safe to assume that the difference between theoretical and actual extraction would be about the same with both processes, with possibly a greater chance for discrepancies to arise with flotation than with cyanidation.

Comparision of Cost of Treatment

In considering the cost of treatment by the two processes, the first item is the relative cost of plant, since amortization and interest charges upon the cost of plant, although frequently omitted, form an important item in ore-treatment costs. Fine-grinding is required for satisfactory flotation of gold and silver ores; this on account of the necessity of freeing the gold and silver or minerals containing these metals from the gangue, as well as on account of the high specific gravity of the two metals.

Consideration of the phenomena of flotation clearly indicates that metallic gold and silver must be finely subdivided in order to float, particularly so in the case of gold. In the case of any given ore, my experience, which has been confirmed by the observation of others, has demonstrated that fine-grinding is required to the same extent for flotation as for cyanidation, and in some cases even finer grinding is required for flotation. This being the case, it is apparent that the cost of the grinding plant necessary for flotation would be at least as great as that for cyanidation, so that the two processes would be on a parity in respect to this item. From this point on, the cost of equipment for cyanidation would be much greater than that for flotation. It will be observed that, in this respect, flotation has an advantage over cyanidation. However, if local treatment of the concentrate is practiced, the additional cost of such a plant may tend to equalize the total plant cost.

On the other hand, if the concentrate is shipped to an outside plant for treatment, an advantage may be realized, but generally through sacrifice in net recovery. In the case of a new property where it is desired to obtain quick results, or in a case where adequate capital is not available for plant construction, flotation would have an advantage, provided there was not too great a discrepancy in net recovery. As previously pointed out, the cost of grinding may be taken as the same for both processes. The cost of flotation would be less in most cases than the cost of cyanide treatment, and particularly so at present, with the high costs of all mill supplies. However, it should be remembered that cyanidation produces bullion, whereas flotation produces a concentrate.

Concentrates Not Always Easily Marketed

Freight, treatment charges, and losses upon the bulky wet concentrate form a very considerable item. The drying of the concentrate has not proved an easy problem, particularly in the case of small mines in localities where fuel is high, so that the operator is at times left in the dilemma of choosing between expensive drying or paying freight upon water. I have also heard many complaints of the difficulty of disposing of the concentrate. This is perhaps more aggravated under present abnormal conditions than it would be under ordinary circumstances. In a number of cases which have come to my attention, flotation, though apparently possessing a decided advantage over cyanidation, was found by the test of more extended operation to be less efficacious than the last-named process.

Thus far I have considered ores upon which it was assumed that approximately the same extraction could be obtained by the two processes. As a matter of fact, there are a number of ores in this country being treated by cyanidation which are giving better extractions than could be obtained by flotation. Such cases, I think, may be at once dismissed from the discussion, as flotation, in order to compete with cyanidation, must at least give as good an extraction as the older process. Again, there are cases of ores or tailings which are not readily amenable to cyanidation and upon which flotation will give very good extractions. A case in point is the tailing resulting from the amalgamation of Mother Lode (California) gold ores. Much of the tailing is too low grade for profitable treatment, but in certain cases it contains sufficient gold. Most of this tailing gives a very poor extraction by cyanidation, for reasons which have never been entirely made clear. In the case of one mine which used flotation, good extractions were obtained, but it was reported that the power consumption was excessive. It would appear that this disadvantage could be overcome.

In cases of ores containing base metals or other interfering elements, flotation might precede cyanidation for the recovery of these valuable products, as well as to eliminate their effect upon cyanidation. Indeed, in case of such ores, it frequently would happen that the gold and silver would be removed with the concentrate containing the base metals, in which case cyanidation would be superfluous. In the case of ores which give a good extraction by cyanidation, but where the tailing still contains sufficient gold and silver to render its further treatment desirable, flotation would seem to present promising possibilities. A well-known company in the Cobalt (Canada) district has been investigating the use of the process at its plant upon a large scale for some time. All the tailing from the cyanide plant is passed through flotation machines. Flotation in very weak cyanide solutions under certain conditions is possible, and J. M. Tippett has patented a combination process of cyanidation and flotation which, upon raw Cripple Creek ores, gives a high extraction by cyanida-

tion and a high-grade concentrate containing a large proportion of the gold not recoverable by simple cyanidation. In continuous operation there is some question regarding the effect of organic material resulting from the oils used in the cyanide solution, upon dissolution and precipitation, but, on the whole, the process would seem to merit further investigation.

Treatment of Flotation Concentrate

The advantage of local treatment of flotation concentrate does not permit of satisfactory generalization. The concentrate from no two ores appears to be the same. Unquestionably the recovery of silver from this material presents a more troublesome problem than the recovery of gold. In certain cases the concentrate can be treated directly by cyanidation. In the case of gold, where this is not possible, an oxidizing roast generally renders it amenable to cyanidation. With silver, an oxidizing roast is out of the question, for although it breaks up the original combination in which the silver occurs, it renders much of the silver insoluble through combinations formed during roasting. This is a subject upon which much light is being thrown by investigations recently made under my direction. At Cobalt it is thought that the flotation concentrate resulting from the treatment of silver ores of the district can be satisfactorily treated by the Holt-Dern process. The ordinary chloridizing roast prior to cyanidation, while to a degree effective, is not looked upon by most metallurgists with favor, on account of the possibility of volatilization losses.

Present Status of Flotation

This brief review, while by no means complete, will indicate the present position of flotation in some of the more prominent precious-metal mining districts of the United States and Canada. The process is not in use in the Porcupine district (Canada), and it is generally conceded that at present it would not be possible for it to compete with the cyanide method for the treatment of the gold ores of the district, which, it may be remembered, are particularly well adapted to cyanidation.

In the Cobalt (Canada) district, flotation is finding extensive application to the treatment of rather refractory low-grade silver ores. In two cases, a combination of gravity concentration and cyanidation has been displaced by a combination of gravity concentration and flotation. Both of these plants, at the time of my visit to the district last summer, were installing equipment for the treatment of the concentrate by the Holt-Dern process. Two plants are still using a combination of gravity concentration and cyanidation and two plants formerly using water concentration have added flotation plants for the treatment of certain of their products. One plant employing cyanidation has added a flotation plant for treating cyanide tailings.. Flotation has a distinct field of usefulness in this district, and has made a better showing here than elsewhere.

Amalgamation Tailings of Mother Lode Show Good Flotation Recoveries

It has been demonstrated that good recoveries can be made from the amalgamation tailings of the Mother Lode (California) mines, which are not amenable to cyanidation. In the Grass Valley district, where the amalgamation tailings are amenable to cyanidation, flotation has not displaced the older process, although at one time it was thought that this might come about.

No flotation plants are in operation at Tonopah (Nevada) for the treatment of the silver-gold ores of the district, which are now universally treated by cyanidation. It is generally thought by metallurgists most familiar with these ores that flotation cannot compete with cyanidation. One well-known company in the Goldfield (Nevada) district, after large-scale experimentation, converted the cyanide section of its combination cyanide and gravity concentration plant into a flotation plant, the plan being to treat the flotation concentrate in the existent roasting and cyanide plant used for treating the other concentrates. As this was a gold ore, this method of treating the concentrates, with the exception of difficulties arising on account of the finely divided nature of the material, was satisfactory. Soon after starting the plant, the results by flotation became unsatisfactory, and it was found necessary to return to cyanidation of the ore, with the exception of the part high in copper, which was not amenable to cyanide treatment, and which fortunately could be satisfactorily treated by flotation.

The treatment of the low-grade ores of the Cripple Creek disrict by flotation has been investigated on a large scale under the most favorable auspices. One well-known company operating in the district converted the cyanide part of its combination cyanide and gravity concentration plant over to flotation, and after operation for a number of months abandoned flotation and went back to cyanidation, on account of the higher net recovery made possible by the older process. Another company is at the present time operating a combination gravity concentration and flotation plant, but comparison of its results with those of the other company are not available.

Preliminary Experimental Work

There are a number of points which I should like to make clear in connection with the preliminary experimental work which is necessary for ascertaining whether an ore is suitable for treatment by flotation, for through proper cognizance of these and an accurate analysis of the experimental results disappointment in the operation of the process may be avoided.

It is perhaps superfluous to call attention to the necessity of performing experiments upon representative samples of ore, but it has frequently come to my attention, in connection with preliminary experimental work with a number of processes, that conclusions have been reached as a result of work done upon a few supposed representative samples only to discover later that there existed in the mine ore of a character not represented by the samples. The ore from different parts of a mine may vary greatly, although this may not be apparent on casual inspection, and there may be slight physical and chemical differences which have an important influence upon the operation of a delicately balanced process such as flotation. A sufficiently large number of samples from various parts of the orebody should be experimented upon to guard against this danger.

Drying of an ore which is to be milled wet often has an important effect upon extraction through changes in the colloidal portion of the ore. Even drying in the air, which may occur during the period intervening be-

tween the time that the sample is taken and the tests are made, may have an important effect. For this reason, I prefer to have the samples, as soon as taken, at once sealed in tin cans. In making tests by flotation, there are generally at least three products: concentrate, middling and tailing. It has been general practice to assume that extraction is represented by the content of the concentrate plus the middling, while the grade of the concentrate to be expected is represented by the grade of the concentrate obtained in the test. This presupposes that it will be possible to bring the grade of the middling up to that of the concentrate, without any additional tailing loss. This appears to be possible with many base-metal ores, but it has been demonstrated that with precious-metal ores it cannot always be accomplished, so that, instead of producing in actual operation, as expected, a high-grade concentrate and a low tailing, it is necessary to make a low-grade concentrate in order to obtain a low tailing. Mere size of the test is no guarantee that this point will not be overlooked, as it is customary, even when of a number of tons' capacity, to operate testing plants only on the day shift and to make a complete clean-up at the end of each shift.

New Kraut Flotation Machine

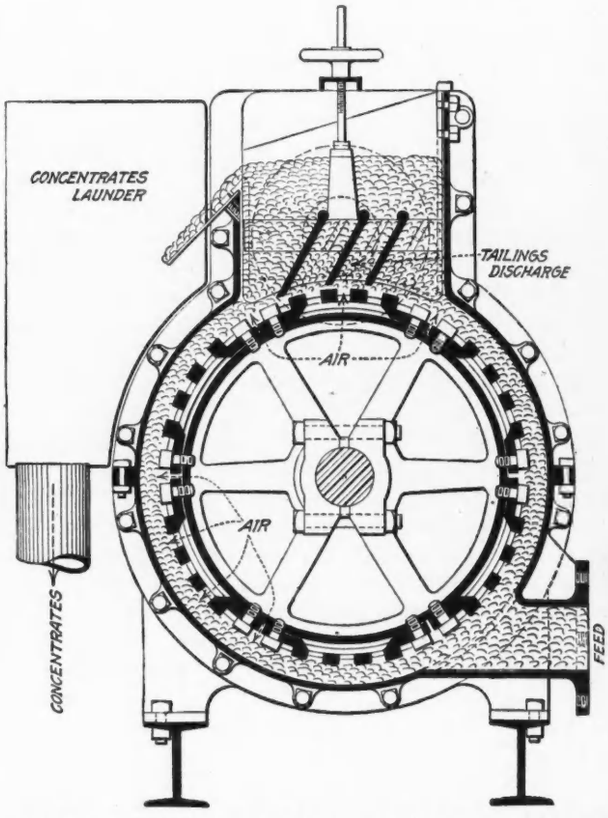
The new Kraut flotation machine (patent applied for) made by the Southwestern Engineering Co., of Los Angeles, Calif., is an improvement on the K. & K. flotation machine which has been on the market for about a year. The principle or means of operation employed in this latest type is identical with that in use in the K. & K. machine. Again, the rotor consists essentially of a hollow cylinder, the surface of which is provided with longitudinal riffles and air spaces between, through which air is introduced into the pulp from the atmosphere by the reduction in static pressure caused by the velocity or motion of a relatively thin layer of pulp adhering to and following the surface of the rotating cylinder. The air is entrapped between the riffles and a thin film of pulp drawn over it, causing the formation of bubbles to which the mineral particles adhere.

The essential feature which distinguishes this new machine from the older type is that it dispenses with the spitzkasten in front. Intead there is a bubble-collecting chamber on top and a series of adjustable skimmers, as shown in the illustration. By means of these skimmers, the bubbles carrying the mineral particles are removed from the rotating pulp almost as fast as they are made, and accumulated in the collecting chamber until there is a sufficient quantity to fill it to the top, when they are made to overflow over a discharge lip into a concentrates launder.

The pulp entering at the bottom at one end of the machine is rotated continually by the rotor, moving in a helical path toward the tail end of the machine, where it is finally discharged at the top, after leaving its mineral contents behind.

The makers claim that the advantage of the machine, as compared with previous types of K. & K. machines, consists in its increased efficiency, combined with reduced floor space, which is about one-half that of the older type, and in the fact that no head room is lost, but is rather gained, the tailings discharge being 18 in. above the feed intake. This makes it possible, when desired, to pass the tailings from one machine to another for retreatment on the same floor level.

In operation, one of the distinguishing features of this machine, as compared with others, is that there is no pulp level, but instead a more or less mixed zone of mineral-carrying bubbles and pulp at the point of contact with the skimmers. Regulation of a pulp level or



CROSS SECTIONAL VIEW OF NEW KRAUT FLOTATION MACHINE—PATENT APPLIED FOR

any kind of adjustment for this object is therefore unnecessary.

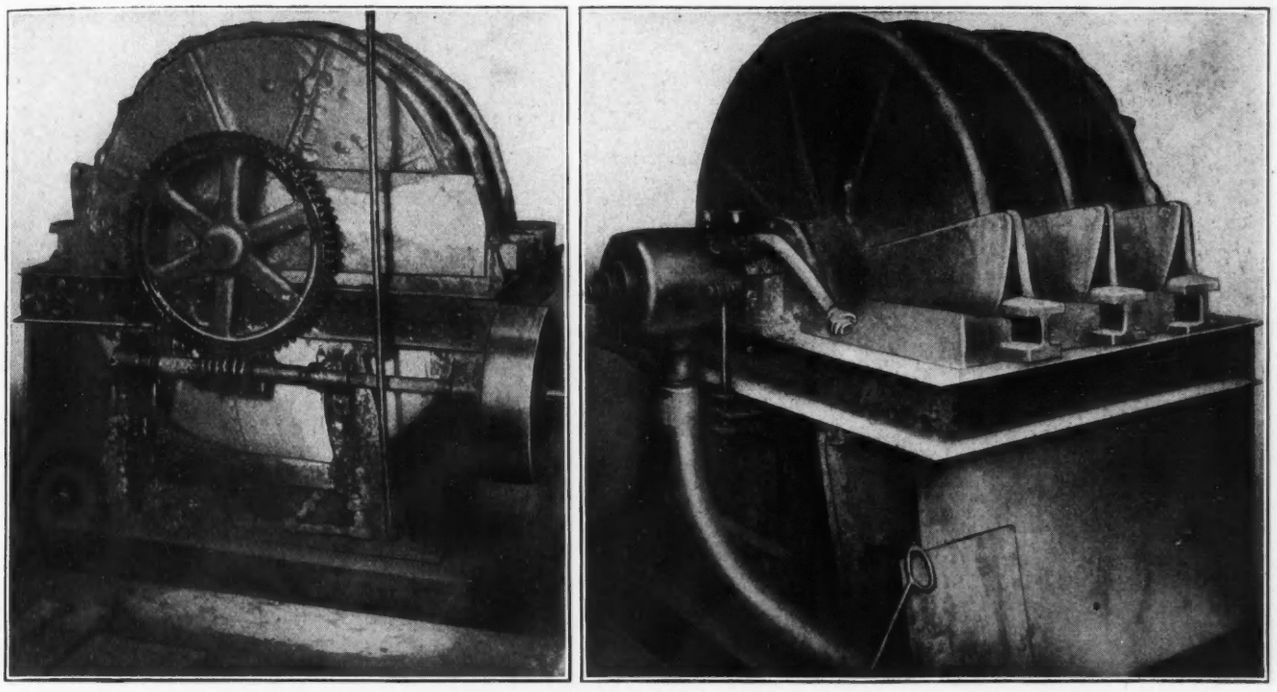
A simple device at the tail end of the machine regulates the tailings discharge automatically, so that it always equals the feed intake in volume. Another adjustment makes it possible to control the amount of pulp maintained in the machine at one time. The entire machine will be built of steel and cast iron and will be placed on the market soon by the makers.

Germany Furnishes the Proof

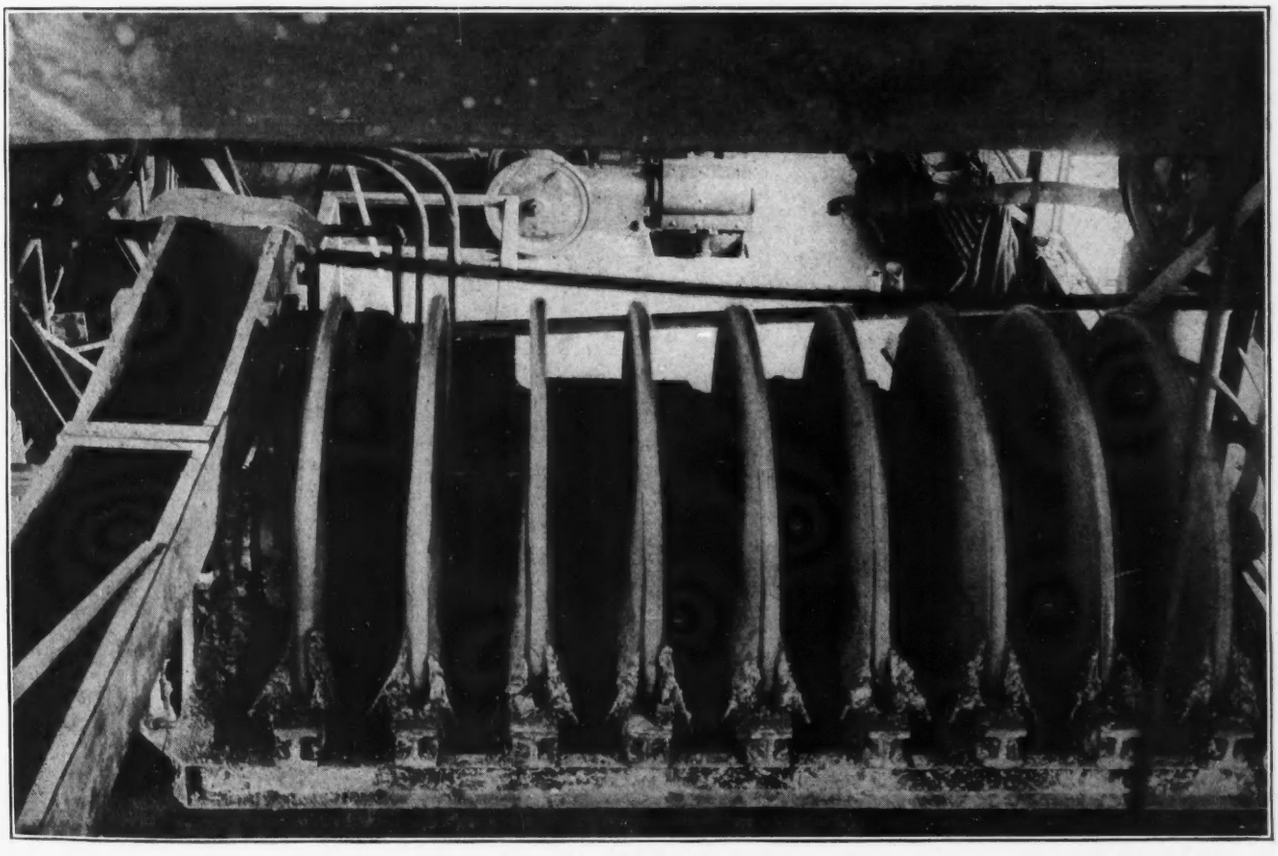
The imperative necessity of America's participation has been justified and proved by every development since the entrance of the United States into the war. Every German success and every German failure have shown how necessary to America's welfare and peace, how necessary to the safety and peace of the world, the defeat of Germany is. Every foot of ground Germany has been forced to give up, every foot of land she has seized, have demonstrated the absolute necessity of defeating that sinister. intolerable thing called Germanism.

It is better to wear a Liberty Bond button on your coat than the print of the Kaiser's heel on your neck.

