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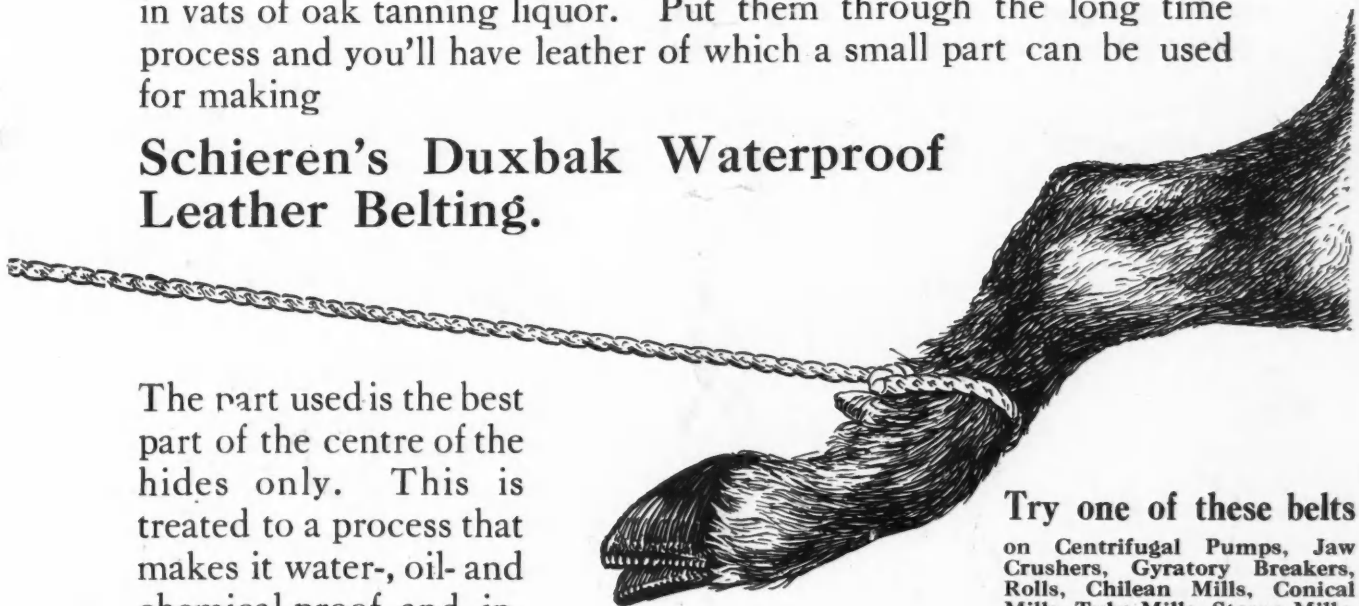
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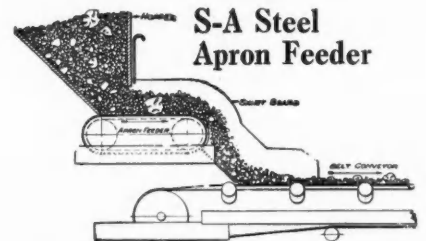
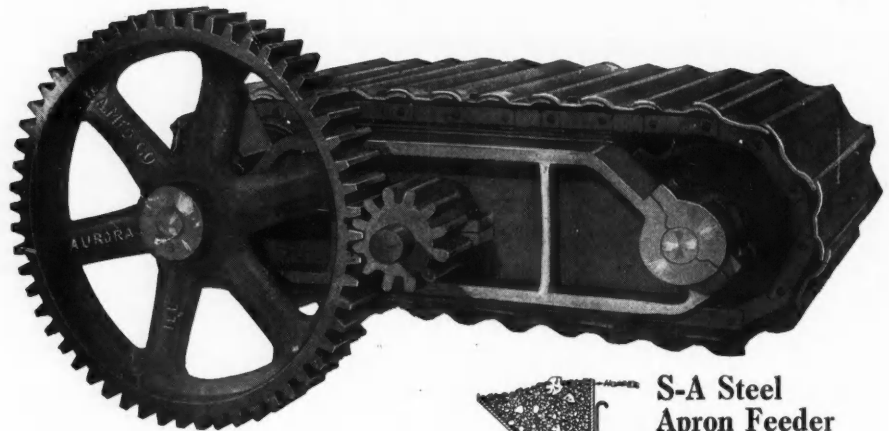
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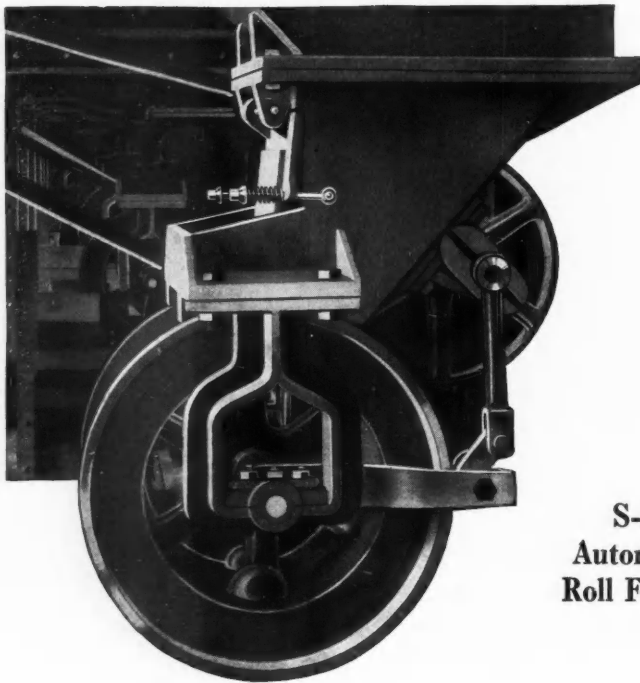
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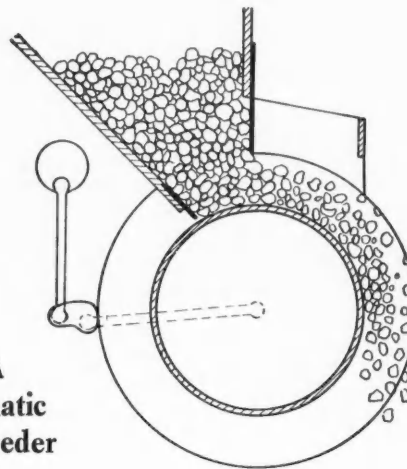
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Operating Conditions in the San Juan Country, Colorado

By L. HALL GOODWIN*

SYNOPSIS—The "San Juan Country," at elevations from 12,000 to 14,000 ft., presents difficult mining conditions. There are several large and famous producers, but the leasing system is much in vogue and small operators are numerous. Immense lava flows mark the district. Veins are all of the open-fissure type. Total mineral production of the San Juan more than \$200,000,000.

The rather picturesque term "San Juan Country" or simply "San Juan" is somewhat loosely applied to a large

region in southwestern Colorado embracing the range of mountains known by that name, roughly an area of 80 mi. east and west by 25 to 40 mi. north and south, together with an uncertain extent of plains country on all sides. Within this area are several mining districts and many operations that are of peculiar interest to the mining profession because of the particularly severe external conditions which have to be met and overcome. When this feature is combined with the natural picturesqueness of the mining camps, situated as they are among lofty and extremely rugged mountains which generally rise to heights of 2500 to 5000 ft. above the valley floors and to total elevations of 14,000 ft. and more above sea level, the region becomes one of the most interesting in the United States. It is essentially a region of many small mines which present a variety of metals and ores



GENERAL VIEW OF THE TOMBOY GOLD MINES CO., LTD., TELLURIDE, COLO.

region in southwestern Colorado embracing the range of mountains known by that name, roughly an area of 80 mi. east and west by 25 to 40 mi. north and south,

*Care of Virginia Smelting Co., West Norfolk, Va.

and a corresponding variety in mining and metallurgical problems. Although it claims such large and famous producers as the Camp Bird, Tomboy, Smuggler-Union, Liberty Bell, Silver Lake and others, a considerable

proportion of the production of the whole district comes from a large number of comparatively small mines. In 1913, for instance, a yield of over \$7,500,000 came from a total of 142 producers,¹ so it is apparent that the small operator has more of a field here than in most of our mining districts, and the leasing system is much in vogue.

The main features of the geology of this region are simple. The entire surface was invaded by immense flows of lavas, mostly andesites and rhyolites, as a result of intensely active dynamic disturbances in three great epochs of the early Tertiary. A great amount of volcanic material was poured out which covers an area of at least 15,000 sq. mi., and reaches a thickness of several thousand feet. From the central portion of this the massive San Juan Mountains have been cut. Later in the same geologic period fissuring took place, which was particularly intense near the sources of the earlier vulcanism, but it is thought that this fracturing was largely dependent upon slow-working gravitative forces within the mass rather than upon violent disturbance by further tectonic action. Before the close of the Tertiary the mineralization of the region was probably complete, and the dissection of the great plateau of lava by erosion had probably already largely determined the outlines of the present topography.

PERSISTENT FISSURE VEINS

Several types of ore deposits have been worked, but by far the most common is that of filled fissures which as a rule were not planes of movement, or if they were faults, the throw was always moderate. No general direction may be given to the fissuring as a whole, but when individual fractures are considered, they are remarkable for their continuity in direction and strength for long distances. The Smuggler vein has been worked for a length of more than two miles, and many non-mineralized fissures may be traced for much longer distances. The ores mined vary widely in the different districts: From the mines near Silverton the production has been mostly from silver-lead ores, but the low price of silver prior to the war caused the production to become more diversified, and it is now largely gold with considerable lead, silver, copper and zinc; in the San Miguel district, as well as in the mines about Ouray, the greater part of the production has always been gold, but considerable quantities of the other metals enumerated have also been mined.

No prospecting was done in this region before the 70's, but in the following decade exploration was active and most of the extensive valuable lodes since worked were discovered and opened. The output was at first restricted entirely to high-grade ores which would stand the expense of animal haulage, and as the nearest smelters were almost 500 mi. away, ores worth less than \$100 per ton could seldom be worked at a profit. With the advent of the railroad, mining of lower-grade ores became active. Narrow-gauge branch lines of the Denver & Rio Grande reached Silverton in 1882 and Telluride in 1890, and in the latter year the concentration of low-grade ores, which had not been attempted previously, was begun at the Silver Lake and the Sunny-

side mines. In these early days the high-grade ores and concentrates had to be shipped to Denver or Pueblo and freight rates were high—about \$16 per ton at first—but later the smeltery at Durango and other local reduction works obviated much of this extra expense.

The value of the production from this region cannot be accurately estimated, as no records were kept for many years. The authors of the respective United States Geological Survey folios covering the Silverton, Telluride and Rico quadrangles state the following as minimum estimates: In the Silverton district the production had been \$35,000,000 up to 1900, at Telluride it had been \$25,000,000 up to 1897, and at Rico \$10,000,000 up to 1903. The production of the various counties contributing to the San Juan region for the years 1904 to 1914 inclusive was well over \$90,000,000, so that the total production of the various districts to date must be over \$200,000,000 if allowance be made for the gap in the years previous to 1904 and for the production in the outlying districts in all years prior to that date, as the early output of the Ouray mines must have been large.

DIFFICULT OPERATING CONDITIONS

Many factors combine to make operating conditions difficult, the most potent of them being the extreme altitude and the steep slopes. The outcrops of many of the mines are above an altitude of 12,000 ft.; the rarity of the atmosphere makes manual labor difficult and inefficient, while the steep slopes render the use of ordinary means of haulage of ores and supplies expensive and necessitate the use of aerial tramways wherever natural conditions permit and the operation is large enough to stand the initial cost.

During the short summer season the climatic conditions are excellent, but the winters are long and severe and the snowfall heavy. The severity of the winters would be a minor factor if it were not for the extreme abruptness of the slopes which, with even a comparatively light snowfall, causes a great deal of trouble from snowslides. It is always difficult and often impossible to place mine buildings where they will be out of danger from this source, and the destruction of tramway towers and other structures is a constant occurrence. It is common for such large mines as the Liberty Bell and the Camp Bird to have to shut down for several months to allow reconstruction of buildings destroyed by slides, and with the smaller mines, especially those in the development stage, accidents of this kind are even more frequent. It is common practice to protect exposed tramway towers with huge barricades of logs anchored in place by boulders, the object being to split the slide into two streams which will pass on either side.

Any discussion of the mining costs obtained in this district, unless made by a man of extensive operating experience in this or similar regions, or else by one who has had access to such data as only these operators would possess, will be very incomplete and unsatisfactory. It is true that most of the larger companies render excellent reports to their stockholders, so that a study of the cost of these larger operations may easily be made. Such costs of going mines are interesting and instructive if properly presented, but are of comparatively little service to the examining engineer or to the operator who is dealing with the problem of working a partly developed property; sizing up such a proposition in this district calls for

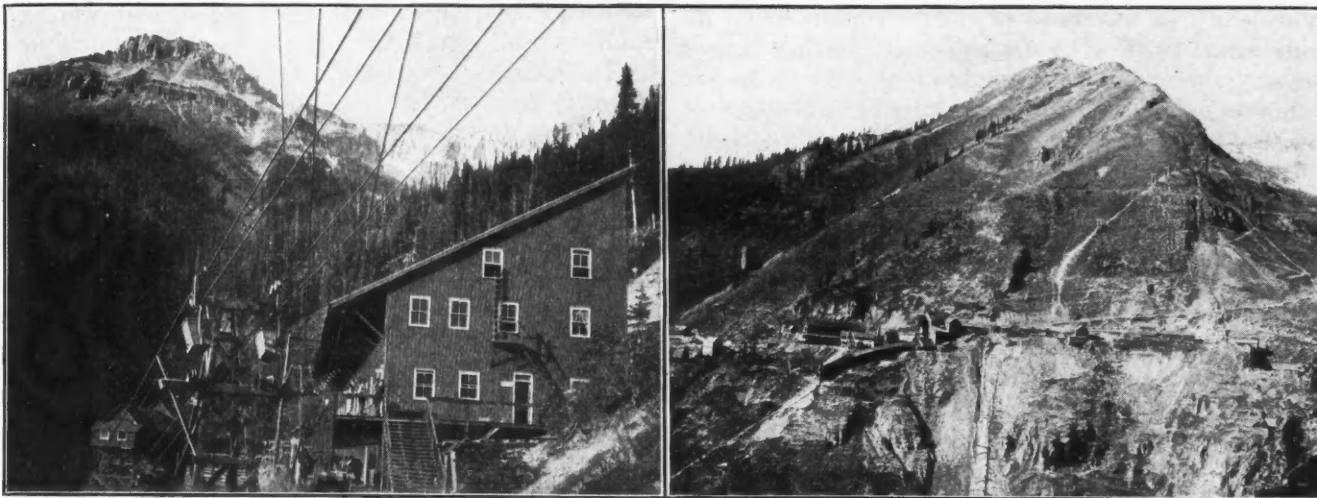
¹"Mineral Resources of the United States," U. S. Geological Survey.

much more knowledge and care than in those districts where conditions are less variable and severe.

The principal factors which make the average mining cost in this region higher than in most others are the effect of the altitude in decreasing the efficiency of workmen, and the transportation problem. Thus, although the price of labor per unit of time is not higher than in many other districts, the price per unit of work accomplished is conspicuously high. The transportation problem is serious in practically all cases, but makes itself especially prominent in the early stages of mining. The installation of a tramway to serve a mine of proved value is not a serious problem, as the original cost may be closely estimated in advance and the cost of operation forms only an inconsiderable item in the total costs. In the case of prospects or of mines where a tram is not warranted, this item of transportation has decided the fate of many deposits; a good illustration of how important this factor may become in such cases is furnished by the cost of the wagon road from Telluride to Savage

case, it would be instructive to know just what proportion of this extravagance is due to its London directorate, or as a complementary fact, just what proportion may be ascribed to local factors such as the high grade of ore and the exceptionally difficult operating conditions. When the mine was examined in 1900 for the London syndicate which was trading with the owner, Thomas F. Walsh, it was found² that \$2,535,000 worth of ore had been extracted at an average cost of \$6.50 per ton; the assured ore remaining was estimated at \$6,000,000, and it was anticipated that costs could be reduced to \$5.25 per ton by employing improved equipment. These estimates have been more than fulfilled as to tonnage and grade, but the costs have been \$10 per ton, and apparently the excess over the estimates was entirely due to the extra expense incurred as a result of operating the mine from London as compared with the performance of the thrifty local management upon which the opinion was based.

The actual figures as reported to the Camp Bird stockholders show that from the beginning of operations



TWO VIEWS IN THE RUGGED SAN JUAN COUNTRY

On the left the tramway terminal at the Liberty Bell and on the right a general view of the Smuggler Union, both at Telluride

Basin, which is 4 mi. long and was built by the county at a cost of about \$50,000. The frequency of snowslides is another factor imposing risks, and in this district the mine that does not have a certain amount of reconstruction to do every year is rare. This is often of more importance in causing loss by curtailing or stopping operations than in the cost of replacing the destroyed equipment, as the latter may be only a tramway tower or other structure which is comparatively inexpensive to rebuild, but weeks may be consumed in this operation, during which time the whole mine has to be idle.

The operating costs obtained at the larger mines in this district have been ably discussed by J. R. Finlay in his treatise on mining costs, and records for several of the mines during recent years are given by Skinner and Plate in their handbook on the subject. A factor that is generally admitted as having a pronounced influence on operating costs is the fact that some of the companies are owned by English capital and the broad features in the policies of mine development and operation, as well as the general administration of the work, are directed from London. The famous Camp Bird mine, for instance, is generally thought to have been extravagantly managed, but granting that such is the

in 1903 to the end of the fiscal year in 1915 there had been mined a total of 759,129 tons of an average recovered value of \$27.86 per ton at an average cost of \$10.44 per ton. To compare with this is the performance of the Liberty Bell mine, which is managed by an American company, extending over a similar period of years, namely from 1899 to 1913, during which period there was mined 1,397,168 tons of ore of an average recovered value of \$6.96 per ton at an average cost of \$5.17 per ton. It is interesting to note that this figure of cost is practically the same as that estimated for Camp Bird and so far this analysis certainly warrants the belief that the London management has been an expensive luxury for the latter mine.

However, the results obtained at the Tomboy mine, which, like the Camp Bird, is managed from London, and a comparison with those of the Liberty Bell lead to a negative conclusion and indicate that in this case the London management has at least secured as good results as the local. The Tomboy from the beginning of operations in 1899 to 1915 had treated 1,612,215 tons of ore of an average recovered value of

²Transactions of the International Engineering Congress, 1915; "Mining Engineering," p. 76.

\$8.40 per ton at an average cost of \$5.01 per ton, so that it had actually secured a slightly lower cost than the local management of the Liberty Bell on a grade of ore averaging over \$1 per ton higher; this latter factor becomes more significant when it is considered that the average profit obtained at the Tomboy was \$3.39 per ton, while that of the Liberty Bell was only \$1.82. External conditions at the two properties are probably about the same in spite of the fact that the Liberty Bell has a tramway, while the Tomboy mill is near the mine plant; but this comparison is probably somewhat unfair to the Liberty Bell, because its ore is not as favorable metallurgically as that of the Tomboy.

⌘

Ferrocerium and Other Pyrophoric Alloys*

The earliest methods of producing fire, as has been shown by archaeological research, were those employed in the Stone Age by the rapid attrition or striking of one piece of flint against another. Later on, the native disulphide of iron was found to produce copious sparks on being struck with a harder substance. Hence it was named pyrite or fire stone. Subsequently the tinder-box came into use. The production of fire by means of flint and steel is due to the combustion of the small particles which are torn from both the steel and flint. These particles become incandescent, owing to the heat developed by the blow and friction.

About the year 1903 Welsbach discovered that certain alloys of the rare earths, when filed, gave off showers of bright sparks which would readily ignite inflammable gases. It was subsequently found that the best results were secured when employing an alloy carrying about 65% iron. The same action takes place with these alloys as with the flint and steel, except that a spark is produced much easier than with the primitive tinder-box.

The mixture of certain earth metals, often called *misch* metal, consists mainly of the elements cerium, lanthanum, didymium, neodymium, praseodymium and samarium. All these metals are white to light yellow in color and not readily oxidized in the air. The commercial *misch* metal which has appeared in the market varies in character according to the manufacture. For example, the *misch* metal produced by one large German chemical manufacturer is quite soft, whereas that produced by another manufacturer using electric reduction is quite hard and often very brittle. The brittleness in most cases is caused by the presence of silicon as an impurity, which comes from the crucible in which the alloy is produced. Welsbach patented his discovery and for a time monopolized the market. Subsequently the German courts limited the operation of the patent and at one time threatened to annul it entirely.

The price of ferrocerium alloys when first produced was about \$60 per kg. Later this was reduced to \$12 per kg. and in 1913 to about \$4.60 per kg. The present return to the old price is, of course, due to abnormal conditions which have affected nearly all products.

While the original pyrophoric alloy (ferrocerium) manufactured by Welsbach contains nearly 40% iron, the competing products have only about 15% iron, and for the purpose of hardening, about 2% antimony or bismuth is

added. Silicon is, of course, found in nearly all ferrocerium alloys, because it is either contained in the raw *misch* metal as an impurity or has been absorbed from the clay crucibles in which the alloy is often produced. To produce a low-melting and smooth-casting pyrophoric alloy, certain manufacturers add about 5% copper. Various theories have been advanced to explain the pyrophoric character of ferrocerium alloys, and various authorities claim that it is due to nitrides, hydrides or suboxides. None of these theories has been substantiated, however.

Several alloys, interesting solely from a scientific standpoint, have been produced with mercury and platinum. The former is highly explosive. The latter alloy, when carrying about 25% platinum, possesses the greatest pyrophoric properties of any of the known cerium alloys; but, of course, on account of the high price of platinum, it is an alloy that could not be used in commercial quantities. A zinc-cerium alloy is especially suitable for the ignition of mine lamps. Cerium alloys carrying boron have also been recommended for a like purpose.

By the addition of 25% aluminum or magnesium to the cerium alloys, a very brittle metal is produced, which is readily pulverized. Inferior pyrophoric alloys containing high percentages of carbides are very unstable, and unless protected from the air by a film of oil, readily oxidize and become worthless within a few weeks.

The manufacture of ferrocerium is a task fraught with considerable difficulty. The raw material used is generally the waste from gas-mantle factories, which consume large quantities of monazite sand. After the extraction of the thorium from the sand, there is produced as a by-product what is known as rare earth residues or *misch* metal oxides.

Most manufacturers produce ferrocerium by the electrolysis of the anhydrous chlorides of cerium, lanthanum, didymium, etc. A good grade of mixed anhydrous chlorides costs, under normal conditions, about 70c. per kg. The fluorides of the cerium metals have not proved satisfactory, as they produce a thick, pasty metal in which the *misch* metal separates in a fine state of distribution and not in the form of a solid mass as in the case of the chlorides. For the production of ferrocerium by the electrolytic process, it is necessary that cheap current be available. Many manufacturers use ordinary graphite or clay crucibles with large iron cathodes. Others use water-jacketed iron crucibles.

In the early days of the industry, the small pocket lighters, in which the pyrophoric alloy was employed, contained only small pieces of metal weighing from 1/4 to 1/6 gram and these lighters were regarded more or less as scientific toys. At the present time there are two distinct types of lighters on the market, in one of which the pyrophoric alloy is fed in the form of a small stick against a hard steel wheel with a file-like surface. This wheel, when revolved, produces a shower of sparks, which are projected on a cotton wick impregnated with benzine or gasoline. The other type of lighter consists of a long strip of pyrophoric alloy against which a hard steel pin is struck, around which is wrapped an asbestos thread, which is kept saturated, when not in use, with gasoline in a small reservoir constructed in the body of the lighter.

The largest consumption of ferrocerium in the United States is for patent gas-lighters. In Europe, where the match industry is a government monopoly, the main consumption of ferrocerium is for cigar lighters.

*Extracts from "Die Verwendung der Seltenen Erden," by "Mineral Foote Notes," Foote Mineral Co., Philadelphia, Penn.

Flotation at the Magma Mill*

SYNOPSIS—The Magma ores are of different kinds, so that different milling processes are in use. The sulphide filming of oxide and carbonate ores is an intensely interesting feature. The gas method is used, and its system, results and costs are presented in detail.

The use of three different milling methods on the ores coming from one mine is somewhat unusual, but this is what is taking place at the Magma Copper Co., Superior, Ariz. The ores, as described by W. C. Browning, manager for the company, all occur in a porphyry-filled fissure vein. Three classes of milling ore are being mined, the first being a copper sulphide ore which contains varying amounts of bornite, chalcopryrite, pyrite and chalcocite, impregnated or ribboned through a gangue of altered, siliceous porphyry or altered diabase. The second is an oxidized ore from the upper levels of the mine, which contains malachite, chrysocolla, and at times a small amount of cuprite, native copper, chalcocite and covellite.

flotation. The 6x4½ Marcy mill, here used, was the first machine of this type installed commercially. Some early troubles were experienced from overspeed and too much pulp dilution. Since then it has given excellent service. The pulp density is now 60% solids and the revolutions, 22 per minute.

As first installed, flotation followed gravity, with Dorr tanks for thickening the feed in the interval. The principal defect of this arrangement was the large amount of pulp storage ahead of flotation, so that adjustment of the oil, when fed in the tube mill, could not be followed in the flotation plant. This was changed, and flotation was sandwiched in between the first and second tabling. The lower cells are still retained in operation as "gleaners." These gleaner cells, at the present time, contribute something less than 5% to the total recovery and take care of any irregularity in the operation of the main plant.

The distribution of labor is as shown in Table 1.

TABLE 1. LABOR DISTRIBUTION AT THE MAGMA MILL

	Total Men
Ore sorting and coarse crushing, 1 shift of 12 men.....	12
Table floor, 3 shifts of 2 men.....	6
Flotation, 3 shifts of 1 man.....	3
Filter presses and concentrate settling tanks, 3 shifts of 2 men.....	6
Shift bosses, 3 shifts of 1 man.....	3
Ore loaders, 1 shift of 4 men.....	4
Watchmen, 2 shifts of 1 man.....	2
Total operating.....	36
For repairs, general cleaning up, tailings-dam upkeep:	
Carpenters.....	2
Head repairmen.....	1
Repairmen helpers.....	5
Roustabouts.....	16
Sampler.....	1
Total.....	61

which gives 3.6 tons handled per man.

Distribution of Power:

	Hp.	Shifts.
Sorting plant.....	45	1
No. 64½ Marcy mill.....	45	3
5 x 12-in. tube mill.....	45	3
Concentrating machinery and miscellaneous.....	80	3
Flotation (15 cells).....	80	3
Pumping water.....	15	3
Total.....	6,720*	

which equals 22.8 kw.-hr. per ton.