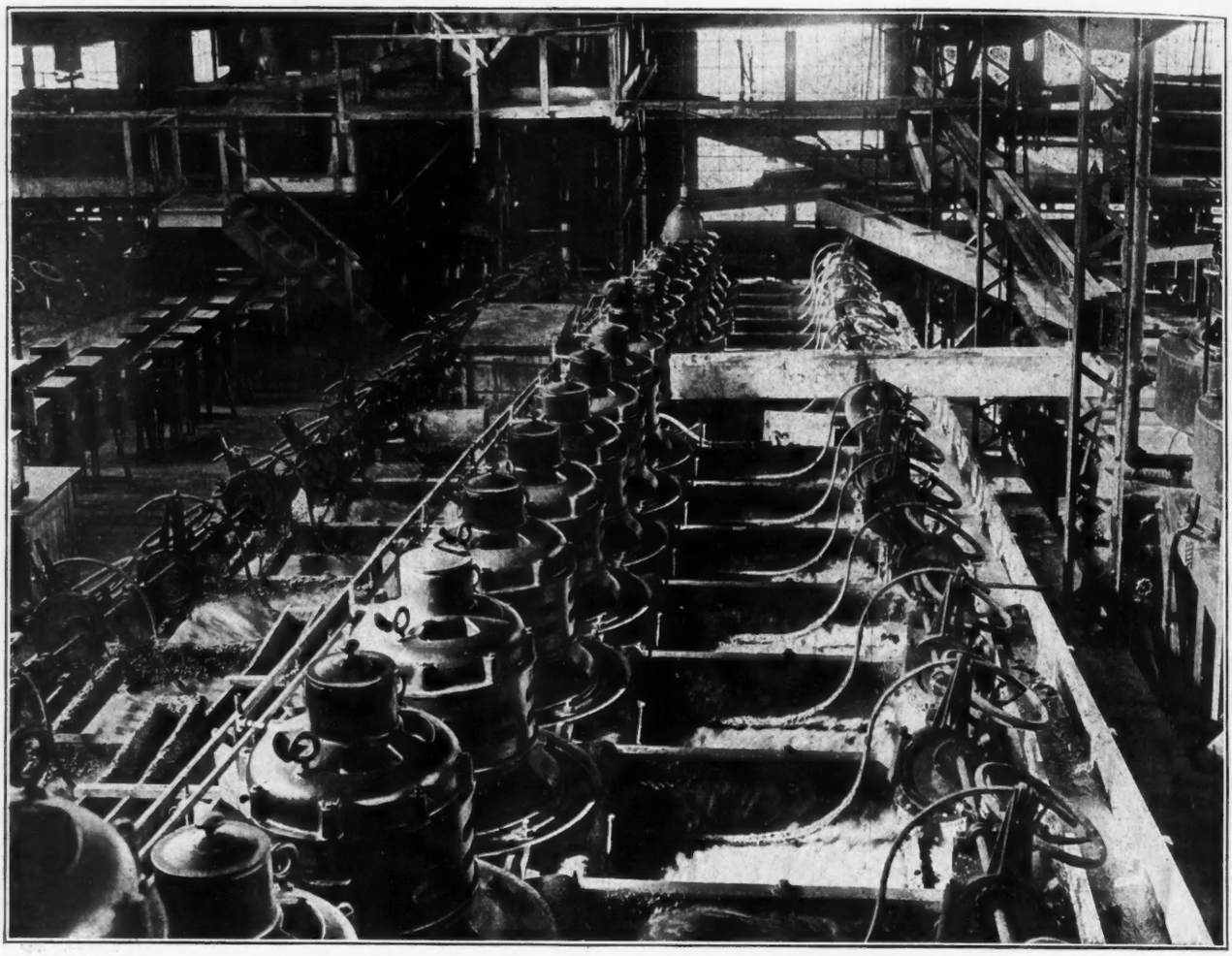
Appliances Used in Flotation Plants



AMERICAN DISK TYPE OF SLIME FILTER IN USE AT KELLOGG, IDAHO

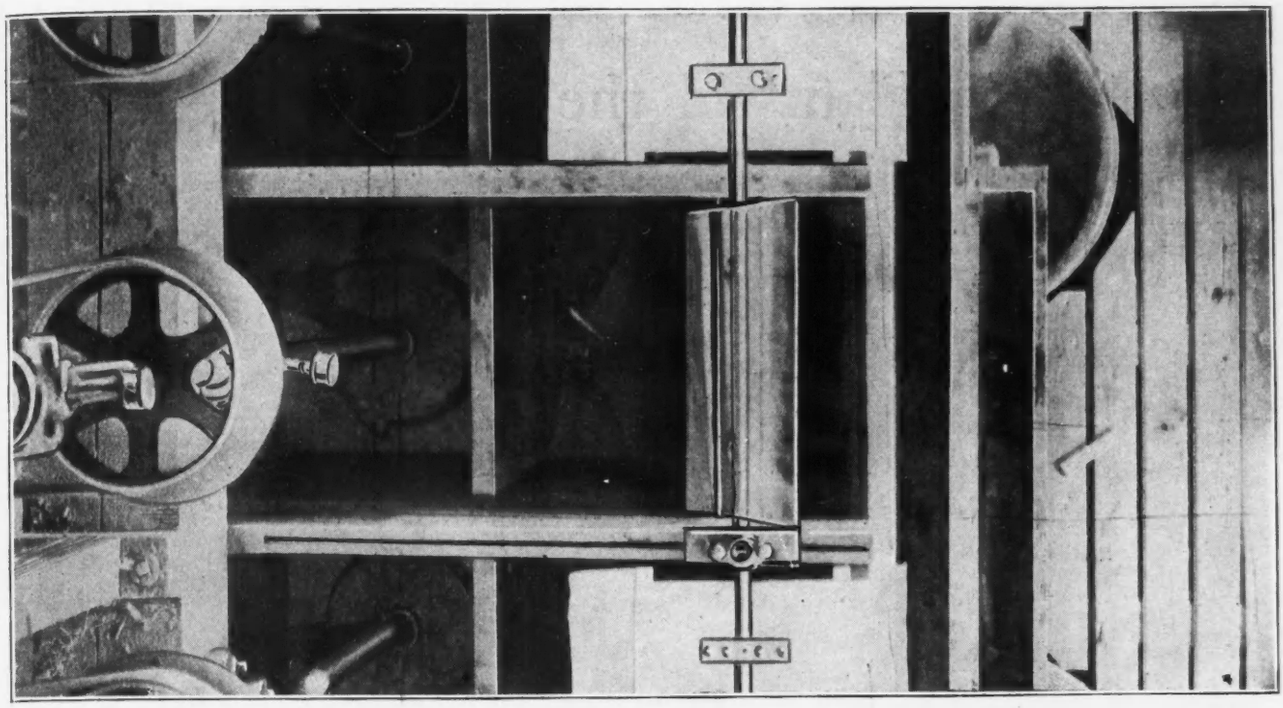


AMERICAN DISK TYPE OF FILTER USED FOR DEWATERING THICKENED FLOTATION CONCENTRATES

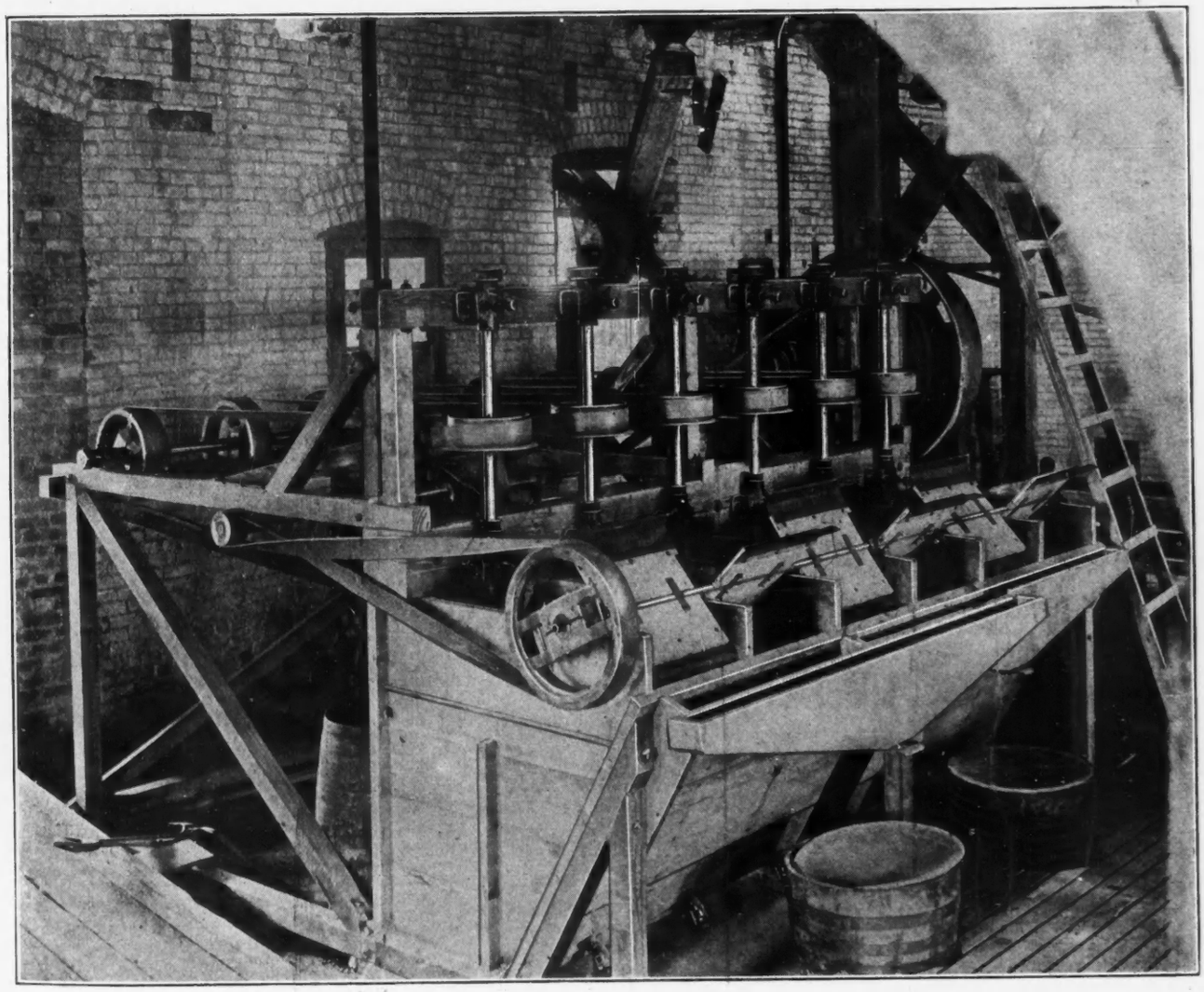


JANNEY "STRAIGHT MECHANICAL" FLOTATION MAÇHIN

JANNEY "MECHANICAL AIR" FLOTATION MACHINES

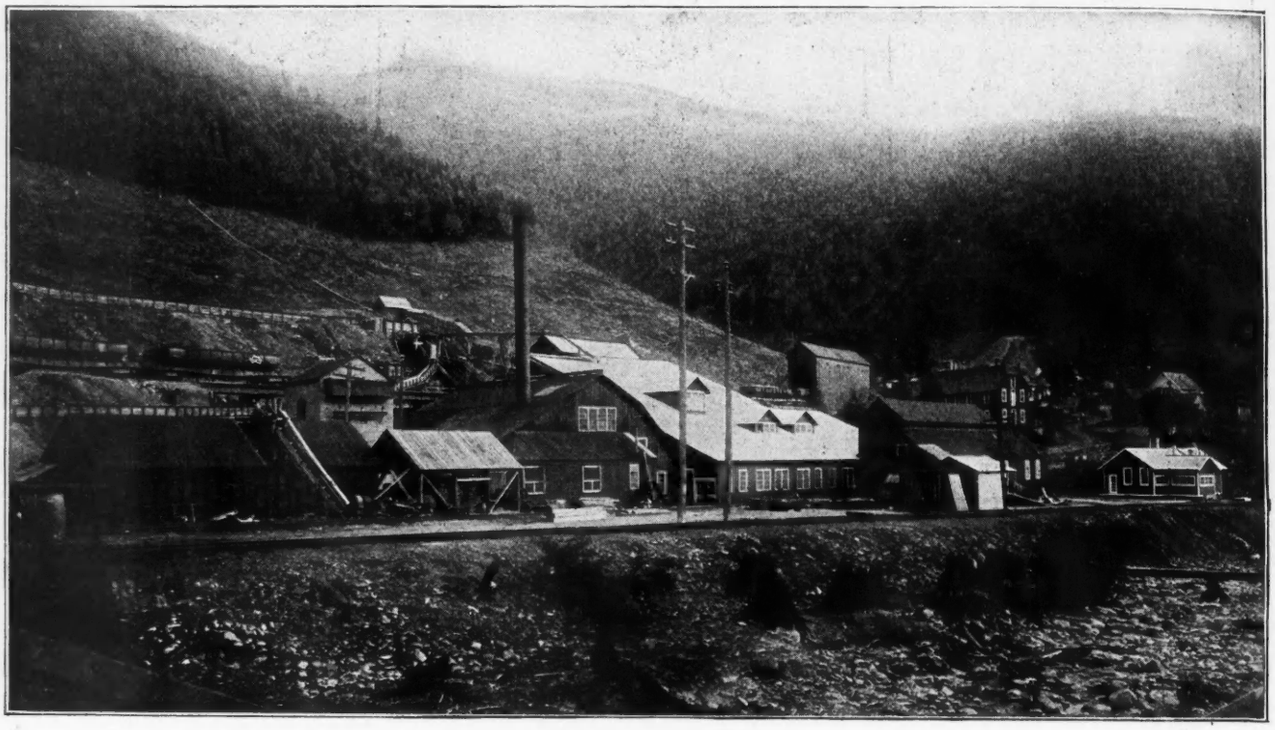


RUTH FLOTATION MACHINE—VIEW LOOKING INTO IMPELLER COMPARTMENT



RUTH FLOTATION MACHINE—6 CELL TYPE

Milling Plants in the Coeur d'Alenes



HECLA MILL, GEM, IDAHO

MORNING NO. 1 MILL, MULLAN, IDAHO

HERCULES MILL, BURKE, IDAHO

GREENHILL-CLEVELAND AND MORNING NO. 2 MILL, MACE, IDAHO

The Ruth Flotation Machine

By Joseph P. Ruth, Jr. *

The Ruth flotation machine is of the compartment and impeller type. The impeller is similar in principle to the inclosed runner of the centrifugal pump. The lower part of the impeller lifts the pulp through an axial opening and discharges it through openings in the periphery. The upper part of the impeller connects through three passages with a hollow shaft, through which air is drawn down and discharged through openings in the periphery of the impeller, each opening being midway between neighboring pulp-

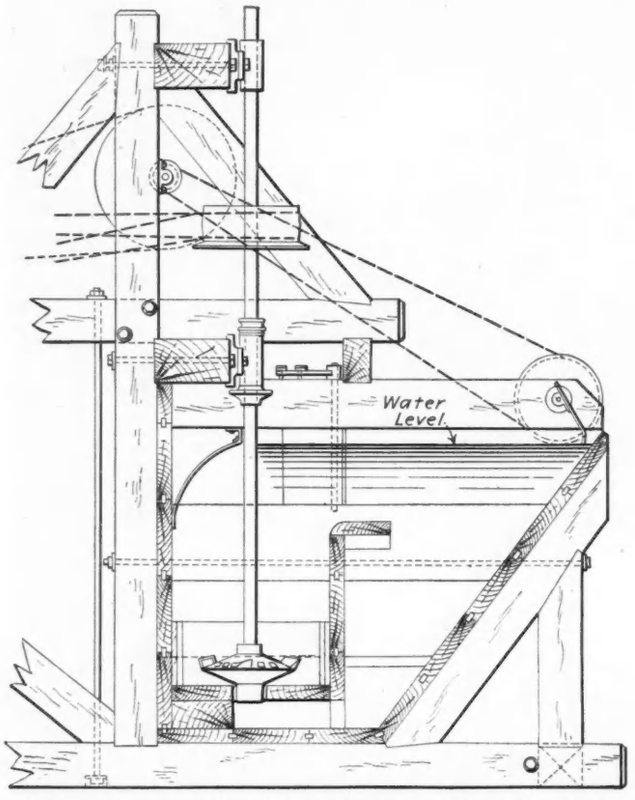


FIG. 1. RUTH FLOTATION MACHINE—SECTIONAL VIEW

discharge openings. The air discharge openings are provided with small hoods that assist in the free discharge of the air into the pulp. The discharged pulp mixed with air rises in a cylindrical chamber and overflows into the spitzkasten compartment. This compartment is V-shaped and connects by a lower passage with the inlet opening of the impeller. A curved deflecting plate is placed at the back of the impeller compartment and throws a steady surface stream of pulp toward the spitzkasten compartment and the discharge lip.

The discharge of the froth is assisted by a froth paddle. There are no pipes or valves between neighboring compartments. The pulp level in the machine is maintained by large openings between the compartments and a discharge opening on the last compartment. This discharge opening can be raised or lowered and the height of the pulp in the machine varied. The openings between compartments are in the side walls of the impeller chamber and are provided with gates, all of which on a given machine are controlled by a single lever. By means of these gates the rate of flow between compartments can be readily controlled. A valve or plug is used on the upper end of the impeller shaft for the regulation of the air.

The Ruth machine has a number of advantages, among which may be stated: Absence of pipes and the avoidance of choked-up passages; a pulp level that is maintained automatically without the use of floats, valves or other mechanism; a low power consumption

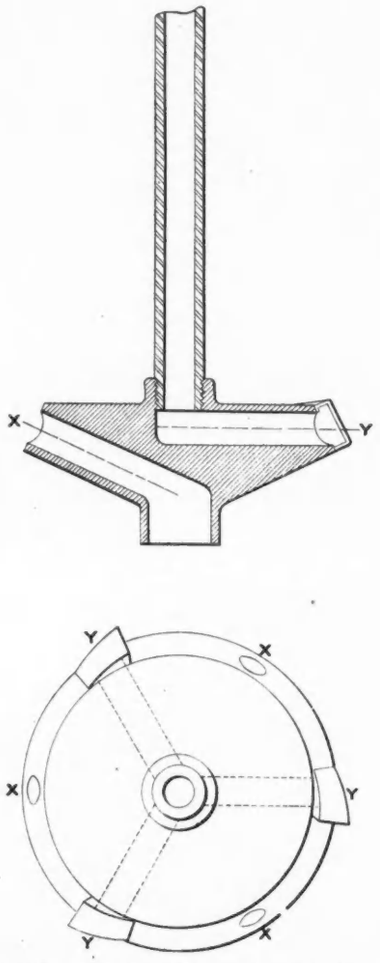


FIG. 2. IMPELLER OF RUTH FLOTATION MACHINE

(an impeller 13 in. diameter and operating at 270 r.p.m. uses less than one horsepower); the machine can be shut down with the average mill feed for any length of time without draining and can then be started without difficulty; thorough distribution of the air in the pulp and a positive circulation of the pulp at all times; air bubbles and mineral particles are raised together toward the surface and swept continuously toward the discharge lip; air regulation on each cell.

There are eight large machines in operation, and experimental machines of a convenient type have been constructed.

Plumbago shipped from Ceylon in 1916 was 668,216 cwt., valued at $7,298,128, as compared with 436,351 cwt., valued at $2,569,434, in 1915, according to *Commerce Reports*. Three-fourths of the total exports went to the United States, about 18% to the United Kingdom and possessions and nearly all of the remainder to Russia. France is said to get her supplies from Madagascar.

*Manager, The Ruth Co., Denver, Colorado.

Events and Economics of the War

In the third week of the German offensive, the attack was shifted to the northern front from Armentières to La Bassée; after taking the former place by gas attack, the Germans advanced along the River Lys to Merville; Bailleul was stormed and with it was taken most of Messines Ridge. American troops are reported to have reached the British front. The justice of French claims to Alsace Lorraine was admitted a year ago by Emperor Charles of Austria, the French Government has revealed, when the Austrian ruler secretly suggested peace. Bolo "Pasha" was executed at Vincennes on April 17. Conscription for Ireland, proposed by Lloyd George in presenting the manpower bill, was adopted by Parliament, which refused delay until home rule was established. Spanish ports were reported under blockade by German submarines. A Turko-German offensive has begun against the British in Palestine. Daylight saving became effective in Canada on Apr. 14.

In the United States, one-man control of the air program was demanded by the Senate Committee on Military Affairs. The War Industries Board has announced those industries that will receive preference in coal and coke. The President signed the Webb Export bill on Apr. 11 and placed the principal coastwise steamship lines under the control of the Director General of Railroads. A general investigation into freight rates on petroleum and its products was ordered by the Interstate Commerce Commission. Senator Stone, of Missouri, died on Apr. 14. The U. S. S. "Cyclops" was reported missing. Charles M. Schwab was appointed Director General of the Emergency Fleet Corporation.

What the Railways Have Done

Alfred H. Smith, Regional Director of Eastern Railroads, speaking before the Rotary Club on the subject of "Transportation," called attention to the fact that the operating revenue of the railroads in the United States in 1917 amounted to $415,716,868 more than in 1916, that the expenses had increased by $476,463,154, and that taxes had amounted to more than $60,000,000.

"Our railroads have 264,000 miles of main line and 391,000 miles of track, which is 37% of all the railroads in the world," said Mr. Smith. "Their main line would girdle the earth at the equator more than 10 times. This is about seven times greater than all the railroad mileage of Germany. They own 2,500,000 freight cars, 55,000 passenger cars, and 64,000 locomotives. There are 1,800,000 employees, who, counting two dependents each, sustain directly 5,400,000 people, not counting affiliated supply industries; 20 billions is invested.

"This stupendous machine during 1917 carried the equivalent of 400,000,000,000 tons of freight one mile, which means 4000 tons hauled a mile per capita.

"The Eastern Region includes 206 companies, several of them very large systems. It comprises about 80,000 miles of main line, with nearly 1,000,000 employees. Although our Eastern lines have only about one-fourth of the country's mileage, they handle about one-half the total tonnage.

During 1917, with the same plant as in 1915, because financial conditions virtually stopped expansion, the railroads carried 120,000,000,000 ton-miles more freight. The increased freight service rendered was upward of 15% greater than the preceding year, due to intensified effort by the railroad army and some measure of better public coöperation. Instead of 'breaking down,' the railroads distinctly have 'speeded-up.' "

With such a splendid record of speeding up by the railways, what was the reason for the freight congestion last winter? Mr. Smith does not explain this, but we quote from another railway official as follows:

(a) Vessel shortage for transatlantic trade; (b) extraordinary increase in freight traffic (Governmental and commercial) and in passenger, mail and express traffic; (c) necessity of handling in most expeditious manner the movement of troops and materials for cantonments; (d) concentration within eastern territory of industries supplying directly or indirectly Government needs; (e) necessity for military purposes of handling traffic through ports in this territory; (f) elimination of water transportation; (g) shortage, inexperience and consequent inefficiency of labor; (h) shortage of motive power and equipment due to military reasons; (i) Government priority and preference orders last summer and fall; (j) delays to passenger trains while loading mail into insufficient car-space, under "space plan" of pay.

To meet this situation the carriers, with the coöperation of the Government and shippers, have:

(a) Increased carload and trainload; (b) decreased the number of locomotives under repair, reduced the number of cars necessary for lake and tidewater coal, provided for joint use by all carriers of open-top cars, and secured the use of motive power belonging to western and southern railroads; (c) created (under direction of Director General McAdoo) an administration which practically operates eastern lines as a unit, which controls export traffic so as to reduce congestion at the Atlantic seaboard, prevents the movement of traffic through congested gateways, transfers the power or traffic from one road to another and generally obtains a closer coöperation in all operating details among different roads.

Requa Meets Wire-Rope Men

Representatives of wire-rope manufacturers conferred on Apr. 9 with Mark L. Requa, head of the oil division of the U. S. Fuel Administration. At the meeting, which was held in New York, it was decided that a general speeding up of production in the domestic wire-rope industry would be necessary if the new oil and gas wells now in course of development for naval and other war purposes were to be properly equipped.

The wire-rope representatives told Mr. Requa that the scarcity in wire rope at this time was due to the abnormally large contracts placed by the Government for the Navy and Army. The conference developed the fact that between 20,000 and 25,000 tons of wire rope would be required to equip the projected enlargements in oil and gas production in the United States. This

tonnage the manufacturers present promised to furnish.

Mr. Requa had a word of warning to say to the ropemakers against profiteering. "I find," he said, "that there has been considerable profiteering in wire rope, not by the manufacturers, but by jobbers. This profiteering has amounted to as high as 300%. That practice we will stop wherever found. The provisions of the Lever law under which the Fuel Administration is working will be applied to correct this abuse."

Coal and Coke Preference List Issued

The priorities division of the War Industries Board has adopted what is known as preference list No. 1 for the guidance of all Governmental agencies in the supply and distribution, by rail or water, of coal and coke. The board has not undertaken to classify any industry as non-essential or at this time to limit the quantity of fuel which any particular industry or plant shall receive. The following plants, etc., are included among those classed as preferred:

Plants engaged exclusively in manufacturing chemicals; coke plants; domestic consumers; plants making electrical equipment, electrodes, explosives, ferroalloys, fire brick, or gas; iron and steel blast furnaces and foundries; plants making machine tools; mines; plants making mining tools and equipment exclusively; oil refineries (mineral and vegetable); plants making oil-well equipment exclusively; rolling mills; manufacturers of tin plate; plants producing rope (hemp) exclusively; and manufacturers of wire rope and rope wire.

Automobile plants are not in the list.

Studying the "Cost-Plus" Contract

On account of the "cost-plus" contracts made during the present war, Attorney General Gregory is giving special consideration to problems likely to arise in connection therewith. The Supreme Court has denounced profiteering, or the padding of costs in suits resulting from contracts analogous to the "cost-plus" agreements. It is believed that these decisions place the burden of proof on the "cost-plus" contractor whose contract is annulled on account of fraudulent padding.

In a recent case, Crocker vs. United States (240 U. S., 74), the Supreme Court held that no recovery could be had upon a Government contract tainted with fraud and rescinded by the proper officer of the Government on that ground.

The contractor may obtain a reasonable price for goods actually delivered and accepted by the Government, but he has the burden of proving what is a fair price. If prices be named in a contract annulled for fraud, such prices are not taken as an admission by the Government and cannot be used by the contractor in establishing his claim. He must prove his case without assistance from the terms of his vitiated contract.

The Supreme Court has denounced the procursement of Government contracts by agents employed on a contingent fee basis, declaring that there is no difference in principle between agreements to procure favors from legislative bodies and agreements to procure them in the shape of contracts from executive officers; that the "no-contract-no-fee" arrangement suggests an attempt to use sinister and corrupt means. "The law meets the suggestion of evil, and strikes down the contract from its inception."

Kaiser Bill's Long-Range Gun

Various descriptions have appeared in the daily papers, since Hindenburg started his latest drive, of the monster gun, otherwise known as the supergun, handled by supermen, of course, that is bombarding Paris from the vicinity of Laon, so it is said, 75 miles away. According to one Paris newspaper, the gun is of 22 cm. calibre and uses 200-lb. shells, about 50 cm. in length, carrying about 20 lb. of explosive. Inside, the shell is said to be divided into two longitudinal compartments, one over the other, the separating diaphragm being pierced with three holes, which permits two successive explosions with a short interval between. A long-pointed nosecap made of sheet iron is used to reduce the resistance of the wind. The writer is thought to have examined an unexploded shell.

A dispatch from the Hague to the *Times* says that Prof. Fritz Rausenberger, manager of the Krupp works, who built the 42-cm. mortar, is the designer of the new gun and assisted personally at firing the first shots on Paris. According to the *Lokal Anzeiger*, of Berlin, the gun looks more like an enormous gray crane than a real gun and can throw a shell 80 miles. Firing at a shorter distance on Paris the shell took 183 seconds to reach its mark. A dispatch from Washington says that the gun is one of the battle cruiser Hindenburg's 16-in. battery, which has been rebuilt for smaller projectiles, by shrinking the muzzle, the chamber remaining as cast. At any rate one such gun is reported to have burst on Mar. 25, and Paris is still there.

Pershing Gets Steel in France

Testimony of Chairman Hurley of the U. S. Shipping Board and J. Leonard Replogle, director of steel supplies for the War Industries Board, given before the Senate Commerce Committee in executive session, was made public recently and disclosed that General Pershing has obtained 750,000 tons of steel products from the French and British goverments to meet urgent needs in France, with an agreement to replace the tonnage in plates, projectiles and other forms from the United States. American mills now are working to capacity, the witnesses said, to meet the demands of the allied countries and the requirements of the United States.

Mr. Replogle told the committee he did not believe it practicable for the Government to arrange to send steel to fabricating plants as far West as Omaha, Neb., when the fabricated material must be shipped back to the East to be used in ship construction. Other testimony had indicated a belief that this would be practicable.

May Generate Power at Coal Mines

Steps have been taken by U. S. Fuel Administrator Garfield that may lead to the establishment of central generating plants at mines centers, from which electric power may be distributed to communities within a radius of 150 miles. Transmission of power over high tension wires to industrial plants at a distance would eliminate coal haulage to a corresponding extent. A

preliminary survey has been authorized by Dr. Garfield, who also announced that the project will probably be financed by the Government. Coal too poor to haul could thus be consumed at the mines.

Achievements of Shipping Board

A comprehensive analysis of the entire shipbuilding situation was made by Edward N. Hurley, chairman of the U. S. Shipping Board, in a speech delivered before the National Marine League of the U. S. A. on Mar. 26. Hitherto unpublished data were given by Mr. Hurley as to the number of new shipyards and ways, built and building, and the tonnage and types of vessels under construction and planned. The following salient facts were stated by Mr. Hurley:

"There were 37 steel shipyards in America at the time of our entrance into war. We have established 81 additional steel and wood yards, while 18 other yards have been expanded. We are building in the new and expanded steel yards 235 new steel ship ways, or 26 more than at present exist in all of the steel shipyards of England. The total amount of our steel construction on Mar. 1 was 8,205,708 deadweight tons, made up of 5,160,300 deadweight tons under contract with the Emergency Fleet Corporation, and 3,045,408 deadweight tons of requisition vessels. Of this 2,121,568 deadweight tons, or approximately 28%, has been completed. Of the steel ships under contract and under requisition, 655,456 deadweight tons, or approximately 8%, were actually completed and in service on Mar. 1 of this year. This amount of floating tonnage exceeds our total output in 1916, including steel, wooden and sailing vessels, by approximately 50 per cent.

"We have had to build up a tremendous administrative organization. We have had to negotiate for neutral tonnage. We have had to requisition and provide for the operation of the entire existing American merchant marine. With the expenditure of a little less than $8,000,000 we have succeeded in placing in our war service and in the service of the Allies 112 first-class German and Austrian vessels, representing a carrying capacity of nearly 800,000 deadweight tons.

"At the outset, the 37 old steel yards began increasing their capacity, until they now have 195 ways, as against 162 eight months ago. We then made provision for additional new steel yards, some of which have been given financial assistance by the Emergency Fleet Corporation. Thirty additional new steel shipyards are thus being erected, with a total of 203 shipbuilding ways. Thus we now have in the aggregate 67 steel shipyards either wholly or partly engaged in Fleet Corporation work. These yards will have a total of 398 steel building ways. Of these, 35 yards, with 258 ways, are on the Atlantic and Gulf Coast; 19 yards, with 66 ways, are on the Pacific, while 13 yards, with 74 ways, are on the Great Lakes.

"We found 24 old wooden shipyards, with 73 ship ways. We now have 81, with 332 ways completed or nearing completion. These ways should turn out about 2,300,000 deadweight tons of wooden ships annually. These 332, added to our 398 steel building ways, will give us a total of 730, an increase of 495 and 521 more berths than Sir Eric Geddes in his recent speech stated England has at the present time.

"We have established a large training school at Newport News as well as a department for training electric welders. We have recruited a volunteer force of 250,000 highly skilled mechanics, who have agreed to hold themselves in readiness for our call. These men are being held in reserve, remaining in their present employment until such time as in the development of our yards the demand arises for their services.

"In 1916 there were less than 45,000 men employed in all the shipyards of the country, and on March 2, 1918, we had increased this number to 236,000, of which 170,589 were working on actual ship construction and the remainder in yard construction and other branches of the industry. Thousands of others are employed in taking out the timbers for our wooden construction and at the scores of inland steel plants which are fabricating the parts for steel vessels."

Britain Plans Post-War Trade

The British Empire's plans for the trade war that most people believe will follow the present armed conflict are gradually taking definite form. A feature of its preparations is the creation of the Overseas Trade Department, under which 16 trade commissioners will operate in the various countries of the empire, and a number of commercial attachés will work in foreign countries. The House of Commons recently made an appropriation of $10,000 for preliminary expenses of the department. This department, which has been quietly reconstructing the whole government commercial business throughout the world, is in charge of Sir A. D. Steel-Maitland, a social and constitutional reform advocate of Birmingham.

The new organization is controlled by a joint committee of the Foreign Office, which corresponds to the American State Department, and the Board of Trade, which has much the same functions as the American Department of Commerce. The reason for joint control by these particular departments is that in foreign countries trade questions and political issues are often interwoven. The commercial attachés will supervise and link up the work of a reformed consular service and supply important reports embodying trade and financial surveys of the countries in which they are.

Chemists in National Army

Practically all of the chemists in the National Army have now been transferred from camp to the laboratories of the Government or the industries, says *Journ. Ind. and Eng. Chem.*, where their highest service to the country can be rendered. The chemical service section of the National Army has reached France and is now in its research laboratory, a remodeled factory building which has been placed at its disposal by the French government.

"Peace once restored," the *Economiste Francaise* believes, "people in the countries overstrained by war must gird up their loins in earnest, work earlier and longer than they used to do, and thereby eventually produce new wealth in greater quantity than before the war."

Industrial News from Washington

By Paul Wooton, Special Correspondent

Importation of Chromite Restricted To Save Shipping

Authorities in Washington are restricting importation of chromite from all countries other than those in North, South and Central America and the West Indies for the purpose of gaining additional shipping for the supreme military effort now being made.

There are considerable stocks of New Caledonian ore on hand and in transit. Besides, new sources of the mineral have recently been opened in Cuba and Brazil. Brazil is counted upon to produce 25,000 tons of ore in 1918. A large tonnage is expected from one mine in Cuba, which already has been partly developed and will be put in operation at once.

Estimates differ as to the amount of ore which can be produced in California and Washington, our principal domestic sources, but every effort will be made by the Government to stimulate and encourage this production. In addition to this, however, much would depend upon the attitude of the chrome industry and upon the methods used by producers and consumers alike. It appears that the chrome industry in California is not organized and that an immense amount of annoyance has been caused by middlemen, who do not represent responsible concerns and who operate between the producer and the consumer in such a way as to discourage the former in many cases.

In an attempt to correct this evil, the Electro-Metallurgical Co., the chief purchaser of chrome ores, has inserted an advertisement in many local California papers, quoting minimum ore prices on a basis of $1.25 per unit for 38% ore. Organized action by the Pacific Coast chrome industry would doubtless be effective in this and other matters. The War Industries Board and other departments in Washington, it is understood, will coöperate in stimulating production. This coöperation must also be extended by the Railroad Administration, and the discouraging effect of railroad embargoes must be removed, if the shipping program is to be carried out. Several plants are being built on the Pacific Coast to manufacture ferrochrome, and their chief difficulty has been in obtaining electrodes. It is to be hoped that this lack will soon be overcome.

Concentration of low-grade ores must be gone into if expected requirements are to be met. With the increased prices for chromium, it is possible that the old Pennsylvania-Maryland chrome district may be able to produce some ores which can be concentrated to a workable product.

On the part of the consumers, great economies can be effected in the use of chromite, and some are already being carried into effect. For example, about 40,000 tons of ore have been used annually for refractory linings in copper and steel furnaces, but it has been ascertained recently, beyond any doubt, that 90% of this chromite can be replaced by magnesite, of which we have abundant supplies in Canada and Washington. As a matter of fact, these economies in the substitution of magnesite for chromite linings have already been widely adopted. Manufacturers are urged to practice this economy largely and carefully. The U. S. Bureau of Mines estimates that the maximum allotment of 12,000 to 15,000 tons for refractory purposes for 1918 will be ample, and from information obtained from manufacturers it would seem that this estimate is liberal and can be diminished.

Manufacturers of ferrochrome may be obliged to use lower-grade ores than those to which they have been accustomed. This appears to be perfectly feasible from a metallurgical standpoint, and it will simply be a matter of adjustment of practice. Steel makers can get along with a lower grade of ferrochrome if it becomes necessary.

War Industries Board Announces Plans

A central directing agency has been created within the War Industries Board. This is the principal feature of the board's reorganization, which has just been announced. "The general purpose of the plan," says the statement, "is to prevent confusion and conflict in ordering and delivering supplies and to secure unification of the Government's policy in dealing with industrial problems." The directing agency is to be known as the requirements division, through which the policies of the chairman are to be carried out.

This division will keep the chairman advised of contracts, purchases and deliveries, to enable him to analyze the progress of business in the several branches of the Government. It will also receive from the purchasing departments of the Government at Washington and of the Allied governments advance statements as to their needs for raw materials and finished products.

While the War Industries Board emphasizes the fact that it will "let alone what is being done successfully and will interfere as little as possible with the present normal processes of purchase and delivery in the several departments," it is stated that the requirements division will handle statements that will include "not only commodities in which a present or threatened shortage exists, but also those in which the supply is ample."

The announcement reads in part as follows:

> Speaking generally, the requirements of both the American Government and the Allies can be met satisfactorily if orders and deliveries are given systematic allocation according to the relative urgency of the needs of the various departments demanding them. Shortage in materials is very frequently found on analysis to be not actual, but rather the result of badly planned distribution.

Special commodity sections, following the existing plan, are to take charge of particular problems of supply. Each of these sections will be charged with the responsibility of collecting information as to the production of the particular commodity for which it is held responsible, from the several departments of the Government, from the manufacturers and producers and

from committees representing them, and especially from the war-service committees created under the supervision of the U. S. Chamber of Commerce, and from any other reliable sources. This information must cover available supplies, new sources of supply and methods to increase production.

Considerable speculation has been excited by the following statement: "It is the purpose of the chairman of the War Industries Board to make each of the section heads the sole Government agency for dealing with the industry for which his section is responsible."

Opposition to Silver-Purchase Bill Is Forecast

Few Senators have made a careful study of Senator Pittman's bill providing, among other things, for the purchase of silver at the fixed price of $1 per oz. Any legislation which delves into the silver question is sufficient cause for considerable reserve on the part of lawmakers. It is certain, however, that the bill will face determined opposition. Some of this will be based on the argument that it is still another measure granting far-reaching powers to the executive division of the Government. Senator Pittman's bill, which has been referred to the Committee on Banking and Currency, is given in its entirety as follows:

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Secretary of the Treasury is hereby authorized from time to time to melt or break up and to sell as bullion not in excess of 250,000,000 standard silver dollars now or hereafter held in the Treasury of the United States. Any silver certificates which may be outstanding against such standard silver dollars so melted or broken up shall be retired at the rate of $1 face amount of such certificates for each standard silver dollar so melted and broken up. Sales of such bullion shall be made at such prices and upon such terms as shall be established from time to time by the Secretary of the Treasury.

Section 2. That upon every such sale of bullion from time to time the Secretary of the Treasury shall immediately direct the Director of the Mint to purchase an amount of silver equal to 371.25 grains of pure silver in respect of every standard silver dollar so melted or broken up and sold as bullion. Such purchases shall be made in accordance with the then existing regulations of the Mint and at the fixed price of $1 per oz. of silver 1000 fine, delivered at the option of the Director of the Mint at New York, Philadelphia, Denver, or San Francisco. Such silver so purchased may be resold for any of the purposes hereinafter specified in section three of this act, under rules and regulations to be established by the Secretary of the Treasury, and any excess of such silver so purchased over and above the requirements for such purposes, shall be coined into standard silver dollars or held for the purpose of such coinage. The net amount of silver so purchased, after making allowance for all resales, shall not exceed at any one time the amount needed to coin an aggregate number of standard silver dollars equal to the aggregate number of standard silver dollars theretofore melted or broken up and sold as bullion under the provisions of this act, but such purchases of silver shall continue until the net amount of silver so purchased, after making allowance for all resales, shall be sufficient to coin therefrom an aggregate number of standard silver dollars equal to the aggregate number of standard silver dollars theretofore so melted or broken up and sold as bullion.

Section 3. That sales of silver bullion under authority of this act may be made for the purpose of conserving the existing stock of gold in the United States, of facilitating the settlement in silver of trade balances adverse to the United States, of providing silver for subsidiary coinage and for commercial use, and of assisting foreign governments at war with the enemies of the United States. The allocation of any silver to the Director of the Mint for subsidiary coinage shall, for the purposes of this act, be regarded as a sale or resale.

Section 4. That the Secretary of the Treasury is authorized, from any moneys in the Treasury not otherwise appropriated, to reimburse the Treasurer of the United States for the difference between the nominal or face value of all standard silver dollars so melted or broken up and the value of the silver bullion, at $1 per oz. of silver 1000 fine, resulting from the melting or breaking up of such standard silver dollars.

Section 5. That in order to prevent contraction of the currency, the Federal reserve banks may be either permitted or required by the Federal Reserve Board, at the request of the Secretary of the Treasury, to issue Federal reserve bank notes, in any denominations (including denominations of $1 and $2) authorized by the Federal Reserve Board, in an aggregate amount not exceeding the amount of standard silver dollars melted or broken up and sold as bullion under authority of this act, upon deposit as provided by law with the Treasurer of the United States as security therefor, of United States certificates of indebtedness, or of United States one-year gold notes. The Secretary of the Treasury may, at his option, extend the time of payment of any maturing United States certificates of indebtedness deposited as security for such Federal reserve bank notes for any period not exceeding one year at any one extension and may, at his option, pay such certificates of indebtedness prior to maturity, whether or not so extended. The deposit of United States certificates of indebtedness by Federal reserve banks as security for Federal reserve bank notes under authority of this act shall be deemed to constitute an agreement on the part of the Federal reserve bank making such deposit that the Secretary of the Treasury may so extend the time of payment of such certificates of indebtedness beyond the original maturity date or beyond any maturity date to which such certificates of indebtedness may have been extended, and that the Secretary of the Treasury may pay such certificates in advance of maturity, whether or not so extended.

Section 6. That as and when standard silver dollars shall be coined out of bullion purchased under authority of this act, the Federal reserve banks shall be required by the Federal Reserve Board to retire Federal reserve bank notes in an amount equal to the amount of standard silver dollars so coined, and the Secretary of the Treasury shall pay off and cancel any United States certificates of indebtedness deposited as security for Federal reserve bank notes so retired.

Section 7. That the tax on any Federal reserve bank notes issued under authority of this act, secured by the deposit of United States certificates of indebtedness or United States one-year gold notes, shall be so adjusted that the net return on such certificates of indebtedness, or such one-year gold notes, calculated on the face value thereof, shall be equal to the net return on United States 2% bonds, used to secure Federal reserve bank notes, after deducting the amount of the tax upon such Federal reserve bank notes so secured.

Section 8. That nothing in this act shall be construed as repealing or restricting the right of Federal reserve banks to issue Federal reserve bank notes under authority of the Federal reserve act, and except as herein provided, Federal reserve bank notes issued under authority of this act, shall be subject to all existing provisions of law relating to Federal reserve bank notes.

Senators Will Consider Mineral Bill

Hearings will be undertaken in the near future by the Senate Committee on Mines and Mining on the Mineral-Control bill. The committee held an executive session last week, at which the personal views of the members were set forth. Apparently a majority favors a measure such as that already introduced in the House by Representative Foster, the chairman of the House Committee on Mines and Mining. There are many objections, however, to this bill as introduced, and it seems probable that the Senate committee will insist on numerous changes.

The U. S. Bureau of Mines is busy drafting plans for the division of the appropriation that is to be granted for investigatory work in the war minerals. Some difficulty is being experienced in securing the necessary technical assistance.

One Remedy for Flotation Trouble

Why get agitated over less than one per cent. of oil? Think about this instead: Less than one per cent. of *Journal* readers have contributed to the Comfort Fund for the 27th Engineers. Have you, yourself, given the regiment a thought? Give your money, too. It's your regiment, whether you are in mill or mine. On it should centre your interest in the troops abroad. The mining regiment is our mining world in miniature. Skilled and finely equipped for mining operations, it is also trained to fight and in first-aid and rescue work, and it is taking *your* place at the front. Show it your loyality by boosting the Comfort Fund. You, of course, are loyal, but let your money do the talking. Think about the troubles of the men in the regiment and see how quickly you forget your own.

The list of contributors to the Comfort Funds is as follows:

Engineering and Mining Journal	$1000.00
New York Engineering Co.	1000.00
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Iowa Gold Mining and Milling Co.	50.00
L. L. Middelkamp	15.00
G. C. Townsend	10.00
H. S. Monroe	10.00
Jesse Scobey	10.00
J. H. McCormick	10.00
William Young Westervelt	50.00
B. Britton Gottsberger	50.00
Oscar Lachmund (second contribution)	10.00
L. R. Budrow	10.00
Horace V. Winchell	50.00
W. J. Pentland	10.00
Dome Mines Co.	50.00
Butte Copper and Zinc Co.	100.00
Eagle & Blue Bell Mining Co.	100.00
William A. Nicholls	10.00
Robert S. Lewis	10.00
Earl R. Pembroke	10.00
East Butte Copper Mining Co.	50.00
Job H. Winwood	10.00
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R. M. Raymond	50.00
J. Allen McKay	10.00
C. E. Hart (second contribution)	5.00
C. J. Trauerman	5.00
Thomas H. Garnett	5.00
Robert E. Dye	10.00
Louis Ross	25.00
Willis B. Parsons	5.00
Total	$10,459.00

Make your checks payable to W. R. Ingalls, treasurer of the Association. Because of the work involved in administering the Comfort Fund, contributions are acknowledged only by publication in the *Journal*.

Minerals Separation Limited

At a meeting of the stockholders of the Minerals Separation, Ltd., in London, on Dec. 22, 1917, reported in the *Mining Journal*, the total income for the year just ended was stated to have been $213,497, which was a gain of $31,768 over the previous year. The cost of management, traveling, staff, examination of properties and metallurgical expenditure in England and abroad amounted to $34,963, as compared with $34,529 in the previous year. Patent renewal and fees amounted to $6467, as against $11,722 in 1915. Under the North American patents, a balance of $138,336 was carried to the appropriation account. The first item on the credit side of this account, $239,176, is the balance of the profit and loss account, less income tax, as at Dec. 31, 1915. The second credit item, $474,727, represents the profit on the sale of the North American patents to the Mineral Separation American Syndicate (1913), less the income tax.

On Dec. 18, 1917, an interim dividend for the current year of $2.30 per share, or 50%, payable less in-

come tax on June 15, 1918, was declared. The stockholders thus received the cash dividend and the distribution in 1916 and 1917 of trust certificates in the Minerals Separation North American Corporation as returns upon this investment.

The first item on the debit side of the appropriation account represents the distribution to the shareholders of 250,000 Voting Trust certificates in Minerals Separation North American Corporation. The second item on the debit side of the account is the distribution of 12,000 Voting Trust certificates among the directors, in accordance with a resolution of shareholders passed at the extraordinary general meeting held on Mar. 14, 1917. The next item represents bonus to two members of the metallurgical staff in recognition of their services to the company since its incorporation. The balance of $222,863 has been carried to the balance-sheet.

In December, 1916, the Minerals Separation North American Corporation was formed with a capital of 500,000 shares of no nominal, or face, value, for the purpose of acquiring all the undertaking and business of Minerals Separation Syndicate (1913), Ltd. The consideration for this sale was the allotment to the 1913 syndicate of the whole of the 500,000 shares of the North American Corporation. Voting Trust certificates representing these shares were issued to the shareholders of the 1913 syndicate. Minerals Separation, Ltd., as holders of 32,616 "A" shares of £1 each and 250,000 "B" shares of 10s. each in the 1913 syndicate, received 315,232 Voting Trust certificates of the American Corporation. Of these 315,232 Voting Trust certificates, 250,000 were immediately distributed among the shareholders of Minerals Separation, Ltd. The management of the American corporation's business is in the hands of Mr. Ballot, Dr. Gregory, and one of the partners of Messrs. Lazard Frères, of New York.

The chairman, at the London meeting of stockholders, briefly reviewed significant features in the companies' business, mentioning in particular the enlargement of new business, which consisted in the development of new patents by the London staff of experts by which ores that could not be treated a year ago can now be successfully handled. Since the war material assistance in producing metals essential for war purposes has been rendered by Minerals Separation processes. It is expected that several plants will be established in Wales, where mines are being reopened for the purpose of increasing the output of war materials. Steps have been taken in Norway to demonstrate the suitability of the processes for the treatment of molybdenite ores, and one plant has been erected. French mining interests in Spain are considering the utilization of the processes. Russia presents increasing possibilities. Licenses were issued before the war to the Caucasus Copper Co., in Siberia. A small unit is being operated by a French mining company in Sardinia. In Bolivia a plant has been forwarded to the Corocoro United Copper Mines, Ltd., and is expected to be in operation early in 1918.

Crystalline graphite to the amount of 6800 tons was produced in the United States during 1917, according to an estimate made by H. G. Ferguson, of the U. S. Geological Survey. Of this amount, nearly 4000 tons was flake suitable for crucible use. The 1916 production was 5466 tons. Railroad embargoes against shipments into territory north of the Potomac hindered graphite operations in Alabama.

The Minerals Administration Bill

As a member of the War Minerals Committee I have been keenly interested in your editorials on the Minerals Administration bill now before Congress. In preparing the bill last autumn, our committee realized the difficulties over which you are concerned, and then, as recently, every effort was made to eliminate as far as possible all features of which objectionable use might be made. Price-fixing, for example, is distasteful to many, but in the light of the Food Administration's experience it seems inadvisable to omit these and other powers, probably seldom to be used, but whose existence is essential in handling recalcitrants. As far as the minerals named are concerned, the essential features are still retained, and I hope that the bill now before the House is such as, under the circumstances, you will be able heartily to endorse.

As you know, the condition with which we are confronted is that Governmental control of the fundamentals of industry is to be upon us, to remain until the end of the war, whether we will or no. To us of the mineral industry, the prime question is whether this control over us is to be divided among various departments and committees having little knowledge of the conditions and needs of our industry, or is to be unified under a single Minerals Administration of large mining and metallurgical executive experience.

The details of the bill will doubtless be modified by both House and Senate, but the essentials, it is hoped, can be successfully carried through both houses of Congress. The great need is the granting of sufficient power and resources to some man eminent in the mineral industry, situated in Washington and assisted by an able body of mining men. Second only to the prime duty of all of us to help win the war, this Mineral Administration's principal duty would be the direction of inevitable Governmental interference during the war toward the fostering, rather than the suppression, of our industry. Our committee, in its original draft of the bill, endeavored to gain this protection for all the mineral industries, but the principal metal industries, such as those of iron, steel, copper, lead and zinc, have not as yet been sufficiently aroused to the ever-increasing disadvantages under which they will be compelled to work while the war continues. Their indifference, and in some cases opposition, where support is essential, has necessitated limiting the bill now before Congress to the minor minerals.

In the case of such minerals as pyrite, manganese, chromite, etc., the necessity for immediate fostering is so obvious to the producers, that (granting we can get our profession aroused to enthusiastic support) there is excellent chance that this modified bill can be passed in some practical form. This done and a satisfactory Minerals Administrator appointed, it is hoped that the principal industries will come to realize the advantages that this administration may be made to have for them and see to it that they are included in the protection thus afforded before too great damage is done.