* "Motor" horsepower-hours—not net horsepower-hours.

Ratio of water to ore in the tailrace is about 7½ to 1.

The mill was designed for 150 tons per day. On occasions it handles 250 tons per day. The original laboratory tests on this ore promised an 86% recovery on a 5.21 feed to the mill.

Part of the flotation concentrates are now settled by Dorr continuous thickeners and part in intermittent decantation tanks.

MAGMA ZINC-PLANT FLOW SHEET

The flow sheet, given in Fig. 2, is substantially the same as the one at the sulphide copper plant. The main difference is that a drag classifier is used in closed circuit with a Marcy mill instead of a Callow screen. This mill crushes to 48-mesh instead of 10-mesh, as in the sulphide mill. A 6-ft. Hardinge mill, used for the final crush, is loaded with steel pebbles. The final crushing is now to 150-mesh. The plant was designed for 50 tons a day, which it will handle with ease.

For commercial reasons, the plant is now temporarily treating about 75 to 100 tons per day of sulphide copper ore, with results that are fully up to the standard for the sulphide copper plant. The only change necessary was to change the launders to the tables handling the zinc

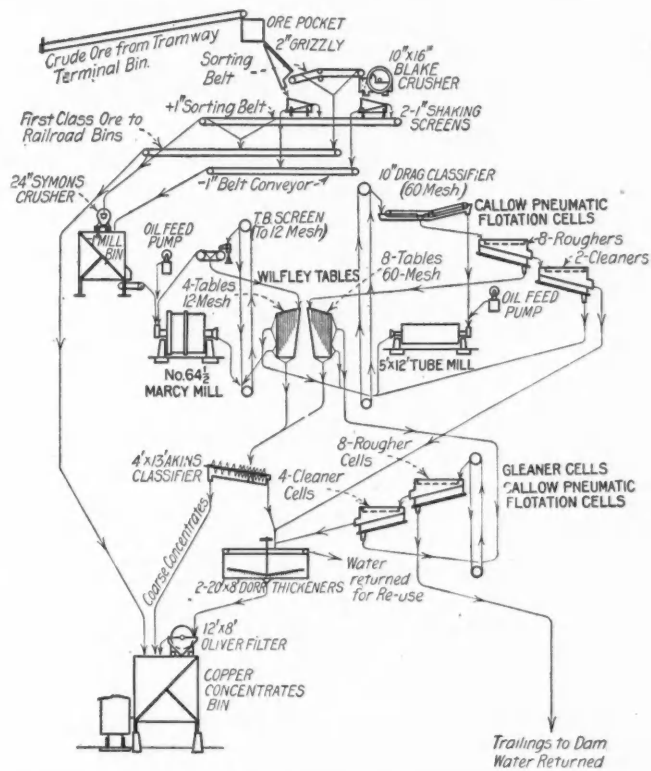


FIG. 1. FLOW SHEET OF SULPHIDE COPPER PLANT AT MAGMA MILL

This ore is an oxidized product of the sulphide ores. The third is a zinc sulphide ore, containing the black form of sphalerite, galena, pyrite and a small amount of chalcopryrite. This ore occurs in separate shoots from the copper ores. The gangue is usually a very siliceous, altered porphyry. Both copper and zinc ores usually carry an ounce of silver to the per cent. copper or zinc.

The accompanying drawing shows the flow sheet, which comprises a combination of hand sorting, gravity and

*From "Notes on Flotation, 1916," by J. M. Callow, a paper to be presented at the February, 1917, meeting of the American Institute of Mining Engineers

flotation concentrates. With the addition of the two more cells, it is expected to raise the tonnage to 150 tons per day.

This ore was first tested by the General Engineering Co. with a combination of roasting and magnetic separation, gravity and flotation. This gave excellent results, but the process was complicated and costly. Persistent experimenting with flotation eventually led to the present flow sheet.

TABLE 2. MAGMA COPPER CO., SULPHIDE MILL RESULTS

	October, 1916				Recoveries, Per Cent.
	Average Tons per Day	Assay in Total	Copper Oxides		
Hand-sorted ore.....	31.035	15.500		38.9	= 92.7%
Mill-feed.....	187.565	4.042		53.8	
Mill concentrates.....	50.670	13.165		7.3	= 88% of mill feed
Mill tails.....	136.895	0.660	0.11	100.0	
Crude ore.....	218.600	5.672			= loss

	September, 1916				Recoveries, Per Cent.
	Average Tons per Day	Assay in Total	Copper Oxides		
Hand-sorted ore.....	17.830	18.000		28.90	= 93.39%
Mill feed.....	188.590	4.173		64.42	
Mill concentrates.....	49.563	14.400		6.61	= 90.02% of mill feed
Mill tails.....	139.027	0.529	0.14		
Crude ore.....	206.420	5.672			= loss

TABLE 3. MAGMA COPPER CO., SULPHIDE MILL COSTS

	Costs per Ton Crude Ore	
	September	October
Ore sorting.....	\$0.2130	\$0.230
Coarse crushing.....	0.0879	0.150
Marcy mill.....	0.0790	0.087
Tube mill.....	0.0637	0.086
Callow screen.....	0.0143	0.010
Tables.....	0.1840	0.200
Flotation.....	0.3210	0.345
Filter pressing.....	0.0746	0.072
Total.....	\$1.0375	\$1.180

These costs include all items of direct labor, supplies, maintenance and power, but no general expense or overhead charges.

It was found that No. 34 gravity fuel oil in combination with General Naval Stores No. 17 oil had the property of floating the zinc in preference to the iron. These tests have been substantially duplicated in practice.

Some trouble was experienced at first in making both the desired grade of zinc and tailings. Frequent changes in the grade of ore and the percentage of iron and zinc, owing to unavoidable conditions at the mine, made it difficult at first to get the desired results. It was also found that returned water from the sulphide mill pond contained sufficient coal-tar products to float the iron, thereby reducing the grade of zinc. Trouble was experienced at first with the oils which had lost some of their volatile constituents, due to hot weather. After correcting these conditions, results steadily improved.

The use of a small quantity ($\frac{1}{10}$ lb.) of copper sulphate was decidedly beneficial, reducing the tails from 2 to 3% zinc without materially affecting the grade of the concentrates. Prior to the use of copper sulphate, acid was tried and, while it lowered the tailings, it also lowered the concentrates. The dilution was 6 to 1 and was an important item in maintaining the grade of concentrates. The cells were sometimes run in parallel and sometimes in series. No differences in results were noticed.

The mill proper was operated with two men per shift. As it was found necessary to operate the sorting and crushing plants only a few hours per day, no labor was employed here regularly; two men were taken from the crushing department of the sulphide plant for this work. Some iron and copper was hand-sorted at this plant and, together with the iron concentrates from the —150-mesh tailing tables, was shipped with the regular product of the sulphide plant. The intermittent settling system, as

indicated in the flow sheet, was decidedly successful, delivering a 70% solid feed to the filter with a clear overflow from the tank. A summary of results is given in Table 4, showing the difference in results with and without copper sulphate.

THE SULPHIDE FILMING PLANT

The process in use in this plant is covered by Schwarz' U. S. patent No. 807,501, which is the first disclosure of the use of a soluble sulphide for converting an oxide of a metal into a superficial sulphide, and afterward recovering it by a flotation process.

Earliest experiments were made with H₂S gas as the filming agent. A plant of 25 tons daily capacity was built. In this the gas was applied to the pulp by intro-

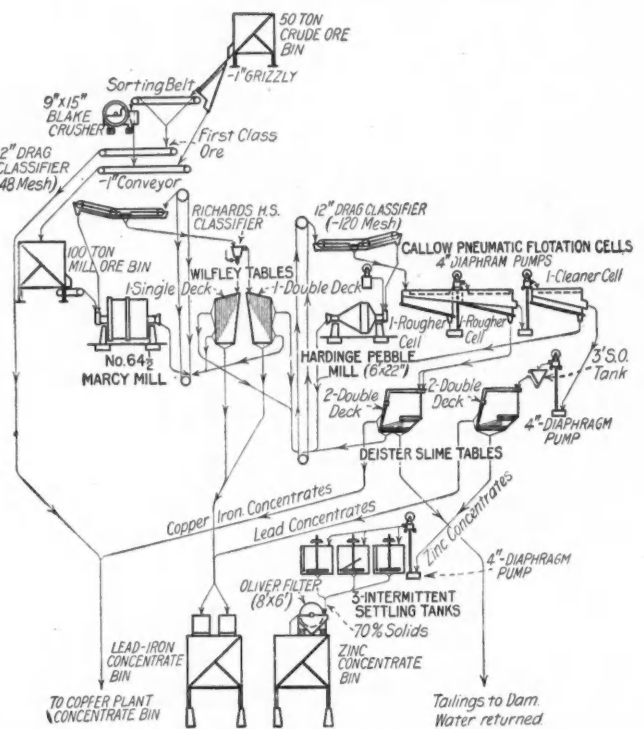


FIG. 2. FLOW SHEET OF ZINC PLANT AT MAGMA MILL

ducing it into the bottom of an open tank, having a mixing agitator. The results were encouraging, but the consumption of gas prohibitive—as much as 8 or 10 lb. per ton. The ore treated was the tailings of the Magma sulphide mill, which at that time carried considerable oxide. Occasional recoveries of 60% (of the total copper) were made, but the results were erratic owing to the difficulty of getting uniform filming of the pulp with this method of applying gas. Then followed an interval of several months when sodium sulphide, calcium sulphide and calcium sulpho-hydrate were used in an endeavor to avoid the use of gas, on the assumption that it was objectionable, owing to the danger of its poisoning the surrounding atmosphere. This was true when attempting to use it in an open tank, much of it being lost in the atmosphere. During this time a number of theories were advanced, exploited and abandoned. One of these was that natural and artificial sulphides could not be floated together, and that H₂S interfered with the flotation of the natural sulphides. Our experience now is that H₂S, in the proper quantity, really promotes flotation of natural sulphides in company with the filmed oxides, and also that it is im-

material whether the oiling is done before or after filming, either plan is merely a matter of convenience.

In treating Magma sulphide tails, in which the principal losses were sulphides, the introduction of the gas not only filmed the oxides present, a goodly percentage of

TABLE 4. MAGMA ZINC-PLANT RESULTS WITH AND WITHOUT COPPER SULPHATE

	Zinc	Iron	Lead
Without Copper Sulphate, Oct. 1 to 19, 1916			
Heads.....	15.38	7.80	3.89
Zinc concentrates.....	39.55	7.96	8.16
Lead concentrates.....	12.43	22.60	20.04
Tails.....	6.50	4.62	0.81
With Copper Sulphate, Oct. 20 to 31, 1916			
Heads.....	12.50	8.80	3.50
Zinc concentrates.....	38.50*	9.16	6.57
Lead concentrates.....	15.93	24.01	12.60
Tails.....	3.23	4.56	0.78

* The lower zinc concentrates in the latter period were due to lower heads and not to use of copper sulphate.

which was recovered, but it also raised an entirely new crop of refractory sulphides. An all-sulphide sample of regular Magma ore was tested with and without H₂S. The results are given in Table 5.

The commercial plant was shut down, and laboratory work was again reverted to, which resulted in the adherence to H₂S in preference to any other agent on this particular ore, and also to a complete change in the method of applying it. The plant was reconstructed, crushing machinery and more cells added in accordance with the flow sheet shown in Fig. 3, for the purpose of treating Magma oxidized ores on a commercial scale.

The gas method used at present introduces the gas into the suction of a centrifugal pump in the manner indicated in the flow sheet. This has proved effective, greatly reducing the gas consumption, giving more uniform recoveries, and has removed all danger from the poisoning of the atmosphere; in fact, the commercial results now being obtained date from the first use of this expedient.

TABLE 5. EFFECT OF H₂S ON NATURAL SULPHIDES

	Magma Sulphide Ore				
	No H ₂ S Gas	Heads	Tails	Concentrates	Recovery
Test 1.....	2.45	0.22	11.82	92.70	
Test 2.....	2.45	0.25	9.62	92.20	
Average.....	2.45	0.235	10.72	92.45	
With H ₂ S Gas to Excess					
Test 1.....	2.45	0.28	9.40	91.30	
Test 2.....	2.45	0.20	8.41	94.10	
Average.....	2.45	0.24	8.90	92.70	

The present method of making H₂S gas is to heat sulphur and oil in a retort. Various proportions of sulphur and oil have been tried, the present ratio being 1 of sulphur to 2½ of oil. The temperature in the retort is kept at a uniform 300° C. At times the making of gas has given considerable trouble, owing almost entirely to changes from time to time in the quality of the oil used. Satisfactory results have been obtained at all times with California crude oil, but Texas oil always gives trouble, making a gas containing what is believed to be hydrogen-persulphide, which interferes with flotation and can always be identified by its eye-burning properties. This is in a measure overcome by careful scrubbing, sulphur being precipitated in the scrubbers with free H₂S liberated.

Free gas in a pulp is fatal to flotation, hence the use of the blowing cell at the head of the first flotation cell. Experiments indicate that heating the pulp slightly before adding the gas is beneficial.

The cost of manufacturing the gas by this method will of course vary greatly according to local conditions. Those at Magma are abnormal. Sulphur is costing nearly

3c. today, and oil nearly 1c. per lb., f.o.b. Superior, and costs on a basis of 30 tons per day and maximum of 3 lb. per ton stand as follows: 90 lb. of sulphur at 2.74c., \$2.51; 225 lb. of oil at 0.914c., \$2.16; total \$4.77 = 15.25c. per ton, or approximately 5c. per ton for each pound of sulphur per ton required by the ore.

On Magma sulphide tailings the gas consumption varies from ½ to 1½ lb. sulphur per ton. On strictly carbonate ore assaying 3 or 4% copper, 3 lb. is an average figure, and on the latest test with a mixed carbonate and silicate ore assaying from 4 to 5% copper, 2 lb. of sulphur per ton. The fuel required for heating the retort is almost negligible. There are no cost figures since so far scrap lumber left over from construction has been burned for fuel. The labor item is unduly heavy, as the retort is situated about 600 ft. away and one man has to be held in reserve for the purpose. He could as easily make gas on one shift for 500 tons per day. With sulphur and oil

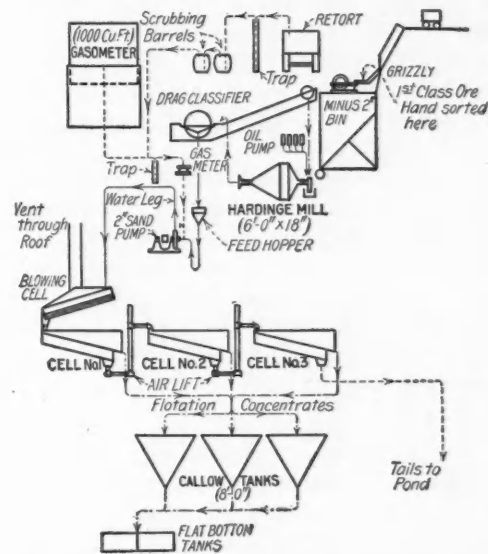


FIG. 3. FLOW SHEET OF SULPHIDE FILMING PLANT AT MAGMA MILL

at moderate prices on a 500-ton scale, using 2 lb. of sulphur per ton, an estimate of total gas cost is as follows: 1000 lb. of sulphur at \$45 per ton (2.25c. per lb.), \$22.50; 2500 lb. of oil at \$1.75 per barrel (0.436c. per lb.), \$11; 1 man at \$4; extra fuel for heating retort and sundry repairs, \$2.50; a total of \$40 per day. Thus the probable cost is 8c. per ton of ore, or 4c. per ton for each pound of sulphur required for the ore.

Other methods were tried—one using powdered coal in a separate retort instead of the oil mixture, and another in which the oil, instead of being mixed with the sulphur, was dripped into the sulphur retort with a force-feed lubricator. The usual iron-matte and sulphuric-acid method was also tried, but none of these had anything to recommend it over the one adopted. Iron matte was never seriously considered as a commercial possibility on account of the cost of acid.

The flow sheet given in Fig. 3 is self-explanatory. The 6-ft. by 18-in. Hardinge ball mill has a capacity of 35 tons per day when loaded with balls requiring 35 hp., or 45 tons per day when loaded up to 50-hp. requirements and grinding to 83% —150 mesh.

The power requirements are distributed as shown in Table 6.

TABLE 6. POWER DISTRIBUTION AT MAGMA MILL

1 6-ft. by 16-in. Hardinge ball mill.....	35 hp.
1 8 ft. by 14 1/2 Root blower, No. 1 (400 cu.ft. at 5 lb.).....	
1 7 by 14 Dodge crusher (1 shift only).....	20 hp.
1 2-in. centrifugal gasing pump.....	
1 4-ft. diaphragm pump.....	
1 10-in. belt drag classifier.....	
1 Oil feeder.....	55 hp.
1 Ore feeder.....	

This is the equivalent of 37.6 hp.-hr. per ton, or 28 kw.-hr. per ton.

The plant is operated by four men for the three shifts, the extra man on day shift crushing the ore and at the same time hand-sorting out any first-class ore there is.

MAGMA RESULTS SUMMARIZED

Table 7 gives the results of gasing the sulphide mill tailings, the feed in all these experiments being the feed to the lower cells, or gleaner cells, as they are described on the flow sheet. The soluble copper in these tests varied from 0.3 to 0.45%, and the average for the entire period was 0.35%. Attention is directed to tests Nos. 63A and 67, giving results on this feed without gasing; further comparisons of more direct kind are given in Table 9.

The results on strictly carbonate ore are given in Table 10, and on a mixed carbonate-silicate-sulphide ore, in Table 11. The latter tabulation gives a complete record and shows the contribution that hand-sorting makes to the total recovery. The carbonate results, for the most part, were on the rejections from the hand-sorting done at the mine, but in all these results the heads referred to are

actual mill feeds, and the effect of hand-sorting is therefore not shown. On the mixed ore, gravity tables on the flotation tails would have added considerable to the total recovery, but on the straight carbonate ores they would have served no purpose. The question of the use of gravity-concentration machinery on flotation tailings here receives some light, but not enough to permit formulation of definite rules.

TABLE 8. SCREEN ANALYSIS

Screen Size	Heads				Tails			
	% Indi.	Weights Total Cu	Assays, % Cu Oxide	% Sulphide Cu	% Indi.	Weights Total Cu	Assays, % Cu Oxide	% Sulphide Cu
+ 60	8.3	0.63	0.16	0.47	10.8	0.490	0.14	0.350
+100	25.6	0.77	0.29	0.48	25.6	0.420	0.21	0.210
+200	20.8	0.75	0.35	0.40	24.4	0.350	0.16	0.190
-200	44.8	1.32	0.67	0.65	39.2	0.310	0.17	0.140
Total..	100.0	1.00	0.44	0.56	100.0	0.368	0.17	0.198
Assay..		1.00	0.44			0.350	0.17	0.180

TABLE 9. EFFECT OF H₂S ON MIXED SULPHIDES AND OXIDES IN MAGMA SULPHIDE TAILINGS

No H ₂ S	Heads	Tails	Concentrates	Recovery
	0.86	0.67	9.86	23.70
	0.78	0.60	9.63	24.70
Average.....	0.82	0.635	9.74	24.20
With H ₂ S				
	0.81	0.30	5.05	67.11
	0.78	0.29	5.51	66.38
Average.....	0.79	0.295	5.28	66.24

In all these tests pine-tar oil was used, the tonnage rate was 25 per day and the sulphur consumption 1 1/2 lb. sulphur per ton of feed; the soluble copper was 0.3%. The concentrates "with H₂S" are rougher concentrates.

TABLE 7. SUMMARY OF RESULTS IN TREATING SULPHIDE MILL TAILINGS BY FILMING, MAGMA COPPER CO., SUPERIOR, ARIZ., 1916

Test No.	Concentrates		Tonnage		Oils, % C.T.C.	Weight F.O.	P.T.O.	C.P.O.	Retort Mixture		Remarks on Gas, Etc.	
	Heads	Tails	Recovery*	Rate					S	O		
56	1.10	0.64	8.25	12.10	65.0	60	40		23	77		
57	1.32	0.96	3.60	12.00	31.0	60	40		23	77		
62B	1.15	0.88	10.50	14.00	25.0	60	40		23	77	Excessive heat on old gas charge, test 57	
C	1.15	0.69	10.50	14.00	43.0	60	40		23	77	Moderate heat, 1st firing, 0.77 lb. S per ton	
63A	1.40	1.21	11.90	18.30	15.1	60	40		23	77	No gas used	
B	1.40	0.96	12.90	15.10	34.0	60	40		23	77	Same retort as 62C, 2d firing, 0.36 lb. S per ton	
C	0.74	0.58	5.10	8.40	24.4	60	40		23	77	Same retort, 3d firing, poor gas	
64	1.24	0.69	5.40	9.80	50.9	60	40		23	77	Gas from iron matte	
66	0.91	0.63	7.00	8.20	33.2	29.40	60	40	23	77	Gas from iron matte	
67	0.58	0.47	5.00		21.0	29.40	60	40	23	77	No gas used	
68	0.83	0.49	6.70	12.50	44.2	31.20	60	40	23	77	Slow continuous firing, trying effect of oils	
69	1.16	0.83	12.20		30.9		40	60	23	77	Slow continuous firing, trying effect of oils	
70A	0.94	0.34	7.90	15.10	67.1	28.80	55	36	23	77	Slow continuous firing, trying effect of oils	
B	0.66	0.37	5.00	15.70	58.1	21.60	60	40	23	77	Slow continuous firing, trying effect of oils	
71B	0.91	0.44	7.90	15.70	54.5	34.00	55	36	23	77	Slow continuous firing, trying effect of oils	
72	1.08	0.47	7.20	11.50	60.5	16.50			23	77	Slow continuous firing, trying effect of oils	
73	0.88	0.44	7.40	17.10	53.3	27.20	55	36	23	77	Slow continuous firing, trying effect of oils	
74	0.86	0.49	7.70		45.8	17.30	60	40	23	77	To try out different oil mixtures†	
75A	0.76	0.38	3.80	8.80	55.6	31.20	32	20	25	25	77	To try out different oil mixtures
75B	0.76	0.31	3.50	12.30	65.8	31.20	30	45	10	25	77	To try out different oil mixtures
75C	0.76	0.38	7.40		52.5	31.20	30	20	25	25	77	To try out different oil mixtures
76	0.80	0.47	4.10	17.20	46.6	31.20	30	45	25	25	77	Trouble with gas
77	0.69	0.29	3.80	12.00	62.6	24.15	30	45	25	25	77	Repetition under better conditions
78†	1.00	0.35	4.85	14.80	70.1	29.30	30	45	25	25	77	Repetition under better conditions
79	1.23	0.42	7.40	11.25	69.9	30.90	30	45	25	25	77	Repetition under better conditions
80	1.01	0.49	4.85	12.90	57.3	27.30					77	But with overheated gas

* Based on rougher concentrates only. † For complete analysis of heads and tails see Table 8. ‡ Pulp was already oiled, and additional oils had very little effect on results.
C.T. = coal tar. C.T.C. = coal-tar creosote. F.O. = fuel oil. P.T.O. = pine-tar oil. C.P.O. = crude pine oil.

TABLE 11. SUMMARY OF RESULTS IN TREATMENT OF OXIDE ORES BY FILMING AT MAGMA COPPER CO.

Description	Oct. 14 to 27, 1916				Nov. 1 to 10, 1916			
	Tons	Assay, % Cu	Contents	Recovery on O.F.	Tons	Assay, % Cu	Contents	Recovery on O.F.
Crude ore received for period.....	173.300	5.61	972.0	100.0	193.10	5.19	1,002	100.0
High-grade sorted out.....	3.772	22.70	85.6	8.8	10.98	26.35	289	28.9
Mill feed.....	169.528	5.22	886.4	91.2	182.12	3.91	713	71.1
Mill concentrates.....	31.300	16.90	592.0	60.9	25.30	18.70	474	47.4
Mill tails.....	138.228	2.14	294.4	30.3	156.82	1.52	239	23.7
Sum of high-grade and concentrates	35.072	19.30	677.6	69.7	36.28	21.06	763	76.3
Mill ratio.....			5.4 to 1				5.02 to 1	
Mill recovery.....			66.5%				66.5%	
Sulphur consumption per ton crude.	4.66 lb. per ton.	High consumption due to faulty oil used. Figure therefore of little value.			2.06 lb. including all line losses and leaks			
Oil consumption per ton crude.....					5.2 lb.			
Flotation oils used.....					Coal tar			
					Coal-tar creosote			
					G.N.S. No. 17			
Composition of heads.....					Carbonate.....	2.110		
					Silicate.....	0.865		
					Sulphide.....	1.490		
		Total Cu..... 5.22				Total..... 4.460 (3.91)		
Approximate screen analysis of crushing.....								
					+150 = 13.6%			
					-150 = 86.4%			

No tables were used in this flow sheet. The results would have been improved if there had been.

The arrangement of plant did not permit of cleaning the filmed concentrates. The concentrates "no H₂S" were cleaned in the regular way.

TABLE 10. SUMMARY OF RESULTS IN TREATMENT OF OXIDE ORE BY FILMING AT MAGMA COPPER CO.

Date	Test No.	Tonnage Rate	Heads	Tails	Concentrates	Ratio	Recovery
July 8	150	35.00	2.78	0.86	9.50	4.50	75.94
July 9	151	30.00	3.15	1.06	9.72	4.18	74.31
July 12	154	26.00	2.92	1.17	7.02	3.34	72.00
July 13	155	30.00	3.24	1.22	11.66	5.16	69.72
July 14	156	33.00	2.92	1.35	10.26	5.67	61.94
July 15	157	28.00	2.92	1.08	8.21	3.89	72.27
July 16	158	28.00	2.75	0.83	8.30	4.14	77.25
July 18	159	30.00	2.99	0.70	8.32	3.32	83.78
July 20	161	30.00	3.08	1.08	9.18	4.05	73.62
July 23	164	31.00	3.92	1.62	10.80	3.95	69.76
Average		30.33	3.06	1.09	9.34	4.22	73.08
Aug. 9	175	25.0	3.04	0.71	14.85	5.41	80.49
Aug. 10	176	30.0	3.63	0.81	16.07	5.40	81.82
Aug. 11	177	27.0	5.46	1.25	17.36	3.82	83.22
Aug. 12	178	25.0	5.46	1.80	22.74	5.72	72.81
Aug. 13	179	27.0	5.12	1.43	16.80	4.17	78.68
Aug. 14	180	25.0	5.04	1.85	16.91	4.72	71.09
Aug. 17	181	25.0	4.23	1.62	18.48	6.46	67.64
Aug. 18	182	25.0	11.66	2.65	26.50	2.65	85.76
Aug. 19	183	25.0	6.73	2.67	22.26	4.82	68.62
Aug. 20	184	25.0	8.35	2.45	20.67	3.09	80.12
Average		25.9	5.87	1.72	19.26	4.63	77.025
Sept. 25	185	28	4.90	1.33	14.8	3.77	80.0
Sept. 27	186	27	5.50	0.79	17.8	3.61	90.0
Sept. 28	187	30	5.00	1.50	18.1	4.74	76.4
Sept. 29	188	25	3.10	0.61	13.9	5.30	84.7
Sept. 30	189	24	2.80	0.54	13.2	5.60	84.1
Oct. 1	190	23	2.30	0.58	15.1	8.40	77.8
Oct. 2	191	24	2.40	0.68	14.4	8.00	75.0
Oct. 3	192	27	2.60	0.41	14.3	6.30	86.0
Oct. 3	192	27	2.70	0.36	14.9	6.20	89.2
Oct. 4	193	26	3.60	0.61	10.3	3.60	89.6
Average		26	3.49	0.74	14.68	5.55	83.28

Best result in July tests were obtained with a consumption of about 4 lb. sulphur and 10 lb. fuel oil per ton feed. Sulphur consumption on tests 181 to 184 inclusive was 6 lb. per ton. In the other August tests a minimum of 2.25 and maximum of 3 lb. per ton. The September and October results were obtained with a sulphur consumption of 2.8 minimum and 3.5 maximum per ton.