The war has already compelled drastic steps in Governmental control over such essentials of industry as labor, transportation and supplies (particularly imports), and practically complete Governmental control will be upon us at no very distant date if the war experience of our Allies is any guide. In the labor situa-

tion, we already have millions of men being drawn into military service, while other millions are being employed by "cost plus 10 per cent" and "rush regardless of cost" Governmental contracts, which have absolute command of the labor market as against normal industries. Again, the Government's recent large-scale labor-housing undertaking will shift labor centers of gravity away from industries failing to receive proper consideration. The embargo on transportation, both of our supplies and our products, is requiring evermore careful attention and supervision. Imports either already are or soon will be limited to the barest necessities, and the mineral industry must be prepared in advance either to furnish its own needs or to see to it that its indispensable imports are maintained.

The power back of these forces is indicated by the size of the loans the Government is being obliged to call for. With billions of dollars being raised every few months for expenses wholly abnormal and solely for the destructive purposes of war, is it not futile to expect that ordinary conditions will prevail in the mineral or any other industry? Even the largest and most highly organized of our mineral industries cannot of themselves expect to meet these forces properly. Patriotism and self-interest will have to combine to unite large and small in shaping themselves to these war compulsions and to seeing to it that there is an adequate Mineral Administration in Washington, with which they can coördinate and through which they can, as far as possible, turn these compulsions to constructive rather than destructive action on our industry.

WILLIAM YOUNG WESTERVELT,
Chairman War Minerals Committee.

New York, Apr. 10, 1918.

Major Things To Be Thought About

Germany is, to all intent, mistress of Central Europe and the Balkans, of Turkey and of Russia. As I write these lines (in December, 1917,) the last part of the German scheme is in preparation. All the disposable forces of Pan-Germany are concentrating on the Western front. If such a state of affairs is possible when the Entente has an abundance of admirable troops and boundless resources, it is because, as Mr. Lloyd George declared in his speech of Nov. 12, with his wonted and most salutary frankness, after more than three years of war the Entente has no strategic plan. What is the cause of this unfortunate condition? That is what it is most important to ascertain first of all, for the Allies cannot think seriously of winning a decisive victory unless the problem of the strategy which is an indispensable necessity of their position is stated in such terms that it can readily be solved. But it has not yet been so stated. To be sure, Mr. Lloyd George dwelt upon the extreme gravity of the situation, but, despite the fact that he is certainly the most keen-sighted of the leaders of the Entente in Europe, he did not point out definitely the positive remedies capable of putting an end to a state of affairs which is intolerable because it is infinitely dangerous.

The reason for this absence of concrete suggestions on Mr. Lloyd George's part is that, notwithstanding his great natural intelligence, he too is subject to that profound failure of insight in respect to the conduct of the war which has befallen men of the Entente without exception. This failure, which is wholly independent of their will, is due mainly to the fact that the present leaders of the Entente, having one and all been firmly convinced that the war would never take place, had not trained themselves intellectually to carry it on when it should break out.—André Cheradame in the *Atlantic Monthly*, Mar., 1918.

A very favorable impression has been created by the report of the British War Cabinet for 1917. "The War Cabinet, according to its own account of itself," says the *Westminster Gazette*, "is not a war cabinet, as the public understands the term, but a committee perpetually engaged in settling questions of overlapping and conflicting departments, of interviewing and being interviewed by other ministers."—New York *Sun*, Mar. 22, 1918.

President Wilson, recognizing the need for greater coördination of war machinery, intends to give more of his time to personal supervision of manufacturing and transportation phases of administration. Hitherto he has devoted himself very largely to the diplomatic side of the war, and his conferences have been confined to Cabinet meetings. When he wanted to take up the shipping problem, he talked with Chairman Hurley; when he wanted to discuss some phase of the railroad administration, he called Mr. McAdoo. There have been few, if any, conferences in which active heads of the war-making agencies conferred with the President at one time.

The President's conference with McAdoo, Hurley, Hoover, Garfield and Vance McCormick was the beginning of a series of such conferences with the actual war heads. The President intends to do much of the correlating himself, letting members of the unofficial Cabinet connect their programs and straighten out their overlapping functions in his presence. It is expected a more efficient war machine will be worked out at these conferences—Boston *News Bureau*, Mar. 23, 1918.

"Unless business men are taken into the councils of the Administration without further delay, this war is going to be lost. In this war, businesss men have not had their part. On the contrary, there is the finest aggregation of office boys at Washington that I have ever seen.

"The people do not trust the business men. Ever since the insurance investigation this distrust has been increasing. That is why the appointment of a college professor to handle the coal problem was more pleasing to the people than the appointment of an expert and prominent coal operator would have been."—Waddill Catchings, chairman of the war committee of the Chamber of Commerce of the United States, Mar. 28, 1918.

Stand by Our Fighting Men

From hundreds of thousands of American farms, in answer to the call of their country and in obedience to the law of their country, American boys have gone and today are fighting side by side with hundreds of thousands of American boys from the cities and towns of the country, confronting danger and death.

Buy Liberty Bonds.

Foreign Trade in Lead and Zinc

Lead imports in January, February and the first two months of 1918 are reported by the Department of Commerce as follows:

Articles and Countries	January, Contents, Lb.	February, Contents, Lb.	Jan.-Feb. Contents, Lb.
Lead Ore:			
Canada	852,545	1,205,828	2,058,373
Mexico	1,342,353	1,155,439	2,497,792
Totals	2,194,898	2,361,267	4,556,165
Lead—Base Bullion and Bullion:			
Peru	5,086	.....	5,086
Mexico	15,571,602	7,208,437	22,780,039
Totals	15,576,688	7,208,437	22,785,125
Lead—Pigs, Bars, Etc.:			
Panama	8,100	.....	8,100
Canada	2,605,634	1,350,514	3,956,148
Guatemala	3,674	.....	3,674
Mexico	2,597,768	1,128,745	3,726,513
Others	300	40	340
Totals	5,215,476	2,479,299	7,694,775

The gross weight of lead ore imported in January was 10,823 long tons, and in February it was 6,798 long tons.

The actual tonnage of zinc ore imported in January and February amounted to 6604 and 10,742 long tons, respectively. The countries of origin and the metal contents were as follows:

Countries:	January, Contents, Lb.	February, Contents, Lb.	Jan.-Feb., Contents, Lb.
Canada	1,038,666	1,092,000	2,130,666
Chile	.....	2,297,316	2,297,316
Mexico	3,673,434	6,239,977	9,913,411
Totals	4,712,100	9,629,293	14,341,393
Zinc in Blocks, Pigs, Etc.:			
Costa Rica	678	2,730	3,408
Japan	22,630	.....	22,630
Cuba	8,530	.....	8,530
French Oceania	.....	2,671	2,671
Others	816	740	1,556
Totals	32,654	6,141	38,795

Imports of zinc dust in February amounted to 646 lb. from Costa Rica. None was received in January.

Exports of lead and zinc were as follows:

Lead:	January, Contents, Lb.	February, Contents, Lb.	Jan.-Feb., Contents, Lb.
Pigs, bars, etc., produced from domestic ore	9,012,126	10,436,237	19,448,363
Pigs, bars, etc., produced from foreign ore	6,210,713	10,200,170	16,410,883
Zinc:			
Pigs, etc., produced from domestic ore	19,078,929	5,320,616	24,399,545
Pigs, etc., produced from foreign ore	8,331,747	1,421,741	9,753,488
Sheets, etc	1,767,262	1,130,287	2,897,549

Special Liberty Loan Committee for the Mining Industry

A group of special Liberty Loan committees has been appointed in New York covering the business and professional activity of the city. This group is known as the "Rainbow Division" and is composed of representative citizens, forming compact working units to reach every firm and individual in their lines to sell Liberty Bonds to themselves and thus demonstrate the patriotism of their respective groups. Charles Hayden is chairman of the special committee for the mining industry, and W. B. Thompson vice chairman. Following are the members of the committee:

Sherwood Aldrich, Ray Consolidated Copper Co.; W. A. Bostwick, International Nickel Co.; Arthur V. Davis, Aluminum Co. of America; E. P. Earle, Nipissing Mines Co.; B. Elkan, Beer, Sondheimer & Co.; Daniel Guggenheim, American Smelting and Refining Co.; Charles Hayden, Chino Copper Co.; William Crawford Hirsch, "Daily Metal Reporter"; J. G. Hopkins, Ray Hercules Copper Co.; Walter R. Ingalls, "Engineering and Mining Journal"; D. C. Jackling, Butte & Superior Mining Co.; Arthur C. James, Phelps Dodge Corporation; Sidney J. Jennings, United States Smelting, Refining and Mining Co.; Eli Joseph, Jos. Joseph & Bros. Co.; Adolph Lewisohn, Miami Copper Co.; Henry Lissberger, Eagle Smelting and Refining Co.; C. M. Loeb, American Metal Co.; Paul Loewenthal, Loewenthal Co.; N. B. MacKelvie, American Zinc, Lead and Smelting Co.; Chas. M. MacNeill, Utah Copper Co.; W. H. Nichols, Nichols Copper Co.; Edgar Palmer, New Jersey Zinc Co.; F. Y. Robertson, U. S. Metals Refining Co.; John D. Ryan, Anaconda Copper Mining Co.; Emanuel Salomon, A. Salomon, Inc.; Edw. A. Stone, Stone Bros.; W. B. Thompson, Inspiration Consolidated Copper Co. E. S. H. Prendergast is bond adviser of the committee, J. J. Rockwell, publicity manager, and Philip Boyer, secretary. Headquarters of the committee are at 25 Broad St., Room 811.

Potash Leasing Regulations Issued

Franklin K. Lane, Secretary of the Interior, has approved working instructions and regulations under the potash leasing act of Oct. 2, 1917, a matter which has been given the most careful consideration, in view of the importance attached to this pioneer work in the development of a great national asset.

The act is liberal in its terms, authorizing the exploration for and disposition of potash deposits generally in the public lands of the United States, under a system that provides for a preliminary permit to the holder for the exclusive privilege of searching for deposits of potash for a period of not exceeding two years. The acreage embraced within one permit is limited to 2560 acres, and the Secretary, upon a satisfactory showing that valuable deposits of potash have been found within the permit, is authorized to issue a patent to not exceed one-fourth of the amount covered by the permit, the remaining lands in the permit being subject to lease either by the permittee or others, after advertisement, competitive bidding, or such other methods as the Secretary may by general regulations adopt.

To the end, therefore, that the liberal purposes of the act may find the fullest scope of operation, the instructions and regulations now approved are broad in outline, simple in form, yet so directly addressed to the matter in hand that it is believed all applicants under the law will find little difficulty in presenting their claims for consideration by the department. Requests for copies of these instructions should be addressed to the Commissioner of the General Land Office, Washington, D. C.

The Money Comes Back

The cycle of money invested in Liberty Bonds is short and complete. The people lend the money to the Government, the Government lends some to our Allies, and our Government and our Allies straightway spend the money, or the greater portion of it, among the people of the United States in the way of wages before the next bond installment is due.

Buy Liberty Bonds.

Editorials

The Mines-Control Bill

THE mines-control bill was formally introduced in the House of Representatives by Dr. Foster, on Apr. 6, as H. R. 11,259. As actually introduced, the bill has been altered in several important particulars from that which was before the Committee on Mines and Mining in the preliminary hearings.

Section 1 has been amended with the manifest intention of limiting the authority of the bill to the substances specifically mentioned, excluding the major metals—iron, copper, lead and zinc—and the chief precious metals—gold and silver; but the language of this section is not yet precise enough to exclude the extension of the act to many important copper, zinc and lead mines by administrative construction if the administrators desire to do so. This section should be further amended by the addition of the sentence: "Nothing in this act shall be construed as authorizing Governmental control of the production of the substances named herein when they are produced as by-products of ores of metals not specified herein; or in works wherein they are produced only as subsidiary products." We understand this to be the intention of Dr. Foster's committee, but so far they have failed to express it clearly.

Section 2 now provides specifically for the administration of the act by the President through the Secretary of the Interior. If we have got to have the act, it is better to have it this way than to let the industry be thrown upon the mercy of some unknown "dictator."

Section 14 has been changed so as to provide for a straight and unmistakable guarantee of minimum prices. This eliminates some of the danger of the bill defeating its own purpose, to which we called attention in our article in the Journal of Apr. 6, but perhaps not all of it.

While freely admitting these improvements, our conviction is unshaken that this bill is not only unnecessary but also is likely to be mischievous. The word is being quietly passed around that the bill should be accepted, lest something worse be imposed upon the industry. This argument, which is advanced by the Washington exponents of the bill, is like saying, "We know that what we are proposing is bad, but you would better let us make you only a little sick than very sick." It might be supposed that there is some great pressure that it is desirable to head off or divert; that there are some crying evils that it is necessary to correct. There is nothing of the kind. The agitation is rather a cooked-up affair, we think, and the intimations that the industry would better submit to a little regulation than to a lot of it come from *agents provocateurs*, so to speak.

Mr. De Wolf and Mr. Hotchkiss were delightfully frank about this in their testimony before the House committee. The War Minerals Committee became interested in increasing the production of pyrites and ran up against the problem of getting capital for the exploitation of deposits that private citizens would not put their money into. They tried the Shipping Board, the War Industries Board and every other activity in Washington that had any relation to the mining industry, and could not find any one that would, or could, supply Governmental money for such a purpose. Finally, the only thing that they could come to was that there must be some administrator for sulphur and pyrites. Consultation about this with other departments in Washington elicited the advice that an administrator for pyrites would soon be followed by administrators for other minerals. "So it was impelled upon us that the whole mineral industry . . . needed and absolutely must have some such organization. . . . So we sat down and prepared this bill." (Hotchkiss). The logic is rather weird.

The bill that was originally drafted included all minerals. In reply to an inquiry why some were subsequently excluded, Mr. De Wolf explained that "a certain amount of opposition from the mining industry has been expressed, and the directors of the American Institute of Mining Engineers, whose judgment carries a good deal of weight, were unable to approve of the bill in its original form, because they thought the other minerals did not require this sort of administration."

Much was made of a subsequent endorsement of the modified bill by the board of directors of the A. I. M. E. According to Mr. Stoughton, the secretary, "probably adverse action would have been taken but for the fact that Mr. Manning appeared before our board." The endorsement finally obtained was an action of the board alone and not an endorsement by or committal of the organization of 6600 members, the constitution of the Institute conferring no authority upon the directors to speak for the membership in such a matter. Incidentally there seems to be considerable mortification among the directors who voted in favor of this endorsement by their board.

As for the Committee of Mines and Mining of the House of Representatives, they were pretty well befogged respecting the state of the mining industry, the manner of its conduction, the emergencies and factors that the several witnesses talked about, and, most of all, respecting the effect of the bill on which they were going to vote. Some of the witnesses did not play fair with the committee. Thus Mr. Baruch coolly testified, "Here is the Anaconda company, which says, 'We have this low-grade manganese, and it would take an investment of $1,500,000. . . . If we can sell ferromanganese and make ourselves whole, . . . we would immediately get into operation.' . . . I rather think they will do it anyhow, because Mr. Ryan is that kind of a man." Mr. Baruch did not tell the committee that the Anaconda company *was already engaged* on construction for this purpose. Other witnesses referred to the matter of arsenic, whereof the United States was

represented as furnishing only 60% of its requirements. The committee failed to draw out that the other 40% comes from Canada and Mexico, which supply us because they are able to do so competitively and require no shipping for the purpose.

The promoters of this bill are patriotic and zealous, but we do not think that the men who are engaged in our industries are in anywise inferior in their patriotism, and we may be forgiven if we judge them to be more experienced in their work. We are skeptical regarding all Washington estimates. The overestimate of the Treasury last year in the matter of financial requirements tended to destroy confidence. Coming nearer to home, the overestimate of lead requirements by the War Industries Board last spring, which played mischief with our lead industry, causes us to pray to be let alone.

But if the War Minerals Committee thinks that more manganese, chrome, pyrites and graphite are going to be required than natural market conditions will induce, and if additional supplies can be obtained only from deposits that private capital will not undertake, by all means let the Government do it; but strip off the camouflage and let it be done by straight subsidy or direct venture. Mr. Hotchkiss had this in mind when he told Dr. Foster's committee of a tin property in Virginia and said that "The only way in which it can be operated is for the Government to take it over and operate it and turn the money over to the court" (there being rival claimants). This has the merit of honesty. It is what the Government ought to do if it thinks it can get any tin there. It may be that a great tin mine will be developed there, but private capital, which has been solicited off and on during the last 25 years, has not had the nerve to try it. We should be really curious to see that judgment tested by the Government.

However, we do not imagine that the Government is going to do any prospecting and developing on its own account. The idea will be rather to introduce regulatory measures for going concerns and to satisfy the official desire to boss the men who have created successful business organizations. Besides the irritation of this, there is the danger, and a very real one, that in monkeying with the machinery they will put it out of order. It is therefore to be prayed that the pending bill can be limited to the minerals specially named, which constitute only a minor part of the industry and can stand interference without the major part of the industry being put out of joint. We wish, however, that there were less of the careless talk about profiteering. We have not observed any desire for profiteering in the mining industry; we discern nothing but a desire to live and to produce. The passage of a bill to guarantee minimum prices will do more to promote profits than anything ever conceived by business men since the days of the Secrétan Syndicate in copper.

Copper Production

WE HAVE improved our system of reporting monthly the crude-copper production, it being necessary to estimate only the output of the group of smelters on the Atlantic seaboard and a part of the Lake Superior production, both of which are small and neither being subject to any great variation from month to month. Because of certain changes in method, our figures, beginning with January, 1918, should not be compared too closely with the corresponding figures for 1917.

Notwithstanding the increased completeness of these reports, the present monthly figures will be regularly too high; i. e., their aggregate will exceed the figures reported by the same companies for the whole year, and this will be for the following reasons:

1. The probability that some companies report blister copper instead of fine copper contents thereof.

2. Non-allowance for loss in smelting in the case of the porphyry mines that report concentrate and non-allowing for loss in refining in other cases.

3. Duplication of imported copper, which is included to some extent in the figures reported by American smelters and is also included in the statement of copper imported.

On these accounts the monthly figures will regularly be too high, perhaps as much as 5 per cent. Being computed from month to month on the same basis, however, they will be properly comparable, and will be reliably informing, with the understanding that they involve a regular "plus" error.

The production of crude copper in the United States in January was 165,431,568 pounds. In February it was 160,011,364 pounds.

The Silver Bill

THE silver bill that was introduced in Congress last week is nothing like any of the free-coinage measures of a quarter of a century ago. Its purpose is to release the hoard of silver in the Treasury with which to settle trade balances in the Orient. On the other hand, the Government proposes to enter into a contract with the silver producers to replace this silver at $1 per ounce. This is the main idea, but the bill is extremely complicated, and we do not yet venture to discuss fully the working of the scheme.

Presumably the Government will not sell silver to the East unless it can get at least $1 per ounce for it. If the East can buy silver in London or elsewhere for less, undoubtedly it will do so. All cheap silver will therefore have to be cleaned up before the Treasury can sell. When it has sold any it must replace it by taking silver from the producers at $1 per oz. It does not give them an unlimited put.

Suppose the Treasury succeeded in selling 75,000,000 oz. to the East (and to domestic consumers), it would then take about a year's output from our producers. But how about the silver produced by American refiners from foreign sources? In the meanwhile, the price for silver in London might decline. Our producers would then be in a position of simply filling an order for silver previously sold for forward delivery on excellent terms. But suppose the Treasury sold only 15,000,000 oz.; the producers in two months would be back upon the open market.

These are not arguments for or against the bill. They are simply to point out that it does not necessarily "fix" the price for silver, but rather gives the producers an opportunity to make some forward sales at a specified price. On the other hand, the Government does not stand to lose anything, except temporarily the seigniorage with which it gave itself credit. However, this

is purely a bookkeeping matter. Really, it would make a good bargain if it could dispose of all of its silver at $1 per oz. and stay sold, but, of course, Congress would never consent to that.

The business will be fairly simple if the Treasury succeeds in selling all of its silver, or a large part of it; but if its sales should prove to be small and irregular, there may be complications. As to this, everything depends manifestly upon the quantity that the Orient is willing to take at $1 per oz. or more. It has been the understanding all along that it stood ready to absorb a good deal, but, of course, it is in a position to drive a bargain. We foresee a good many perplexities in the project. However, we do not see that it violates any principles of sound banking and economics.

The Milling Number

THE current issue, our annual Milling Number, is given over principally to articles dealing with the flotation process. The present condition of flotation, enmeshed as it is in a tangle of litigation, has made it especially difficult to secure suitable material. However that may be, some degree of success has attended our efforts, and we are able to present a number of interesting and important articles.

Reviewing the subject as presented in this number, a few generalizations may be made. The first is that flotation is finding its position in relation to other methods of ore dressing. For the treatment of sulphide ores, when finely divided or in the condition of slime, flotation has been so successfully applied as to warrant the belief that the slime problem has been solved. As a primary process, flotation has not attained the success that many of its enthusiastic supporters predicted, but as a supplementary process, to be applied after jigging and tabling, accompanied by regrinding, satisfactory results have been obtained, and the process has established itself in lead, zinc and copper ore-dressing plants.

Some success has attended the application of selective flotation and sulphidizing, sufficient to warrant us in the belief that it is in these two branches that much future development is to be expected.

The variety of new mechanical appliances, such as flotation machines, and the application of thickening and filtration appliances (first applied in the cyanide process), illustrate the development of mechanical equipment that inevitably follows close upon the introduction of a new method of ore treatment.

More prominently there stands out the uncertainty of knowledge concerning the fundamental physical and chemical factors that control flotation. Our science has not kept pace with the practical application of the process. In spite of the many excellent articles and books on the subject, we are still groping around for a substantial hold upon the intricacies and subtleties of the subject. We know that mineral particles have to be finely divided, that slimed particles are more readily saved than the coarser ones, but do we definitely know how coarse we can crush and still secure a high extraction?

There is much uncertainty about the selection of suitable flotation agents, but progress in removing this uncertainty is being made. Manufacturers are standardizing their products and millmen are making greater use of laboratory testing. The field is broad and by no means exhausted.

We know that there must be intimate contact between flotation agent and ore pulp. Millmen have developed agitation and mixing appliances and have experimented with the introduction of the flotation agent in crushing and grinding machines until they have succeeded in securing a sufficiently intimate incorporation of the flotation agent with the pulp. But do we know what degree of admixture is necessary, to what extent must the flotation agents be broken up; in how many cases are we overdoing agitation, or, in other words, wasting power in unnecessary mixing?

Air must be minutely subdivided and disseminated throughout the pulp. How definite is our knowledge on the subject of the emulsification of air under the conditions that are present in the flotation cell?

Curiously enough, we may have the flotation agent and the air bubbles quite thoroughly incorporated in the pulp; nevertheless, when the mixture reaches the froth-separation compartment, the froth fails to form. What are the precise physical conditions that must be secured for the formation of the froth? Must an electrolyte be present? Must the cell be grounded in order to equalize static charges; must we have conditions favorable for the flocculation of oiled sulphide particles; does temperature play an important part; must certain chemicals be present or absent? We consider that this is one of the most important divisions of the subject.

Skimming off the flotation concentrate and the dewatering, filtration and drying of the concentrate are mechanical steps that have been thoroughly worked out and in which there is only moderate opportunity for improvement.

Ralston, Bancroft, Van Arsdale, Anderson, Taggart, Hildebrand and others have proposed various theories, but we seem to be no nearer to a theory that meets with general acceptance and that will serve for the development of a flotation practice along scientific lines. While the amount of available knowledge on the subject is large, we feel that there is need for coördination and additional research that will be more specific and directed toward determining the limitations of the fundamental principles controlling the process. Obviously this is not for the millman, but rather for the thoroughly trained physical chemist.

Industrial Dislocations

THE Wholesale Coal Trade Association of New York has issued a circular which comprises the following remarks:

> The practical coal man is convinced that certain proposals with respect to the distribution of coal cars will result in a serious curtailment of the output of coal, and the effect will be that next winter the country will be faced with a coal famine compared to which that of last year will fade into insignificance.
>
> The Railroad Administration is attempting to make contracts with coal operators for coal for railroad purposes at a price less than that fixed by the Fuel Administration, offering as an inducement 100% car supply.
>
> Car supply is the governing factor in the quantity of coal produced and the cost of production, as the overhead charges, when distributed over a production reduced to

20 or 25% of normal, are tremendous, as compared to 100% production.

Another phase of the matter is that such discrimination in car supply has its direct effect upon the labor situation, causing unrest and dissatisfaction among the miners at operations so discriminated against.

It is no secret that the Railway Administration and the Fuel Administration are quarreling over this matter. But what will you have? When you undertake to regulate an industry, such things are just what are to be expected.

The copper strikes of last summer, the coal shortage of last winter, the present troubles in the smelting and refining industry, the mining and shipping of dirty coal—these and kindred economic troubles are not things that "just happened." Rather are they symptoms of the economic disease whereof the germs were deliberately introduced about a year ago. The United States is industrially and financially too strong for this to be economic suicide, but we have made ourselves sufficiently sick to reduce our efficiency. Instead of putting a 100% punch into the war, we are doing something less. The pity of it is that the whole thing is so camouflaged and so ill-understood by the people at large that they will never know that we did not do in the war all that we might have done.

Nor were the delay in our shipbuilding program, the delay in our rifle and artillery manufacture, the recently revealed fiasco of our aëroplane program, the intensification of the railway congestion last winter, the dislocation of labor supply, the injection of an exaggerated housing problem, mysterious events that "just happened." They were the natural results of the bungling of incompetent planners and inefficient administrative officers.

BY THE WAY

Speaking of the National War Bonds, which England now keeps continuously on sale, Sir Felix Schuster remarked at the recent annual meeting of the Union Bank that "this method of continuous borrowing entails the least disturbance of the money market, and is, I am glad to think—our figures in the bank show it—highly successful."

"Spanish as she is spoke" by some American shifters is often fluent, if not always according to Hoyle. In a Southwestern camp employing Mexican labor, an admonition to a delinquent mucker was overheard as follows: "Usted necesita trabajar poco mas. Si Usted no trabajar poco mas. Poco tiempo usted no trabajar mas." And that day an extra car was sent to the mill.

In the *Journal* of Mar. 9, on page 466, were printed some engravings showing occurrences of brimstone in Culberson County, Texas, in connection with which the caption read "Workings of Gulf Sulphur Co., Culberson County, Texas, where deposits of 90% sulphur occur." Our attention has been drawn to the error in this statement. Upon investigation we find that the photographs showed sulphur deposits in Culberson County, Texas, but not of the Gulf Sulphur Co. The error occurred in our own office, and arose through the confusion of photographs.

Platinum has been commandeered by the Government. The campaign begun at Kansas City a year ago is ended, says *Journ. Ind. and Eng. Chem.* The metal can now hold up its head with justifiable pride, because of its functional metamorphosis from vainglorious adornment of the *nouveau riche* to the more appropriate rôle of catalyst in acid manufacture. What about that scrap platinum, odds and ends, lying about your laboratories? Every little bit helps.

President A. A. Cole, of the Canadian Mining Institute, in his annual address at the recent Montreal convention, drew attention to the low estimation in which mining and chemical engineers were held by the public as compared with members of the other professions. An illustration of this point was found in a recent advertisement issued by the Civil Service Commission of Canada, calling for candidates qualified to fill the following positions:

1. A legal officer to be appointed to one of the departments at an initial salary of $3300 per annum. Candidates must be at least 28 years of age, must have had a few years' practical experience in law and must possess a good general education.
2. A chemist for the fuel-testing division of the mines branch of the Department of Mines, initial salary $1600 per annum. Candidates must have a thorough training in chemistry and physics and hold a degree from a recognized university, should have proved their ability to take out original research, and have had subsequent experience in practical chemistry. They must be thoroughly familiar with the methods of gas analysis where great accuracy is required, and must be capable of testing the methods and calibrating the apparatus used in their work.

The qualifications necessary in the chemist are such as would entitle him to a Ph.D. degree. This lack of appreciation of the value of technical standing and experience is further emphasized by the fact that the only officer of the mines branch with a salary higher than that at which the legal officer mentioned would start is the director. Where does the fault lie?

The Scout Engineer

You can talk about the traveling men who roam,
Of the sailor boys who never have a home;
But the scouting engineer has no chance to pound his ear
As he travels round this little ball of loam.

"It's a scouting proposition," they will say;
"And you're due to leave for Timbuctoo today."
And in this itinerary they include old Tipperary;
Which leaves no time for you to hit the hay.

While you're wrestling with a rowboat on the waves of Bristol Bay,
You must listen to the bull-con of some wild promoter's lay,
As he tells you of the copper, gold and silver lying bare—
A million dollar mountain sticking straight up in the air.

Or you're headed for a real mine in the heat of Morelos,
Over ranges of the tropics where no white man willing goes;
When your greasers all desert you and your shoes begin to hurt you,
Then a point o' two Au is all it shows.

But there is a fascination to this branch of the profession,
Which keeps you straining onward while you leave the miles behind,
And you feel that you're rewarded when with words and phrases guarded
You report in that at last you've made the find.

ANONYMOUS.

NEW PUBLICATIONS

Geology of Massachusetts and Rhode Island. By B. K. Emerson. Pp. 289, illus. Bull. 597, U. S. Geological Survey, Washington.

The Geology and Ore Deposits of Ely, Nevada. By Arthur C. Spencer. Pp. 189, illus. U. S. Geological Survey, Washington, D. C.

Anthracite and Bituminous Coal, Report of the Federal Trade Commission on. Pp. 420. Federal Trade Commission, Washington.

The Journal of the Iron and Steel Institute, Vol. XCV, No. 1. Edited by George C. Lloyd, Secretary. 5¼ x 8¼, pp. 472, illus. Iron and Steel Institute, London.

The Clays of the Piedmont Province, Virginia. By H. Ries and R. E. Somers. Pp. 86, illus. Bull. XIII, Virginia Geological Survey, Charlottesville, Va.

Road Material Surveys in 1915. By L. Reinecke. Pp. 190, illus. Memoir 99, Canada Department of Mines, Geological Survey Branch, Ottawa, Canada.

Technology of Salt Making in the United States. By W. C. Phalen. Pp. 149, illus. Bull. 148, U. S. Bureau of Mines, Washington, D. C.

The Journal of the Iron and Steel Institute, Volume XCVI. Edited by George C. Lloyd. Pp. 509, illus. Iron and Steel Institute, London, England.

Cannel Coal in the United States. By George H. Ashley. Pp. 127, illus. Bull. 659, U. S. Geological Survey, Washington, D. C.

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Seventh Annual Report by the Director of the Bureau of Mines to the Secretary of the Interior for the Year Ended June 30, 1917. Pp. 106. U. S. Bureau of Mines, Washington, D. C.

Blast-Furnace Breakouts, Explosions and Slips, and Methods of Prevention. By F. H. Wilcox. Pp. 280, illus. Bull. 130, U. S. Bureau of Mines, Washington.

Thirtieth Annual Report of the Bureau of Mines, Mining and Mine Inspection of the State of Missouri, for the Year 1916. Pp. 135. Missouri Bureau of Mines, Jefferson City, Missouri.

Annual Report, 1915, with Accompanying Papers. Iowa Geological Survey, Vol. XXVI. George F. Kay and James H. Lees. 7½ x 10. Pp. 556, illus. Iowa Geological Survey, Des Moines, Iowa.

Illinois Geological Survey; Biennial Report for 1913 and 1914. Administrative Report and Economic and Geological Papers. 7 x 10, pp. 161, illus. Bull. 30, Illinois Geological Survey, Urbana, Illinois.

Geology of the Moonta and Wallaroo Mining District. By R. Lockhart Jack. Pp. 135, illus. Bull. 6, Geological Survey of South Australia, Department of Mines, Adelaide, Australia.

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Occupational Hazards at Blast-Furnace Plants and Accident Prevention, Based on Records of Accidents at Blast Furnaces in Pennsylvania in 1915. By Frederick H. Willcox. Pp. 155, illus. Bull. 140, U. S. Bureau of Mines, Washington, D. C.

The Essentials of Descriptive Geometry. By F. G. Higbee. 6 x 9, pp. 218, illus.; $1.80. John Wiley and Sons, New York.

A good presentation of the subject for the student, engineer and draftsman. There is an appendix on making models of piping from paper and cardboard that contains useful suggestions for the blast furnace constructor.

A Laboratory Manual of General Chemistry. By William J. Hale, 5 x 7½, pp. 474, illus.; $1.50. MacMillan Co., New York.

This is a student's manual which lays more stress than usual on the resemblance that the various metals of a given group have for each other, without waiting for the study of qualitative analysis to bring out this point. The book is conveniently interleaved for notes.

Metallurgical Calculations. By Joseph W. Richards. 6 x 9, pp. 675; $5. McGraw-Hill Book Co., New York. Part I, Introduction, Chemical and Thermal Principles, Problems in Combustion, and Radiation and Conduction of Heat. Part II, Application to the Metallurgy of Iron and Steel. Part III, Applications to Other Metals (Non-Ferrous Metals).

This well-known and useful book requires no introduction. It serves the demands of quantitative metallurgy.

Quin's Metal Handbook and Statistics, 1918. Compiled by L. H. Quin. 6½ x 4¼, pp. 237; 3s. 6d. Metal Information Bureau, London, England.

This is a valuable little reference book of statistics, covering prices, production, exports and imports of the various metals and ores. In the foreword, the compiler refers to the effect of the war on the collection of statistics, but states that he has given as complete details as can be gathered.

The Petroleum and Natural Gas Register: A Directory of the Petroleum and Natural Gas Industries in the United States, Canada and Mexico. 8½ x 12, pp. 548, illus.; $12. Oil Trade Journal, New York.

Trade directories serve an important purpose and are extensively used. This directory includes producers, refiners, compounders, marketers and jobbers of petroleum and its products, casinghead gasoline manufacturers, oil-pipe lines, natural-gas producers and distributors, geologists, manufacturers of and dealers in equipment and the membership lists of oil and gas associations.

Personals

Have you contributed to the Association of the 27th Engineers?

H. W. Gepp is general manager of the Electrolytic Zinc Co., Tasmania.

David Sloane has been appointed manager of the Davidson Gold Mines, Ltd., in Porcupine, Ontario.

R. S. Wile, inventor of the Wile electric furnace, has moved from Pittsburgh to New York.

J. M. Morrison has resigned as manager of the Lake Shore Mines, Ltd., at Kirkland Lake, Ontario.

J. P. Bickell, president of the McIntyre Mines at Porcupine, Ont., is in British Columbia investigating properties.

K. B. Heberlein and **Otto Sussman** have recently examined the holdings of the American Metals Co., Ltd., at Baxter, Kansas.

R. A. Bryce, of Toronto, has been retained by the McKinley-Darragh Mines, Cobalt, Ont., to look for new mining properties this season.

D. L. H. Forbes, who is on construction work on aluminum plants in the south of France for the French government, is soon to return to Toronto.

L. W. Ledyard, who was recently appointed manager of the Kirkland Porphyry property at Kirkland Lake, Ont., has tendered his resignation.

W. E. Casson, of Carson, Nev., will assume the management of the Shasta Belmont Mining Co., at Redding, Calif. Mr. Casson is president of the company.

C. D. Kaeding, general manager of the Dome Mines., Ltd., Porcupine, Ont., has returned to Porcupine from Nevada, where he also has charge of the Bluestone mine, in Lyon County.

C. A. Wright, superintendent of the experiment station of the U. S. Bureau of Mines at Moscow, Idaho, is making tests in selective flotation on lead-zinc ores of the Cœur d'Alenes.

Douglas A. Mutch, manager of the Hudson Bay mine in Cobalt, Ont., has been appointed general manager also of the Dome Lake Mining and Milling Co., Ltd., in Porcupine, Ontario.

J. S. Coupal, manager of the Engineering Management Corporation, 165 Broadway, New York, has sailed for Venezuela, to be gone several weeks, in connection with examination work.

Addison H. McKay, formerly in charge of the Harriman oil and railroad interests in Mexico, is engaged at Caracas, Venezuela, where he has extensive oil and mining interests. Mr. McKay is in New York for a short stay.

Edward P. Scallon, formerly superintendent of the Hill Annex mine at Calumet, Minn., for the Interstate Iron Co., has accepted the position of superintendent of the United Verde Extension Mining Co. at Jerome, Arizona.

W. J. Dick, who has been mining engineer of the Canadian Commission on Conservation for eight years, has resigned to become fuel engineer for Coal Sellers, Ltd., of Winnipeg, and consulting engineer for several Western colliery companies.

E. T. Eddingfield, of the U. S. Bureau of Mines, is on the Mesabi range, where he is continuing the investigations begun by J. R. Finlay, of New York, as to whether the state-owned mines are operated in accordance with the best methods.

John Sargeson, mill construction expert, has returned from Quebec province, where he was engaged in superintending the erection of a large mining plant, and has gone to Kirkland Lake to superintend the erection of a mill at the Kirkland Porphyry mine.

W. L. Williamson, formerly connected with the Gaston mine in Nevada County, Calif., has succeeded **William Harvey** as superintendent of the Allison Ranch property at Grass Valley, Calif., which is now operated by the Grass Valley Consolidated Mines Company.

H. D. Mortenson is president of the Klamath Iron and Steel Works, Klamath Falls, Ore. The company was formerly known as the Grant's Pass Iron and Steel Works, and was situated at Grant's Pass, Ore. **B. M. Hall** is general manager and **J. W. Fitzpatrick** secretary treasurer.

R. C. Bergen, assistant editor of "Metallurgical and Chemical Engineering," has resigned his position to go into manufacturing work. He has been with the journal since its change to a semi-monthly in 1915 and was formerly with the Roessler & Hasslacher Chemical Company.

T. E. Agnew has been appointed assistant superintendent of blast furnaces of the McKinney Steel Co., Cleveland, Ohio, succeeding **George O. Hollenbaugh,** who is now superintendent. **Charles E. Ash,** former superintendent, is now with the Taylor-Wharton Steel Co., at Wharton, in the same capacity.

H. Foster Bain, recently appointed assistant director of the U. S. Bureau of Mines, has assumed his duties. Mr. Bain is not joining the organization as a volunteer, but is filling the regular office of assistant director, which has been vacant since Van. H. Manning was advanced from that post to that of director.

George L. Danforth, Jr., has been appointed assistant general superintendent of the south works of the Illinois Steel Co., succeeding **Herman A. Brassert,** resigned. Mr. Danforth has been with the company since 1900, and is looked upon as an authority on the manufacture of openhearth steel. He has made many improvements in openhearth furnace construction and practice.

Rudolf Gahl has resigned as metallurgist in charge of the concentration of the Inspiration Consolidated Copper Co., Arizona, and will be succeded by **Guy H. Ruggles,** formerly his assistant at Inspiration, but lately mill superintendent of the Consolidated Arizona Smelting Co., at Humboldt, Ariz. Dr. Gahl will take up consulting work and will be in the Globe-Miami district for some time to come.

Obituary

Frederick Ayer, who was identified with various mining and timber operations in northern Michigan, died recently in Washington, aged 96 years. At the outbreak of the war, Mr. Ayer, together with J. M. Longyear, disposed of coal and mineral interests in Spitzbergen to Norwegian capitalists.

John McMartin, vice president of the Hollinger Consolidated Gold Mines, Ltd., at Cobalt, Ont., died on Apr. 13 at his home in Montreal. Mr. McMartin was born in Charlottenburg, Ont. At the time of his death, he was member of the Dominion Parliament from Flengarry County, Ont. He was also a member of the Rocky Mountain and Catholic clubs, New York, and of the American Universities and Cornwall clubs, in London.

Societies

American Institute of Mining Engineers, Utah Section, elected the following officers for 1918 at the meeting on Apr. 4 in Salt Lake City: William Wraith, chairman; Cecil Fitch, vice chairman; F. G. Moses, secretary; E. R. Zalinski and Ernest Gayford, executive committee.

Engineers' Club, New York, met jointly with the New York Electrical Society on Apr. 18, in the Engineering Societies Bldg., New York. Major O. O. Ellis, assisted by Major E. B. Garey, addressed those present on "Using the Motion Picture to Train the Officers and Enlisted Men of the Army." Hudson Maxim spoke on "High Explosives in Modern Warfare."

American Institute of Mining Engineers, Columbia Section, met on Apr. 8 in Spokane, Wash., to welcome C. W. Goodale, vice president of the national organization, and Bradley Stoughton, secretary. Mr. Goodale spoke on the work the Institute is doing in reference to the relation of capital and labor after the war. Mr. Stoughton told of the war services of the members of the Institute. The section took under consideration a resolution proposing a change in the society's title to the "American Institute of Mining and Metallurgy."

American Institute of Mining Engineers, New York Section, will hold its April meeting at the Machinery Club, 30 Church St., on Apr. 23 at 8 p.m. The meeting will be preceded by a dinner at 6.45 p.m. The report of the committee on mine taxation will be discussed. It is expected that Dr. L. D. Ricketts, past president, will be present and will show moving pictures of the Ajo copper mine, in Arizona. Members who wish to attend the dinner are urged to notify C. A. Bohn, American Smelting and Refining Co., 120 Broadway. Presentation of the John Fritz medal for 1918 took place on Apr. 17, in the auditorium of the Engineering Societies Bldg. The medal was awarded to J. Waldo Smith for "achievement as engineer in providing the City of New York with a supply of water." Col. John J. Carty, past president of the American Institute of Electrical Engineers, presided. Presentation was made by Ambrose Swasey, past president of the American Society of Mechanical Engineers. The other speakers were Nelson P. Lewis, vice president of the American Society of Civil Engineers; Hon. A. T. Clearwater and J. Waldo Smith. The John Fritz medal is awarded by the John Fritz medal board of award, composed of representatives of the four founder societies.

Industrial News

C. L. Miller, formerly chief engineer and sales manager of the Scottdale Machine and Manufacturing Co., has resigned to enter the contracting field. Mr. Miller will specialize in mine equipment and conveying machinery under the name of C. L. Miller Co., Scottdale, Pennsylvania.

S. R. Scott Co., Inc., 29 Broadway, New York, importers and exporters, are interested in shipping manganese ore from Brazil to this country; also in shipping zirconium ore, monazite sand and other unusual minerals. They are particularly desirous of knowing the requirements of buyers in the United States.

Machinery Tool and Supply Industries of th country will hold a war convention in Cleveland, Ohio, during the week of May 13. Representatives of the four national associations, namely, the American Supply and Machinery Manufacturers' Association, the National Supply and Machinery Dealers' Association, the Southern Supply and Machinery Dealers' Association and the National Pipe and Supplies Association, will meet jointly with the idea of laying out a plan of keeping the munitions program going at full speed. They will be assisted in this by Government officials.

Trade Catalogs

How to Save Coal. Bailey Meter Co., 141 Milk St., Boston, Mass. Bulletin No. 41. Pp. 20; 8 x 10½ in. Illustrated. A description of the Bailey boiler meter and of the uses to which it may be put in a boiler plant. Other types of Bailey meters are mentioned briefly.

Steam Tables for Condenser Work. Wheeler Condenser and Engineering Co., Carteret, N. J., Pp. 32; 7¾ x 4¼ in. Illustrated. A handbook of steam tables, with pressures below atmosphere expressed in inches of mercury referred to a 30-in. barometer; also including a discussion of the use of the mercury column, the errors in such measurements and correction constants.

New Patents

United States patent specifications listed below may be obtained from "The Engineering and Mining Journal" at 25c. each. British patents are supplied at 40c. each.

Asbestos. Process of Asbestos Treatment and Product Thereof. Harry Williams Charlton, New York, N. Y. (U. S. No. 1,256,296; Feb. 12, 1918.)

Classifier and Separator. Charles Allen, El Paso, Tex. (U. S. No. 1,259,709; Mar. 19, 1918.)

Dynamite, Process of Bonding Kieselguhr Powder and Product Thereof. Charles S. Kinnison, Birmingham, Mich. (U. S. No. 1,259,525; Mar. 19, 1918.)

Mining Sulphur, Process of. Anthony F. Lucas and Godfrey M. S. Tait, Washington, D. C.; said Tait assignor to said Lucas. (U. S. Nos. 1,259,536; 1,259,537. Mar. 19, 1918).

Potash. Process of Replacing Alkali Metals in Alkali Metal Carrying Rocks and Product Thereof. Harry Williams Charlton, New York, N. Y., assignor to Kaolin Products Corporation. (U. S. No. 1,256,295; Feb. 12, 1918.)

Potash Extraction from Feldspar. Edward L. Anderson, Pittsburgh, Penn. (U. S. No. 1,253,560; Jan. 15, 1918.)

Editorial Correspondence

SAN FRANCISCO—April 12

Gold Mining in the Mother Lode Region is not advancing in a measure equal to normal possibilities. High costs of materials and supplies and the uncertainty of labor have combined to discourage the outlay of large sums in development beyond immediate requirements. Mining companies that do not need the development capital for carrying on their enterprises are evidently of the opinion that it will pay better in the end to reduce production and keep their mines alive without hope of present profit. Other companies whose properties produce only a small margin above the total costs of mining and milling can better afford to let the orebodies stand unworked than to pay out the profits of normal operation in excessive costs for new development. The gold will not get away nor the mines be destroyed if kept clear of water and well repaired; and this will cost less ultimately than to operate at a profit so small that the margin will all be spent in taxes and in insurance. From north to south along the Mother Lode the following mines are operating at present in Amador County: Plymouth, Fremont, Bunker Hill, Treasure, Keystone, Old Eureka, Central Eureka, Kennedy, Argonaut. The idle mines along the Mother Lode in Amador County are Original Amador, South Eureka, Oneida, Zeila and Hardenberg. In Calaveras County the active producers are the Utica, Gold Cliff, Melones and Calaveras Consolidated. In Tuolumne County the mines operating are chiefly doing development work and are the Dutch-App, Eagle Shawmut, Black Oak and Springfield Tunnel.

The Cost of Reopening the Old Eureka mine on the Mother Lode in Amador County, covering a period of about 18 months from May, 1916, to September, 1917, totaled $218,183, according to a statement recently issued. In addition, 111 acres of adjoining ground was purchased. The amount estimated by Manager T. Walter Beam to be necessary for the purchase, reopening and development was $1,000,000. The sum was quickly oversubscribed and provided approximately $500,000 for reopening and development. The purchase price of the adjoining land may be properly chargeable to development, as the acquisition of new ground was necessary if not actually essential to the conduct of the extensive development plans. There is a balance of $271,606 available for development, assuming that the purchase of the property used only about one-half of the $1,000,000 subscribed. The mine, which was originally owned by Alvinza Hayward and later by Hetty Green, had been idle until March, 1916, for 30 years. The Hayward and Green interests never got below 2000 ft. vertical depth. The shaft is now being deepened to 3000 ft. The labor of reopening was not confined to unwatering and ordinary repairs, but included the excavation and removal of a large tonnage of mud and silt that had accumulated in the workings. The items of expenditures are as follows: Construction and equipment, $71,735; tools and equipment, $3756; pumping and shaft repairs, $117,657; general operating charge, $19,415; taxes, $1771; mine development, $3849; purchase 111 acres ground, $10,211. Total, $228,394. Ordinarily the item of development, $3849, might be properly chargeable to development account to begin with the deepening of the shaft. But it is a reasonable supposition from the nature of the ground that the development work done during the reopening period was a part of the reopening work. However, the amount expended in the work up to September, 1917, is well within the amount estimated by Mr. Beam, and the time of completion well within the period set, and that despite numerous delays in transportation. The development so far has given satisfactory results, and the deepening the shaft is believed to be wholly warranted, not merely as exploration for new orebodies, but as part of a development campaign to prove the persistence of known orebodies. The company formed at the beginning of the enterprise is known as the Consolidated Amador, but the name Old Eureka has persisted, as did the name Hetty Green mine for a long time, although both these names were merely local appellations. Among the owners who were the original subscribers are: W. E. Corey, John D. Ryan, Thomas Cole, Ambrose Monell, John B. Farish.