Leadville Mineral Production in 1916

LEADVILLE CORRESPONDENCE

The output of the mines of the Leadville district for 1916 as compared with that of the previous year is given in the accompanying table.

LEADVILLE MINERAL PRODUCTION

	1915	1916
Gold, oz.	115,121	85,933
Silver, oz.	2,733,646	3,101,376
Lead, lb.	18,534,052	23,772,485
Copper, lb.	2,254,268	2,925,280
Spelter, lb.	74,208,015	73,308,833
Manganese, tons.	6,250	11,360

The average value of ore extracted during 1916 was approximately \$35.40, an increase of \$6.15 per ton over the previous year. This is due to a smaller tonnage extracted in 1916 and to the marked increase in the prices of silver and copper.

Mining activity in the district in 1916 was marked by the entrance of a number of strong companies new to the territory and the expansion of several of the pioneer operators. The United States Smelting, Refining, and Mining Exploration Co., The Down Town Mines Co., The Empire Zinc Co., The Iron Silver Mining Co., and the Western Mining Co., were responsible for a number of large drainage projects launched and completed during the year. They unwatered a great part of the central district to considerable depth, and opened for development an immense area known to be rich in deposits of lead, silver, zinc, iron, and manganese ores. These companies now control extensive tracts of valuable ground which previously was either idle or under lease to small concerns that were unable to thoroughly develop it. Elaborate plans for the exploitation of these areas have

been outlined by the new operators, the carrying out of which result in the discovery of many new large orebodies.

The most interesting feature at present is the sinking of the Jamie Lee shaft on Fryer Hill by the Leadville Unit of the United States Smelting, Refining, and Mining Exploration Co. This section is famous for the great wealth it produced during the early days of the district, when, it is stated, the mine dumps were green with silver chlorides found almost at the grass roots. Following this period of great production during which developments were confined to the upper contact, Fryer Hill has been practically neglected. A heavy flow of water throughout the section was a barrier against deep mining so the parting quartzite was never pierced. The Leadville Unit has drained the area and is now sinking the Jamie Lee shaft an additional 300 to 400 ft., a sufficient distance to cut the white lime and permit drifting from the shaft under all the ore-bearing formations. This lower zone, the second contact, is the most alluring mining opportunity in the district and should it prove as rich in mineral as the formations exploited above, Fryer Hill will again be the cause of another history-making epoch in the Leadville district.

The discovery of an 8-ft. vein of high-grade silver ore in the old Bartlett tunnel on Sugar Loaf was one of the important events of the month. The vein was reached by drifting from the bottom of a 60-ft. winze put down from a point near the breast of the main tunnel which is 1700 ft. long. Assays taken from the vein showed the entire face of ore to average about \$200 per ton. Seams of ore on the walls of the vein about 2½ ft. wide contain quantities of ruby and wire silver. The center of the vein is talc assaying 41 oz. silver.

The discovery was made by the Prince of Wales Leasing Co., which has been operating the property for several months. An electric hoist is now being installed at the collar of the winze and preparations are being made to maintain a large production of the rich ore.

The old Fortune mine in South Evans gulch, famous in the early history of the district, is the scene of a rich strike recently made in the deepest workings of the mine. The bottom of the Fortune shaft is at the level of the Yak tunnel which passes through the property at a depth of 1000 ft. Until recently, no work was done in the mine below the tunnel. Last fall, several blocks extending under the tunnel level were let out on lease and a winze was put down 70 ft. Drifting from the bottom the main Fortune vein was encountered and exposed a breast of ore assaying \$95 per ton, in lead, copper, silver and gold. The vein was cut on the hanging wall which is now being stripped preparatory to blocking out the ore. An electric pump is being installed in the winze to handle the flow of water expected as soon as the work of cutting through the vein is started.

The Fortune vein where it was developed in the upper workings of the mine was one of the richest and largest ore shoots in that section. Gold ore assaying as high as 600 oz. per ton is said to have been extracted. James McNeece, owner of the mine made a fortune from it in the early days prior to the advent of the Yak tunnel. Draining at that time had to be accomplished by pumping and was very costly, and McNeece, closed the property. It had been idle for years until reopened in 1915. It was put on the leasing system last summer.

Symposium on the High Cost of Mining, Milling and Smelting

At the December meeting of the Mining and Metallurgical Society of America, the subject, "How and why do present conditions affect the cost of mining, smelting and milling," brought out many interesting and some very unexpected facts as to present conditions and the readjustment that will come when peace abroad is restored.

UNITED STATES SMELTING, REFINING AND MINING CO.

Sidney J. Jennings, vice-president of the United States Smelting Refining and Mining Co. said: The mining of ore in the United States is done almost entirely by foreigners. In the mines with which I am connected, 27 different nationalities are represented. In some mines, especially copper mines, Spaniards are in the majority; in others, Finns predominate for running rock drills, while shoveling and pushing cars is done largely by Austrians, work on the surface being done mostly by Greeks.

The breaking out of the war called to the armies of the different nations those, at least, who were sufficiently patriotic to want to be called. There are still undoubtedly a number of foreigners working in this country who, during the past two and a half or three years, have accumulated large sums of money. They do not spend much, their families are not here, and consequently they accumulate money. The wages in the mines with which I am connected have been advanced in order to keep up with what we might call the scale advance, that is, in proportion to the price of copper, so that wages paid to miners are now about 60% higher than they were three years ago. As wages constitute approximately two-thirds the cost of mining, the actual cost of mining has increased very largely from that factor alone.

COST OF SUPPLIES ADVANCED AS MUCH AS COST OF LABOR

The price of all supplies, owing to the insistent demand for materials which enter into the manufacture of explosives, fuse and all machinery, has increased very largely. For the first year and a half of the war, our supplies were delivered to us on contracts which had been made before the war broke out, and the increase in their cost was not felt by the mining companies until the expiration of those contracts. At the present time, I should say, the cost of supplies has certainly advanced as much as the cost of labor. Now, that increase has occurred not only in the cost of mining, but in all industries, and the miner now has to pay, for his food and clothing and rent and transportation, an increase proportionate to his increased wages; but of course his capacity for saving has likewise increased in proportion, so that all his increased wages have not been consumed by the increased cost to him. Taking a very broad view of the situation, it appears to me that the United States has financed a rise in price of all commodities, including labor, and that this prosperity, which is so apparent at present, will probably not remain with us, because the reducing of the price of all things will be accomplished with so much greater difficulty than the raising was accomplished, the wealth accumulated in this period of prosperity will be absorbed in that period of depression. It will need our best effort and our most careful study how to economize in the use of

labor, especially, and in consumption of supplies, if we wish to retain in this country some of the prosperity which has been so apparent in the past two years.

In Pachuca we have operated continuously during all this period, on more or less of a scale. In April, 1914, we took out all our American employees in Pachuca, and left the mines in charge of one of our Mexican officials, together with two Englishmen. During that period the pumps were kept working and development was carried on; one of the mills was run for the whole period and part of the time two of the mills were run, so that actually the expenses were met by the product of the mine. Then our American managers returned in October of that year and during 1915 we operated with difficulty, mainly in obtaining supplies such as cyanide and dynamite. Every once in a while there would be difficulty with the American government about exporting dynamite to Mexico, and of course there were times when the Mexican factory couldn't supply any dynamite at all because it was in possession of the opposing faction.

Pachuca has been under Carranza most of the time since he has obtained the upper hand in Mexico. In June 1916 all our Americans came out, leaving the property in the hands of two Englishmen; one mill has been operating continuously with the exception of about six weeks when we had no cyanide.

MONETARY DIFFICULTIES ADD TO MEXICAN TROUBLES

The difficulty has become acute in the last six weeks or two months, from the fact that there is no circulating medium to pay our men or to pay for our supplies. Mexican laborers absolutely refuse to accept paper money of any kind. The Carranza government passed a decree that you should pay 50% of the wages in paper and 50% in metallic currency, at the normal rate of wages which prevailed before the outbreak of revolution—"stated in terms of Mexican gold." When the laborers realized that they were getting only 50% of their former rate of wages in metallic currency, and the balance in something that wasn't worth anything, they struck and started rioting, about a thousand shots being exchanged between the guards and the rioting laborers. It was explained to the men by the government officials that that was the decree and that the company could not pay differently, although it was willing to do so. Then when it was learned also that the stores would have to accept payment for their goods half in metallic currency and half in paper money of no value, the workmen quieted down, but until there is some form of circulating medium that the people can accept there is going to be trouble.

One of the difficulties that confront the Mexican government, of course, is the fact that a Mexican dollar (*peso*), considered as bullion, is worth 59c., instead of 50c. as it is stamped. In other words, when you coin a *peso* you take 59c. worth of silver, put it through a mint, make a coin and stamp it, and it loses 9c. in value. Now, no government, however rich, can continue that practice for an indefinite period of time. The Mexican government, in order to get around the difficulty to some extent, created a half dollar which is 800 fine, but even that,

at present price, is worth slightly more as bullion than it is as a half *peso*; some financier will have to get up a scheme for a circulating medium that will be effective, which will be satisfactory to the laborer, and will not cost the government too much.

The question of obtaining supplies in Mexico, especially cyanide, is an extremely difficult one. The sources of cyanide previous to the outbreak of the European War were Germany and England. The source of German supply is absolutely cut off and the English supply is completely absorbed by the English companies in South Africa and Canada. All other raw material that would go to make cyanide is utilized for the manufacture of powder. In the United States, they have started a plant to make sodium cyanide, but great difficulties have been encountered because the firm has been placed on the blacklist of the English government, and consequently cannot get power from Canada, and is deprived of a lot of things. An American company has recently started manufacturing cyanamide, which contains the equivalent of 20% of potassium cyanide, and the officials think they can manufacture that at such a price including freight, that we can afford to use it. Experiments have been made, which show that the percentage of carbon in it is not detrimental, because when it is dissolved the carbon settles to the bottom, and after filtering you have a solution which is as efficient in the dissolving of silver and gold as potassium cyanide. Dynamite, of course, is one of those supplies with which we have continual difficulty. We have solved that by operating two special trains, the locomotives and cars of which we have borrowed from American railroads and bonded, which we run to our works in Pachuca, and they are returned with the same engines, crews and cars to the United States.

NEW JERSEY ZINC CO.

George C. Stone, of the New Jersey Zinc Co., much to the amusement of his hearers, began: I think that we zinc men have been some of the worst sufferers in the last two years. There have been compensations sufficient to make up for the large increase in labor costs, but aside from this we have suffered severely from the scarcity of skilled furnacemen. Good spelter men are always scarce, and when the smelting capacity of the country was doubled in a very short time, the lack of experienced men was severely felt. Owing to the shortage, they could get practically what they asked for and they asked frequently. We found considerable difference in the amount of trouble involved in obtaining suitable men in different parts of the country, depending on the proximity of other smelters. The southwest, where the works are numerous, close together, and were rapidly increasing their capacity, was the worst point. The Mississippi Valley, where there are fewer works and less expansion, was not so bad, and in the east, where there are no other spelter works, our only trouble was due to the general shortage of labor.

The scarcity of skilled labor has been a much more serious matter than high wages, the latter being compensated for by the high price of the product. Spelter furnacemen, like poets, are largely born and not made, and the presence of a large proportion of men who do not know the business tends generally to poor work, both in recoveries and in quality of the product. Owing to the labor shortage, the men were very independent and it has

been impossible to enforce discipline. The men did not care if they were discharged as they knew they could go to the next works and get an equally good job at the same pay. It is impossible to state in dollars and cents the loss through poor and careless work, but it is very large and is likely to continue for some time after the conditions that have caused it are removed. It is much easier for the men to do things in a careless way which causes losses in recoveries and quality, and it will take a long period of hard times to make them again take proper care. The success of spelter work depends more on the individual care and skill of the men than in almost any other branch of metallurgy, which is my reason for saying that we have suffered more than others.

AMERICAN SMELTING AND REFINING CO.

H. H. Alexander, manager of the American Smelting and Refining Co.'s lead plant at Perth Amboy, N. J.: In common with other metallurgical operations, lead refining has had to stand heavy increases in price for all items entering into the cost of operations. The increased cost may be divided into two classes: Labor, and supplies and material.

Labor has been given increases varying from 20 to 50%, common labor getting the greater amount. Usually when such increases have been made, there has been more or less increase in the amount of labor performed. I think it has been the usual experience that where wages have been increased there has been a corresponding improvement in performance; but this has not been the case in this instance. On the contrary, there has been a decided falling off in the amount of work done. Without attempting to explain this condition, the fact remains that the employers of common labor have found it to exist, thus making it an important factor of cost. Our experience with common labor shows a decrease in efficiency of between 25% and 30%. As 40% of the cost of labor in lead refining comes under this classification, it makes the expense more than the increase would indicate. This criticism does not apply to the steady labor, furnacemen, helpers, and that class, who have been long on that particular job. They are doing as much as ever.

Another factor which adds to costs is a shortage of labor. We estimate the supply at somewhere around 80% in our vicinity. That is, if each employer had all the labor he desired to do his work, we would absorb 20% more than we have. This means that something is left undone and has to be done when you can get around to it, which naturally increases cost all along the line.

The second cause of increase has been due to the higher prices for material. This can be shown best by the following list of the increases.

Material	Comparative Increase, %
Firebrick	50
Common brick	30
Magnesite brick	300
Iron	45
Steel	80
Castings	45
Crucibles	135
Retorts	265
Nitric acid	35
Sulphuric acid	30
Zinc	170

In the softening, cupelling, and refining processes themselves, there are no particular items other than those previously mentioned which have risen in cost, except fuel. The desilverizing operation has been hit particularly hard by the advance in the price of zinc. There is

a fixed loss in refining of between 12 and 13 lb. of zinc per ton of lead, through saturation.

Moreover, the cost of kettles has followed the upward trend of iron and steel prices. Retorts made of American clay cost over three times as much as those formerly in use, made of foreign clay, and do not show the same length of life. This disadvantage of short life is being improved and we have no doubt that eventually we shall obtain as long life from the American article as formerly from the imported one. At one time we contracted for all retorts on a given life, and if a retort did not last that long a certain deduction was made. The last retorts we got are lasting about 75% as long as old retorts, but they are improving right along. The bags now being used cost 100% more and are not so durable as those formerly obtained for half the price.

The higher cost of operating reverberatories has been due to the higher cost of common labor. The transfer of material to and from these furnaces is done by this common labor, which has received the increase.

Summarizing the various increases in cost, the expense of lead refining today is 50% more than formerly.

UNITED STATES METALS REFINING CO.

F. R. Pyne, assistant superintendent, United States Metals Refining Co., Chrome, N. J.: In connection with copper refining, we have likewise suffered a large increase in the cost of operation. Inasmuch as Germany and Austria consumed a large part of our production, it seemed wise to the producers of this country when the war in Europe started to cut the production approximately in half, so that in a few months the refineries were desolate looking places. The ore trade with the west coast of South America went all to pot, largely on account of the monetary situation. Then the tremendous demand for copper by the munition makers started and everybody began to ship to the refineries everything resembling copper. Although it had never been thought possible that the smelters could overship, the plants very soon began to resemble large stockyards. Everybody had copper and ore piled up. So we immediately decided to enlarge, but when it came to letting the contracts we couldn't get any deliveries under six to nine months, but we are finally getting out of this hole and pretty soon we hope to have the situation in hand. The accumulation of these stocks has resulted, naturally, in a tremendous interest charge; then labor, which, has advanced anywhere from 30 to 60% in price and lowered 20 to 30 and 40% in efficiency, has also boosted costs sky-high. In fact, I should say where formerly we could get a piece of work done with a thousand hours of work, it now takes twelve or thirteen hundred to get the same thing done. That occurs in handling, more than anything else. The men on the furnace are still doing their job about as they did, although one remarked, when we were trying to speed him up, that this is 1916 and not 1914, and if we didn't like it he'd go next door and get another job.

The price of supplies has gone kiting, as a natural consequence of the labor situation, and there is a marked falling off in the quality of the materials. Refractory material has not only gone away up in price, magnesite and chrome brick going up 300%, and not to be had, but the quality of silica brick and clay brick has absolutely gone to pieces, resulting in additional furnace repairs, and loss of production from having to shut down the furnaces more often than in the past.

A big factor in the rising cost is the tremendous increase in the value of metal losses. These have been reduced in past years to a very low figure; we were gradually getting them lower and lower as years went by; but when the price of copper is doubled and the price of silver increased by 50%, it can be seen that the value of metal losses has gone away up in X, without any prospect of its coming down until prices fall.

Another thing that has helped to increase costs is the transportation situation. The railroad gives cars if it feels like it; if it does not feel like it they are not to be had, and that necessitates putting copper into stock and taking it out again, where formerly it was put directly into cars. The question of lighterage is similar, and at times barges cannot be had at all. Also, the frequent embargoes that the railroads have placed have disorganized things to a greater or less extent.

With conditions as they are at present, I do not think the demands for labor are satisfied. In fact, raises seem to be coming along as a regular performance, and I imagine they will continue for the months to come. Most of the refineries here employ Hungarians, Poles, Austrians and other Europeans, a great many of whom have signified their intention of going back to their countries when peace is declared, to see what has happened over there. A great many of the steamship companies have been flooded with applications for reservations on the first steamship leaving for Europe. If they are going to leave in such great numbers as is indicated, it does not look as though the labor situation is going to improve, and I expect that we shall be faced with high costs for a long time to come.

PHELPS, DODGE & CO.

Walter Douglas, vice-president of Phelps, Dodge & Co.: I have tried to prepare some figures that might be regarded as comparative and would show the effect of increase in wages and supplies on the cost of copper. The conditions surrounding our operations have been so abnormal during the last three years that the result of my investigation has been extremely unsuccessful. We are operating four producing properties, three in the United States and one in Mexico, and I have been unable to reconcile the operations this year with those of 1914 and 1915 so as to arrive at any comparisons that might be regarded as of interest.

In the case of Bisbee, where we have what is called a "white camp," that is we employ American or Northern European labor underground exclusively, our wages in 1916 have increased over the 1914 scale by 48%, the average wages paid underground in 1915 having been \$5.35 while the miners wage, December, 1916, based on the price of copper for the month of November, is \$6.12. We are, and have been for two years past, operating on a sliding scale. We take 14c. copper as the base rate, and on that base the miner receives \$3.75 per day, and the mucker and mule skinner \$3.50. For each cent increase in the price of copper wages rise 12½c. per day, so that our increase in wages in 1915 was 13% over 1914, and 48% in 1916.

Strangely enough, our costs have not increased in anything like the proportion that would be expected by these additional wages. Probably this is due to an improvement in efficiency and to a very small reduction in overhead, through increased production. We show little or no marked increase per ton of ore in the cost of supplies,

which may be ascribed largely to the main items which enter into such an account which were contracted for prior to the war and cover a period of years. This is especially true as to fuel, and largely as to mine timber, etc. Explosives have increased greatly in price.

When we consider the Morenci district, where we work Mexicans, Spaniards and Italians underground, we encounter a condition which forbids comparison. We were there tied up with a strike from August, 1915, to March, 1916, and after resuming operations we had the mines to pump out and the concentrator and smelters to overhaul, so that with such extraordinary expenses all comparisons are useless. Here, our wage scale has increased 70% over that in force in 1914; the average wage of the underground man for 1916 has been \$4.15, and the December wage approximately \$4.60.

In our Mexican mines, again, comparisons are impossible. We there carry an additional burden, due to the high selling price of copper, in that, in order to meet the extraordinary expenses of maintaining the present army in Mexico, the Carranza government has enforced a high export tax, varying according to the selling price of the metal. This tax, which is in addition to any other tax paid before, amounts at present to about 2.6c. (gold) per pound of copper. The concession under which we operate provides that we shall be permitted to export copper free of all duties, although we are required to pay taxes on the export of precious metals. The cost of labor has also increased enormously, as the state government requires that wages now be paid in silver, as it was found impossible to induce the Mexican laborers to accept the depreciated paper currency of the country. We have also been required, by decree, to put all classes of labor on an 8-hr. day basis, which has likewise increased operating costs.

WAGE SCALE BASED ON MARKET

As to the question of adjustment of wages after the war there is, I daresay, a variety of ideas as to what will happen. On only one occasion have we had to meet the problem of lowering the wage scale on account of a drop in copper, and that occurred last July. We had been paying on a 27c. market, and in July the price dropped to about 23c.; in fact, there were no sales of any considerable tonnage of copper through the months of June and July, and such sales as were made were at a sacrifice. Therefore, in August, our men had to take a cut of something over 50c., and they took it; there was no kick at all. They were very familiar with this sliding scale of wages. In 1914, when copper dropped to 11c. or lower, we then cut the base rate by 10%. Miners had been getting \$3.75 and muckers \$3.50, and they accepted a 10% reduction without any objection at all; it was a question of taking that or shutting down.

Another condition presents itself in our Western mining camps; a heavy drop in the price of copper means that production is restricted. We cease to work low-grade ores that are profitable only at a high price for copper, and a large number of men are necessarily thrown out of employment. Probably when the war ceases there will be a period of readjustment when the price of copper will be rather low; but I believe that when the price does drop it will drop fast, entailing a partial suspension of operations in many cases, absolute suspension in others, and very material curtailment in the whole industry.

This will result in throwing a great number of men out of employment, and a man who wishes to hold his job will accept the agreed wages when copper falls to the base figure.

Eli T. Conner, mining engineer of Philadelphia: In my work the last two years in remodeling anthracite coal breakers, enlargement of power plants, installation of pumping equipment, etc., "recent conditions" have increased the cost of all improvements mentioned about 65 to 79% over the costs of 1915, and about 90% above similar installations in 1914. Not only has material of all kinds greatly advanced in price, but labor also has gone up and the work day has been reduced from nine to eight hours. The general efficiency of working forces has decreased more than one hour per day.

MIAMI COPPER CO.

J. Parke Channing: The only property which I am actively operating is the Miami Copper Co., and the conditions are very similar to those represented by Mr. Douglas. Our labor is on practically the same scale, except that at 14c. copper our base is \$3.50 and advances 12½c. for each cent increase in the price of copper, so that at present we are paying about \$5.50 a day. I should say, roughly, that, as compared with the early part of 1914, our labor cost has advanced 55%. The efficiency of the labor has not increased, nor has it fallen off, so that the tons per man per day remain just about the same as they were in the early year of 1914. We are not particularly short of labor, although it is rather difficult to get good machine men.

Powder has advanced, about 50% and in the last few months timber has gone up 15%. Our power is derived from burning fuel oil and we fortunately have a long contract, so that the price of that article has not advanced. In fact, if anything, the cost per kilowatt-hour in our power plant has been reduced from 1.1c. to 0.9c. per kilowatt-hour, because of certain modifications which we made in our engines so as to be able to run the three of them continuously. Previously we have operated two and kept one as a spare.

For 1916 the cost of copper will not be very much in excess of 1915. The cost of our copper in 1915 was about 8½c. a pound and I think that for 1916 it will be in the neighborhood of 9c. a pound, or only half a cent increase, notwithstanding this increased cost of labor, powder, timber and the various miners' supplies.

The principal factor which has held down our cost has been the increased tonnage, which has reduced overhead expenses per ton of ore, both actual overhead expenses and also in underground work, because the same number of foremen are able to supervise a larger number of men.

For purposes of comparison I have taken the two months of November, 1915, and November, 1916, for the reason that the grade of ore was very nearly the same. I can hardly give any credit to improved metallurgical conditions, because although flotation has helped us out some, we were using flotation in November, 1915, although probably not so efficiently as we are doing now, but I think the amount of oxidized copper in the ore is now slightly in excess of what it was in 1915. In the month of November, 1915, we treated but 130,000 tons, whereas in November, 1916, we treated 170,000 tons; that is, 40,000 tons more. The grade of ore in 1915 was 2.18%; in 1916 it was 2.13%. The net pounds of copper

extracted per ton of ore, after allowing for smeltery losses, were 30.9 lb. in 1915 and 30.3 lb. in 1916, so metallurgical returns are nearly the same. The production of 1915 was 4,011,242 lb., whereas in 1916 it was 5,141,000, giving, of course, a larger divisor. Mining in 1915 was \$1.04 per ton and in 1916 it was \$1.14, an increase of 10c.

I have divided, for these months, the cost of mining between labor and supplies. In November, 1915, the labor cost per ton was 55c. and the supply cost was 37c. In 1916 the labor cost was 74c., very nearly a 50% increase, whereas the supply cost has gone down to 26c. That reduction in the supply cost is due to the fact that we are drawing much more ore from shrinkage stopes this year than last, so we are using less timber, less explosives, less of everything; hence a great many factors come in to complicate the results.

Milling has been reduced from 58 to 47c. The question of tonnage enters largely here, notwithstanding the fact that we are doing finer grinding now than we were then.

The cost of general expense shows a decrease because of increased tonnage. In general expense we include everything which cannot be properly called mining, milling or smelting. That has fallen from 26c. to 18c. a ton.

Smelting is practically the same, 2.3c. per lb. of final copper. This is so because we have a long-time contract and the smelter, notwithstanding that his costs have gone up, gets only the same rate. I think, in our case, he possibly has a slight advantage, for the reason that he turns us back only 95% of the copper contained in our concentrate. I think his saving is probably in the neighborhood of 97 or 98%, so he has gained slightly.

The other items remain just about the same, so that, curiously enough, in November, 1915, our cost was 8.7c. per lb., whereas in November, 1916, it was only 8.2c. per lb. In other words, notwithstanding all these increased items, our cost is about 1/2c. per lb. lower. This will not be the case for the whole year; for the entire year the average cost will be about 1/2c. per lb. more.