SALT LAKE CITY—Apr. 10

Labor Agitation at Utah Copper has been instigated by a hundred or so machinists at the Arthur and Magna mills out of a total of 3500 employees. These few are ostensibly agitating the question of unionism, seeking to advance their cause by alleging discrimination against the union on the part of the company. The company has an open shop and employs both union and non-union labor indiscriminately, and in the words of an official of the company, according to the ability of the individual "to do the work we want done." A report of the Federal investigator in the matter—signed also by representatives of the state industrial commission—recommends that the men accept the word of the company that there will be no discrimination, and that the men remain on the job as a patriotic duty. At a meeting held on the evening of March 29, however, the disaffected employees voted to go on strike. This move will not of course materially affect the operation of the plants, as the number concerned is small in comparison with the total number of employees. As is well known, the company has in recent years many times increased the wages of its men, who are working under most favorable conditions

WALLACE, IDAHO—April 10

The labor shortage has become a serious problem throughout the district, and the outlook is anything but promising. The chief difficulty is in obtaining miners, although the shortage also applies to common labor. It is feared that the effect will soon result in a curtailment of output from the mines; in fact, the output of some is now below normal; notably the Morning, which has not been able to secure the maximum force since the resumption of operations in February. There is comparatively little work on new properties, which, however, is not attributable to labor shortage, though that is the reason to some extent. The suspension in this line of mining has been caused by the high cost of supplies and wages, and also to a patriotic feeling among strictly development companies that all efforts should be directed to lines that contribute to direct production only, in support of the war.

Selective Flotation Experiments by the Bureau of Mines in connection with the State University at Moscow, on Coeur d'Alene-district lead-zinc ores have been encouraging. C. A. Wright, superintendent of the experimental station, states that there is a wide difference between the ores from the different mines, some responding readily to the process, while in other cases the ores have proved quite refractory in yielding a clean product. Steady progress is being made, however, and he confidently expects to solve the problem and make a practically perfect separation of lead and zinc through flotation. The work of the station is being watched with much interest by operators in this district.

JOPLIN, MO.—Apl. 12

Large Companies Are Supplanting Small ones in this field. A few years ago the only single large output was that of the American Zinc, Lead and Smelting Co. with its Carterville sheet-ground mines. Now the Eagle-Pitcher Lead Co., with seven mills in operation, is the largest producer in the field. The Skeleton Lead and Zinc Co. also has seven mills operating in Oklahoma and is the second largest producer. The Admiralty Zinc, the Golden Rod M. & S., the Bethel-Domando-Croesus, the Commerce Mining and Royalty, the Acme, the Ramage, the Vinegar Hill, the Montreal, the Hettig, and several other companies are yielding a higher production than did the companies of the district a few years ago. The American Metal Co. is only now getting its operations well under way, and is known as the Chanute Spelter Co. Almost any of these companies, it is believed, can continue operation even when prices become so low that smaller concerns have to cease, and it is considered that this condition is bringing about an entirely new situation in the Joplin district. Whether it will eventually be better for the district is problematic; for one thing, it is thought that the absence of labor trouble here has been largely due to the fact that many of the mine owners were, earlier in their experience, underground laborers, and thus have been better able to appreciate and grant the needs and rights of their men.

Steadily Dropping Zinc Ore Prices are worrying producers considerably. Within the last few weeks the two leading operators' associations in this field, the Tri-State, which meets weekly at Picher, Okla., and the Southwest Missouri, which meets at Webb City, have issued urgent invitations to members of Congress to visit the district and view conditions. Champ Clark, Scott Ferris, and Senators Stone, Reed, and Owen have been among those invited, along with Congressman Perl Decker, of Joplin. At the last meeting the Southwest Missouri association decided to try to persuade Secretary McAdoo to visit the district. So far Congressman Decker is the only one who has come, and he holds out little hope. A meeting of operators and business men was held in Joplin last week, at which it was decided to send a committee of 15 to Washington; but it is not believed that much could be accomplished. Most operators incline to the opinion that it is simply a matter of overproduction of spelter at this time. Later a greater demand from galvanizers may help the situation, they think, but in the meantime, many of the smaller mining companies are going to suffer, and this is going to be particularly noticeable in the Oklahoma section of the field, where royalties are high and there have been some unjustified promotions. It is significant that despite the fact, that virtually the entire sheet-ground district around Webb City is idle, the output of the district as a whole is still greater than it was four or five years ago. Most operators believe there will be little betterment of prices until a marked decline in production takes place.

TORONTO—Apl. 10

Activity Is Shown at West Shining Tree gold camp, where operations have been for some time under way at the Wasapika, which is successfully developing the Ribble vein. At five other mines in the immediate neighborhood development is about to start. Large quantities of machinery are being brought in by way of Kashbaw station, on the Canadian Northern Railway, a point about 80 miles northwest of Sudbury, and about 30 teams are engaged in transporting it to the mines.

New Regulation Regarding Idleness in Canada has just been passed by the Dominion Parliament that may have a beneficial effect on the supply of labor for the mines. In the gold camps particularly the majority of the labor is foreign, and a large proportion of it alien enemies. Difficulty is experienced in keeping these men at work, as they have more money than they ever had before. On account of the restriction, they cannot send it out of the country, and through fear of its being seized they do not put it in the banks. As a consequence the majority of them are walking depositories, and with this feeling of wealth often comes a disinclination to work. The new regulations declare that "all persons domiciled in Canada, in the absence of reasonable cause to the contrary, shall engage in useful occuptions." The regulations declare that they are not intended to affect any right of labor men to strike on account of actual differences with employers, but are designed to prevent persons capable of useful work from remaining in idleness at a time when the country needs all human energy possible. Violation of the regulations imposes liability to a fine not exceeding $100, or, in default of the fine, imprisonment not exceeding six months. Any institution or farm owned by a municipality or province shall for the purposes of the law be deemed a common jail.

The Mining News

ARIZONA

Cochise County

SHATTUCK (Bisbee)—Production in March 1,013,593 lb. copper, 66,878 lb. lead, 11,429 oz. silver and 88.98 oz. gold.

Gila County

BISHOP'S KNOLL (Payson)—Recently incorporated. Incorporators are John McCormick, E. B. Simanton, Mrs. E. B. Simanton, and William Brown, all of Arizona.

Graham County

INSPIRATION (Miami)—Production in March 8,750,000 lb. copper.

Greenlee County

ARIZONA COPPER (Clifton)—Giving special instruction to 200 employees at concentrator and smeltery in seven different class—five in Clifton and two in Morenci. Four classes are composed of Americans, one of Americans and Mexicans and two entirely of non-English-speaking Mexicans. Classes are held three times daily to accommodate different shifts and are to be continued until Apr. 23. S. C. Dickinson, safety engineer of the Arizona State Bureau of Mines, Tucson, is instructor.

Maricopa County

COBRITA VERDE COPPER (Wickenburg)—Leased block of ground on Little Giant and sinking to proceed.

Mohave County

GOLD ORE MINING AND MILLING (Oatman)—Transportation over new road to mill delayed on account of storms.

McCRACKEN SILVER MINES (Yucca)—Has designed new mill which will be furnished with dry concentrators; oil engines to furnish power.

TOM REED (Oatman)—Annual meeting to be held at Kingman, April 29. A shaft to be raised to surface from new orebody and tramline installed to mill.

UNITED EASTERN (Oatman)—Developments on new eighth level progressing satisfactorily. Orebody said to be disclosing excellent ore.

Pima County

ARIZONA COPPER AND MINING CORPORATION. (Tucson)—Shaft nearly down to 500 level. Plan to crosscut at that level.

Pinal County

BUNKER HILL MINING (Ray)—Erroneously reported permanently closed. Present reports are that property has been sold to Pittsburgh interests, who plan to begin development directly.

Santa Cruz County

RED PRINCE COPPER (Nogales)—Recently incorporated. Incorporators—H. D. Bush, Baltimore, Md.; N. J. Purcell, Hillsboro, Va., and W. R. Moore, Kansas City Missouri.

Yavapai County

BLACK CANYON DISTRICT reports option on tungsten deposits by Dr. C. B. Linderman, of Pittsburgh.

HILLSIDE COPPER CREEK (Prescott)—To open new wagon road to auto traffic in May. Mine reported under option and sale conditioned on the road being opened.

JEROME VERDE COPPER (Jerome)—Report for week ending March 12, shows a progress of 356 ft. of diamond drilling and 143 ft. of underground workings. Superintendent, J. P. Harper.

STORM CLOUD MINE (Prescott)—O'Brien Syndicate recently ordered the unwatering of mine, idle for ten years.

TIP TOP CON. (Prescott)—Reported to be under option to Kansas City syndicate represented by A. Decamp, of Humboldt.

Yuma County

EMPIRE-ARIZONA CONSOLIDATED COPPER CO. (Parker)—Water level reached at 640 ft. in Eagle's Nest shaft. Sinking being continued with three shifts to 700 level, where station is to be cut and crosscut driven to contact.

ARKANSAS

Stone County

KILGORE MINING (Parma)—Oil engine and 600 ft. of pipe to be purchased. Ike Kilgore is in charge.

CALIFORNIA

Glenn County

TWIN ROCK (Newville)—This chrome property and the Salt Spring claim have been leased to G. D. and O. D. Avery by Conklin & Williams. The two will be worked conjunctively and both said to contain high-grade chrome deposits. Ore will be hauled by motor trucks to the Southern Pacific at Orland for rail shipment.

Inyo County

BUNKER HILL (Big Pine)—Producing lead-silver ore steadily since last June when taken over by the Base Metals Co Located on east side of Inyo Range. Ore is jigged and hauled by motor trucks to Zurich, about 44 miles. Delivery from mines to trucks is by gravity tram 2900 ft. long.

CERRO GORDO (Keeler)—Large yield of zinc and silver-lead ores continues. Aerial tramway operating at capacity and handling some local custom ore. Recent developments at greater depth continue encouraging.

DARWIN DEVELOPMENT (Darwin)—Reported to be opening large amount of new grounds adjoining main workings. Mill operating successfully on complex ores. Some properties being deepened were former producers at shallow depths.

Madera County

MINARETS (Mammoth)—Situated in the northeast edge of county and reported optioned by International Smelting Co. Is more accessible from Mammoth than from west side of the Sierra. Will be necessary before actual development to build road to connect with the trail across Mammoth pass to Red's Meadows.

Nevada County

ALLISON RANCH (Grass Valley)—Now operated by Grass Valley Consolidated Mines Co. Crosscutting started at the 700 level to intersect old Harterey ledge, which outcrops in the Allison for a length of 3400 ft. Development on a large scale is planned. W. L. Williamson is superintendent.

Placer County

BIG OAK (Colfax)—D. A. Russell and Lee Gray have purchased one-half interest owned by the Valentine estate. The other one-half is owned by Mrs. Rose Werry, of Colfax. Property was idle for 30 years. Now being worked, and good returns from cyanidation reported by Hathaway and Martin, of Nevada City, working under lease.

Shasta County

U. S. SMELTING (Kennett)—Copper production from smeltery in March was 1,620,000 pounds.

Siskiyou County

BLUE LEDGE (Yreka)—Reported that large production of copper this year is planned by a British-Canadian syndicate. Stated that the property produced about 8,000,000 lb. copper last year. Concentrating equipment said to be contemplated. Property in course of development for several years, but lack of ore reduction and transportation facilities retarded development.

MERCURY MINING CO. (Yreka)—Company recently purchased the mineral springs, two hotels and mines at Cinnabar, 30 miles west of Hilt, a station on the Southern Pacific in the northern part of the county. Purpose developing on large scale. Also stated that company has optioned Morgan Brothers' property, on Empire Creek, and the Herzog property.

Yuba County

GREEN LEAD (Smartsville)—Lease taken on property owned by Thomas Mooney and situated on Empire ranch. Will be operated by the present operators of the copper property on McGonnigal ranch.

COLORADO

San Juan County

HAMLET (Howardsville)—Development continued with favorable results. Mill overhauled and remodeled, and has resumed operations.

PEERLESS SAN JUAN (Maggie Gulch)—Developed by the Caladonian Mining and Milling Co. under the management of D. W. Fleming. The mill being overhauled and remodeled.

SUNNYSIDE (Eureka)—Production started in one unit of 500-ton mill. Ore transported to mill by three-mile tramway. Equipment Marcey mills, Dorr classifiers ball-mills, table and flotation concentrators. Ore is crushed at head end of tramway.

San Miguel County

ALTA (Telluride)—Developing in Alta and St. Louis workings. Expect large tonnage to be developed by time mill is completed. Equipment to include crushers, ball-mills, tables and flotation.

LEWIS (Telluride)—Milling discontinued and developing only in two main headings.

MOLYBDENUM ORE in western San Miguel County, 25 miles west of Norwood, found recently. Some high-grade ore and large quantity of milling grade. Remoteness of deposit makes treatment at mine necessary. Another deposit of molybdenum ore opened near Ophir. This is of good grade, but not so large as that at Norwood.

Summit County

CHAMBERLAIN ORE SAMPLING CO. (Breckenridge)—Local plant to be closed and dismantled. In operation 16 years, and loss will be felt by small producers.

FRENCH GULCH DREDGING CO. (Breckenridge)—Dredge now operating in channel 50 ft. deep and 500 ft. wide. Exceptionally good cleanups made. Some nuggets of considerable size.

LIBERTY LEASING CO. (Breckenridge)—Mill overhauled, and now in operation. Blanket deposit exposed on hillside with little or no overburden. Lead and zinc sulphide ore.

MOLLY B (Breckenridge)—Operated by recently organized Denver Company. Tunnelling to cut blanket deposit. Compressor house completed, and machinery to be installed at once. Power line finished.

POWDER RIVER DREDGING CO. (Breckenridge)—New transformers installed since recent fire, and new dredge, completed a short time ago by Yuba Construction Co., operating successfully.

Teller County

CRIPPLE CREEK PRODUCTION for March 92,470 tons; gross value, $875,880.

CAMP BIRD (Cripple Creek)—Operating Rose Nicol mine under lease and has cut Dexter vein on 800 level. Shows 4-ft. shoot of $30 per ton ore. Production to begin soon. Roosevelt tunnel has cut what is believed to be Hidden Treasure vein of Portland system at depth of 2000 ft. in Rose Nicol ground. Vein to be developed from tunnel level. Orehouse to be built at mine, and aërial tramway from railroad at Eclipse station.

ELKTON (Cripple Creek)—Developing on 1100 level. Drifting north on Raven vein.

MARY MCKINNEY (Cripple Creek)—Lease on five blocks, including Howard shaft and adjacent territory, sold recently by former lessee, Elmer Smith, to Victory Gold Mining Co. Same company operating Prince Albert group on Beacon Hill. E. P. Arthur is general manager.

MILLASIER LEASING CO. (Cripple Creek)—Shaft 1425 ft. deep. Station cut at 1400 level, and development to be started.

ORPHA MAY (Cripple Creek)—Lessees on this Stratton estate mine made initial shipment from new shoot opened recently on 1000 level. Ore is six to eight ft. wide.

PORTLAND (Cripple Creek)—Old treatment plant at Colorado City to be abandoned. Hereafter all ores to be treated

at Portland and Independence plants. High-grade ores to be treated in high-grade section of Independence mill. Some machinery and tanks to be moved from old plant to this mill, and during change high-grade ores to be treated at Golden Cycle mill. Stated old Portland plant may be taken over by Government for use as chemical products testing plant and experimental work in treatment of rare minerals. Portion of plant has been used by Government for latter purpose for some time.

SHOOFLY (Cripple Creek)—Air line extended from El Paso mine. Lessees now breaking ore for shipment.

W. P. H. MINE (Cripple Creek)—Operated by lessees, owned by United Gold Mines Co. New "flat" vein opened on 900-ft. level assaying well in gold, with streak of talc showing crystals of calaverite.

IDAHO

Shoshone County

BEAR TOP (Murray)—Property under lease to Henrietta Exploration Co. Ore to be hauled 10 miles to railroad at Delta. Large body of clean lead ore developed. Two carloads shipped and third ready.

BIG CREEK (Wallace)—Shipped 40-ton car of ore of grade 50% lead and one ounce silver per unit of lead. Now loading another car of gray copper ore of estimated value $150 per ton in combined silver and copper. Expects to ship two carloads monthly. Oreshoot proved 100 ft., with ore in east and west faces. Ore occurs in independent shoots of galena and gray copper for a width of 12 feet.

FLYNN GROUP (Mullan)—Group of 20 patented claims recently secured under bond by Ed. Ehrenberg. Privilege obtained of driving crosscut from Star workings and operation started. Vein parallel to Star and expect to cut in 600 or 700 ft. at depth from surface of 1500 ft. Promising ground on summit between Mullan and Canyon Creek and within proved ore belt. Bonded for $500,000 for 2½ years from July 1.

REX CONSOLIDATED (Wallace)—Absorption of old Rex company accomplished and deed to all property recorded. Old company receives equal number of shares in new company. Consolidated has 5,000,000 shares, and management announces that $350,000 is in treasury for further exploration of Rex and for acquisition of new property. Plan now to extend Red Monarch tunnel, which starts on opposite side of divide, to point under Rex shaft and raise to connection. Necessary to drive 2300 ft., and would gain 208 ft. in depth of shaft, now at depth of 700 ft.

REX LEASE (Wallace)—Upper workings of Rex mine under lease to N. C. Sheridan, superintendent of company. Recently struck body of clean shipping ore said to have a grade of 60% lead or better. Also a considerable body of high-grade zinc ore alongside, which can be mined separately. Promising body of lead-carbonate ore developed on No. 1 level.

RICHMOND (Adair)—Preparing to resume shipments. Much development work accomplished during winter with satisfactory results. Mine connected with railroad at Adair by aërial tram. Ore contains copper and gold.

ST. LAWRENCE (Saltese, Mont.)—Crosscutting during winter to cut orebody at additional depth of 150 ft. Expect vein by May. Shipping to be resumed in few weeks, hauling six miles to Saltese. Property controlled by Pittsburgh interests. Copper-gold ore from same vein as Richmond.

SUCCESS (Wallace)—contemplating a one-half-mile monorail tramway from mill to railroad. Teams now used. Drifted on new oreshoot on 1500 level over 100 ft. and average width 16 ft. In place 25 ft. wide. Same oreshoot now cut on 1600 level and on 1400. The ore averages 5% lead and 15% zinc.

KANSAS

Joplin District

LAWTON MINING CO. (Lawton)—Mill purchased by J. J. McLellan and Ray Munson, who will move to Douthat, Okla., and convert into tailing mill.

PLAYTER BROS. (Joplin, Mo.)—Into rich cave formation at new property near Treece, Kansas.

KENTUCKY

Pike County

VIRGINIA-ELKHORN BYPRODUCTS COAL CO. (Praise)—Recently incorporated with capital of $300,000, at Huntington, W. Va. Plans to develop coal property on Kentucky-Virginia line, and erection of 1000-ton plant. Will require a 250-volt D. C. motor, boilers, 250-volt coal cutters and other equipment, including cars. H. T. Lambert, of Huntington, is chief engineer. J R Slaton is president.

MICHIGAN

Copper

CHEROKEE (Houghton)—Annual meeting held and plans for reopening property discussed, but no action to be taken until conditions become more propitious. Shaft is down 450 ft., and drifts of 670 ft. have been made. The limited tonnage taken out showed high-grade copper ore.

WYANDOT (Houghton)—Continues to operate in small way. Shipments to Winona mill show better than 1% grade of ore.

MINNESOTA

Mesabi Range

BENNETT MINE (Keewatin)—Contracts let by Pickands Mather Co., for erection of 10 entirely modern cottages. Contract for boarding house and dormitory. Much work expected at mine this summer.

FAYAL MINE (Eveleth)—Oliver Iron Mining Co. have started to deepen the old No. 4 shaft.

LA RUE MINE (Nashwauk)—M. A. Hanna Co. announces that a large amount of stripping and development work will be done this summer in addition to getting out ore. In order to take care of the additional work, two more engines and a steam shovel will be added to the equipment. This mine employed 300 men last summer.

MYERS MINE (Chisholm)—Oliver Iron Mining Co. hoisted last skip of ore and dismantling of property begun. Estimated mine has produced 1,400,000 tons of high-grade ore.

TIOGA MINE (Chisholm)—Shenango Furnace Co. gave orders to vacate to squatters who live on this property, which is soon to be caved.

Vermillion Range

LA RUE MINE (Tower)—Work on Armstrong Bay temporarily suspended awaiting arrival of machinery. Estimated two months before reopening.

MISSOURI

Joplin District

BADGER MINING & DEV. (Joplin)—Drifted into fine ore north of old Hubbard mine near Badger. Preparing to erect mill. Drilling on other tracts.

D. C. & E. (Webb City)—Made final clearing. Mill is for sale.

NEVADA

Nye County

TONOPAH ORE PRODUCTION for the week ended March 30 amounted to 10,792 tons, of a gross milling value estimated at $183,464. Producers were: Tonopah Belmont, 1956 tons; Tonopah Mining, 4050; Tonopah Extension, 3407; Jim Butler, 365; West End, 843; MacNamara, 607; Montana, 305; Cash Boy, 160; Halifax, 46; Rescue, 53 tons.

MANHATTAN CON. (Manhattan)—Water flow reduced 50%. Crosscut on 500 advanced 50 ft. from station in shale and quartzite.

UNION AMALGAMATED (Manhattan)—Drift 614 north along limestone footwall advanced 22 ft. through broken ground. Drift 622 extended 22 ft. without change of ground. The 350 level preparations completed for resumption of mining and drift 354 advanced 8 ft. in development of Swanson orebody.

WHITE CAPS EXTENSION (Manhattan)—Southeast drift in 400 level advanced along limestone footwall a total distance of 52 ft. and a distance from the shaft of 324 feet.

WHITE CAPS (Manhattan)—Raise 504 in east orebody reported entirely in milling ore for whole distance, 82 ft. above 500 level. Crosscut 503 west is in 430 ft. Last five feet in limestone belt. Distance to west orebody 50 to 60 ft. Report states 47.5 tons broken in stoping per man underground and 9.2 tons per man employed. Last bi-weekly clean-up of precipitates from cyanidation was 326 lb., producing $12,000 in gold. Present clean-up 665 lb. dry weight.

OKLAHOMA

Joplin District

KENTEX (Miami)—New mill near Quapaw near completion. Recent developments show lead-zinc deposits.

LENORA (Douthat)—Sunk shaft in limestone to below third ore level at over 200 ft. Heavy water to fight, and company has provided for three pumps. Moving mill from Webb City.

SANTE FE (Oklahoma City)—New mill completed, but will not be started until water is sufficiently under control to work second level at 200 ft. Mine south of Hockerville and east of Picher. W. G. Skelly, of Tulsa, is principal owner.

UTAH

Juab County

GOLD CHAIN (Mammoth)—February shipments, 26 cars; January, 21; and first three weeks March, 14 cars or about 700 tons.

IRON KING (Eureka)—Shaft down 500 ft., to be continued until reaches point offering conditions favorable to systematic prospecting.

Piute County

DEER TRAIL (Marysvale)—New 100-ton mill for treatment of complex gold-silver-copper ores given successful try-out.

FLORENCE MINING & MILLING (Marysvale)—Stated to be considering erection of mill at mine, for treatment of alunite.

MINERAL PRODUCTS (Marysvale)—Mill destroyed by fire in October, 1917, rebuilt and treating 200 tons of alunite daily.

Salt Lake County

CARDIFF (Salt Lake)—New ore opened from winze at 250-ft. depth, from tunnel level, thought by management to be extension of old body. Twelve-foot face showing shipping ore and four feet more of lower grade.

COLUMBUS-REXALL (Alta)—Shipments resumed with spring opening of roads.

EMMA CONSOLIDATED (Alta)—Roads being put into condition for shipment, and transportation of ores to begin soon. Approximately 200 tons of silver-lead ore showing some manganese accumulated. Three shifts working in winze and crosscut on diamond drill hole No. 43, which indicated good body of ore. Crosscut to be started at 400 level, from which diamond drilling to be undertaken.

MICHIGAN-UTAH (Alta)—Tramway being repaired after damage from winter snow, and regular shipments to be resumed.

MONETAIRE (Alta)—Supreme court, reversing judgment of trial court, grants right of this company to carry on development from 1200 level of Columbus-Rexall, privilege being granted through extension of right of eminent domain to include mining property.

VIRGINIA

Frederick County

MINERAL RIDGE MANGANESE CORP. (Strasburg)—Recently chartered, with capital of $250,000. Has acquired mineral rights on 700 acres. 200 tons of high-grade ore averaging 47 to 49% Mn, 1 to 1.5% Fe and 3.5 to 4.5% SiO_2. Production of washed ore at completed plant at the rate of one car per day, and increasing output immediate expectation. W. B. Shaffer, Nazareth, Penn., is president, and M. W. Shaffer, of Star Tannery, Va., is general manager.

CANADA

Manitoba

HOLLINGER (Porcupine)—Producing approximately $500,000 per month in gold.