WAGE ADJUSTMENT ON OUTBREAK OF WAR

When the war broke out, instead of reducing wages at Miami—I think we were paying about \$3.50—we simply put the men on half time. Each man worked three days a week and got his full rate. To those men who, of necessity, had to work the full week we made a 10% cut. The conditions very soon adjusted themselves. Men did not care to work half time and they gradually drifted off, so that along in January, 1915, we were working our men full time.

I am very much inclined to think that when the reaction comes, as it surely will, we shall have to stop probably at a higher minimum than we had before. The men have increased their standard of living, and I do not think they will be satisfied to go back to the old one. If the cost of living should very materially decrease, which it is not likely to do, they might be satisfied. In the Globe-Miami district, merely that the labor unions might have something to say, it has often been suggested that this minimum should be placed at \$4. We have not considered this officially, though we are probably inclined to suppose that maybe \$4 may be the irreducible minimum.

As has already been suggested, there certainly is a very great opportunity for increase of efficiency. I never

shall forget what Walter Fitch told me along in 1895. In 1893 he was running the Champion iron mine in northern Michigan and when the panic of '93 came they nearly had to shut down the Champion mine. They told the men, "Here is the price that we are going to get for a ton of ore that costs so much. Here is the balance that is left after paying for supplies, and we will give that to you. We will mine this ore and stock it, and in the spring send it down to Cleveland. If we get a new dollar for an old one, well and good. We will not consider the fact we are depleting the mine." Mr. Fitch told me that this one winter revolutionized things, and that the efficiency of the men doubled.

There are two ways in which you can increase efficiency. You may be able to educate the men up to doing better work, but of course, you must so modify your methods of mining, so improve your machines or your machinery, that you can get increased tons per man per day.

OVERCOMING THE MINERS' PREJUDICE

When we started the Miami mine, Mr. Lawton, who came from Michigan, was very anxious to introduce one-man machines. Our men said they had always been accustomed to two men to a machine and that is what they were going to have. Instead of bulling it through, we went around in the stopes and whenever we got a chance we told the men, "Here, this is wrong. You men have got the wrong idea of this thing. We do not want to have a man work alone with one of these great heavy machines. We want to give you light machines and instead of there being two men working in this drift with this large machine, we are going to give each a light machine, in a drift by himself. Now here is what you must realize: If we have got to work two men on a machine this rock is not ore; it will not pay to treat it; but if we can work one man on a machine, then it becomes ore; so you are standing in your own light. It does not mean that one man is going to be thrown out; it simply means we are going to make places for two to work."

They gradually realized this and inside of a year you could not get the men to go back to two men on a machine, because they felt that now each man stood on his own merit and got credit for the work he did. Therefore, what we must do in the future is so to improve our mining and our metallurgical methods that we can afford to pay these higher wages, make the men better American citizens and permit them to live better, and we shall do just as well, make just as much profit, and shall have a much better and a much better satisfied community.

That is the point of view that we have. We have been trying to inculcate into some of these men the idea of saving at these high wages. When I was down there last, Mr. Gottsberger said he imagined probably only 10% of the men did any saving. Now, conditions have certainly improved in Arizona on account of the prohibition law. This law was in full force and effect for 15 months, then, by a strange decision of the Supreme Court, the importation of liquor for personal use was permitted. That went on for nine months. Last November the question was brought up of making the state really prohibition, and it was carried by a large majority, showing that the people themselves were in favor of prohibition; it wasn't something that was forced on them by an order of the Czar, as in Russia, or by the Government as in France or England. When men have that point of view, that they are willing to cut liquor out (which is one of the worst curses

of the laboring man) you will find a pretty good community. They tell me, in Arizona, that when the prohibition law was first introduced, almost immediately the sales in the stores increased 25%. The bankers did not notice any change until about six months, and then suddenly the bank deposits commenced to increase. They figured it out that it took the men six months to pay up their debts and then they were able to put something aside; hence the solution is not to try to cut wages to the minimum, but to try and keep them as high as we can, and to inculcate into the men the desire for efficiency and to show them if they are efficient and do good work that we *can* divide with them and that we *will* divide with them.

ZINC SMELTING IN KANSAS—OKLAHOMA

W. R. Ingalls: Not long ago I had occasion to look over the cost sheets of a zinc plant in the natural gas district, which is on the front, so to speak, where conditions have been most difficult. While with regard to this particular plant, which is a new concern, I had no means for comparison with previous years, out of curiosity I compared the figures with those of some other works of the same character a few years before the war. Of course the comparison is not a perfect parallel, for the works are not of the same capacity nor under the same management, but they are in the same district, where general conditions are the same.

The labor cost per ton of ore had doubled, being in round numbers \$8.50 against \$4.25 previously. Reduction material was \$2.50 against \$1.30. Retorts and condensers were \$2 against 65c. Other clay material was 25c. against 11c. Miscellaneous supplies were 60c. against 20c. Repairs and renewals were \$1.50 against 70c. General expense was \$1 against 85c. The total was \$16.35 against \$8.25. These totals are exclusive of the cost of natural gas—the fuel—which lately has been almost anything. Smelters have been paying 7, 8, 10c. per 1000 cu.ft. and even more. It will be observed that operating costs have increased from two to three times in all principal items except general expense, which was not much above that of normal times. This is because taxes and insurance have not increased, and the increase in salaries has been very small.

Increased operating cost is not the whole story in zinc smelting. In general the metallurgical extraction has fallen off, owing to the indifference and independence of the smelters and the necessity for employing a good many green hands. Experience in this respect has not been uniform. At some plants where the working force is of more permanent character there has been but little falling off. At other plants, however, recent results have been atrocious, and I know of one at least where they are nothing less than a metallurgical crime.

NICHOLS COPPER CO.

H. H. Stout, Nichols Copper Co., Laurel Hill, Long Island: Roughly speaking, our labor for the year 1916 received average wages 26% in excess of 1914. Present rates are 44% in advance of 1914.

As to labor efficiency, man-hour per unit of product or charge, we found that when increased wages were demanded and obtained by a strike the efficiency fell off, in one case 28% for a few months. On the other hand, by giving labor an increase sufficiently ahead of time for it to be more or less of a surprise, our efficiency has in-

creased about 12%. It may be noted, however, that an increased tonnage has had some effect in this direction. Our costs are reduced to base price of labor and metal losses. We allocate our metal losses to each step in the operations.

As refiners, we view the increase in labor and commodities with something akin to a panic, for the simple reason that, not being producers (only custom refiners with long-term contracts), our path is not made smooth by the receipt of 30c. per lb. for our product.

The returning of 100% of copper by the refinery is a piece of stupidity on its part; the present price of copper has increased its costs, from metal losses alone, about \$1 because of the necessity for purchasing 7 lb. of copper at 30c., to make good the losses, as against the usual 15c. per lb. As refiners, we should like to see copper go to zero. On the other hand, the smeltery, with its usual 1.3% off, makes us wish copper were \$1.

Consider a typical ore in the smelter; 14% copper, 61% slag fall. The price of copper at 30c. against 15c. has increased the value of this ore, to the producer, about \$37 per ton. The increased toll from 1.3% at 30c., as against 15c., is \$3.90. Of this \$3.90 our labor received \$1.50; supply men, 90c.; losses, 48c.; and we, an additional profit of \$1.12 per ton. Of the \$37 increased value there remains, as far as we are concerned, \$33 per ton. From the discussion, I judge that the increased cost of mining and freight has been about \$8 per ton on this ore, leaving \$25 per ton net additional profit to producers, over and above normal times. It can be seen that their cries of distress are not, therefore, without their humorous side.

There is one phase of this question the inevitable reaction, in which, operators are interested, which has not yet been touched upon. Even the most sanguine will not predict a continuation of present metal prices. A return to normal times will probably bring an adjustment in commodities which is the other fellow's job to regulate. Since practically 70% of the refining capacity for copper produced in this country is situated near New York, if some scheme can be devised by which wage reductions can be made without the usual friction, it would be highly desirable. As operators, we have been of the opinion that in the copper industry wages should be divided into two classes, base rate in one envelope, and a bonus, depending on price of copper, in another envelope. Please note I suggest labor should receive two envelopes. None of the refineries has such a scheme, and if it could be put into effect soon enough, so that the laborer would become educated to the variation in his bonus envelope as it relates to the price of copper, reductions might take place with less interruption of operations.

EMMIGRATION OF LABOR AFTER THE WAR

Judd Stewart of the American Smelting and Refining Co.: My idea on the subject is that, after the war, we shall have worse labor conditions than we have now, rather than better. In normal times, according to Immigration Bureau statistics, 30 or 40% of all the immigrants go back; after they have accumulated enough to live on the sunny slopes of Italy or the Balkan hills, they return. We keep about 60 or 70% of them. Now, those who have been interned here by the war have accumulated vast wealth, for that class of people, and it is only human nature for them to want to go back and see what hap-

pened. As great numbers of men were taken out of industrial pursuits by this war, many killed or crippled and many will be called upon to rehabilitate Europe, there is likely to be an exodus rather than an influx, and we shall have a worse labor situation after the war than we have now.

M. B. Spaulding: I have recently been informed that the North German-Lloyd and the Hamburg-American boats here in New York Harbor have been fully prepared to start on a moment's notice, and that they had all their freight arranged for. The freight will consist primarily of cotton and food stuffs, cotton at the rate of 3c. a pound and food stuffs 2½c. a pound. There is not a single accommodation for passengers at present available on one of those boats, everything having been fully reserved; hence, the statement in regard to the possible shortage of labor appears to be true. We all know what the capacity of these boats is as to passenger service. When we are told, on such authority, that all passenger space has been spoken for, it shows the intention of those who are interned in this country to go back to the other side to see what has happened.

Allen H. Rogers, consulting engineer, Boston, Mass.: I have little to do with actual operations, but in regard to the conditions after the war, I have no doubt that there will be a considerable exodus of labor from this country, and in view of that fact, there is likely to be some considerable reduction in the supply of labor. Whether the reduction in the extent of industrial operations will keep pace with that I do not see how you can very well tell.

Mr. Douglas looks for a slump in copper after the war. For my own part, I do not agree with that view. I do not see how that can occur when we have been given to understand that Germany and Austria have used up for munitions enormous amounts of copper that had been used for other purposes. It seems to me that this has to be replaced in some way. Again, industrial development in Europe has been at an absolute standstill for two years, which is true of a large part of the rest of the world, also. To my mind, that amount of industrial development must be made up. In other words, for a period of years following the war we shall experience more than normal increases in industrial development, so that there will be a market for all the copper we can produce probably not at 30c. but still at very good prices compared with those before the war.

HOW TO MEET THE READJUSTMENT

R. W. Raymond, professor of mining, School of Mines, Columbia University, New York City: The striking question which presents itself is what are we going to do about it. After the war, a great many men will go back to Europe. Labor instead of being as abundant as it is now, will be greatly reduced. One of the things that is beginning to be felt is the advantage of educating men and getting them worked up to a greater speed and greater efficiency. Some of the results of this, which are noticeable around the country, are shown in the good work being done in Arizona, where, in some of the mines, instead of getting out only 2 or 5 tons a day the men underground are getting out 10 or 15 to 25 tons, due to the development of mechanical appliances, betterment of drills, more efficient stoping, all tending, with the help which the mining companies are giving to the training of

their men along this line, to reduce the cost and make the men more efficient. When we come to it, we may be able to reduce wages on account of the lower price of copper, and the men may be willing to agree to a reduction, but we shall find that they will demand as high a price, and perhaps higher, than in the *ante-bellum* days, so that better training for the workmen is a thing for serious consideration all along this line.

One of the most notable examples of this is an interesting case in the iron mines of Minnesota. The mining of ore from underground, whether it be soft ore or hard ore, costs about \$1 a ton on the surface. One mine is doing a great deal better than this by speeding up the efficiency of the men; they are worked in small gangs of 30 or 40 men, under charge of a district boss or a gang boss, the men being paid, not their usual wages of \$3 a day, but at the rate of \$2.50 a day, plus 8 to 10c. a car (or 10c. a ton) for the number of cars they get out. Every man speeds up to his utmost to get as many cars as he can and the higher wages per day. The extra wages for every gang of men throughout the mine is posted, so each man knows the next morning what he gained the day before. It is developing a wonderful state of efficiency among the men and a wonderful weeding out of inefficient men. This company is getting out its ore for about 60c. a ton. Those things pay, and training along that line is worth taking up throughout the whole country, particularly when our men are sure to be fewer in number after the war than they are now.

UNFORTUNATE PLIGHT OF THE GOLD MINER

E. Gybbon Spilsbury, consulting mining and metallurgical engineer, New York City: I have heard with a great deal of interest the complaints of the miners of copper and zinc on account of the increased cost of labor and of supplies. Nothing has been said as to the increased value of their products which they are enjoying during this time. I want to call attention to the poor, unfortunate gold miner. His product has not increased in value at all, while its purchasing power has decreased; therefore, while he is met with exactly the same conditions as the copper, the zinc, and the lead men, so far as the increase in the cost of labor and supplies is concerned, he is getting no more for his product than he did when everything was from 30 to 60 or 75% cheaper than it is now. Copper and zinc producers are all looking forward, though, to a terrible slump at the end of the war, while the gold miner is looking forward with great hopes to the time when he will once more continue to get his \$20 an ounce real value for his product.

Robert Peele, professor of mining, School of Mines, Columbia University, New York City: I have had chiefly to do for some years with a different kind of engineering work. But we, also, at Columbia are interested in the matter of increased cost, and it might be worth while to call attention to the fact that it is now costing much more than formerly to turn out graduates at the School of Mines. This is mainly due to the fact that about the time the war began a new graduate course went into effect in the School of Mines. Instead of the old four-year course, we have now a three-year course, preceded by the equivalent of three years of scientific college training, as preparation for entrance.

Since the change has gone into operation the size of the classes has been temporarily reduced, so that the cost

of turning out a graduate during the next few years at the School of Mines will probably be two or even two and a half times what it has been under the old four-year plan. The smaller classes bring to the university a correspondingly reduced income from fees, while the cost of maintaining the school has certainly not decreased. But, running expenses have not increased in the same way that the cost of the operation of mines and metallurgical works have increased. Wages and salaries remain about the same up on the hill, notwithstanding the higher cost of living. However, we manage to get on.

The value of the product, we hope, is being improved; not because it is costing more to produce it, but because of the better preparation at entrance. It used to cost for a School of Mines class graduating, say an average of twenty-five, about \$2600 or \$2700 per student. Of that, the student paid \$1000; that is, since the increase of the annual fee to \$250, he would in four years pay \$1000. I suppose that, with the small classes in prospect for the next few years, it will probably cost the University \$5000 or \$5500 per student. I don't know whether the gentlemen who are the prospective employers of these young men will think it necessary to increase the inducements to get School of Mines graduates into their service, but I hope so. We look forward to turning out even a better product than we have in the past, chiefly as the result of more thorough preparation on the part of the students.

Additions to the Reduction Works at Trail, B. C.

E. H. Hamilton, metallurgical manager for the Consolidated Mining and Smelting Co. at Trail, B. C., gives some interesting data regarding extensions and operations at the Trail reduction works, in the annual report for the year ended Sept. 30, 1916. From 1894 to date, there has been treated at the British Columbian smeltery 4,819,903 tons of ore, of which 447,017 was smelted in 1916. Construction expenses in 1916, according to the balance sheet, were \$2,326,021; the greater part of this was spent at Trail, presumably for the new refineries, though there was considerable work done in the smelting department.

Improvements in the lead department of the smelting works included a Cottrell precipitating plant for the Wedge roasters, a briquetting plant for flue dust, a sampling room for the laboratory and extensions to the mechanical shops. A series of reinforced-concrete bins were built, with hoppers, scales, etc., for weighing charges for the lead blast furnaces; also convenient trestles, tracks, etc., for filling and discharging. A crushing plant with skip and belt-conveyor system was installed for crushing and handling the product from the Huntington-Heberlein pots; also skipway, motor, etc., for conveying product to the lead blast-furnace bins. The lead sampling mill, with tube mill for fine grinding, was completed. An ore-bedding system was housed in substantial steel buildings with concrete floors, covering 21,000 sq.ft.

In the copper-smelting department two 12-ft. basic-lined upright converters were installed; also an Ingersoll-Rand turbine blower with 900-hp. motor; a reverberatory furnace and anode-casting apparatus.

Floor space occupied by the new metallurgical plants lately built at Trail are given in Mr. Hamilton's report as follows:

The 15-ton sulphuric-acid plant, built of tile brick, containing two lead chambers, towers, etc., covers an area of 8983 sq.ft. The hydrofluosilicic-acid plant covers 1472 sq.ft. The 12-ton electrolytic copper refinery, including generator room, occupies a building having a floor area of 8024 sq.ft., besides a basement, with concrete floor protected with asphalt; the building is of steel construction with walls of hollow tile. An extension to the refinery to bring the capacity up to 17 tons of refined copper daily occupies a floor area of 5664 sq.ft. The copper-melting department, housed in a separate steel, hollow tile and concrete building, covers 3600 sq.ft., being 60 ft. square by 18 ft. high. The electrolytic zinc plant, completed in March, 1916, is housed in steel buildings with concrete floors and tile walls; floor space covered is 163,641 sq.ft.

Smoke Damage to Vegetation

At the January meeting of the New York Section of the American Institute of Mining Engineers, Lignon Johnson, attorney for the International Nickel Co. and the American Smelting and Refining Co., gave a discourse on the legal phases of the smoke problem of the smelting plant. It was found by scientific investigation that much of the damage usually attributed to the smoke from the smelting plant was actually due to other causes. The problem has been studied by physicians, veterinary surgeons, agronomists, entomologists and botanists—besides the smelting-company chemists. Damage to human beings or to animals had, he said, been practically eliminated with the improved methods of clearance for the gases. With the perfection of clearance methods, the use of high stacks and the dispersion of hot gases, the smoke problem had been solved at most of the big works.

In regard to alleged damage to vegetation, it was found in many instances that the condition of the damaged plants arose from other causes than smoke. Smoke of much higher SO₂ concentration was tested on other growing plants, and it was found that they would stand without damage much more sulphur dioxide than was contained in the gases of the smelting plant. In a number of instances the botanists and entomologists found that the plants were diseased; cultures were made from such plants and the same diseases introduced into healthy plants. With elimination of certain plant diseases, both the crop yield and the nutritive value had been increased. On some alkali land the crop had been improved by the addition of sulphuric acid. The scientific study of the vegetation in the vicinity of smelting plants had thus revealed many causes of crop failures that had formerly been attributed to the smoke.

Power from Volcanoes

The presence of subterranean steam coupled with high coal prices has led to the erection of a power plant in Italy, using a volcano as a source of energy. Drill holes were put down through which the steam issues at a pressure of two to three atmospheres and a temperature of 150° to 190° C. On account of the presence of borax salts and sulphuric acid in the steam, it could not be used directly. By applying the superheated steam to a boiler directly (using the steam in the same manner as fuel) power was successfully generated. Three plants having a total of 9,000 kw. are at present in operation.

The Origin of the Sudbury Nickel Ores

By C. F. TOLMAN, JR.,* AND AUSTIN F. ROGERS†

SYNOPSIS—By a complete microscopic examination of the Sudbury ores with the polarizing and reflecting microscopes, the relative ages of the rock minerals and the ore minerals have been positively determined. This study reconciles the two antagonistic views regarding the origin of these ores.

To mention the copper-nickel deposits at Sudbury, Canada, is to arouse the interest of all who are connected with mining or engaged in the study of ores. This interest is due not only to the great size and importance of the orebodies which furnish the bulk of the world's output of nickel, but also to the mooted question as to their origin.

The literature devoted to the description of the Sudbury ore deposits and to the discussion of the problems of their genesis is extensive, the bibliography including about 60 titles. A number of these articles have appeared in the *Journal*.¹ These include the most recent contributions of Coleman and Knight.

In spite of the prolonged discussion no one theory as to the origin of the Sudbury ores has received general acceptance. For example, favoring the igneous origin we note the names of von Foulton, Barlow, Browne, Adams, Walker, Vogt, Coleman, Stutzer, St. Clair, Hore, and Howe. Opposed to this view and favoring the hydrothermal origin are Bell, Argall, Posépnny, Bush, Beck, Collins, Hixon, Dickson, Weed, Emmons, Gregory, Campbell, and Knight. Neither is there in the literature a clear summary of the characteristics of these ores, which might serve as a guide to those in search of new deposits.

In connection with a general study² of the magmatic sulphide ores carried on by us for the last two years, we undertook a complete microscopic examination of the Sudbury ores, using both the polarizing microscope and the reflecting microscope. In this study we have been able to determine positively the relative ages of both the rock minerals and the ore minerals, and also to place definitely the period of hydro-thermal alteration with reference to ore deposition.

The sequence of the minerals as determined by the microscope furnishes a rather full account of the history of ore deposition, and as sound theory of today becomes one of the working tools by which the value of a prospect is determined tomorrow, we venture to summarize

briefly some of the data we have gathered in regard to the Sudbury deposits.

We are chiefly indebted to the excellent work of Coleman³ for our knowledge of the geology of the Sudbury region. In brief, the Sudbury orebodies are found at the base or margin of an intrusive sheet of igneous rock designated by Coleman as "norite-micropegmatite" and also informally called by him the "nickel eruptive." This intrusive occurs as a great interformational sheet, or laccolith, which forms the base of a spoon-shaped syncline about 35 mi. in length and about 15 mi. in width. Above the norite-micropegmatic sheet is a younger metamorphosed sedimentary series, and below a complex of schistose sedimentary and intrusive rocks known as the Sudbury series.

The orebodies are distributed along the entire ellipse traced by the base of this sheet, and also occur in dikelike apophyses and small parallel sheets of norite which extend out from the main sheet into the underlying Sudbury series.

The basal portion of this laccolith is quartz norite (hypersthene and plagioclase with subordinate quartz). It includes masses or segregations of hornblende-bearing acid material which is especially abundant as inclusions in the rich ore. The upper portion of the laccolith is an acid granitic rock in which the quartz and feldspar often occur in fine graphic intergrowths, and hence was early designated as micropegmatite.

EXPLANATION OF ACID AND BASIC PORTIONS OF OREBODY

A reasonable explanation of the relation of the upper acid portion of the sheet to the lower basic portion is that differentiation was controlled by gravity. The nickel eruptive or, more accurately speaking, the nickel intrusive broke through the older granites and greenstone schists, and along its margin a later granite was intruded. This forms, according to Knight⁴, the foot wall of the great Creighton ore deposit. Our study of material kindly furnished by Dr. Knight leads us to believe that the later granite, as well as the granitic material often intimately associated with the ores, is an acid differentiate from the magma basin which furnished the norite.

From the fact that the ore lies at the base of the norite, the proponents of the magmatic theory postulate that the ores were the first minerals to separate from the magma and that they sank and thus accumulated at the base of the norite sheet.

The earlier observers impressed by the brecciation and fissuring connected with the orebodies believed that the ores were brought in by solutions, as does also Dickson, who made a careful microscope study of the ores. Knight has made recent field studies and states: "These deposits were probably formed, like all the other deposits in the area, by solutions circulating along crushed and sheared zones."⁵

³"The Nickel Industry with Special Reference to the Sudbury Region, Ontario, Canada." Dept. Mines, Mines Branch, Publ. 170, 260 pp. (1912).

⁴"Eng. and Min. Journ.," Vol. 102, p. 554, Sept. 23, 1916.

⁵"Eng. and Min. Journ.," Vol. 102, p. 555 (1916).

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¹Browne, D. H., "The Composition of Nickeliferous Pyrrhotite," *Eng. and Min. Journ.*, Vol. 56, 565-6 (1893). Bush, E. R., "The Sudbury Nickel Region," Vol. 57, 245-6 (1894). Coleman, A. P., "Geology of the Sudbury District," Vol. 79, 189-90 (1905); "Geological Relations of the Sudbury Nickel Ores," Vol. 102, 104-5 (1916). Dickson, C. W., "Note on the Condition of Nickel in Nickeliferous Pyrrhotite from Sudbury," Vol. 73, 660 (1902). Hixon, H. W., "Geology of the Sudbury District," Vol. 79, 334-5 (1905); "The Sudbury Nickel Region," Vol. 82, 313-14 (1906). Knight, C. W., "Origin of Sudbury Nickel-Copper Deposits," Vol. 101, 811-12 (1916); "Geological Relations of Sudbury Nickel Ores," Vol. 102, 554-5 (1916). Miller, W. G. and Knight, C. W., "Sudbury, Cobalt and Porcupine Geology," Vol. 95, 1129-33 (1913). Thomas, K., "The Sudbury Nickel District of Ontario," Vol. 97, 152-4 (1914). Thompson, P., "The Sudbury Nickel Region," Vol. 82, 3-4 (1906).

²"A Study of the Magmatic Sulphide Ores." C. F. Tolman, Jr., and Austin F. Rogers. Leland Stanford, Jr., University Publications. University series, 76 pp., 20 plates (1916).

Our study of the Sudbury ores checked and amplified by the investigation of ores of the same character elsewhere brings out the following facts:

1. The Sudbury ores are not affected by intense rock alteration as are other types of high-temperature ore deposits such as the tin-stone veins with tourmaline, topaz, lepidolite, etc., or the contact metamorphic deposits with garnet, diopside, epidote, etc.

2. Prior to the formation of the ore minerals, however, the pyroxene of the norite was converted wholly or in part into hornblende. Therefore it seems certain that the ores were formed not only after the solidification of the rock (as proved by data in paragraph 3), but also after the conversion of the pyroxene to hornblende, which we have shown in our study to be a magmatic mineral.

3. The ore minerals cut the silicates in well-defined veinlets (see Figs. 1 and 2) and replace the silicates selectively. Feldspar, for example, is more easily replaced than quartz, and occasionally graphic texture is thus preserved (see Fig. 3, center of photograph).

4. The veinlets, such as those shown in Figs. 1 and 2, are not due to "later rearrangement," but the main masses of sulphides extend out into veinlets, as shown in Fig. 4. The veinlets and the massive ore are undoubtedly of the same age.

5. In view of the emphasis placed upon rearrangement of the ore minerals by Coleman and others, it is interesting to note that we were unable to find any evidence of the migration of copper in the typical Sudbury ores. However, microscopic crystals of pentlandite along hydrothermal alteration veinlets show that there is an insignificant migration of nickel subsequent to the magmatic state (see Fig. 5).

6. All rock alteration, if the formation of hornblende be excepted, was subsequent to ore formation, for the hydrothermal minerals (tremolite and chlorite) distinctly cut the ore minerals (see Fig. 6). Our microscopic study shows that the Sudbury nickel- and copper-bearing pyrrhotitic ores, as well as all occurrences of this type, have certain definite and easily recognizable characteristics. In every occurrence studied the ores are later than the rock-forming silicates and replace them. The ore minerals are not formed simultaneously, but are introduced one after another in the

following definite order: (1) Magnetite (intergrown with illmenite as shown in Fig. 7); (2) pyrrhotite; (3) pentlandite (shown in Fig. 6); (4) chalcopyrite. Hydrothermal alteration is subsequent to the formation of the ores and generally accomplishes little or no rearrangement of the ore minerals.

The ores are associated with certain types of basic igneous rocks, usually norite or gabbro. They are found within the intrusive rock, generally near its margin, and may impregnate to a minor extent the adjacent rock.

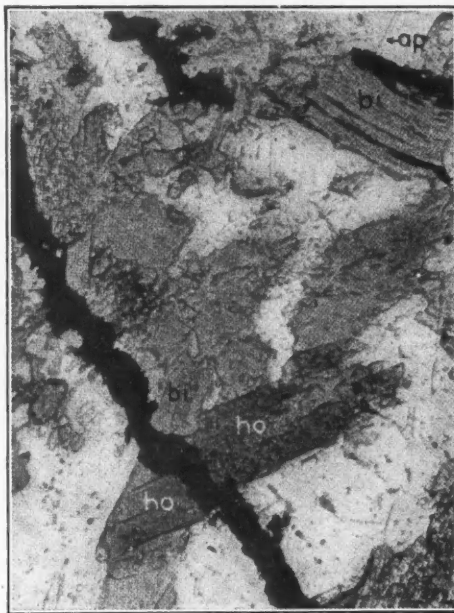


Fig. 1

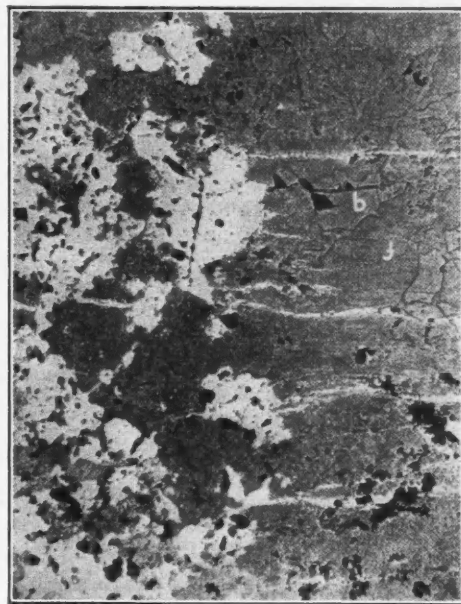


Fig. 2

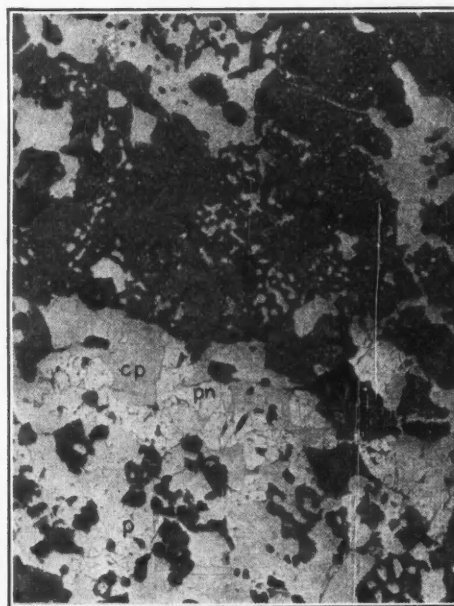


Fig. 3

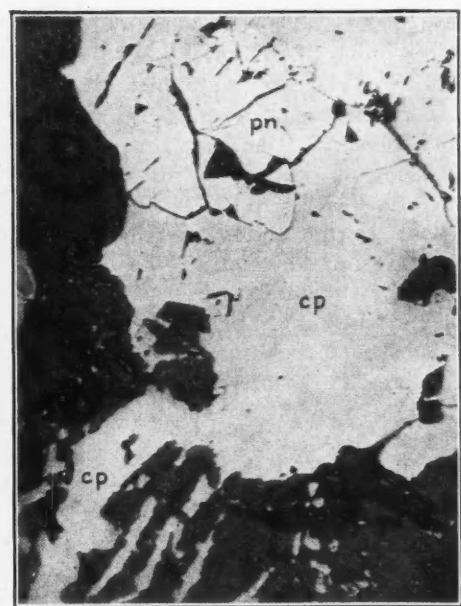


Fig. 4

FIGS. 1 TO 4. PHOTOMICROGRAPHS OF ORES FROM THE EVANS AND CREIGHTON MINES

Although the ores are formed after the consolidation of the basic rock and its acid differentiates, ore deposition precedes the hydrothermal stage. Rock consolidation is a long and complex process as we have discussed elsewhere,⁶ and ore formation falls within the late mag-

⁶Tolman and Rogers, *op. cit.*

matic stage as defined by us, and so the term magmatic may be retained for this class of ores. We recognize, however, that certain misconceptions have been attached to this term, such as the sinking of crystals in the magma, and other erroneous assumptions, which should be avoided in the future.

Our study reconciles the two antagonistic views in regard to the origin of these ores. We confirm the conclusions of the opponents of the magmatic theory that the ores were formed after the rock-forming silicates. We agree, on the other hand, with the magmatic school that the ores are not hydrothermal, but for different reasons than advanced by these investigators. Detailed microscopic study has shown among other things that the typical hydrothermal minerals are later than the ores. The recent discovery of nickel-copper deposits of this type in San Diego County, California,⁷ gives added interest to all information that can be obtained from the study of the important deposits in the Sudbury district. The very definite characteristics of this class of ore deposits and its close relation to certain types of igneous rocks should be understood by all who are prospecting and developing such deposits. Fig. 1, magnified 158 diameters, shows a thin section of ore from the Evans mine, showing a chalcopryrite veinlet (black) cutting a hornblende (*ho*) crystal. Data of this character prove that the ores are formed after rock consolidation. In thin sections viewed by transmitted light, the opaque ore minerals are black and the silicates are light gray. In polished surfaces, under reflected light, the ore minerals are white or light gray and the silicates dark gray. Fig. 2, magnified 10 diameters, is from a polished surface of granitic material from the Creighton mine. This shows sulphide masses, pyrrhotite and chalcopryrite on the right extending out into veinlets (largely chalcopryrite) which cut and replace the quartz (*q*) and feldspar (*f*). Fig. 3, magnified 18 diameters, is from a polished surface of granitic material from the Creighton mine, Sudbury, showing pyrrhotite (*p*), pentlandite (*pn*) and chalcopryrite (*cp*). In the center the structure of the original, graphic intergrowth of quartz

and feldspar is retained through the selective replacement of the feldspar by the ore minerals. Fig. 4 shows a polished surface (99 diameters) of granitic material from the Creighton mine. Chalcopryrite (*cp*) extends from the main mass out into veinlets. Both are of the same age. This proves that the veinlets are not due to rearrangement.

Fig. 5, magnified 35 diameters, is from a polished surface of massive ore from the Creighton mine. Pyrrhotite (*p*) is cut by vein-like areas of pentlandite (*pn*).

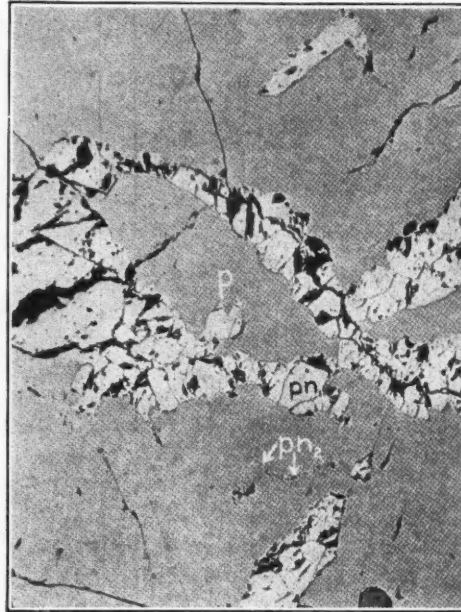


Fig. 5

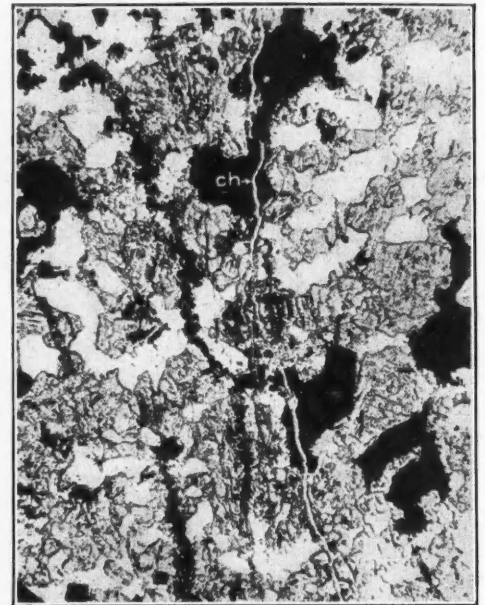


Fig. 6

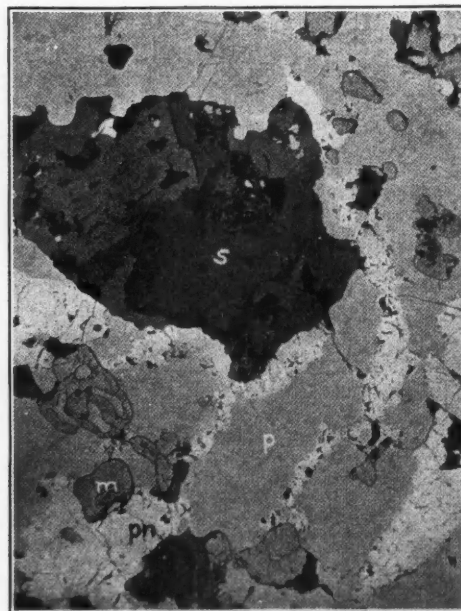


Fig. 7

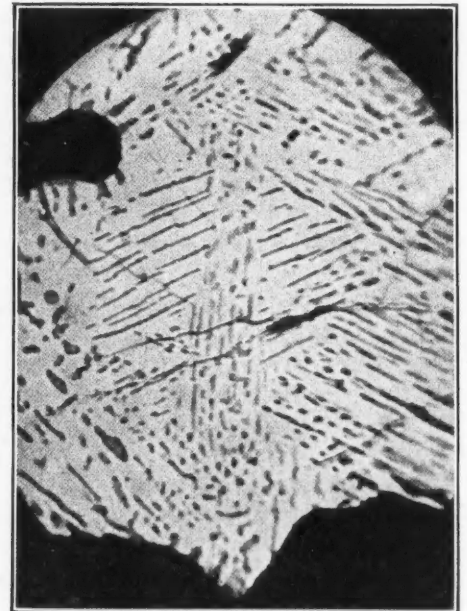


Fig. 8

FIGS. 5 TO 8. PHOTOMICROGRAPHS OF ORES FROM THE CREIGHTON AND STOBIE MINES

The contrast between the pyrrhotite and pentlandite is brought out by polishing, not by etching. A small amount of pentlandite of a second generation (*pn₂*) has formed along later cracks and veinlets. Fig. 6, magnified 36 diameters, shows a thin section of norite from the Stobie mine, showing sulphides, chalcopryrite and pyrrhotite (black) cut by a veinlet of chlorite. This proves

⁷Calkins, F. C. "An Occurrence of Nickel Ore in San Diego County, California." Bull. 649, U. S. Geol. Surv., 77-82 (1916).

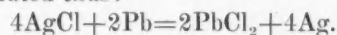
that the hydrothermal alteration is post mineral. Fig. 7, magnified 14 diameters, shows a polished surface of typical rich ore from the Creighton mine showing residual or unreplaced silicates (*s*) and magnetite (*m*); also pyrrhotite (*p*) cut by veins of pentlandite (*pn*). Fig. 8 shows a polished surface, highly magnified (790 diameters), of an intergrowth of magnetite (main mass) with illmenite (parallel dark lines). The specimen is not etched, but contrast is brought out by high polish. This photograph proves that the problem of treating titaniferous magnetite is one of metallurgy and not one of ore dressing.

Extraction of Silver from Manganiferous Ores

A paper recently presented before the Chemical, Metallurgical and Mining Society of South Africa by Walter Neal, describing metallurgical experiments on the manganese-bearing silver ores of El Favor, in Jalisco, Mexico, brought out some discussion by F. Wartenweiler. Referring to Mr. Neal's data on extracting 32 oz. silver from 34 oz. of ore of the character mentioned, Mr. Wartenweiler said it reminded him of an investigation on silver-gold ores and tailings carrying pyrolusite in considerable quantity. The investigation included the dissolving action of sodium-chloride solutions in wet chloridizing and the chloridization of silver ore by roasting supplemented by wet chloridization roasting.

The process of forming silver-chloride and dissolving with basic chloride was being worked by nature and was exemplified by the silver content of the acid mine water issuing from underground workings. The conditions were favorable through the presence of silver minerals, pyrolusite, chlorides, base mineral sulphides and by mine water passing through a mineral zone of partial oxidation.

The tailings assaying 4.2 oz. silver and 0.05 oz. gold per ton, were leached with an 18% salt solution, which had been charged with electrolytically generated chlorine by passing through an absorption tower. The extraction on the silver was 64.3%, and on the gold, 75%. The precious metals were precipitated on lead shavings, giving excellent deposition provided no free chlorine remained in the effluent from the leaching vats. The solution of the silver chloride in strong salt brine is an old method and was at one time practiced under the name of the Augustin process. The precipitation reaction for the silver may be illustrated thus:



The partly oxidized silver-gold ores with which are associated pyrolusite, mispickel and pyrite, were roasted in a large muffle furnace with 4% salt, then leached with the salt solution (containing 18% NaCl and 0.20% free Cl), giving an extraction of silver, 90.7% on an original value of 22.7 oz. and gold 75.0% on an original value of 0.10 oz.

The chloridization of the silver during the roast was 85.9% (by hypo test), and to obtain this it was necessary to subject the ore first to an oxidizing roast, adding the salt in the later stage on account of the rapid evolution of SO₂ at the beginning of the roast. By keeping a low heat throughout, the volatilization loss was kept down to 5% silver and gold.

In leaching this ore with the salt solution, it is interesting to observe that an effluent carrying as high as 17 oz.

silver per ton was obtained. This silver content seemed to be the saturation point as experienced in leaching high-grade ore assaying 150 oz. silver per ton. Such high silver content required a long time for dissolution by the salt solution.

The same partly oxidized ore yielded to cyanide treatment after grinding through 150-mesh, giving extractions shown in the accompanying table.

EXTRACTIONS BY CYANIDE TREATMENT

	Silver	Gold
Original value.....	18.9 oz.	0.103 oz.
Extraction by cyaniding.....	64.5%	66.1%
Extraction by cyaniding plus concentration.....	75.9%	83.9%

The old and costly mill practice of chloridizing roasting with 15% salt, followed by pan amalgamation, gave an extraction of 90% silver and 56% gold. By chloridizing roasting with 6% salt, followed by cyaniding, the extraction was 90% silver and 74% gold.

When the ore was given an oxidizing roast only (no salt added), the solubility of the silver in cyanide solution decreased remarkably, only 18.5% being dissolved.

Hanyang Iron Works Flourishing

Through the courtesy of Z. T. K. Woo, superintendent of the Hanyang Iron and Steel Works, China's largest plant, statistics of the work done in 1915 by the Hanyang Iron and Coal Co., Ltd., have been made public by the Far Eastern Bureau. Mr. Woo reports: "The output of the iron and steel works for 1915 was as follows: Matin iron, 34,906 tons; foundry iron, 101,635 tons; rail steel, 30,776 tons; mild steel, 16,624 tons. The output of the Tayeh iron mines was 545,819 tons of iron ore, and that of the Pingsiang colliery was 365,000 tons of coal and 273,000 tons of coke. During the year the following additions to the plant were completed or in hand: One blast furnace, capacity, 250 tons per day; eight boilers; one steel chimney; one blower; plant for unloading ore and stone and loading pig iron and steel products mechanically on the wharves; machinery for removing pig iron from the casting bed and pig breaking; openhearth furnace of 70 tons; and, in the dolomite mill, four calcining cupolas and a grinder; an improved water system to utilize water from the rivers, for which the necessary settling beds and water channels have been also completed. During the year there was a rise in value of 9% in pig iron, and over 100% in structural steel material. The present staff comprises 17 Chinese engineers, 10 foreign chemists, 252 general staff, 2000 skilled workmen and 2500 laborers."

Industrial Gold in Germany

A note in a recent issue of *Madrid Cientifico* calls attention to the publication in the *Frankfort Gazette*, of an estimate of the quantity of gold being liberated by the Reichsbank for use in jewelry and embroidery trades. The quantity which, before the war, was used by these industries and the dentists, photographers, gilders and china makers is estimated at about 80,000,000 marks per year. Now the consumption is but 14,000,000 to 15,000,000 marks per year, and of this amount four-fifths is destined for export. The jewelry trade now uses about 2,500,000 to 3,000,000 marks in its manufactures.

The Chilean Nitrate Industry

By A. W. ALLEN*

SYNOPSIS—The preparation of nitrate from "caliche," or nitrate-bearing rock, is somewhat analogous to cyanide metallurgy. The rock is crushed coarsely and the nitrate leached out in tanks. Vacuum filters are used to separate solutions from finely ground rock. The choice grade of product contains not less than 95% combined sodium and potassium nitrates and not over 1% of sodium chloride.

Chile has the world's monopoly of sodium-nitrate production. There are 174 *oficinas*, or nitrate plants, distributed over the province of Tarapacá; the departments of Tocopilla, Antofagasta and Taltal, in the province of Antofagasta; and at Aguas Blancas, a district in the province of Antofagasta.

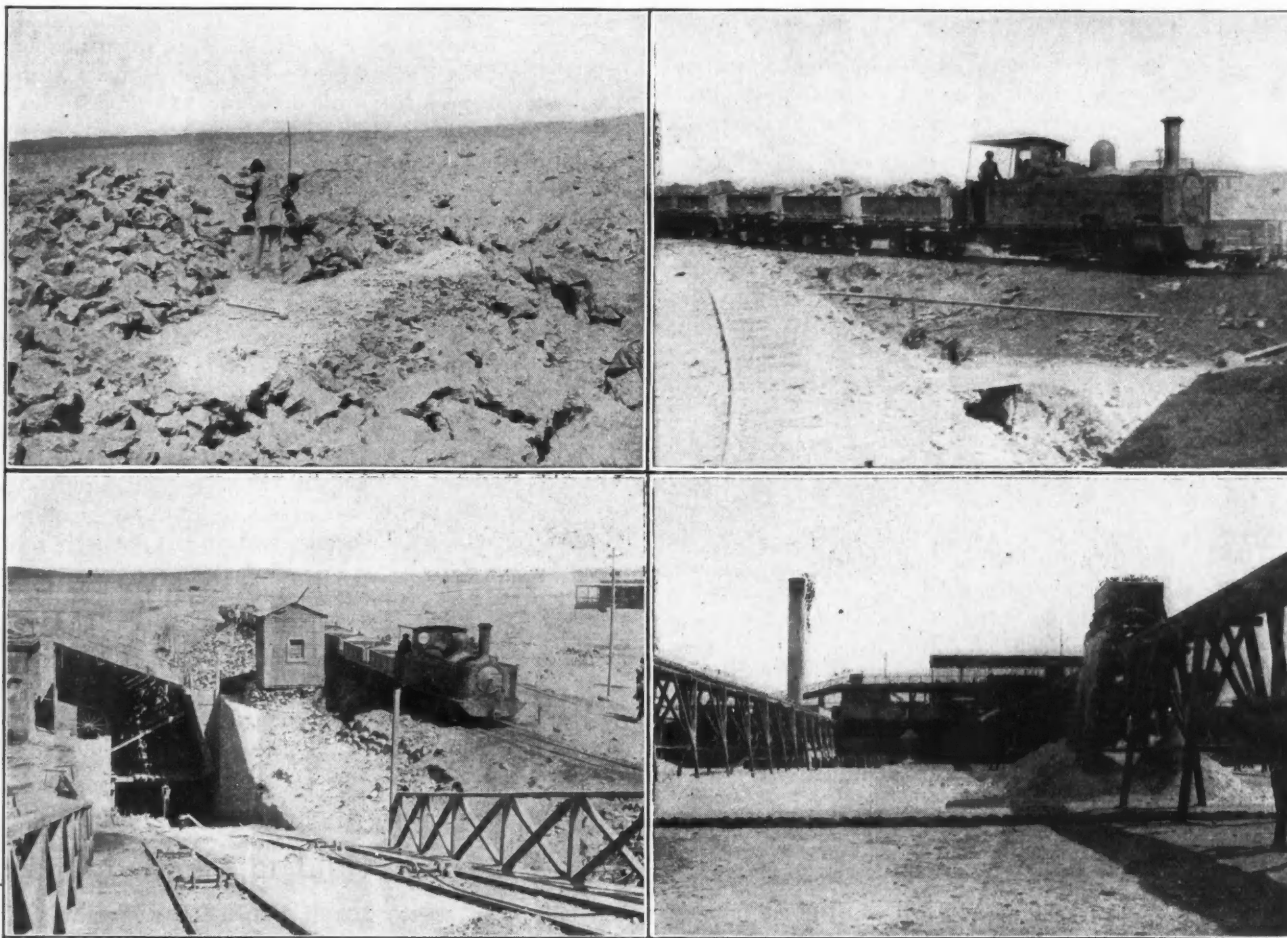
The available statistics for August, 1916, show that 30 of these *oficinas* were closed previous to the war and that

which 40,000,000, valued at about \$80,000,000, had been shipped.

The necessity for nitrate in the manufacture of certain munitions has largely stimulated the demand for the salt, but the comparison between peace and war statistics, and excluding the increases of the past few months, do not show the variation that might have been expected. This is largely due to the dislocation in shipping.

All calculations dealing with nitrate production and all statistics show the Spanish *quintal*, of approximately 100 lb., as the invariable unit of weight. Market quotations are based on the English standards of shillings and pence per *quintal*.

The principal importer of nitrate at the present time is the United States. Taking the period from July 1, to June 30, the year 1913-14 showed an import of over 12,000,000; during 1914-15 of over 13,000,000, and during 1915-16 of over 23,000,000 *quintals*. The United Kingdom is the next largest importer, with about 17,-



VIEWS AT THE CHILEAN NITRATE FIELDS

The upper illustrations show sorting at the Salitreras, and bringing the ore to the plant. The lower ones show dumping into crusher bins and dumping the nitrate at the patio for drying and sacking

34 have since suspended operations. The production for September amounted to 7,150,000 *quintals*, valued at over \$14,000,000. Up to the end of August the production for 1916 had been about 43,000,000 *quintals*, of

000,000 *quintals* during a similar period, 1915-16. Germany's imports, which stood at over 13,000,000 *quintals* in 1913-14, were reduced to under 800,000 during 1914-15, and none for the subsequent year. Japan, Russia, Spain, Italy and Denmark all show notable increases in import.

*Metallurgical engineer, 309 Broadway, New York.

The *caliche*, or nitrate-bearing rock, is carted from the *salitreras*, where the deposits are a few feet below the surface of the ground, to central loading stations. From here the material is hauled by locomotive in large trucks to the treatment plant. The *caliche* is hand-picked on the ground, and all fines are rejected, as the *borra*, or slime associated with the broken *caliche*, is viewed as that part of the product which not only yields nothing by the old methods of treatment, but actually leaves the plant carrying a larger percentage of nitrate than when it entered.

Rock breakers of the Blake or Blake-Marsden type are in general use to reduce the *caliche* to a size suitable for leaching treatment or further reduction. In the former case the jaws are set at about 1½ in. The *caliche* is easily broken, and the breaker wearing parts have a long life. Secondary breaking to produce a finer product is practiced only in a few instances. Symons disk crushers are used at the Irene *oficina* and take the whole of the product direct from the rock breakers. Rolls are also in use in other plants and have proved satisfactory.

At the Agua Santa *oficina* the fines, of sand and *caliche* dust separated by means of a shaking screen, are delivered to a bin and pass from there to the scoop feed of a Hardinge tube mill, where they mix with plant liquor. No return system for unground product has been arranged, and the whole of the tube-mill discharge passes to the Butters-filter plant.

LEACHING OF THE BROKEN CALICHE

Leaching of the broken *caliche* is performed in rectangular vats termed *cachuco*, built in nests and grouped together, thus affording economy in construction cost and minimum heat loss by radiation. The broken *caliche* is generally delivered to these by means of gable trucks of large capacity, so that two vats can be filled simultaneously. In some instances belt conveyors are used, and at Agua Santa a bucket elevator has been installed.

The capacity of the *cachuco* varies, but 80 tons or thereabouts may be taken as the average. A few inches from the bottom of the vat a removable screen rests on appropriate supports. This consists of steel plate in sections, perforated with circular holes or diagonal slits, and is the equivalent of the filter bottom in an ordinary cyanide leaching vat. Steam coils are arranged in each vat to raise the temperature of the percolating liquor and to facilitate the solution of the nitrate contained in the *caliche*.

Cooking with steam is continued until an economic percentage of the nitrate is removed, the solvent solution used being the *agua vieja*, or "mother liquor" from the crystallizing tanks. The nitrate contents of the liquor are gradually enriched by passage from one vat to another until hydrometer tests show that it contains sufficient nitrate for satisfactory crystallization.

Washing of the vat contents after drainage of the strong liquor is done by circulating sufficient cold water through the material in a single vat until the bulk of the dissolved nitrate is removed; or the wash water may follow the same course as the leaching solution. The residue, or *ripio*, is discharged by hand into trucks through large bottom-discharge gates, and the trucks are drawn to the dump by locomotive.

Underneath the perforated plates, or *crinolinas*, of the leaching vats a deposit of *borra*, or slime, accumulates. The amount of *borra* thus found varies with the class of

caliche being handled and, according to its quantity, necessitates the frequent or occasional removal of the *crinolina* and the shoveling of the slime into the residue trucks. This slime carries a high percentage of moisture in the form of nitrate liquor. The loss from this source is considerable in some plants where *borra* percentage is high, and insignificant in others where only a small amount of slime finds its way below the *crinolinas*. In some cases the screen has to be removed and the space cleaned out after each charge. In the latter case the *borra* discharged may represent 5% of the tonnage of *caliche* treated, and the loss of nitrate is then considerable.

The *caldo*, or strong liquor, is tested by hydrometer at every stage of the process, and when a satisfactory density has been reached, it is passed to one of several *chulladores*, or settling tanks, from which the clear liquor is decanted by pipes which can be lowered into the tanks by means of screw joints. Lime, flour and guano are all used as coagulating agents to hasten settlement. The efficiency of the last two in this capacity may be somewhat difficult to understand, but the action is obvious and results are satisfactory.