LULEO CLAIMS (Rice Lake)—A 10-stamp battery, boilers and other equipment on way. This is to be first mill in Rice Lake camp.

McINTYRE (Porcupine)—Signed option for controlling interest in the Newray mine. Company is also investigating a property in British Columbia.

Ontario

CANADIAN KIRKLAND (Kirkland Lake)—New vein 10 to 15 ft. wide and well mineralized discovered lying between the two main veins. Camp buildings to accommodate large force completed.

DICKSON CREEK (Cobalt)—On this property between Haileyberry and New Liskeard a 2-ft. vein has been followed to a depth of 160 ft. on a slight incline.

MEXICO

Sonora

GREENE CANANEA (Cananea)—Production in March 4,480,000 lb. copper, 130,400 oz. silver and 1225 oz. gold. Labor and general conditions reported much improved, and continued operations seem assured.

CHOSEN

ORIENTAL CONSOLIDATED (Unsankinko)—March cleanup, $128,700.

The Market Report

SILVER AND STERLING EXCHANGE

Apr.	Sterling Exchange	Silver: New York, Cents	Silver: London, Pence	Apr.	Sterling Exchange	Silver: New York, Cents	Silver: London, Pence
11	4.7540	93⅜	46¼	15	4.7550	95⅛	47
12	4.7540	93⅜	46¼	16	4.7550	95⅛	47¼
13	4.7540	93⅜	46¼	17	4.7550	95⅛	47¼

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of bar silver, 999 fine. London quotations are in pence per troy ounce of sterling silver, 925 fine.

DAILY PRICES OF METALS IN NEW YORK

Apr.	Copper: Electrolytic	Tin: Spot.	Lead: N. Y.	Lead: St. L.	Zinc: St. L.
11	*23½	†	6.80 @6.85 6.75	6.75 @6.85 6.75	6.77½ @6.82½ 6.75
12	*23½	†	@6.85 6.70	@6.85 6.70	@6.80 6.75
13	*23½	†	@6.80 6.70	@6.75 6.60	@6.80 6.75
15	*23½	†	@6.80 6.70	@6 70 6.60	@6.80 6.70
16	*23½	†	@6.80 6.70	@6.70 6.60	@6.75
17	*23½	†	@6 80	@6 70	6.70

* Price fixed by agreement between American copper producers and the U. S. Government, according to official statement for publication on Friday, September 21, 1917.

† No market.

The above quotations (except as to copper, the price for which has been fixed by agreement between American copper producers and the U. S. Government, wherein there is no free market) are our appraisal of the average of the major markets based generally on sales as made and reported by producers and agencies, and represent to the best of our judgment the prevailing values of the metals for the deliveries constituting the major markets, reduced to basis of New York, cash, except where St. Louis is the normal basing point.

The quotations for electrolytic copper are for cakes, ingots and wirebars.

We quote electrolytic cathodes at 0.05 to 0.10c. below the price of wirebars, cakes and ingots.

Quotations for spelter are for ordinary Prime Western brands. We quote New York price at 17.5c. per 100 lb. above St. Louis.

Some current freight rates on metals per 100 lb. are: St. Louis-New York 17c.; St. Louis-Chicago, 13c.; St. Louis-Pittsburgh, 13.1 cents.

LONDON

Apr.	Copper: Standard Spot	Copper: Standard 3 Mos.	Copper: Electrolytic	Tin: Spot	Tin: 3 Mos.	Lead Spot	Zinc Spot
11	110	110	125	322	322	29½	54
12	110	110	125	322	322	29½	54
13	...	...	...	...	...	...	...
15	110	110	125	322	322	29½	54
16	110	110	125	322	322	29½	54
17	110	110	125	327	327	29½	54

The above table gives the closing quotations on London Metal Exchange. All prices are in pounds sterling per ton of 2,240 lb. For convenience in comparison of London prices, in pounds sterling per 2,240 lb., with American prices in cents per pound the following approximate ratios are given, reckoning exchange at $4.7515. £29½ = 6.2576c.; £54 = 11.4545c.; £110 = 23.3333c.; £125 = 26.5151c.; £260 = 55.1513c.; £280 = 59.3937c.; £300 = 63.6362c. Variations, £1 = 0.2121205c.

Metal Markets

NEW YORK—Apr. 17, 1918

The weakening tendency in lead and zinc continued to be exhibited. With respect to copper and tin there is nothing special to report.

Copper—Production of the refineries is gradually increasing, but they are still behindhand in their deliveries on contracts with domestic consumers.

Copper Sheets are quoted at 31½c. per lb. for hot rolled, and 1c. higher for cold rolled. Copper wire is quoted at 26½c. f.o.b. mill, carload lots.

Tin—The situation remains unchanged. The sale of a spot lot of Chinese tin at 89c. is indicative of values.

Lead—The American Smelting and Refining Co. reduced its price to 7c. on Apr. 11, but this was more nominal than anything else, the actual market being already lower than that. The leading producers continue in a well-sold condition, but the smaller producers have supplies of lead that they want to sell and cut prices in order to attract buyers. The latter have not been numerous, owing, no doubt, to their obtaining supplies from lead on railway cars, previously bought. However, the time will come, of course, when they will have used up such supplies and will re-enter the market. It was encouraging to find this week that inquiries were increasing. Transactions amounted to 2500 tons or more. The smelting works of the St. Joseph Lead Co. are still closed by the strike.

Zinc—During another week the market continued to sag from day to day on moderate transactions. The general feeling in the trade is pessimistic. However, there is reason to believe that unsold stocks in the hands of smelters, and the situation generally, are neither so bad as is commonly believed. The stocks have increased since Jan. 1, but not much. The most disturbing feature of the recent market has been the absence of buyers, which is easily explained by the conjecture that they have been obtaining their supplies from previous purchases delayed in transit. This may keep them out of the market for a little while longer. On the other hand, it is to be observed that the curtailment of production has not yet become really effective, nor will it until about the end of the month. While some plants were closed during the first quarter, there were two new plants, the tail-end of the new construction in 1917, that came into operation. Other plants whereof closing was announced in March had to continue operations in order to work off stocks of ore, and will not really cease production until this month.

Zinc Sheet—Unchanged at $15 per 100 lb., less usual trade discounts.

Other Metals

Aluminum—The price quoted is the Government price of 33c. per lb. but there is no market; the situation is unsettled; few export orders.

Antimony—Unchanged at 12½c. for spot, while we quote futures nominally at 11⅜c., c.i.f., in bond. A fair volume of business was done, there being a good demand for consumption, but the accumulation of stocks has not yet been absorbed. The spot market commands the major attention, the foreign producers being uninterested in offering metal for future delivery at present prices.

Bismuth—Metal of the highest purity for pharmaceutical use is quoted at $3.50 per lb. for wholesale lots—500 lb. and over.

Cadmium—This metal is quoted at $1.40 per pound.

Nickel—By an agreement between representatives of the International Nickel Co., Bernard M. Baruch and the council of National Defence, a price was fixed at 40c. per lb. for the highest grades nickel and 38c. per lb. for the lowest grade. Unchanged since Apr. 2.

Quicksilver—Quiet but steady at $120@122. San Francisco reports, by telegraph, $115. Mexican quicksilver is said to be available in New York at $118@120.

The War Industries Board, in conference with the producers of quicksilver, arranged by agreement with them for supply of the Government requirements at $105 per flask for deliveries at San Francisco or at the Mare Island Navy Yard, for the output of mines in California, Oregon and Nevada. Texas producers are to be paid the same price for deliveries at Marathon, Tex. For deliveries at New York or Brooklyn, 75c. per flask is to be added. Quicksilver producers are to supply the Government requirements pro rata.

Gold, Silver and Platinum

Silver—Under the impulse of the introduction into the Senate of the Silver Bill authorizing the secretary of the treasury to provide for export in the shape of bullion 250,000,000 standard silver dollars, and the repurchase of bullion at $1 per oz., the price of bar silver has advanced in London to 47¼d. and in New York to 95⅝c. official figure. The bill is pending in Congress and not yet a law.

Mexican Dollars at New York; Apr. 11, 75; Apr. 12, 75; Apr. 13, 75; Apr. 15, 76½; Apr. 16, 77; Apr. 17, 77.

Platinum—We quote refined ingot at $108, unchanged. Some transactions in platinum sponge were reported at $105. The common understanding is that the Government price of $105 applies only to the platinum content of crude material.

Palladium—Unchanged at $150.

Zinc and Lead Ore Markets

Joplin, Mo., Apr. 13—Blende, per ton, high, $57.21; basis 60% Zn, premium, $55@50; medium to low, $42.50@37.50; average basis, $46.25; calamine, per ton, 40% Zn, $25. Average selling prices: Blende, $46 63, calamine, $33.47; all ores, $45.87 per ton.

Lead, high, $86.40; basis 80% Pb, $85@84; average selling price, all grades of lead, $84.16 per ton.

Shipments the week: Blende, 10,920, calamine, 669, lead, 1727 tons. Value, all ores the week, $677 000.

Ores that sold last week on $45 basis sold this week on $42.50 basis and some ores sold as low as $37.50 basis. About two lots of premium ore brought the $55 basis quotation, with the bulk of premium ore selling $50 basis.

Platteville, Wis., Apr. 13—(By telegraph)—Blende, basis 60% Zn, $50 base for premium grade down to $45 base for second grade. Lead ore, basis 80% lead, $82 per ton. Shipments reported for the week are 2987 tons blende, 408 tons galena and 979 tons of sulphur ore. For the year the totals are 136 541 tons blende, 1869 tons galena, and 12 762 tons sulphur ore. During the week 3315 tons of blende were shipped to separating plants.

Other Ores

Antimony Ore—Business was reported done at $1.75 per unit, c.i.f., New York.

Chrome Ore—Charles Hardy reports that California ore is offered at $1.40@1.60 per unit, f.o.b., shipping points, this being for ore running 45% chromic oxide.

Iron Ore—Since only enough ore will be brought down the Lakes to carry the furnaces, no effort is to be made for early opening of navigation, and the vessels will not buck the ice. A meeting will be held next Tuesday, at which reports of furnace requirements may be presented. The whole ore movement is to be subservient to the railroad capacity, and as the railroads are taking ore from Lake Erie docks, with an ample accumulation there, no occasion arises for stimulating Lake shipments.

Manganese Ore—The schedule remains at $1.20 for 48% metallurgical ore, but any good grade that can be delivered promptly commands a premium. We quote $1.20@1.30.

Molybdenum Ore—The price for molybdenite remains nominally at $1.80 per lb. for 90% material. The interference of the War Trade Board is thought likely to create new difficulties. It is considered improbable that the domestic market will absorb the increasing production at such high prices as have prevailed recently.

Pyrites—Spanish lump is not quotable; no reports have been issued from Government sources up to time of going to press. Situation unchanged from last week's report.

Tungsten Ore—Large business is again reported. Scheelite was done at $24.50 and wolframite at $19@24, according to grade, conditions, etc.

Iron Trade Review

PITTSBURGH—Apr. 16

Steel-ingot production in March was at the rate of approximately 42,000,000 gross tons a year, or at about the average rate in 1917. The rate thus far this month has been substantially the same, or close to 90 % of existing capacity. In both pig iron and ingots, production since Mar. 1 has been about 30% greater than the average rate in January and February. Production at full capacity hinges on there being a better movement of coke by the railroads, pending the completion, during the next few months, of byproduct capacity in the Central West equal to about 100,000 tons of coke weekly. Labor shortage is beginning to be felt at some mills, but is hardly a serious factor thus far.

The familiar puzzle in the trade, "Where is all the steel going?" is present. Director of Steel Supply Replogle, for the purpose of showing that the shipbuilding program has been well taken care of, cites figures indicating steel shipments at the rate of about 250,000 tons a month, of which 60% was plates, but that is only 10% of the finished rolled-steel output. Shell-steel shipments are only 100,000 to 125,000 tons a month. There are no steel shipments for car building, as the car orders have not been let. All reports are that there is scarcely any new construction, for peace purposes, and in general the consumption of steel appears to be low, yet the plain fact is that steel is scarce, with apparently no stocks anywhere, and buyers of small lots have difficulty in placing their orders. The outlook has been that steel would eventually become relatively plentiful, as production increased, but something of that sort ought to be observable by this time, and it is not.

The cotton-tie price has been set at $1.90 per bundle (45 lb.), against $2.10 last season. The price is 54% of the Government price for 100 lb. of hoops, which are $3.50, the proportion being a shade lower than has obtained in the past, on an average.

Pig Iron—The Carnegie Steel Co. is operating 49 of its 59 blast furnaces, the best showing for several months, all idle furnaces being out of blast, there being none banked. The company remains short of pig iron and is producing ingots at 85% of capacity. The National Tube Co. is operating 10 to 11 stacks and is anxious to get the last stack also in blast. Scarcely any merchant furnaces are banked, but a number are running slow. Coke shipments in the past fortnight have been a shade better than previously, but supplies are still not altogether adequate. While merchant furnace shipments are much heavier than formerly, the iron is eagerly taken. Furnaces fell far behind in contract deliveries during the winter. At present little attention is being paid to terms of contracts, furnaces trying simply to work in harmony with customers and place iron where it will conduce to the best operation. Very little is being done in the market, consumers being covered. The market remains quotable at the set prices: Bessemer, $35.20; basic, $32; No. 2 foundry, $33; malleable, $33.50; forge, $32, f.o.b. furnace, freight from Valleys to Pittsburgh being 95c.

Steel—Some of the large steel producers would buy ingots or billets if obtainable, but there are scarcely any offerings. Set prices remain: Billets, $47.50; small billets, $51; slabs, $50; sheet bars, $51; rods, $57. Shell-steel discards are offered in a limited way, at these prices or a shade less.

Ferroalloys

Ferromanganese—The Navy collier "Cyclops," with a cargo of several thousand tons of Brazilian manganese ore, was last heard from Mar. 4, in the West Indies, and is probably lost. Ferromanganese remains quotable at $250 for 70%, with 16% spiegeleisen $70.

Connellsville Coke—In the last two weeks shipments have been between 350,000 and 375,000 tons a week, but this week may not show up as well. There is nearly enough coke now, but, on account of irregular working, quality is not always up to standard, and coke consumption per ton of pig iron is rather high. Shipments are confined almost entirely to contracts.

STOCK QUOTATIONS

N. Y. EXCH.†	Apr. 16
Alaska Gold M.	1⅛
Alaska Juneau	1⅛
Am.Sm.& Ref.,com.	77
Am. Sm. & Ref., pf.	104½
Am. Sm. Sec., pf., A	89
Am. Zinc	13
Am. Zinc, pf.	46
Anaconda	64⅛
Batopilas Min.	1⅛
Bethlehem Steel	79
Bethlehem Steel, pf.	88
Butte & Superior	19
Butte Cop. & Zinc	9⅛
Cerro de Pasco	31⅛
Chile Cop.	15⅛
Chino	41⅛
Colo. Fuel & Iron	37
Crucible Steel	62⅛
Crucible Steel, pf.	88
Dome Mines	8
Federal M. & S.	9
Federal M. & S., pf.	30⅛
Great Nor., ore ctf.	27⅛
Greene Cananea	42⅛
Gulf States Steel	90
Homestake	76
Inspiration Con.	47⅛
International Nickel	28
Kennecott	32⅛
Lackawanna Steel	78⅛
Mexican Petrol.	93⅛
Miami Copper	28⅛
Nat'l Lead, com.	57
National Lead, pf.	105
Nev. Consol.	18⅛
Ontario Min.	9⅛
Ray Con	24⅛
Republic I.&S.,com.	80
Republic I. & S., pf.	97⅛
Sloss-Sheffield	51
Tennessee C. & C.	17⅛
U. S. Steel, com.	91⅛
U. S. Steel, pf.	109⅛
Utah Copper	78⅛
Va. Iron C. & C.	66⅛

N. Y. CURB†	Apr. 16
Big Ledge	⅛
Butte & N. Y.	⅛
Butte Detroit	⅛
Caledonia	.42
Calumet & Jerome	1⅛
Can. Cop. Corpn.	1⅛
Carlisle	‡2
Cashboy	.09
Con. Ariz. Sm.	1⅛
Con. Coppermines	5⅛
Con. Nev.-Utah	‡⅛
Emma Con.	.21⅛
First Nat. Cop.	1⅛
Goldfield Con.	⅛
Goldfield Merger	.03⅛
Greenmonster	⅛
Hecla Min.	4⅛
Howe Sound	‡4⅛
Jerome Verde	⅛
Kerr Lake	5.25
Louisiana	‡.50
Magma	35
Majestic	.24
Marsh	.06
McKinley-Dar-Sa.	.41
Miliford	‡1⅛
Mohican	‡.25
Mother Lode	.35
N. Y. & Hond.	‡12⅛
Nipissing Mines	8.45
Nixon Nevada	⅛
Ohio Cop.	⅛
Rawley	‡2⅛
Ray Hercules	4⅛
Richmond	‡.56
Rochester Mines	.37
St. Joseph Lead	15⅛
Standard S. L.	⅛
Stewart	.21⅛
Success	.08⅛
Tonopah	2⅛
Tonopah Ex.	1⅛
Tribullion	‡.31⅛
Troy Arizona	‡.18
United Cop.	‡⅛
United Verde Ext.	‡37
United Zinc	1⅛
Utica Mines	‡.08

SAN FRAN.*	Apr. 16
Alta	.03
Andes	.17
Best & Belcher	.03
Caledonia	.05
Challenge Con.	.02
Confidence	.04
Con. Virginia	.42
Gould & Curry	.01
Hale & Norcross	.02
Jacket-Cr. Pt.	.06
Mexican	.15
Occidental	‡.60
Ophir	.15
Overman	.01
Savage	‡.03
Sierra Nevada	.11
Union Con.	.96
Utah Con.	.01
Belmont	3.00
Jim Butler	.69
MacNamara	.10
Midway	.07
Mont.-Tonopah	.10
North Star	.05
Rescue Eula	.07
West End Con.	.77
Atlanta	.10
Booth	.05
Comb. Frac.	‡.02
D'field Daisy	‡.02
Florence	.12
Jumbo Extension	.12
Kewanas	.04
Nevada Hills	.03
Nevada Packard	.24
Round Mountain	.31
Silver Pick	.04
White Caps	.43
Big Jim	‡.75
United Eastern	4.25

BOSTON EXCH.*	Apr. 16
Adventure	1
Ahmeek	77
Algomah	.25
Alloues	50
Ariz. Com., ctfs.	13⅛
Arnold	.20
Bonanza	.20
Butte-Balaklava	.25
Calumet & Ariz.	67
Calumet & Hecla	435
Centennial	13
Copper Range	44⅛
Daly West	1⅛
Davis-Daly	5⅛
East Butte	9
Franklin	5
Granby	76
Hancock	7⅛
Hedley	12
Helvetia	15
Indiana	‡.50
Isle Royale	22
Keweenaw	1
Lake	5⅛
La Salle	2⅛
Mason Valley	4⅛
Mass	5
Mayflower	1⅛
Michigan	2⅛
Mohawk	61⅛
New Arcadian	1⅛
New Idria	15
North Butte	13⅛
North Lake	‡.62
Oilbway	.75
Old Dominion	40
Osceola	53
Quincy	70
St. Mary's M. L.	‡50
Santa Fe	.85
Seneca	9
Shannon	4⅛
Shattuck-Ariz.	15
So. Lake	1⅛
So. Utah	.12
Superior	4⅛
Superior & Bost.	2⅛
Trinity	3⅛
Tuolumne	.99
U. S. Smelting	37⅛
U. S. Smelt'g, pf.	43⅛
Utah Apex	2
Utah Con.	10
Utah Metal	2⅛
Victoria	2⅛
Winona	1⅛
Wolverine	27⅛
Wyandot	.70

BOSTON CURB*	Apr. 16
Alaska Mines Corp.	15
Bingham Mines	‡19⅛
Boston Ely	.90
Boston & Mont.	.51
Butte & Lon'n Dev.	.20
Calaveras	1⅛
Calumet-Corbin	‡.01
Chief Con.	2⅛
Cortez	.05
Crown Reserve	.20
Crystal Cop.	.34
Eagle & Blue Bell	.2
Gila Copper	‡17
Houghton Copper	.75
Intermountain	.05
Iron Cap, Com.	17⅛
Mexican Metals	.40
Mines of America	1⅛
Mojave Tungsten	.07
Nat. Zinc & Lead	.20
Nevada-Douglas	.75
New Baltic	.90
New Cornelia	16
Oneco	.20
Pacific Mines	‡.35
Rex Cons.	.11
Yukon Gold	1

SALT LAKE*	Apr. 16
Bannack	‡.26
Cardiff	3.60
Colorado Mining	.06⅛
Daly	1.30
Daly-Judge	5.50
Empire Copper	‡1.00
Gold Chain	.07
Grand Central	.48
Iron Blossom	.38⅛
Lower Mammoth	‡.03
May Day	.01⅛
Moscow	‡.02
Prince Con.	.54
Rico Wellington	.15
Silver-King Coal'n	1.80
Silver King Con.	2.02½
Sioux Con.	.03⅛
So. Hecla	.65
Tintic Standard	‡1.30
Uncle Sam	‡.00⅛
Walker Cop.	1.55
Wilbert	.10⅛
Yankee	.02

TORONTO*	Apr. 16
Adanac	.08⅛
Bailey	.04⅛
Beaver Con.	.26
Chambers Ferland	.09⅛
Coniagas	2.95
Hargraves	.07⅛
La Rose	.53
Peterson Lake	.09⅛
Temiskaming	.26⅛
Wettlaufer-Lor.	.05
Davidson	.34⅛
Dome Exten.	.10⅛
Dome Lake	.22
Hollinger	5.10
McIntyre	1.35
Newray	.18
Porcu. Crown	.13
Teck-Hughes	.49
Vipond	.18
West Dome	.12½

STOCK QUOTATIONS—Continued

COLO. SPRINGS	Apr. 16
Cresson Con.	4.56½
Doctor Jack Pot	.03
Elkton Con.	.04½
El Paso	.12
Gold Sovereign	‡.02
Golden Cycle	1.64½
Granite	.30
Isabella	.05½
Mary McKinney	.05⅛
Portland	.93
United Gold M.	.15
Vindicator	.25

LONDON	Mar. 28
Alaska G. F.	£0 1s 0d
Burma Corp.	4 5 0
Cam & Motor	0 10 6
Camp Bird	0 8 3
El Oro	0 9 0
Esperanza	0 9 3
Mexican Mines	5 5 0
Min. Corp. Can.	0 16 6
Nechi, pfd.	0 10 6
Oroville	0 18 6
Santa Gert'dis.	0 13 3
Tomboy	0 17 6

* Bid prices. † Closing prices. ‡ Last Quotations.

MONTHLY AVERAGE PRICES OF METALS

Silver	New York			London		
	1916	1917	1918	1916	1917	1918
Jan.	56.775	75.630	88.702	26.960	36.682	44.356
Feb.	56.755	77.585	85.716	26.975	37.742	42.792
Mar.	57.935	73.861	88.082	27.597	36.410	43.620
April	64.415	73.875		30.662	36.963	
May	74.269	74.745		35.477	37.940	
June	65.024	76.971		31.060	39.065	
July	62.940	79.010		30.000	40.110	
Aug.	66.083	85.407		31.498	43.418	
Sept.	68.515	100.740		32.584	50.920	
Oct.	67.855	87.332		32.361	44.324	
Nov.	71.604	85.891		34.192	43.584	
Dec.	75.765	85.960		36.410	43.052	
Year	65.661	81.417		31.315	40.851	

New York quotations cents per ounce troy, fine silver; London, pence per ounce, sterling silver, 0.925 fine.

Copper	New York		London			
	Electrolytic		Standard		Electrolytic	
	1917	1918	1917	1918	1917	1918
Jan.	28.673	23.500	131.921	110.000	142.895	125.000
Feb.	31.750	23.500	137.895	110.000	148.100	125.000
Mar.	31.481	23.500	136.750	110.000	151.000	125.000
April	27.935		133.842		147.158	
May	28.788		130.000		142.000	
June	29.962		130.000		142.000	
July	26.620		128.409		140.409	
Aug.	25.380		122.391		137.000	
Sept.	25.073		117.500		135.250	
Oct.	23.500		110.000		125.000	
Nov.	23.500		110.000		125.000	
Dec.	23.500		110.000		125.000	
Year	27.180		124.892		138.401	

Tin	New York		London	
	1917	1918	1917	1918
January	44.175	85.500	185.813	293.227
February	51.420	92.000	198.974	311.525
March	54.388	(a)	207.443	318.875
April	55.910		220.171	
May	63.173		245.114	
June	62.053		242.083	
July	62.570		242.181	
August	62.681		243.978	
September	61.542		244.038	
October	61.851		247.467	
November	74.740		274.943	
December	87.120		298.556	
Av. year	61.802		237.563	

(a) No average computed.