The decanted *caldo* passes to the *bateas*, or crystallizing tanks, where it is allowed to cool. The stage at which it is advisable to decant the *agua vieja* is indicated by soundings of the *batea* to ascertain the depth of crystallization, and is adjusted as nearly as possible to insure crystallization of the maximum of nitrate with the minimum of salt.

After drainage of the remaining liquor in the *batea*, the crystals of nitrate are allowed to dry and are then shoveled into trucks and tipped to the sacking patio, where further exposure to the abnormally dry air of the locality reduces the moisture to 1% or so.

The salt which occurs in the *caliche* in varying quantities (according to locality) is redeposited to a considerable degree on the *ripio* during leaching. A proportion which forms the invariable composition of the *caldo*, or liquor going to the crystallizing tanks, is precipitated in the vats receiving the cold liquor from the latter, and is periodically dumped with the *ripio*.

Approximately half of the nitrate produced is known as "95 and 1%," or refined nitrate. This means that the shipped material must carry at least 95% of combined (sodium and potassium) nitrates, and less than 1% of salt. This grade is insisted upon for munition work. The nitrate is shipped in sacks carrying approximately one quintal each and is weighed in bulk on the railroad cars.

CHEMICAL CONTROL OF OPERATIONS

In addition to hydrometer testing previously mentioned (which corresponds to routine titration work in the cyanide plant), a large amount of analytical work is carried out in the laboratories connected with the *oficinas*. It is imperative that the nitrate produced be high-grade and with a minimum of chlorides or sulphates. Refined nitrate may be produced from some classes of *caliche* with little difficulty and by adopting no more than ordinary precautions against the inclusion of more than the prohibited percentage of salt or sulphate. In other instances the interfering chemicals occur in such quantity or combination that crystallization with the nitrate is inevitable, and the value of the product is consequently lowered.

Various methods of estimating the nitrate content in *caliche* or *ripio* are in practice, the simplest being by ferrous sulphate titration. The local adaptation of this method has the advantage of being exceedingly rapid and is sufficiently accurate for the purpose. Ten grams of the ground sample is weighed out and mixed with 250 c.c. of cold water. The nitrate is readily soluble with shaking, and the supernatant liquor can be drawn off after a few minutes. Twenty-five cubic centimeters of the clear solution is then taken and acidified with excess sulphuric acid, and the titration is then made in a porcelain dish by running 10% ferrous sulphate solution from a burette. The end point is shown by the change from yellow to buff color, and a correction is sometimes made by deducting $\frac{1}{2}$ c.c. from the burette reading before the calculation of nitrate content is made.

An analytical estimation of salt, sulphates (in terms of sodium sulphate), moisture and insolubles contained in the shipped material is made. The nitrate content is then calculated by difference.

The nitrate produced carries varying proportions of the potassium and sodium salt, the bulk being in the latter form.

With regard to a statement of extraction results, any reliable figures would be difficult to obtain. As a general rule the nitrate would seem to be evenly distributed

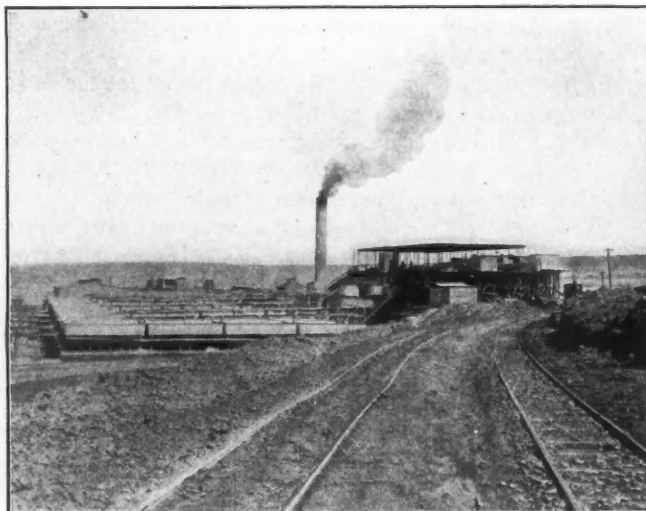
The sample-reducing equipment is generally so primitive that with a *ripio* carrying any considerable variation in nitrate content it would not be wise to ignore the probability that the final sample taken for assay might not be representative.

Where an attempt is made to calculate the assay extraction by means of estimated content of nitrate in *caliche* and *ripio*, the neglect to adjust the latter figure to represent per ton originally handled, results in an excess of nitrate actually produced over that shown by theoretical estimates. With a *caliche* assaying 15% and a *ripio* assaying 5%, the theoretical extraction is not 66.6% of the nitrate brought to the plant. It is necessary to know the actual tonnage of nitrate and salt, or the actual tonnage of *ripio*, before extraction figures are available, thus:

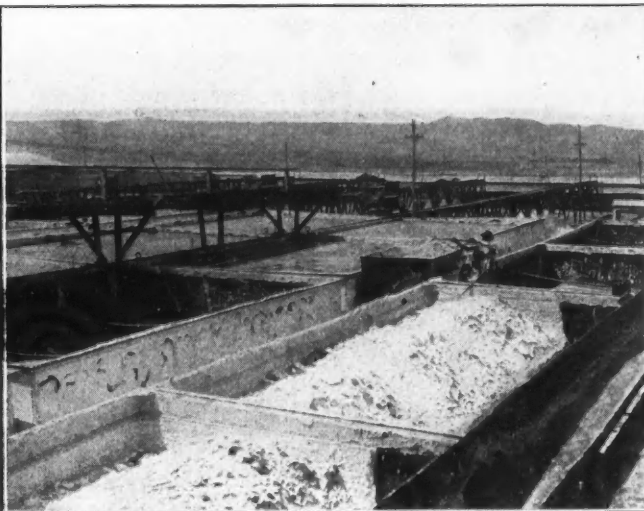
Tons caliche originally handled.....	100.0
Tons nitrate produced.....	15.0
Estimated original nitrate content, 100 tons \times 15% =.....	15.000
Estimated final nitrate content, 89.5 tons \times 5% =.....	4.475
Theoretical extraction; that is, 70% of 15 tons.....	10.525

A GENERAL VIEW OF THE METHODS USED

Considering the extraordinary simplicity of the old method of working, the results are good in many instances, and actual recoveries of 70 to 80% of the nitrate brought to the *maquina* are by no means uncommon. The owners have invested an enormous amount



A GENERAL VIEW OF THE OFICINA



EMPTYING THE CRYSTALLIZING TANKS

in the *caliche*, so that the assayed sample of "heads" should approximate the actual content. Assuming the correctness of this figure and also that of the estimated weight of *caliche* treated, it would be possible to arrive at the amount entering the treatment plant. The returns of nitrate shipped and its analysis would supply the other figure, which would be needed in order to compile actual recovery results. Assay extraction results might be obtainable if it were possible to arrive at any reliable estimate of the nitrate contained in the *ripio*, *borra* or sand discharged as residue, and their respective tonnages. As a matter of fact, any estimate made in this direction would be mere guesswork and the results correspondingly approximate. In some instances assays of a special material, carrying much nitrate and being periodically discharged as residue through faulty plant design, are made for local information only, and the nitrate thus lost is not included in the generally supposed value of the residue.

of capital in their plants, on which depreciation charges are infinitesimal when compared with the corresponding expense in a modern slime-treatment plant. Like many other industries, it has been accused of conservatism for not immediately adopting new schemes and processes when the latter have proved successful in other cases and under other conditions. But it is obvious that any alternative equipment involves capital expense and must not only yield enough to cover amortization, interest and depreciation charges, but must show a distinct advantage over other methods.

The bugbear of the old process is the *borra*, or slime. This is evidenced by the fact that in *oficinas* where the *caliche*, even after secondary breaking, contains only a small percentage of *borra* the results are good.

It is evident that the nitrate in the *caliche* is easily dissolved, and although it would seem that there is a considerable loss of nitrate in those plants where crushing is not carried far enough (where untouched nitrate

may be seen in the center of the larger lumps on the *ripio* dump), it must be admitted that all-sliming is out of the question. Any improvement must be carried out along lines which recognize that (a) the *caliche* must be crushed to a degree permitting free percolation of the solvent liquor, and no more, and (b) the subsequent method of treatment must be simple and cheap, involving the minimum of power-consumption. If the whole product could be treated in one handling, so much the better.

The benefits of secondary crushing are evident from the results of those *oficinas* that have made the change. And even in the case where a slime plant may be added, the improved results in the leaching plant, brought about by handling a finer and more homogeneous product, may be overlooked in a statement of increased yield.

A further effect of finer crushing prior to leaching is that the percentage of voids in the leached product is lowered and the amount of slime washed below the *crinolina* by the action of the percolating liquors is considerably reduced.

The treatment of the *borra* associated with the *caliche* is the main problem for consideration. Fresh points to be solved are encountered with ordinary wet classification methods on account of the high specific gravity of the liquor in circuit, and its tendency to crystallize on lowering of temperature or exposure to the air. To separate the slime efficiently in the dry state is a difficult matter on account of the clogging of any screening apparatus used.

By the use of shaking screens it has been proved possible to separate a sand-and-slime product from the material to be leached. Tube milling (since it has been duly recognized that this is essentially a sliming operation with high power consumption) is not indicated. The mixing of such fines, preparatory to separate treatment, could be carried out in vortex mixers with one-tenth the power consumption and with an elimination of practically the whole of the renewal and upkeep costs of tube mills.

The metallurgy of the process presents many interesting problems, and the results of further research with modern ore-handling and filtration equipment will be awaited with interest.

Australian Loading Plant for Steamers*

The iron-ore deposits of the Broken Hill Proprietary Co. are situated at Iron Knob, 34 mi. N. W. of Hummock Hill, on Spencers Gulf, South Australia. Open-cut quarrying is employed to mine the ore, which is transported by incline railways to the head of a main gravity incline. As there are several quarries, this is the simplest form of transportation. From a bin at the bottom of this incline the ore is conducted to the coarse-crushing plant, where a reduction to 3½-in. is effected. From small receiving bins in front of each crusher the ore is transferred by means of a rubber-belt conveyor to the main storage bin at the shore end of the loading dock. The total storage capacity of this bin is 30,000 tons, of which 15,000 tons can be fed by gravity through the chutes to the 36-in. conveyor belt.

*Excerpts from an article entitled "Quarrying and Shipping Iron Ore" in "Mining and Engineering Review," Sept. 5, 1916.

The conveying plant to transmit this ore to the steamers consists of a set of seven conveyor belts 36 in. wide and ¾ in. thick, discharging from one to the other until the end of the jetty, 2290 ft. in length, is reached. Six of these belts are, roughly, 400 ft. between centers, and each section is driven by a 75-hp. induction motor, running at 485 r.p.m., suitably connected by a double set of gearing to bring the main belt drum down to a peripheral speed of 350 ft. per min. Each of the belts (one of which is shown in the illustration) is elevated near the discharge end at an angle of 15 deg., high enough to provide sufficient discharge room to the next belt. The ore is transferred by means of suitable steel chutes from one belt to the other. All chutes are lined with hard-iron wearing plates to provide against the abnormal wear due to abrasion. The last section of the belt is elevated at an angle of 15 deg. to a vertical height of 25 ft. and discharges upon a short 36-in. belt with 65-ft. centers. This belt is fitted on a steel boom, on which a 25-hp. driving motor is also attached, and the whole structure is fitted with track wheels and so arranged to move out over the vessel's hold to a distance of 28 ft. The vertical rise of No. 7 conveyor belt is necessary to provide sufficient headroom for loading large empty vessels. The boom is a steel latticework structure of the cantilever type, 70 ft. long, running on rails, and is propelled forward or backward by means of a capstan winch, driven by a motor through suitable gearing. The distance this boom can be moved forward is ample to reach the center of the steamer's hold. A swinging chute 10 ft. long, attached to the end of the boom, can be lowered into the ship's hold if desired. The speed of the boom belt is fixed at 420 ft. and all other belts at 350 ft. per min.

The rated capacity of the belt is 1000 tons per hr., and this tonnage has been conveyed without difficulty. All belts are fitted with trough idlers spaced at 3-ft. 6-in. centers on the loading side and flat rollers on the return. Suitable tightening gear of the tension-pulley system, with a suspended weight box, is provided on each belt.

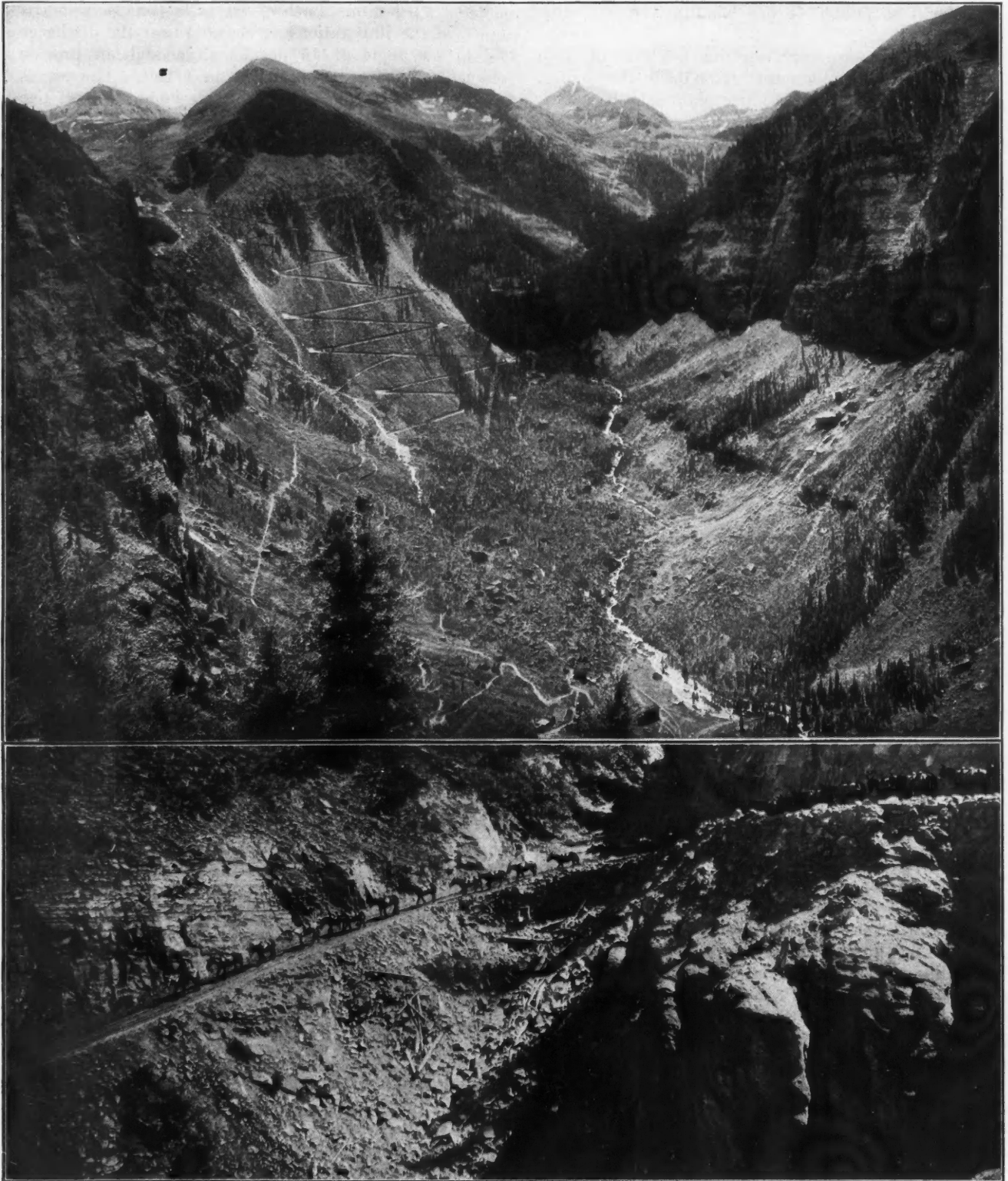
Telephone communication is established between the jetty terminal and power house. Also a reliable system of emergency control in case of accident, is fitted the full length of the jetty and under the storage bins. This consists of a pair of separate electric cables starting from the extreme end of the jetty and terminating on the feeder panel of the main switchboard of the power house, where a magnet is placed directly under the tripper of the main switch. Switches are installed every 200 ft. for the full length of the jetty, and should a serious mishap occur at any part during loading operations, the tripping of any one of these switches will cause the electric current to be cut off and the motors on the jetty to be brought to rest. The power plant providing electric current consists of a 600-hp. engine direct-connected to a 420-kw. generator of 525 volts, running at 167 r.p.m.

Efficiency of Compressed Air Installations

In the *Journal* of Jan. 20, 1917, p. 135, the last formula inadvertently had a plus sign substituted for a minus sign. The correct formula is

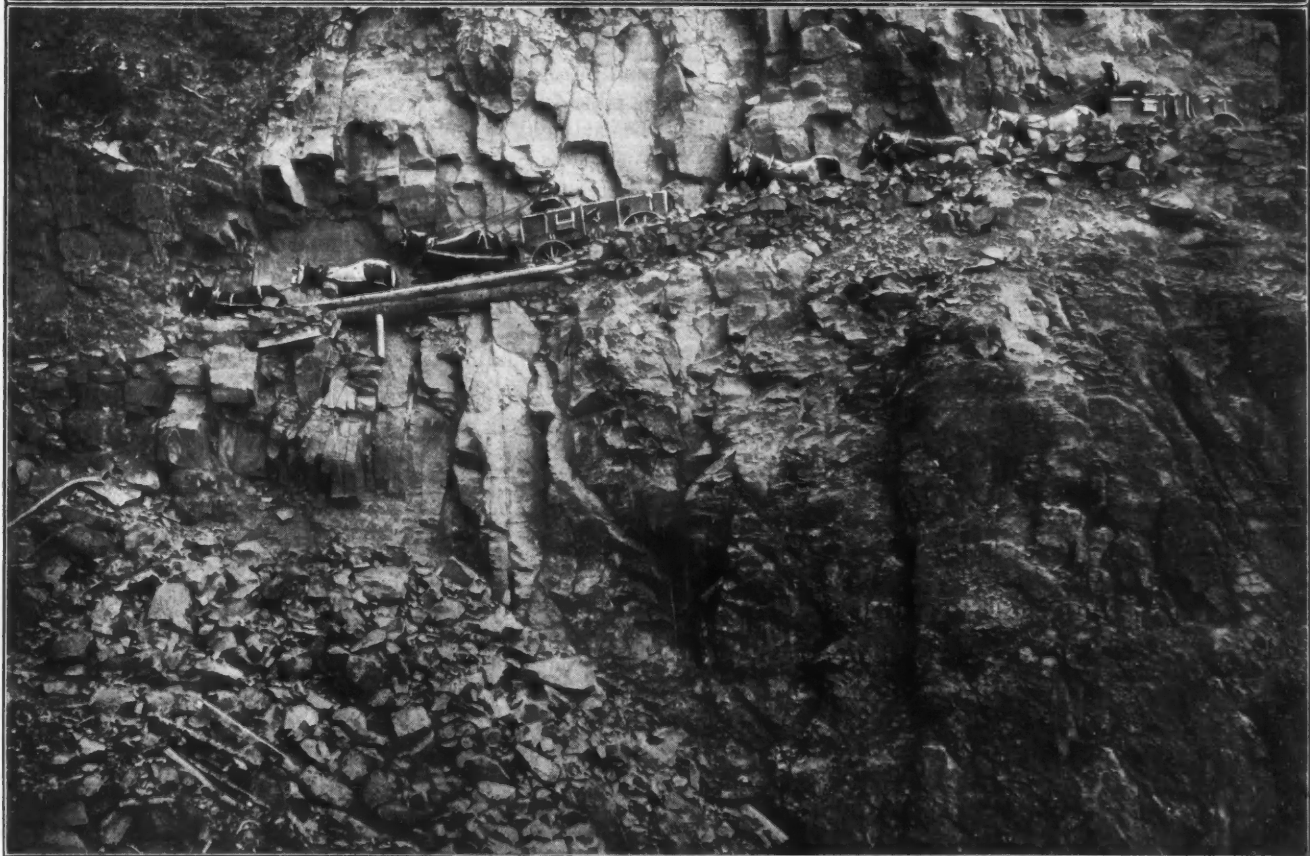
$$T_2 = T_1 \left(\frac{P_2}{P_1} \right)^{\frac{n-1}{n}} = 0.29$$

Photographs from the Field



VIEWS IN THE SAN JUAN COUNTRY, SOUTHWESTERN COLORADO

The mines in this precipitous region are situated at high altitudes and many of the supplies are still transported on muleback, and the products shipped out in the same manner. Note the numerous loops of the road necessary to negotiate the mountain in the left center



THE ROADS TO THE SMUGGLER AND TO THE TOMBOY MINES

The road to the Smuggler mine is shown in the top view and in the lower illustration are six-horse teams coming from the Tomboy mine

Correspondence and Discussion

The Presidency of the Institute

The present rivalry for the next presidency of the Institute between Sidney J. Jennings, of New York, and Philip N. Moore, of St. Louis, has excited much interest, and incidentally there has been published some deprecation of any competition for this office and some urging of the election of Mr. Jennings on the ground that he is the "regular" nominee.

I dissent strongly from this position, as no factor is more promising for the future health and vigor of the Institute than to have a wholesome rivalry for this highly important office. The lack of this spirit resulted in the moribund condition that caused the sloughing off of many of the most active, strongest members into the Mining and Metallurgical Society, and had it not been for hard work and vigorous measures pursued by the recent "insurgents", the Institute would have finally landed on the rocks with the dry rot that was slowly but surely sapping its existence. All honor to the "insurgents" for coming to the rescue of the Institute and for uplifting it to a plane where it is accomplishing much greater results and rendering far superior service to its members than ever before in its history. The continuation of this upbuilding and the inciting of greater interest on the part of its members will be promoted by the present happy condition of having two candidates for its highest office.

The nominating committee rendered a signal service in promoting the prosperity of the Institute by suggesting two names for the presidency, even if for legal reasons it thought it did not have the power officially to present more than one name and had to suggest that the second name be secured by special petition, which latter was promptly done.

That either candidate will be a credit to the Institute their professional record assures and the high standing of all the members of the nominating committee is a guarantee that in suggesting two candidates it carefully considered the best interests of the organization. The function of the nominating committee has been entirely too perfunctory in the past in presenting slates that were usually made up by an inner circle that represented an extremely small fraction of the Institute. The present committee should therefore be grateful for receiving the views of the astoundingly large number that took the trouble of informing it as to their preference for the future occupant of the presidency. While the preference of the great majority of the members in this preliminary ballot for the Western candidate was regarded by some of the committee as having been expressed in too informal a manner to receive its just and fair recognition, its chairman has put the Institute under obligations in establishing a promising precedent by having at least two candidates. Competition and a healthy, vigorous rivalry is not only a fundamental requirement for successful, enduring business, but is equally necessary for the health and vigor of any social or professional organization, and

the past record of the Institute is certainly an illuminating warning of the danger of its absence.

If the majority of the members of the Institute are not big enough and sufficiently broad-minded to appreciate the value of a healthy, friendly rivalry for the highest post in the Institute, then it is time to consider the dropping of the first word in the Institute's title—"American."

St. Louis, Mo., Jan. 20, 1917.

H. A. WHEELER.

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Regarding Engineers and Efficiency

It is the custom, whenever an American consul has nothing else to do, for him to sit down and write a scathing letter concerning the underpayment of postage by his fellow countrymen. But after taking great pains to get a foreign return postal on which to send a question to a foreign country, and having it come back with an extra stamp on its face and all of the reverse taken up with a lecture on the typically American trait of not repaying replies, I thought this might be only a consular tradition.

However, from more recent experiences I expect the worst is probably true. Having received applications for Belgian Kiddies stock, circulars, etc., on unsigned letters, and on letters with addresses of more or still more abbreviated character, and having sent out the appropriate replies to everything received to the best approximation obtainable to the name and address, I now have a table full of stuff returned by the parental Post Office Department accompanied by any number of official admonitions on the advisability of putting real names and addresses on letters.

So maybe that is where your Belgian Kiddies mail is. And for the benefit of engineers in general I give the following advice: After affixing your signature to a letter, then write (or print) your name; street addresses are always helpful, and should be given; but as there are several Colorado Streets in the United States, a town address is of great assistance. Occasionally it is desirable to add the state.

Profanely yours,

SECRETARY BELGIAN KIDDIES.

New York City, Jan. 29, 1917.

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The Fume

The undersigned, who must needs remain *incognito*, is about to begin the preparation of copy for the *Fume*, to be published during the meeting of the American Institute of Mining Engineers, Feb. 19 to 22, inclusive. Contributions are solicited from the profession on any topic and in any vein.

The articles may be long, short or medium; historical, biographical or fanciful, illustrated or unillustrated.

Interesting personal anecdotes are particularly desirable. All material should be addressed care of the *Journal*, to the

FUME EDITOR.

New York, Jan. 27, 1917.

Details of Practical Mining

Mine Unwatering with Air Lift

By S. H. BROCKUNIER*

The unwatering of the Herman mine at Westville, Calif., recently accomplished, presented some unusual features. The large pump had been submerged through the carelessness of a foreman, and the small pumps, while efficient, were not capable of handling the water rapidly. It was therefore decided to try air lifts.

The shaft was inclined at an angle of 52 deg., and was 400 ft. deep. When the mine was closed down, three years before, 256 ft. of 4-in. air column was left in the shaft, with the expectation of using it for air to run the pumps and drills at a higher level. The lower end was therefore closed, but water leaked in and the column was found full.

It was decided to use this air pipe for the lift, but before doing so it was necessary to shoot the lower end off and this involved several nice problems. The length of the column was first carefully measured by weighting a steel tape and lowering it within the column. It was then calculated where a shot should be placed to come midway between the wall plates of the shaft, near the bottom of the pipe, so that it would not disturb the timbers.

The cartridge was prepared by binding four sticks of 40% dynamite tightly together, priming it with two electric detonators, attaching their terminals to No. 18 insulated copper wire, carefully binding the connections with waterproof tape and daubing the latter with pitch. In order to use the insulated wire for lowering the cartridge, as well as for firing it, a half-hitch was made with the wires around the cartridge, securing them firmly, so that there would be no pull on the detonators. The cartridge was weighted by attaching to it a piece of 1-in. pipe cut to such a length that it would support the cartridge at the place, above the bottom of the column, where it was desired the explosion should occur.

The preliminary tests were made with the insulated wire and detonators by firing a pair of detonators under water, after a submergence of half an hour, when it was found that it took six ordinary dry cells connected in series to get good results. When everything was ready, the cartridge was lowered nearly to the bottom of the column before meeting an obstruction—a tee, as was afterward found. If it had not been for the pipe weight, the work would have been held up at that point, but by gently raising and lowering the cartridge, the pipe finally guided it by the obstruction and landed firmly on the bottom, as was shown by a mark previously measured off on the conducting wires. Several hundred feet more wire was then run off and connected to one terminal of the batteries; it was then a simple thing to fire the cartridge by touching the other terminal of the batteries to the remaining conducting wire. Subsequent unwatering

showed that the column had been cut cleanly at the exact point desired.

The factors for the air lift were now: 5000 ft. elevation, compressor capacity 1250 cu.ft. free air per minute compressed to 100 lb., 253 ft. of 4-in. pipe in shaft at slope of 52° giving a vertical head of 199 ft. From these data it was decided that a 1½-in. air pipe within the column would furnish sufficient air to lower the water to the second level, at 164 ft., starting with a submergence of 100% and stopping with a submergence of 33%. As a matter of fact the air lift began to balk at 40% submergence, and failed to unwater as far as the station by 20 ft., thus necessitating the lowering of the air lift to reach it.

A pump head was made by grinding down a 1½-in. return elbow until it would slide inside the 4-in. pipe. To one side of this was screwed the 1½-in. air pipe and to the other side a 1½-in. nipple 9 in. long. On the upper end of this nipple was screwed a cap perforated with ⅜-in. holes, to act as the air vent for the lift. This pump head, with air pipe attached, was then lowered inside the 4-in. pipe to near its bottom, and the air turned on, with the usual result of inexperience—too much air used, resulting in shower baths for onlookers. However, the flow of air was soon regulated and the water flow for several weeks, night and day, averaged 180 gal. per min., as measured over a dam. Subsequently, two additional lifts were put in, consisting of 2-in. pipe with side inlets of 1-in. pipe with ¾-in. nozzles. These delivered 40 gal. per min. each. All failed below 40% submergence.

The consumption of air and power to operate these lifts was much higher than the theoretical figures, but this is partly explained by a break that was found in the large water column after unwatering. After reaching a depth of 164 ft. the remainder of the unwatering had to be done by pumps. This was much slower, even with the smaller amount of water contained in the lower workings.

It is uncertain whether the shot caused the break in the column, two lengths above the location of the shot, or whether it was there before. The air could be heard bubbling up, but the trouble could not be located. If anyone should repeat this experience and hear air bubbling or boiling in the mine, our advice is to first locate the break by raising and then lowering the air pipe within the column and listening to the sound. If the break is too far up, it will be best to abandon the fixed column if possible and lower another. This would be rather a difficult job in an inclined shaft full of wreckage of stulls and timbers, but by careful manipulation and using a large wooden cone attached to the lower end of the column, as described by E. H. Emerson, in the *Journal* of Oct. 14, 1911, it might be accomplished.

It was expected to submit careful tests of power and air consumed, but the break of the main column rendered these useless for comparison with normal working conditions.

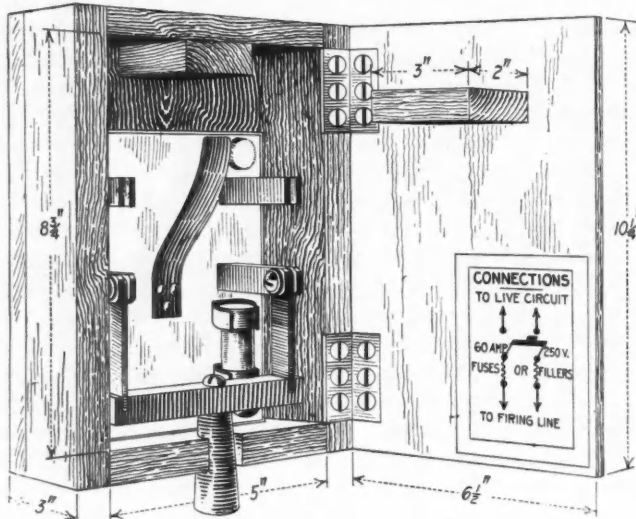
*Mining engineer, Nevada City, Calif.

But even with these unfavorable circumstances six weeks' time was saved and the cost was \$1330 less than it would have been had the pumps available not been used—judging by their expense and rate of work when they were used after abandoning the air lifts.

A Safe Electric Firing Switch

By A. C. DAMAN*

In electric shot firing two general sources of current are usually employed; namely, by means of a hand-operated generator or directly from a source of electrical energy. If the latter method is employed, it is of extreme im-



AN ELECTRIC FIRING SWITCH FOR BLASTING

portance to have a switch that cannot remain closed after contact is made. In the accompanying sketch, which is self-explanatory, I have incorporated many safety-first details in orders to make the switch absolutely foolproof.

Standard Dampers, Breechings and Stacks

At a convention of the Smoke Prevention Association in St. Louis, the following recommendations, abstracted by *Power*, Jan. 16, 1917, for dampers, breechings and stacks for high-pressure steam-power plants were offered by Osborn Monnett, formerly chief smoke inspector of Chicago.

For horizontal return-tubular boilers the dampers should occupy the full width of the available opening and have a free area 25% in excess of the combined area of the tubes. No type of damper plate that restricts the opening should be used. In water-tube boilers a free opening of one-quarter the grate surface should be provided, and the dampers when wide open should hang in such a manner as not to obstruct the movement of the gases. It is recommended that no damper be placed in the main breeching.

The breechings should be as short and direct as possible, preferably having a direct run without turns into the stack. No right-angle turns should be used. If necessary to install a breeching with turns, the latter should be in long-sweep bends with a radius on the center of the turn of not less than the diameter or width of the

breeching. The breeching should not dip below the horizontal, but should have an easy slope upward to the stack. The connection from the breeching to the stack should be preferably at an angle of 45 deg. Breechings should not be constructed of brick or other porous material subject to leakage. Breechings made of steel plate should have angle irons on the outside and have no projections on the inside to resist the flow of the gases. Lagging should be on the outside, where its condition can be readily inspected, where repairs can be made without interrupting the operation of the plant and where loose pieces will not obstruct the flow of the gases. Clean-out doors should be provided at convenient points for the removal of accumulations of soot.

For water-tube boilers the area of the breeching should not be less than 22% of the total area of the grate surface served, or a ratio of breeching to grate surface of 1 to 4 1/2. For horizontal return-tubular boilers the area of the breeching should be 25% in excess of the total area through tubes. Breechings should preferably have a round or square section. In case of rectangular shape, one side should be not more than one-third greater than the other.

Stacks should be located so as to give the most favorable run of breeching possible. Steel stacks should be lined for a height equal to 10 times their diameter. For water-tube boilers the free area of the stack at the smallest point should be not less than one-fifth the area of the total connected grate surface, where the stack is less than 150 ft. high. Where the stack is over 150 ft. high, the area should be not less than one-sixth the grate surface. For horizontal return-tubular boilers the stacks should have an area in free opening at the smallest point 25% in excess of the combined area of the tubes served.

A good formula for calculating the draft available from a certain height of stack is

$$D = 0.52HP \left(\frac{1}{T} - \frac{1}{T_1} \right)$$

in which

D = Draft in inches of water;

H = Height of the stack above the grate in feet;

P = Atmospheric pressure in pounds per square inch;

T = Atmospheric temperature, absolute;

T_1 = Absolute temperature of the stack gases.

For convenience the values of the product $0.52 \times P \left(\frac{1}{T} - \frac{1}{T_1} \right) = K$ have been calculated for a number of different flue-gas temperatures at sea level and 60 deg. F. atmospheric temperature. The formula becomes $D = KH$, the values of K being as follows:

Temp. Stack Gas	K	Temp. Stack Gas	K	Temp. Stack Gas	K
750.....	0.0084	600.....	0.0075	450.....	0.0063
700.....	0.0081	550.....	0.0071	400.....	0.0058
650.....	0.0078	500.....	0.0067	350.....	0.0053

To provide for frictional resistance, 0.001 should be subtracted from the constant K . Let $K - 0.001 = U$, giving the ultimate constant U . Therefore, to find the available draft in a stack of given height, multiply the height of the stack by the constant corresponding to the flue-gas temperature; or $D = HU$.

To find the height of stack above the grate necessary to make available a given draft at a given flue temperature, divide the draft required by the constant corresponding to the temperature; or $H = \frac{D}{U}$

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Editorials

Smelting Capacity of the United States

For a considerable number of years the *Journal* has published in its annual statistical number a summary of the copper-, lead-, and zinc-smelting capacity and copper-refining capacity of North America. These figures are the compilation of reports furnished by the several metallurgical companies at the end of each year. Yet in spite of this official character, they are not to be regarded as precise, and this is primarily for the reason that smelting capacity itself is not precise. Almost any works rated at a certain normal capacity has a plus or minus. It may be forced to considerably more than normal capacity, perhaps by the neglect of upkeep, and at a later date may be capable only of much less than normal capacity during a period when deferred maintenance must be made good. A further source of error in such statistics is misunderstanding on the part of the reporting company as to just what constitutes capacity, or the terms in which it is asked that it be reported. Making allowances for such uncertainties, however, the compilations are of great value as a closely approximate survey of the American capacity for smelting ores and producing metals.

In stating lead- and copper-smelting capacity, we adopt as the unit the ton of furnace charge, exclusive of coal or coke, and express the figures in terms of tons per annum. If an ore be self-fluxing, the ton of charge and ton of ore are the same thing; also if ores can be mixed so as to be self-fluxing, which of course is ever the aim of the good smelter. This acme of metallurgical practice is seldom attained, and in general the ore is a percentage—95, 90, 85, or 80, as the case may be. Owing to this variable, the ton of charge is manifestly the correct unit. Copper-refining capacity is, however, expressed naturally as pounds of copper. Zinc-smelting capacity is conveniently stated in number of retorts, which in America are of substantially the same size. The capacity per retort used to be figured at about $4\frac{1}{4}$ tons of spelter per annum, but in 1915 and 1916 it has been less, and in 1916 may not average more than $3\frac{1}{2}$ tons per annum owing to diminished percentage of extraction, and possibly lower grade of ore smelted.

COPPER-SMELTING WORKS OF NORTH AMERICA
Annual Capacity at Ends of Years in Tons of Charge

Year	Blast Furnaces	Reverberatories	Converters	Total
1913.....	22,116,236	6,156,500	509,778	28,782,514
1914.....	22,522,457	6,466,450	610,438	29,599,345
1915.....	22,265,657	7,887,000	662,200	30,814,857
1916.....	22,443,000	8,367,300	951,422	31,762,122

SMELTING AND REFINING CAPACITY OF NORTH AMERICA
Annual Capacity at Ends of Years

Year	U. S. Electrolytic Copper Refineries, Lb.	N. A. Silver-Lead Smelteries, Tons of Charge	U. S. Zinc Smelteries, Number of Retorts
1911.....	1,494,000,000	87,800
1912.....	1,648,000,000	100,744
1913.....	1,768,000,000	7,173,000	110,746
1914.....	1,778,000,000	7,025,600	120,494
1915.....	1,892,000,000	7,200,000	155,388
1916.....	2,488,000,000*	7,555,000	212,326

The table of copper-smelting capacity reveals some interesting things. In the first place, the blast-furnace

capacity is much the greatest, yet by far the more copper is probably made by the reverberatories. The explanation of this is that the reverberatories work generally on concentrated ore of relatively high grade—even as high as 40% copper—while the blast furnaces are employed for smelting run-of-mine ore averaging much less in copper content. In the second place, it will be noted that blast-furnace capacity has been about stationary during the last four years, while there has been a great increase in reverberatory. With the increased exploitation of low-grade ore deposits, the increased employment of mechanical concentration and improvements in reverberatory-smelting practice, the reverberatory attained unchallenged preëminence. This is clearly reflected by the statistics. The increase in ore smelted in converters simply corresponds with the increase in copper production. With more copper to convert, there have to be more converters, and naturally more ore is charged in them.

In a second table are grouped the lead-smelting, zinc-smelting and copper-refining capacities. These figures require scarcely any explanation in addition to what has already been given. The silver-lead smelting capacity exhibited but little change in 1913-15. Even in those years there was a great surplus on the books, for the reason that through changes in the mining industry many works had lost important sources of ore supply. Thus it is many years since the Colorado plants have been able to obtain sufficient ore in their territory to keep all their furnaces going. A good deal of this capacity ought to be written off. The increase in 1916 was due chiefly to a new plant in the Northwest.

As for the zinc smelters and the copper refiners, the figures speak for themselves. The great increases in 1915 and 1916 reflect the demands created by the war. In two years since 1914 the production of zinc in the United States has more than doubled. The smelting capacity has not increased in the same proportion, for at the end of 1914 the country possessed fortunately a large surplus. Nevertheless the increase shown by our figures is sufficiently spectacular.

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Increased Cost of Mining and Smelting

At the December meeting of the New York Section of the Mining and Metallurgical Society of America there was a very interesting and valuable discussion of the manner and extent in and to which recent conditions have affected the cost of mining, smelting and refining. The members present, who participated in the discussion—men like Walter Douglas, vice-president of Phelps, Dodge & Co.; J. Parke Channing, vice-president of the Miami Copper Co.; H. H. Alexander, manager of the Perth Amboy works of the American Smelting and Refining Co.; Captain Stout, manager of the works of the Nichols Copper Co.; George C. Stone, chief metallurgist of the New Jersey Zinc Co.—were competent to give authoritative testimony on the subject. The version of this interesting

discussion, given in the bulletin of the society, is reproduced elsewhere in this issue of the *Journal*. Unfortunately it is well-nigh impossible to report such discussions with all the interesting details, comments, etc.

A testimony of these high authorities revealed some important things. There was a sharp line of demarcation between the miners and smelters of the West and the refiners of the East. The former united in reporting no particular increase in the cost of production per pound of copper, although the cost of labor and all supplies had increased immensely. On the other hand, the smelters and refiners of the East had a tale of woe. The zinc smelters, like the lead and copper refiners, reported enormous increase in the cost of smelting, but naturally they could not draw very long faces about it in view of the large profits that are known to have been made in that industry.

The explanation of the discrepancies in the reports from East and West is rather simple. The Westerners treat the raw material and deal with large tonnages. Increased unit costs for labor and material have been offset by increasing the tonnage worked; that is, although the dividend has increased, the divisor has also been increased with the result that there is not much change in the quotient. The Easterner, on the other hand, deals with the concentrated product and from the nature of his business, moreover, is unable to increase his divisor in the same ratio as his dividend, wherefore his quotient has gone up.

Everybody agreed that readjustment from existing conditions is going to produce serious problems. The Westerners, who have arranged for payment for wages on a sliding scale, have much less dread of this than the Easterners. The latter have been troubled, not only by repeated demands for increased wages, but also by growing and serious deterioration in the efficiency of their labor—as to that everybody agreed—and they contemplate with uneasiness the prospect of what may happen when it becomes impossible to allow to labor so much as it is getting now.

The Traffic Delay

In our market reports for several weeks back we have been speaking of the extraordinary delay in the movement or freight, a delay that recently has been becoming more and more serious. In the metal markets, and indeed in other markets, this has lately become a factor of major importance. Consumers who contracted last October and November for the supplies of lead, spelter, etc., that they expected to need in January, and not having received them when January came, were in many cases obliged to buy from dealers and speculators all of the near-by supplies that could be obtained. Persons having such supplies naturally took advantage of the situation. The copper business was affected similarly, refiners being unable to get their expected supply of crude copper from the West.

We draw to this situation the attention of some producers of ores in the West—such as tungsten ore, molybdenum ore, etc.—which have to come all the way to the East. Some of them have informed us that they are unable to get offers for their product anything like the quotations in New York. A partial explanation of this, anyway, is that their ore is not in New York, and even if it be put on the cars, nobody can tell when it will get

here. This uncertainty naturally enters into the consideration of buyers who are negotiating for ores in Colorado and elsewhere.

The congestion on the railways is naturally playing a very important part in the markets for copper, lead and zinc. An immense stock of those metals is locked up in railway cars, whence it will some day be released. In the meanwhile there is a renewal of pronounced scarcity in many consuming districts where they are needed.

The Randall Rider

The Randall Rider came a cropper and broke its neck. But Mr. Randall, being apparently a persistent person, has introduced the same idea in the form of an independent bill, which is designated HR-20,204.

It is easier to fix attention upon an independent bill than it is upon a rider, which being attached to some necessary appropriation bill may be carried through with the measure on which it is hitched. Ability to load an important bill with such riders is one of the vicious things of our existing system of legislation.

We do not think that Mr. Randall's bill will stand much chance of passage in this session of Congress, the present Congress expiring automatically on March 4. However, it will be wise for everybody interested to keep his eyes open, lest Mr. Randall's new bill be sneaked through.

American Smelting and Refining Company

The project of the American Smelting and Refining Co. to retire the preferred stock B of the American Smelters Securities Co., following the previous step of retiring the debenture bonds of that company, is obviously another movement toward simplification of the affairs of the two companies, which once were very complicated. Explanation of how the complications originated need not be repeated, but as the business of the two companies developed, it became increasingly evident that discrimination as to ownership of property, contract rights and many other things was troublesome. In the affairs of a house where ownership and rights were not identical, some opposition on the part of the holders of American Smelters Securities preferred stock A, expressed within the last few days, is illuminating of the very things that it is sought to cure.

The first step toward simplification was taken when the smelting company purchased from the Guggenheim Exploration Co. the common stock of the Securities company held by the latter. This concentrated all the common stock of the Smelters Securities company in the hands of the Smelting company. The next step was taken when the retirement of the debenture bonds of the Securities company, convertible into common stock of the Smelting company, was announced recently. This left as the premier issue of both these companies the B preferred stock of the Securities company, which holds the leading place by reason of being not only preferred as to earnings of the Securities company, but also guaranteed as to dividends by the Smelting company.

It is now proposed to issue a first mortgage on the properties of the Smelting company, and exchange the preferred stock B of the Securities company for these

mortgage bonds. Except for removing one more issue of the Securities company, the exchange makes little difference, the interest rate being the same. The holders of the B stock obtain a security which as a mortgage bond will probably rate somewhat higher sentimentally, but for all practical purposes this preferred stock, with the guarantee behind it, possesses all the elements of security of a bond.

When the exchange was announced, opposition was expressed on the part of owners of Securities preferred A that a mortgage should be put ahead of their stock. This opposition was naturally dispelled when it was explained that the mortgage was being placed on the property of the Smelting company, with which the Securities company had nothing to do, wherefore the position of Securities preferred A was altered in no wise. However, this illustrates what the administration of the Smelting company is driving at, we think, and we anticipate that at some opportune time steps will be taken to eliminate the Securities preferred A and bring the ownership of all property and of all the business unqualifiedly into the hands of the American Smelting and Refining Co.

Great interest is exhibited in the election of president of the American Institute of Mining Engineers. The total vote, from present indications, will run nearly to 3,000, which will be a remarkably large percentage of the maximum possible.

BY THE WAY

A market that depends for its strength upon the continuing slaughter of men, the continuing suffering of women and children and the continuing destruction of civilization is a market that the devil himself might hesitate to call his own.—New York World.

Bisbee is adding to its interest as a great center of mining by the prospect that it is going to have a big openpit mine in the near future. The Copper Queen is now making plans for steam-shoveling Sacramento Hill to take out one of the disseminated orebodies in the porphyry stock by that method. Thus does the fame of Bisbee increase.

The following resolution was passed by the Board of Directors of the American Institute of Mining Engineers, at its meeting on Jan. 26, 1917: "In the name of all the members of the American Institute of Mining Engineers, this Board extends to Herbert C. Hoover, an honored vice-president of the Institute, on the occasion of his present temporary return to his native land, the cordial welcome of his colleagues, and their congratulations upon the noble work splendidly done by the Commission for Relief in Belgium of which he is the head. It is understood that a leading purpose of Mr. Hoover's visit to America, at this time, is the collection of additional funds, to be administered by his Commission in the care of the destitute children of Belgium. To this enterprise, endorsed by both the belligerent parties, as well as inspired by the purest and tenderest sentiments of humanity, contributions are solicited from engineers,

especially through an organization known as the 'Belgian Kiddies, Ltd.' which this Board, heartily approving its object and method, recommends to the consideration of the members of the Institute. On motion duly seconded it was unanimously voted, That this minute be spread upon the record of the Board, and published in the Bulletin, and that a copy thereof be transmitted to Mr. Hoover, and to the San Francisco Section of the Institute."

January Mining Dividends

Mining dividends paid in January, 1917, by 41 United States mining companies amounted to \$11,856,270, as compared with \$6,758,276 paid by 30 mines in January, 1916. Metallurgical, holding and steel companies paid \$8,879,019 in 1917, as against \$4,231,879 in 1916, while Canadian, Mexican and Central American companies paid \$1,639,348 in January this year, against \$1,732,257 in 1916.

United States Mining Companies		Situation	Per Share	Total
Ahmeek, c.	Mich.		\$4.00	\$800,000
Allouez, c.	Mich.		3.00	305,000
Ariz. United, c.	Ariz.		.01	25,000
Bunker Hill & Sullivan, l.s.	Ida.		.50	163,500
Caledonia, l.s.	Ida.		.03	78,150
Camp Bird, pfd.	Colo.		.18	110,361
Cerro Gordo	Calif.		.05	50,000
Continental Zinc	Mo.		.50	11,000
Cresson, g.	Colo.		.10	122,000
Doctor Jackpot, g.	Colo.		.01	28,441
Dragon Cons.	Utah		.01	18,750
East Butte, c.	Mont.		1.00	†411,000
Electric Point, l.	Wash.		.01	18,000
Golden Cycle, g.	Colo.		.03	45,000
Hecla, l.s.	Ida.		.15	150,000
Hercules, l.s.	Ida.		.25	250,000
Homestake, g.	S. D.		.65	163,254
Inspiration, c.	Ariz.		2.00	2,363,934
Iowa, g.s.	Colo.		.003	12,500
Iron Blossom, s., l.g.	Utah		.10	100,000
Iron Cap Copper, com.	Ariz.		.20	120,502
Iron Cap Copper, pfd.	Ariz.		.35	15,685
Isle Royale, c.	Mich.		2.00	300,000
Midwest Sulphur	Wyo.		.01	4,125
Moscow, s.l.c.z.	Utah		.023	22,500
Nat. Zinc and Lead, l.z.	Mo.		.02	10,000
N. J. Zinc	U. S.		10.00	3,500,000
North Butte, c.	Mont.		.75	322,500
Oaks Co., pfd., g.s.	N. M.		.10	169
Osceola, c.	Mich.		6.00	576,900
Pittsburgh-Idaho	Ida.		.05	40,885
Portland, g.	Colo.		.03	90,000
Shattuck Arizona, c.	Ariz.		1.25	437,500
Silver King Coalition, s.l.z.	Utah		.15	187,500
Tonopah Belmont, g.s.	Nev.		.123	187,504
Tonopah Extension, s.	Nev.		.15	192,420
Tonopah Min., s.	Nev.		.10	106,000
United Cop. Min., c.	Wash.		.01	10,000
United Verde, c.	Ariz.		1.50	450,000
Utah Apex, c.	Utah		.25	132,000
Vindicator, g.	Colo.		.03	45,000
Metallurgical, Holding and Steel Companies		Situation	Per Share	Total
Am. Smelters, pfd. A.			1.50	249,747
Am. Smelters, pfd. B.			1.25	375,000
Bethlehem Steel, com.	U. S.		7.50	1,114,600
Bethlehem Steel, pfd.	U. S.		1.75	260,000
Brier Hill Steel, com.	U. S.		3.50	424,690
Brier Hill Steel, pfd.	U. S.		1.75	87,500
*Cleveland-Cliffs, l.	U. S.		2.50	184,253
Crucible Steel, pfd.	U. S.		2.00	500,000
Eagle-Picher Lead, pfd.	U. S.		1.50	15,000
Greene Con., holding	Mex.		1.00	1,000,000
Gulf States Steel, com.	U. S.		2.00	65,686
Gulf States Steel, 1st pfd.	U. S.		1.75	22,050
La Belle Iron Wks.	U. S.		1.00	99,154
Nova Scotia Steel, pfd.	N. S.		2.00	21,200
Penn. Salt Mfg.	Penn.		2.00	100,000
Pittsburgh Steel	Penn.		22.00	1,540,000
Republic Iron & Steel, pfd.	U. S.		5.75	1,437,500
Sloss-Sheffield, pfd.	Tenn.		1.75	117,250
United Alloy Steel			1.00	†500,000
U. S. Smelting, com.	U. S.-Mex.		1.25	438,894
U. S. Smelting, pfd.	U. S.-Mex.		.871	425,555
Canadian Mexican and Central American Companies		Situation	Per Share	Total
Alaska Goldfields, g.	Yukon		.10	25,000
Cons. Min. & Sm. Co., c.z.	B. C.		.623	210,695
Crown-Reserve, s.	Ont.		.05	88,441
Hollinger, g.	Ont.		.05	240,000
La Rose, s.	Ont.		.05	74,931
Lucky Tiger-Com., g.	Mex.		.09	64,380
McKinley-Darragh-Savage, s.	Ont.		.03	67,431
N. Y. & Hond. Rosario	C. A.		.50	100,000
Nipissing, s.	Ont.		.50	600,000
Peterson Lake, s.	Ont.		.013	42,032
Porcupine Crown, s.	Ont.		.03	60,000
Tough-Oakes, s.	Ont.		.123	66,438

*Paid also stock dividend of 35% calling for distribution of \$2,580,000 in new shares. †Initial dividend.

Personals

Albert G. Wolf has gone to California on professional business.

H. C. Wilnot has returned to New York after a trip to Chile and Peru.

R. Gilman Brown has removed his office to 7 Gracechurch St., London, E. C.

B. B. Gottsberger, general manager of the Miami Copper Co., is visiting New York.

W. H. Wright of the Malm-Wolf Co. is examining placer ground in Jefferson County, Colorado.

O. C. Martin has been made works manager for the Nichols Copper Co., Laurel Hill, Long Island.

Dr. A. R. Ledoux left New York on Jan. 28 for a business trip. He will return early in February.

Harry L. Day, of Wallace, Idaho, was in Washington last week to deliver the electoral votes of his state.

Daniel C. Jackling has sold his steam yacht "Cyprus" to the Russian Government for a price said to be \$650,000.

R. L. Herrick, recently of the editorial staff of the Engineering and Mining Journal, is now with the Ingersoll-Rand Co.

H. M. Eakin has taken charge of the Georgia property, Chloride, Ariz., in place of J. A. Jacobson, who resigned recently.

Justice Gragan left New York on Jan. 26 for Canada. On Feb. 3 he will leave for Cuba on professional business, to be gone about six weeks.

W. W. Taylor, vice-president and general manager of the Oriskany Ore and Iron Corporation, Lynchburg, Va., has resigned to take up other business.