Lead	New York		St. Louis		London	
	1917	1918	1917	1918	1917	1918
January	7.626	6.782	7.530	6.684	30.500	29.50
February	8.636	6.973	8.595	6.899	30.500	29.50
March	9.199	7.201	9.120	7.091	30.500	29.50
April	9.288		9.158		30.500	
May	10.207		10.202		30.500	
June	11.171		11.123		30.500	
July	10.710		10.644		30.500	
August	10.594		10.518		30.500	
September	8.680		8.611		30.500	
October	6.710		6.650		30.500	
November	6.249		6.187		30.500	
December	6.375		6.312		30.500	
Year	8.787		8.721		30.500	

Spelter	New York		St. Louis		London	
	1917	1918	1917	1918	1917	1918
January	9.619	7.836	9.449	7.661	48.329	54.000
February	10.045	7.814	9.875	7.639	47.000	54.000
March	10.300	7.461	10.130	7.286	47.000	54.000
April	9.459		9.289		54.632	
May	9.362		9.192		54.000	
June	9.371		9.201		54.000	
July	8.643		8.473		54.000	
August	8.360		8.190		54.000	
September	8.136		7.966		54.000	
October	7.983		7.813		54.000	
November	7.847		7.672		54.000	
December	7.685		7.510		54.000	
Year	8.901		8.813		52.413	

New York and St. Louis quotations, cents per pound. London, pounds sterling per long ton.

Pig Iron, Pgh.	Bessemer‡		Basic‡		No. 2 Foundry	
	1917	1918	1917	1918	1917	1918
January	$35.95	$37.25	$30.95	$33.95	$30.95	$33.95
February	36.37	37.25	30.95	33.95	30.95	33.95
March	37.37	37.25	33.49	33.95	35.91	33.95
April	42.23		38.90		40.06	
May	46.94		42.84		43.60	
June	54.22		50.05		50.14	
July	57.45		53.80		53.95	
August	54.17		50.37		53.95	
September	46.40		42.24		48.58	
October	37.25		33.95		33.95	
November	37.25		33.95		33.95	
December	37.25		33.95		33.95	
Year	$43.57		$39.62		$40.83	

‡ As reported by W. P. Snyder & Co.

Current Prices—Materials and Supplies

IRON AND STEEL

SHEETS—Quotations are in cents per pound in various cities from warehouse, also the base quotations from mill:

Blue Annealed	Large Mill Lots, Pittsburgh	St. Louis	Chicago	San Francisco	New York Apr. 15 1918	New York One Yr. Ago
No. 10	4.25	5.52	5.45	6.00	5.45	6.00
No. 12	4.30	5.57	5.50	6.05	5.50	6.05
No. 14	4.35	5.62	5.55	6.10	5.55	6.10
Black						
Nos. 18 and 20	4.80	6.32	6.25	6.90	6.25	6.30
Nos. 22 and 24	4.85	6.37	6.30	6.95	6.30	6.35
No. 26	4.90	6.42	6.35	7.00	6.44	6.40
No. 28	5.00	6.52	6.45	7.10	6.45	6.50
Galvanized						
No. 10	5.25	6.97	6.80	....	6.70	7.10
No. 12	5.35	6.97	6.80	7.45	6.80	7.15
No. 14	5.35	6.97	6.80	7.45	6.80	7.20
Nos. 18 and 20	5.65	7.17	7.10	7.70	7.10	7.50
Nos. 22 and 24	5.80	7.32	7.25	7.90	7.25	7.70
No. 26	5.95	....	7.40	8.05	7.40	7.95
No. 28	6.25	7.77	7.70	8.35	7.70	8.25

STEEL RAILS—The following quotations are per gross ton f.o.b. Pittsburgh and Chicago for carload or larger lots. For less than carload lots 5c. per 100 lb. is charged extra:

	Pittsburgh Apr. 15 1918	Pittsburgh One Year Ago	Chicago Apr. 15, 1918	Chicago One Year Ago
Standard bessemer rails	65	38.00	65	38.00
Standard openhearth rails	67	40.00	67	40.00
Light rails, 8 to 10 lb.	*3.135 (100 lb.)	58.00	*3.135 (100 lb.)	53.00
Light rails, 12 to 14 lb.	*3.09 (100 lb.)	57.00	*3.09 (100 lb.)	54.00
Light rails, 25 to 45 lb.	*3.00 (100 lb.)	53.00	*3.00 (100 lb.)	52.00

*Government price per 100 lb.

TRACK SUPPLIES—The following prices are base per 100 lb. f.o.b. Pittsburgh for carload lots, together with the warehouse prices at the places named:

	Pittsburgh Apr. 15, 1918	Pittsburgh One Year Ago	Chicago	St. Louis	San Francisco
Standard railroad spikes, ⅞-in. and larger	$3.90	$3.65	$4.50	$5.30	$6.25
Track bolts	4.90	5.00	5.50	Premium	7.45
Standard section angle bars	3.25	2.35	4.50	Premium	4.90

STRUCTURAL MATERIAL—The following are the base prices f.o.b. mill, Pittsburgh, together with the quotations per 100 lb. from warehouses at the places named:

	Mill Pittsburgh	New York Apr. 15, 1918	New York 1 Yr. Ago	St. Louis	Chicago	San Francisco	Dallas
Beams, 3 to 15 in.	$3.00	$4.195	$3.95	$4.27	$4.20	$4.90	$5.50
Channels, 3 to 15 in.	3.00	4.195	3.95	4.27	4.75	4.90	5.50
Angles, 3 to 6 in. ¼ in. thick	3.00	4.195	3.95	4.27	4.75	4.90	5.50
Tees, 3 in. and larger	3.00	4.195	3.95	4.27	4.75	4.90	5.50
Plates	3.25	4.445	4.75-5	4.52	5.00	5.25	6.00

STEEL SHEET PILING—The following price is base per 100 lb. f.o.b. Pittsburgh, with a comparison of a month and a year ago:

Apr. 15, 1918	One Month Ago	One Year Ago
$3.10	$3.10	$3.10

RIVETS—The following quotations are per 100 lb.:

	Mill Pittsburgh	New York Apr. 15, 1918	New York One Year Ago	Chicago	St. Louis	San Francisco	Dallas
STRUCTURAL (Warehouse)							
¾ in. and larger	$5.25	$6.095	$5.25	$5.50	$5.55	$6.90	$8.00
CONE HEAD BOILER							
¾ in. and larger	5.35	6.195	5.35	5.60	5.65	7.00	8.00
⅞ and 1	5.50	6.345	5.50	5.75	5.80	7.15	8.15
½ and ⅝	5.85	6.695	5.85	6.10	6.15	7.50	8.50

Lengths shorter than 1 in. take an extra of 50c. Lengths between 1 in. and 2 in. take an extra of 25c.

WIRE ROPE—Discounts from list price on regular grades of bright and galvanized are as follows:

	New York and St. Louis
Galvanized iron rigging	List + 20%
Galvanized cast steel rigging	Net List
Bright plow steel	30%
Bright cast steel	17½%
Bright iron and iron tiller	5%

HORSE AND MULE SHOES—Warehouse prices per 100 lb. in cities named:

	Mill Pittsburgh	Cincinnati	Chicago	St. Louis	Denver	Birmingham
Straight	$5.25	$6.50	$6.50	$6.25	$7.50	$6.25
Assorted	5.40	6.50	7.00	6.40	7.75	6.50

BAR IRON AND STEEL—Per pound to large buyers at mill, Pittsburgh:

Iron bars ..... 3.5c. Steel bars ..... 2.9c.

COAL BIT STEEL—Warehouse price per pound is as follows:

New York	Cincinnati	Birmingham	St. Louis	Denver	Chicago
$0.12	$0.16½	$0.16	$0.16	$0.17	$0.12

DRILL STEEL—Warehouse price per pound:

	New York	St. Louis	Birmingham
Solid	15c.	14c.	15c.
Hollow	24c.	25c.	...

PIPE—The following discounts are for carload lots f.o.b. Pittsburgh, basing card of Nov. 6, 1917, for steel pipe and for iron pipe:

BUTT WELD

Steel Inches	Black	Galvanized	Iron Inches	Black	Galvanized
⅜, ¼ and ⅝	44%	17%	¾ to 1½	33%	17%
½	48%	33½%			
¾ to 3	51%	37½%			

LAP WELD

2	44%	31½%	2	26%	12%
2½ to 6	47%	34½%	2½ to 4	28%	15%
			4½ to 6	28%	15%

BUTT WELD. EXTRA STRONG PLAIN ENDS

⅜, ¼ and ⅝	40%	22½%	¾ to 1½	33%	18%
½	45%	32½%			
¾ to 1½	49%	36½%			

LAP WELD. EXTRA STRONG PLAIN ENDS

2	42%	30½%	2	27%	14%
2½ to 4	45%	33½%	2¼ to 4	29%	17%
4½ to 6	44%	32½%	4½ to 6	28%	16%

Note—National Tube Co. quotes on basing card dated Apr. 1.

From warehouses at the places named the following discounts hold for steel pipe:

	New York Black	Chicago Black	St. Louis Black
¾ to 3 in. butt welded	38%	42.8%	40.1%
3½ to 6 in. lap welded	18%	38.8%	36.1%

	New York Galvanized	Chicago Galvanized	St. Louis Galvanized
¾ to 3 in. butt welded	22%	27.8%	25.1%
3½ to 6 in. butt welded	List	18.8%	22.1%

Malleable fittings, Class B and C, from New York stock sell at list price. Cast iron, standard sizes, 15 and 5%.

MISCELLANEOUS

FLOTATION OILS—Prices of oils for flotation, in cents per gallon, in barrels:

	New York	Chicago	Denver In Bbl. Lots	Denver In Carload Lots
Pure steam-distilled pine oil	$0.51½	$0.45	$0.30	$0.27
Pure destructively distilled pine oil	.48	.43	.30	....
Pine tar oil	.36	.30	.24½	.19
Crude turpentine	.38	.46	.44	.38
Hardwood cresote	.19½*	....	.34½	.31

*F.o.b. Cadillac, Mich.

SODIUM CYANIDE—New York price is 37c. per lb.; Denver, 44c.; in Chicago, 50c.; in St. Louis, 40c.

SODIUM SULPHIDE—In New York the price per pound is 4c. to 4¼c. for concentrated, 2¼c. to 2½c. for crystals. The Denver price for crystals is quoted at 9c.; the St. Louis price, 5c. for concentrated; the Chicago price is 3½c. Concentrated comes in 500-lb. drums, the crystals in 440-lb. bbl.

ZINC DUST—New York price is 18c. per lb. in 1600-lb. barrel; Chicago, 18c.; in Denver, 13c. f.o.b. Pueblo; in St. Louis, 25c.

ALUMINUM DUST—Chicago price is $1 per lb.; St. Louis, $1.25.

CALCIUM CARBIDE—Price f.o.b. cars at warehouse points east of Mississippi River (except in Alabama, Georgia and Florida) is $97.50 for Cameo, $102.50 for Union miners' carbide. In territory between Mississippi River and the Rockies and in Alabama, Georgia and Florida, add $5; west of Rockies, add $10 to $15.

LINOLEUM—No orders being taken, owing to shortage of manufacturing materials.

HOSE—

Fire	50-Ft. Lengths
Underwriters' 2½-in.	75c. per ft.
Common, 2½-in.	40%

Air	First Grade	Second Grade	Third Grade
¾-in. per ft.	$0.55	$0.30	$0.25

Steam—Discounts from list

First grade.... 30% Second grade....30-5% Third grade..40-10%

RUBBER BELTING—The following discounts from list apply to transmission rubber and duck belting:

Competition ..... 50% Best grade 20%
Standard 35%

LEATHER BELTING—Present discounts from list in the following cities are as follows for cut lengths:

	Medium Grade	Heavy Grade
New York	40%	35%
St. Louis	40—5%	30%
Chicago	30—10%	40—5%
Birmingham	35%	40%
Denver	35%	30%

RAWHIDE LACING—40%.

MANILA ROPE—For rope smaller than ⅝-in. the price is ½ to 2c. extra; while for quantities amounting to less than 600 ft. there is an extra charge of 1c. The number of feet per pound for the various sizes is as follows: ⅝-in., 8 ft.; ¾-in., 6; ⅞-in., 4½; 1-in., 3½; for ⅝-in. and larger, in 1200-ft. coils: 1¼-in., 2 ft. 10 in.; 1½-in., 2 ft. 4 in. Following is price per pound

Boston	$0.34½	Denver	$0.30½
New York	.33½	Kansas City	.33½
Cincinnati	.33½	New Orleans	.33
Chicago	.32½	San Francisco	.31
St. Paul	.34	Seattle	.33½

PACKING—Prices per pound:

Rubber and duck for low-pressure steam	$0.90
Asbestos for high-pressure steam	1.60
Duck and rubber for piston packing	1.00
Flax, regular	.90
Flax, waterproofed	1.10
Compressed asbestos sheet	1.00
Wire insertion asbestos sheet	1.20
Rubber sheet	.60
Rubber sheet, wire insertion	.90
Rubber sheet, duck insertion	.50
Rubber sheet, cloth insertion	.25
Asbestos packing, twisted or braided, and graphited, for valve stems and stuffing boxes	1.10
Asbestos wick, ½- and 1-lb. balls	.70

FIRE BRICK—Quotations on the different kinds in the cities named are as follows, f.o.b. works:

	New York	Chicago	Pittsburgh
Silica brick, per 1000	$50.00- 55.00	$55.00-60.00	$50.00- 60.00
Fire clay brick, per 1000, No. 1	45.00- 55.00	55.00-60.00	.....
Magnesite brick, per net ton	135.00-145.00	.....	125.00-135.00
Chrome brick, per net ton	135.00-	.....	150.00-160.00
Deadburned magnesite brick, per net ton	85.00- 90.00	.....	.....
Special furnace chrome brick, per net ton	60.00- 70.00	60.00-80.00	.....

Standard size fire brick, 9 x 4½ x 2½ in. The second quality is $4 to $5 cheaper per 1000.

St. Louis—High grade, $55 to $65; St. Louis grade, $40 to $50.

Birmingham—Fire clay, $25 to $30; Denver, $23, per 1000.

RAILWAY TIES—For fair size orders, the following prices per tie hold:

	Material	7 In. x 9 in. by 8 Ft. 6 In.	6 In. x 8 In. by 8 Ft.
New York	Yellow Pine	$1.30	$1.11
St. Louis	No. 1 White Oak	.95	.71
Chicago	White Oak—Plain	.97	.82
Chicago	White Oak—Creosoted	1.30	1.15
San Francisco	Douglas Fir—Green	1.35	.96
San Francisco	Douglas Fir—Creosoted	2.44	1.62

GREASES—Prices are as follows in the following cities in cents per pound for barrel lots:

	Cincinnati	Chicago	St. Louis	Birmingham	Denver	Pittsburgh
Cup	7	5¼	6.1	7½	10	7½
Fiber or sponge	8	6	6.4	7½	15	7½
Transmission	7	6	6.4	7½	15	8½
Axle	4½	4	3.6	3	5	5¼
Gear	4½	4½	6.5	7½	6	3½
Car journal	22 (gal.)	3½	4.6	3	5	7½

COTTON WASTE—The following prices are in cents per pound:

	New York		Cleveland	Chicago
	Apr. 15, 1918	One Year Ago		
White	11.00 to 13.00	13.00	12.50	12.00
Colored mixed	8.50 to 12.00	10.00	14.00	10.00 to 12.00

WIPING CLOTHS—Jobbers' price per 1000 is as follows.

	13¼ x 13¼	13¼ x 20½
Cleveland	$45.00	$52.00
Chicago	33.00	35.00

LINSEED OIL—These prices are per gallon:

	New York		Cleveland		Chicago	
	Apr. 15, 1918	One Year Ago	Apr. 15, 1918	One Year Ago	Apr. 15, 1918	One Year Ago
Raw per barrel	$1.55*	$0.99	$1.65	$1.05	$1.65	$0.98
5-gal. cans	1.65*	1.09	1.80	1.15	1.75	1.08

*Nominal.

WHITE AND RED LEAD in 500-lb. lots sell as follows in cents per pound:

	Red				White			
	Apr. 15, 1918		1 Year Ago		Apr. 15, 1918		1 Yr. Ago	
	Dry	In Oil	Dry	In Oil	Dry and In Oil		Dry and In Oil	
25- and 50-lb. kegs	11.50	11.00	10.50	11.00	10.50		10.50	
12½-lb. keg	11.75	11.25	10.75	11.25	10.75		10.75	
100-lb. keg	11.25	11.50	11.00	11.50	11.00		11.00	
1- to 5-lb. cans	13.25	13.00	12.50	12.50	13.00		12.50	

NUTS—From warehouse at the places named, on fair-sized orders, the following amount is deducted from list:

	New York		Cleveland		Chicago	
	Apr. 15, 1918	One Year Ago	Apr. 15, 1918	One Year Ago	Apr. 15, 1918	One Year Ago
Hot pressed square	$1.00	$0.50	$1.40	$2.60	$1.05	$3.00
Hot pressed hexagon	1.00	.50	1.20	2.60	.85	3.00
Cold punched square	1.00	.50	.75	3.00	1.00	2.50
Cold punched hexagon	1.00	.50	.75	3.00	1.00	3.00

Semifinished nuts sell at the following discounts from list price:

	Feb. 5, 1918	One Year Ago
New York	40%	50%
Cleveland	60%	50—10%
Chicago	50%	50—10%
St. Louis	50—10%	.....

MACHINE BOLTS—Warehouse discounts in the following cities:

	New York	Cleveland	Chicago	St. Louis
⅜ by 4 in. and smaller	30%	40-10%	40—10%	40%
Larger and longer up to 1 in. by 30 in.	15%	40-5%	33⅓%	30—5%

WASHERS—From warehouses at the places named the following amount is deducted from list price:

New York..$1.00 Cleveland..$3.00 Chicago..$3.00 St. Louis..$3.00

For cast-iron washers the base price per 100 lb. is as follows:

New York..$5.00 Cleveland..$3.50 Chicago..$3.50 St. Louis..$2.75

EXPLOSIVES—Price per pound in small lots at cities named:

	Low Freezing	Gelatin			†Black Powder
	20%	40%	60%	80%	
New York	.....	$0.27½	$0.34½	.....	$2.40
Boston	.....	.....	.36¾	$0.43¾	.....
Cincinnati	$0.18¾	.22¾	.27¾	.....	2.35
Kansas City	.20	.26¼	.33¼	.43¼	....
New Orleans	.....	.25¼	.30¼	.....	....
Seattle	.17½	.24¾	.31¾	.41¾	....
Chicago	.18¾	.23¾	.33	.43	....
St. Paul	.20	.26¼	.33¼	.....	2.45
St. Louis	.20	.24	.29	.43¼	2.45
Denver	.18	.25¼	.32¼	.24¼	....
Dallas	.24	.30¼	.38	.48	....
Los Angeles	.22	.28	.36	.....	....
San Francisco	.17¼*	.23½*	.30½*	.40½*	....

†Per keg. *Carload price.

FUEL OIL—Price variable, depending upon stock. New York quotations not available owing to this fact. In Chicago and St. Louis the following prices are quoted:

	Chicago	St. Louis
Mexican heavy, 12-14 Baumé	7c.	7 1/16c.
Domestic light, 22-26 Baumé	5%	none

Note—There is practically no fuel oil in Chicago at present time.

CONSTRUCTION MATERIALS

ROOFING MATERIALS—Prices per ton f.o.b. New York or Chicago:

	Carload Lots	Less Than Carload Lots
Tar felt (14 lb. per square of 100 sq.ft.)	$61.00	$62.00
vxsTar pitch (in 400-lb. bbl.)	20.00	21.00
Asphalt pitch (in barrels)	30.00	35.00
Asphalt felt	70.00	75.00

PREPARED ROOFINGS—Standard grade rubbered surface complete with nails and cement costs per square as follows in New York and Chicago:

	1-Ply		2-Ply		3-Ply	
	c.l.	l.c.l.	c.l.	l.c.l.	c.l.	l.c.l.
No. 1 grade	$1.30	$1.55	$1.60	$1.75	$1.90	$2.50
No. 2 grade	1.15	1.30	1.45	1.60	1.75	1.90

Asbestos asphalt-saturated felt (14 lb. per square) costs $5.35 per 100 lb.

Slate-surfaced roofing (red and green) in rolls of 108 sq.ft. costs $1.95 per roll in carload lots and $2.20 for smaller quantities.

Shingles, red and green slate finish, cost $5.25 per square in carloads, $5.50 in smaller quantities, in Philadelphia.

HOLLOW TILE—

	4x12x12	8x12x12	12x12x12
Boston	$0.08	$0.15	$0.20
St. Paul	.06	.11	.162
Kansas City	.068	.1285	.1785
Denver	.11	.20	.30
Seattle	.07	.11	.16
Atlanta	.10	.16	.....
Los Angeles	.0633	.1071	.1966
New Orleans	.12	.15	.24

LUMBER—Price per M in carload lots:

	8 x 8-in. x 20 Ft. and Under				12 x 12-In., 20 Ft. and Under	
	Y.P.	Fir	Hemlock	Spruce	Y.P.	Fir
Boston	$52.50	$52.50	....	$40.00	$60.00	$60.00
Cincinnati	36.00	....	35.00	....	40.00	39.00
Kansas City	37.25	38.00	....	....	40.75	40.00
Seattle	24.50	24.50	24.50	24.50	24.50	24.50
New Orleans	30.00	....	....	....	....	45.00
St. Paul	....	55.00	43.00	43.00	....	59.00
Denver	....	38.00	....	34.00	....	41.00
Atlanta	25.00	....	....	....	30.00	....
San Francisco	....	26.00	26.00	26.00	....	26.00

	1-In. Rough, 10 In. x 16 Ft. and Under			2-In. T. and G. 10 In. x 16 Ft.	
	Y.P.	Fir	Hemlock	Y.P.	Fir
Boston	$45.00	....	....	$50.00	$50.00
Cincinnati	42.00	....	38.00	41.00	37.00
Kansas City	46.75	53.00	53.00	54.50	58.00
Seattle	24.50	24.50	24.50	24.50	24.50
New Orleans	38.00	....	....	34.00	....
St. Paul	....	46.00	39.00	61.00	44.00
Denver	35.00	32.00	32.00	....	32.00
Atlanta	36.00	....	....	40.00	....
San Francisco	26.00	26.00	26.00	....	26.00

PORTLAND CEMENT—These prices are for barrels in carload lots, including bags:

	Apr. 15, 1918	One Month Ago	One Year Ago
New York	$2.55	$2.25	$2.12
Jersey City	2.50	2.16	2.00
Boston	2.87	2.37	2.20
Chicago	2.36	2.21	2.16
Pittsburgh	2.71	2.31	2.16
Cleveland	2.84	2.44	2.89
Denver	3.20	3.20	....

LIME—Warehouse prices:

	Hydrated per Ton		Lump per 300-Lb. Barrel	
	Finished	Common	Finished	Common
New York	$16.50	$13.50	$2.35	$2.15
Kansas City	21.20	10.20	2.00†	1.90†
Chicago	15.00	12.00	1.10	1.60
St. Louis	14.00	....	....	1.50
Boston	17.50	15.00	2.95	2.70
Dallas	16.50	....	....	....
San Francisco	17.00	....	....	1.65
St. Paul	17.00	14.00	1.35*	2.25*
New Orleans	17.00	....	....	1.65
Atlanta	15.50	....	....	1.85*
Los Angeles	22.00	....	....	1.90†
Seattle	10.00	....	....	1.80†
Denver	25.00 (paper)	...	....	2.15†

*Per 180-lb. barrel. †200-lb. barrels.

Note—Refund of 10c. per bag, amounting to $2 per ton.