Lausen Stone, superintendent of the Pittsburgh station of the Bureau of Mines, was in Washington last week conferring with Director Manning.

C. V. Hopkins, chief engineer of the United Verde Copper Co. and the United Verde & Pacific R.R. of Jerome is spending two weeks in New York.

James M. Platt has accepted the appointment as mine superintendent for a British mining company in Peru, and will sail for that country before Feb. 1.

W. R. Ingalt has been appointed, by the Director of the U. S. Bureau of Mines, chairman of the Committee of Consulting Engineers on Mining Law Revision.

Chas. E. Lawrence, president of the Lake Superior Mining Institute, was honored with a banquet by Menominee range mining men at Iron River, Mich., Jan. 20.

J. B. Tyrrell left Toronto on Jan. 25 for the Rice Lake district, of Manitoba, where he will examine one of the gold-mining properties that has been most fully developed.

J. P. Bickell, of Toronto, has been chosen president of the McIntyre-Porcupine Mines, Ltd., to succeed the late Col. Alexander M. Hay, and E. F. B. Johnston has been elected a director.

George Giffault, for many years connected with Flitz, Dana & Brown, metal dealers, New York, has become identified with the staff of the North American Copper Co., 52 Vanderbilt Ave., New York, effective Jan. 22.

William Herman, a "cleanup man" at the Butte & Superior mill lost his right hand and sustained serious injury to his shoulder when his hand became caught in a pulley in the mill early in the morning of Jan. 20.

W. M. Weigel has resigned as associate professor of mining at Pennsylvania State College to accept the position of superintendent of concentration for the International Molybdenum Co., Ltd., with headquarters at Renfrew, Ont.

Dr. Edw. Fitch Northrup, research physicist of Princeton University, has been awarded the Elliott Cresson medal by the Franklin Institute of Philadelphia "in recognition of his electrical inventions and high temperature investigations."

H. T. Liang, of the American office of the Wah Chang Mining and Smelting Co., Woolworth building, New York, shortly will return to Changsha, China, where the headquarters of his company are located, for a visit of several months.

Dr. Otto Sussman, of the American Metal Co., of New York, spent the week in Butte conferring with D. F. Haley of Wallace, Ida., who has been making an extensive examination of

the Butte property of the Butte & Superior Mining Co.

William Forsstrom has resigned the position of chief engineer of the LaBelle Iron Works, Steubenville, Ohio, to accept a similar position with the Youngstown Sheet and Tube Co., Youngstown. H. H. Roberts, assistant chief engineer, has been appointed to succeed Mr. Forsstrom.

George L. Collard, general superintendent of the three blast furnaces of the Shenango Furnace Co., Sharpsville, Penn., has been elected president of the Chamber of Commerce of Sharon, Penn. He succeeds in this position Severn P. Ker, who is president of the Sharon Steel Hoop Co.

Dr. M. E. Wadsworth, the first president of the college, now emeritus dean and professor of mining geology in the school of mines of the University of Pittsburgh, gave an address at the recent thirtieth anniversary celebration of the Michigan College of Mines. The subject was, "The Michigan College of Mines in the Nineteenth Century."

Herbert C. Hoover was the guest of honor at a reception and dinner at the Bankers Club, Jan. 29, given by John Hays Hammond and the Rocky Mountain Club. He will be the recipient of all possible courtesies on the occasion of his visit to Washington next week, due to the efforts of mining men and geologists of the Capital. He will be the honor guest at a luncheon on Feb. 6 to be given by the American Mining Congress at the University Club. On Feb. 5 he will be the guest of Mr. and Mrs. Hennen Jennings at dinner. Other affairs in Mr. Hoover's honor are being arranged.

Obituary

Col. Herbert Hughes, director of the well-known steel firm of William Jessop & Sons, Ltd., Sheffield, England, died last week, aged 64 years. He was an eminent lawyer, was lord mayor of Sheffield in 1905-1906, and was prominently associated with the volunteer forces in England, having acted as brigadier-general. He was at one time a member of the Advisory Board at the War Office. Colonel Hughes represented the British Government at the International Conference on Trademarks, held at Washington, D. C., a few years ago. He also represented that government in a similar capacity at conferences held in Berlin and Madrid.

Howard L. Elton, an American mining engineer, was executed at Oaxaca, Mexico, by agents of the de facto government on Dec. 16. He was tried and convicted of aiding rebels—according to the dispatches, by purchasing ore stolen from a mine confiscated by the Carranza administration. Elton was arrested last August, and in September his case was brought to the attention of the United States Government; at the time, the State Department was understood to have succeeded in getting a commutation of the sentence to 20 years, as it was asserted that Elton did not know when he purchased the ore that it had been stolen. A Washington dispatch now states that "reopening of the case enabled Elton to produce no evidence that altered the findings of the court."

Societies

Northwest Mining Convention will be held at Spokane, Wash., Feb. 19 to 25, 1917. A large attendance is expected.

Idaho Mining Association held its fourth annual convention at Boise, Ida., Jan. 16 and 17, 1917. The session on the first day was held at the Boise Commercial Club and included technical addresses on "Flotation in 1916" by O. C. Ralston; "Metal Development of Southern Idaho in the Past Year," by Robert N. Bell; "Cyanidation of Ores," by F. C. Brown, and "Value and Scope of State Mining Bureaus and Geological Surveys," by Prof. E. K. Soper, of the University of Idaho. The second day brought forth a first-aid demonstration by the Hecla crew, and a lantern-slide exhibited prefaced by remarks on the lead industry of the Coeur d'Alenes, by Stanley A. Easton.

American Association of Engineers was organized 19 months ago with the object: "To raise the Standard of Ethics of the Engineering Profession and to Promote the Economic and Social Welfare of Engineers." It now has 1550 members. It embraces all varieties of technical engineers, civil, electrical, mechanical, chemical, mining, etc. As a portion of its routine activities this organization will hold on Feb. 8, 1917, a national promotional convention under the slogan of "For the Good of the Engineer." This convention will be held in the La Salle

Hotel, Chicago. There will be papers and addresses on subjects of business imperative to the profession. The discussion will be of a nature to interest all kinds of engineers.

Engineers' Society of Western Pennsylvania will hold its annual meeting of the mining and metallurgical section at the Society rooms, Oliver Building, Pittsburgh, on Tuesday, Jan. 30, 1917. The technical part of the meeting will consist of a typical discussion on "The Possibilities of Smokeless Operation of Heating Furnaces and Soaking Pits." The discussion will be participated in by A. N. Diehl, Asst. Gen. Supt., Duquesne Works, Carnegie Steel Co.; Julian Kennedy, Consulting Engineer; John S. Unger, Mgr., Central Research Bureau, Carnegie Steel Co.; M. F. McConnell, Superintendent, Mingo Works, Carnegie Steel Co.; W. E. Snyder, Mechanical Engr., American Steel & Wire Co.; H. C. Stebert, Steam Engr., Duquesne Works, Carnegie Steel Co. and W. O. Renkin, Chief Engineer, A. M. Byers Co.

Canadian National Clay Products Association—The fifteenth annual convention of the Canadian National Clay Products Association was held at Hamilton, Ont., Jan. 23-25 with about one hundred members in attendance. President J. Edward Frid, of Hamilton, delivered the opening address and Mayor Booker extended a cordial welcome on behalf of the city. Among the papers read and addresses given were the following: "Success in a One-Horse Tile Yard," by John T. Miner, of Kingsville, Ont.; "The Practical Application of Pyrometers to the Burning of Clayware," by J. P. Goheen, of Philadelphia; "Clays in and Around Hamilton" by Joseph Keele, of the Ceramics Branch of the Mines Department, Ottawa. In connection with the latter paper some of the products of Hamilton shales were exhibited. The use of clay products in engineering was treated by E. H. Darling, C. E., of Hamilton, and J. F. Allen, of New London, Ohio, spoke on labor-saving devices in soft mud brick plants. Principal George L. Sprague dealt with industrial training in the Hamilton Technical School. Several of the industrial works of the city were visited by the delegates. The following officers were elected: President, Greaves Walker, Toronto; 1st vice-president, Thomas Kennedy, Swansea, Ont.; 2nd vice-president, Wm. Burgess, Tomdorden, Ont.; 3rd vice-president, Ryland H. New, Hamilton; secretary-treasurer, Gordon Keith, Toronto; councillors, C. B. Lewis, Milton; D. A. Lochrie, Toronto, J. S. McCannell, Milton; H. Desjardins, Montreal; Walter Clark, Coruyuna; T. H. Graham, Inglewood; C. A. Miller, Toronto and G. A. German, Toronto. The annual banquet was held on the evening of the 24th at which Judge Riddell of Toronto was the guest of honor and the principal speaker.

American Institute of Mining Engineers is completing plans for the social side of the 114th meeting, at New York, Feb. 19-22. Each day of the session will have some special social feature for both the men and women attending the convention. On the evening of the opening day of the meeting, a reunion celebration will be held in the Engineering Societies' Building. Five hundred persons are expected in attendance at this affair, which will be of the nature of an informal smoker, motion picture show, and entertainment. On the second night of the convention, the annual dinner will be held at the Hotel Astor, at which the retiring president, L. D. Ricketts, and the incoming president will make addresses. There will be dancing during and after the dinner. On the evening of the third day of the convention, an exhibition will be given of the technicolor standard films, which is the projection of moving pictures in natural colors from black and white films. This is the first time an exhibition of this process has been given publicly. Probably the most interesting social feature of the convention will be a trip on Washington's Birthday to West Point. In the past year, the mining engineers have cooperated in the organization of the country's industrial resources for military preparedness and a strong bond of common interest has developed between many military officers and officials of the Institute. The delegates to the convention will go to West Point by special train, where there will be riding exhibitions, an address by an officer of the post, and an inspection of the grounds and buildings. The ladies' program for the week includes theatre parties, the witnessing of motion picture making, and a visit to the art galleries of Senator W. A. Clark.

Industrial News

Noble Electric Steel Co., San Francisco, recently shipped to Philadelphia 50 tons of ferrochrome, the first such shipment from its plant at Herout, Calif.

Traylor Engineering and Manufacturing Co., has opened an office at 1414 Fisher Building, Chicago, Ill., in charge of L. J. Hewes, who for the last 36 years has been identified with stone-crushing machinery.

Editorial Correspondence

SAN FRANCISCO—Jan. 24

Relief for California Oil Operators in naval petroleum reserve No. 2 is proposed in an amendment suggested by the Interior Department as a substitute for the Phelan amendments to mineral-land leasing bill, in the Senate Lands Committee recently. It is probably the best that the oil men can get at the present session of Congress. The amendment provides that upon relinquishment to the United States, within 90 days after final denial or withdrawal of application for patent, the claimant shall be entitled to a lease for each location of 160 acres or less, upon a royalty of one-eighth of the production to be placed to the credit of the U. S. Navy. Provision is further made for staying of proceedings in the courts, brought or to be brought by the Government, until the Secretary of the Interior shall have passed upon applications for patent or lease, and for the final dismissal of such suits upon determination by the Secretary that the applicant is entitled to patent or lease.

The Mexican Mine, on the Comstock Lode in Nevada, according to the report of Superintendent Symmes for the last year, has been in an unfortunate position regarding exploration work. The company has been unable to follow the vein on account of water and also unable to work westerly from the east vein towards the main Comstock, on account of the large amount of hot water coming through the old west crosscut near the middle of the area. After the work done on the 2700 level the exploration of the main Comstock from the 2500 level was about all that remained. These adverse conditions are soon to be remedied, as the lowering of the water below the 2700 has been started. The company expects that the barren portion of these veins between the 2500 and the 2700 levels will not continue much deeper; when the water is lowered to the 2900 level it is expected to explore the east vein through the 2700-2900 winze. The company will then be able also to explore the main Comstock and hopes to find quartz below the point where it was shown along the diorite-dabase contact in the drifts from west crosscut No. 2 on the 2500 level. The Mexican mill for last year showed a total bullion production of \$431,569; bullion shipped from the mill, including ore and solution in the mill at time of prior report, \$446,010. Refining charges, \$2305. Cash received for all bullion shipped in the year, \$443,705. Of the bullion shipped, the Union, Sierra Nevada and Ophir were credited with \$417,739, being 90% of the gross assay value of the ore shipped to the mill by these mines. The ore from old Mexican dumps returned \$13,830. The total ore milled was 18,920 tons.

BUTTE—Jan. 25

Proposed Taxation of the Mining Industry continues to be the principal subject of conversation. On Jan. 18, C. F. Kelley, vice-president of the Anaconda company, by appointment, addressed the senate and house committees of the legislature, now in session at Helena, to whom has been referred the subject of the proposed special taxes. In his address, while incidentally referring to the activity and status of the Anaconda company, he pointed out that the mining industry as a whole is now bearing its full share of taxation while it was a matter of common knowledge that other property in Montana has not been taxed as provided by law and that there is ample wealth in Montana to sustain the just burdens of government. He made clear his statements by presenting indisputable facts and figures that were not generally known heretofore, regarding the mining and other industries in Montana, and in the end assured the lawmakers that if the state required more money the Anaconda company would conscientiously pay its share if the burden be distributed fairly and justly among all the industries of the state. Mr. Kelley presented facts and figures taken from the records of the Anaconda company for the last five years. From 1912 to 1916 inclusive he stated that the Anaconda company and its railway subsidiary, the Butte, Anaconda & Pacific Railway Co., have paid out in wages a grand total of \$106,641,125; for freight \$24,679,919; for fuel and power \$16,494,650; for lumber and timber \$8,059,844; for supplies \$35,794,855; for taxes \$3,768,588; for miscellaneous expenses and insurance \$9,335,732. This made a total of \$208,074,718 to which must be added \$13,016,725 paid out for custom ores making a total of \$221,091,443. "The foregoing shows," said Mr. Kelley, "that during the last five years, the Anaconda Copper Mining Co. has put back into circulation in the State of Montana, the enormous sum of \$218,091,443. Now

what about the toll that foreign capitalists are receiving from Montana's business? During the same period of time there has been paid in dividends the amount of \$53,887,500, made up of the following disbursements in the following years: 1912, \$10,831,250; 1913, \$12,997,500; 1914, \$9,077,500; 1915, \$9,325,000; 1916, \$11,656,250. During the last year the total amount of approximately \$63,000,000 was reinvested in Montana. An amount approximating \$200,000 a day was required to carry on the business of the concern. Practically 50% of this money was distributed in wages to the workmen employed directly by the company in this state. The number of men participating in this payroll has varied from 13,000 to 21,000 while indirectly a population in this state amounting to more than 125,000 people were interested in the success of this company. . . . For every \$100 distributed in dividends from all sources both within and without the State of Montana, there has been paid in taxes to the State of Montana \$7. In addition to this the Federal corporation and income taxes have also been paid. I venture the assertion that no other business enterprise in the State of Montana can show a more complete fulfillment of its tax obligations than is disclosed by the foregoing figures. . . . The assessment of the Anaconda company amounts to \$31,310,993, or 6.42% of the total assessed valuation of all property in the state. The total assessed valuation of all of the improvements in real estate in the State of Montana outside of city lots was \$24,223,881, so that the Anaconda company's assessment was approximately \$7,000,000 more than the total assessment on all improvements upon real estate in the State of Montana other than city property. . . . Aside from the uncertainties of mining, the mining business stands upon a plane peculiarly applicable to it alone, because of the necessity for a complete amortization of capital before any return can be regarded as profit. It is said that enormous dividends are earned by the Butte mines, that the business is tremendously profitable and such a conclusion is readily reached from a cursory examination of the figures. But do you realize that after all a mine is like a piece of cheese from which a slice is taken in each day's operations? Be the total amount large or small, there is only so much commercial ore existing in any deposit or in any locality. It is impossible to either replenish or replace the ore once taken from the ground. Do you realize that before you can, as a business proposition, count as profits a single dollar, you must return to the investor the amount which he has expended in capital?"

Labor Trouble in Marysville is threatening. Miners in the Marysville district, including those working at the Barnes-King company's Plegan-Gloster properties have formed the "Marysville Mine Workers' Union"—not affiliated with any outside organization. On Jan. 21 a committee of the union waited on Manager McGee of the company presenting to him the wage scale adopted by the union, providing an increase of 50c. per day over the prevailing scale which is \$3.50 per shift for miners. President Goodale of the company in commenting on the demand referred to the fact that in spite of the greatly increased operating costs and of supplies of every description, the company has not raised the charge to its men for board and room and has at a great expense erected a number of modern and well equipped buildings with improved sanitary arrangements and has taken great pains in the housing and boarding of its men. That in its efforts to revive the mining industry in the Marysville district the company has spent \$300,000 more than it has taken out in bullion; that there has been no increase in the price of gold as there has been in that of copper and zinc and that in view of these conditions the demanded increase in wages cannot be considered by the company at present. What will be the action of the miners as a result of the refusal, is not known at present writing.

Butte & Superior company is conducting a number of important experiments at its mill in Butte to determine whether, by a change in the process used, the requirements in the Minerals Separation case can be so complied with that it will not be necessary for the company to make a contract with the British company. These experiments are being surrounded with secrecy but are on an extensive scale. On account of the experiments now going on, it is said the January output of the Butte & Superior mill will fall materially below that of De-

ember. The mine, up to the time of the fire in the Black Rock shaft, was being operated at the same rate but the ores piled up for use later. Formerly it was with difficulty that the Black Rock shaft could furnish enough ore for the mill. Now the situation is reversed.

DENVER—Jan. 25

Shortage of Freight Cars is seriously affecting both metal and coal mining throughout the state. Metal mines are suffering through inability to ship ores as well as from lack of fuel. At Leadville, sinking operations in one of the New Monarch shafts were necessarily discontinued and the shaft has filled with water. The Wolfstone mine, on Jan. 25, was obliged to lay off its men temporarily for lack of cars, while the Down Town Mines Co., which recently began shipments of ore after its long, costly unwelcome project, is also prevented from making regular shipments. Similar conditions are reported from other districts.

Copper-Lead Find in Fortune Mine at depth suggests interesting possibilities for this old mine on Little Ellen Hill in the Leadville district. The Fortune produced rich gold ore in its earlier history and was worked down to a depth of about 1000 ft. before excessive pumping cost resulted in shutting down. The Yak tunnel now penetrates the property at a depth of about 1000 ft. so that future drainage will be materially lessened in expense. Leasers recently opened a new shoot about 60 ft. below the tunnel; while rich in copper and lead, the ore as at present developed carries but little gold.

SALT LAKE CITY—Jan. 24

New Development Campaign is planned by Utah Apex in Bingham Cañon. A recent report of Utah Apex Mining Co. shows this property to have had an unusually high record of earnings during the spring months of 1916—owing to much improvement in the grade of the shipping ore, together with a larger tonnage than ever before in history of the company. But milling ores during the period were depleted rapidly on account of the increased production taking place in a short time, with an equipment not adequate for a simultaneous corresponding amount of development. The third and fourth quarters showed marked decrease in tonnage of shipping ores, and mill ore was gradually exhausted, until in October there was not enough left to permit of operating the mill. A new five-year smelting contract has been made, as well as a contract with the Zinc Concentrating Co. to treat 12,500 tons of zinc-iron middlings, so that it is expected that additional revenue will be available from the zinc content of the ore, which has hitherto been lost. Work is being done to improve the general condition of the property. A new Nordberg hoist is being installed, and the shaft sunk, and a lower level driven in the expectation of developing additional shipping ore. The installation of the new hoist should be completed by March, after which development of milling ores will be resumed. The collar of the shaft—1000 ft. above the tunnel level—is so situated as to afford ample dumping ground, very little of which is available along the cañon, and the shaft which is now 500 ft. below the tunnel level, will be extended another 1500 ft., or 3000 ft. in all. A new power line is being put in by the Utah Power and Light Co., and should be finished early in February.

SEWARD, ALASKA—Jan. 10

Gold Shipment from Iditarod and vicinity reached Seward this evening on its way to Selby smeltery in California. Shipment consists of gold dust and bullion, valued at nearly \$600,000. It left Iditarod early in December and, with exception of last 40 mi., was conveyed entirely by dog teams, 46 dogs being used on the trip. With opening of Government railroad during coming summer, much prospecting in the Kenai Peninsula is expected; region was not active during the last season.

DEADWOOD, S. D.—Jan. 23

Homestake Power Development, following purchase of Cascade placer on Spearfish River, covering 6 ml. of stream, will nearly double this company's electrical energy. Construction of the new hydro-electric plant is to be begun at once. Four miles of the necessary water conduit will be of wood-stave pipe, while practically 1 ml. will be a tunnel through the rough country. The tunnel work will be done by contract, bids on which have been received. The plant will develop 3000 hp. at low water, and will supplement the electric energy now developed by water in the company's two units at Spearfish and Englewood. Other Homestake improvements include the enlargement of regrinding plant at

Lead, where three 5x14-ft. tube mills, two Dorr classifiers and amalgamating tables are being installed. During 1916 the mine yielded nearly \$7,000,000—of which over \$400,000 was from tungsten products—and paid \$2,210,000 in dividends. Wage bonus to employees, amounting to 7% of each person's earning during 1916, was paid at the January paydays.

JOPLIN—Jan. 27

Extensive Drilling in Kansas Field is assured by the recent acquisition of 1000 acres of leases by L. C. Church, of Joplin, and E. C. Mabon, of Miami, Okla., about 3 mi. north of Baxter Springs. Several drills will be moved to this section immediately.

Danger from High-Royalty Exactions by land-owners has been proclaimed by August Mayerhoff, editor of Commerce, Okla., "News," and himself an investor in mining properties. In editorial he declares that unless land owners and first-lease owners are more reasonable in their demands, trouble will eventually result. After careful investigation, he finds that the royalty charged throughout the district is from 12½ to 25% and that such high royalties will result in killing the entire district when ore prices drop. He pleads for the general adoption of a sliding scale of royalty charges, to be governed by ore prices. In another part of his paper appears a news item to the effect that Z. L. Douthat, a modest land owner at Tar River, Okla., is now receiving \$1100 weekly from royalties. The last week in December the lease on a 200-acre tract in the rich section of Oklahoma was auctioned off by a guardian for John Buffalo, the Indian owner. The high bid was 26%, but this bidder later backed out of the contract which finally was made to a St. Louis man at 22½%. Buffalo, who has since become of age, brought suit last week for annulment of the contract, charging that the high bid was part of a scheme to defraud him by keeping out other bidders.

HOUGHTON, MICH.—Jan. 25

Isle Royale's Milling Operations have gradually extended with its increasing tonnage but the report that three additional stamp heads would be used is probably an exaggeration. Isle Royale today has a three-head stamp mill all its own, handling approximately 60,000 tons a month. Besides that Isle Royale utilizes one head at the Point Mills plant of the Lake Milling corporation, at one time a subsidiary of the Centennial and Allouez properties, now under Calumet & Hecla management. The Lake Milling corporation owns

two stamp mills, one at Point Mills and one at Hubbell—the old Tamarack No. 2 mill, remodeled and rebuilt. At the first-named plant there are six heads operating and at the Tamarack two heads; two more are under construction at the Tamarack mill, so that this plant will have four heads ready for use in the spring. The Lake Milling, Smelting and Refining Co. is owned jointly by Superior, Isle Royale, Hancock, Allouez and Centennial. It is a custom mill designed to serve these companies first but willing to do other custom work when it has room. At present it cannot take care of the rock from its own mines. Of the 100,000 shares of the Lake Milling company, Allouez is the greatest owner of stock and therefore entitled to the greatest service. Allouez owns 36,000 shares, Isle Royale and Superior 19,000 each, Hancock 10,000 and Centennial 16,000. Isle Royale at present using one head out of eight all of the time and another head half of the time is getting her share of milling capacity from this plant. With the two more heads to be added in the spring Isle Royale would not be entitled to any appreciable increase in rock-milling capacity at the Lake Milling plant unless some of the other mines do not need it. And Allouez likely will need it. On the other hand it is well known that the Point Mills plant can have an addition of two more stamp heads at reasonable cost under normal conditions. These may be built next summer, but it would be impossible to have them ready for operation before September and then only at a high figure. The Isle Royale mill at Houghton is particularly advantageous because of the low railway freight charge on the ore, the mine owning its own railway and the haul being short. But the government authorities would not agree to a larger mill at the present site because of the danger of blocking the water way.

DULUTH, MINN.—Jan. 26

Tonnage Tax on Iron Ore proposed in bill just introduced in legislature by Representative Henry O. Borge. It calls for a tax of 2% ad valorem on iron ore mined, in addition to all other taxes; the money so collected is to be credited to the state's general revenue fund. The mining companies of the Mesabi, Vermilion and Cuyuna ranges will make a determined effort to defeat the measure. A tonnage tax bill passed the legislature several years ago, but was vetoed by Gov. J. Johnson. An effort was made in 1913 to get another bill through, but support was lacking.

Chances of Another I. W. W. Strike on the iron ranges have been reduced by the failure

of the effort of the Industrial Workers of the World to tie up the lumbering industry of northern Minnesota. The sentiment is now generally opposed to the I. W. W. and its methods of violence. A bill has been introduced in the legislature providing an annual fund of \$50,000 "for the suppression of emergency disorders." It provides that "whenever the sheriff of any county shall represent to the governor that there is impending in his county a probability of violations by a considerable number of persons of the criminal laws of the state, the governor shall authorize the appointment of a sufficient number of deputies to suppress the threatened disorders."

WASHINGTON, D. C.—Jan. 30

Proposed Revenue Bill is not highly pleasing to Democratic members of Congress from the mining states, as they feel that a large portion of the tax levied by this measure will be paid by the mining industry. At the same time the present bill is regarded as a great improvement over the singling out of certain metals to bear the brunt of taxation. Senator Thomas, of Colorado, thinks a tax on excess profits smacks strongly of class legislation and his view is shared by a number of other Senators and Representatives. The probabilities are, however, that the revenue measure is not sufficiently objectionable to the Democrats from mining states to cause them to vote against it. Northern Democrats are lukewarm in their friendship for the bill, due to the fact that the South will pay only a small proportion of the tax. Majority-Leader Kitchin, in attempting to meet this argument, declares that those who are making particularly large profits should be called upon to meet the extra taxation.

TORONTO—Jan. 26

Mining Claims of Enlisted Men in Ontario will be exempt from forfeiture until Jan. 1, 1918, according to action recently taken by the Ontario government which has again extended the time limit to men enlisted for active service.

Construction of Steel Works has been begun in Toronto by the Imperial Munitions Board, on a site of 60 acres in the Ashbridge's Bay industrial district. The primary object is to supply munition manufacturers with large quantities of high-grade steel. The raw material will be scrap metal and electric furnaces will be used, requiring 20,000 hp. There will be 10 six-ton 3-phase 25-cycle Heroult type electric furnaces, the total capacity being 300 tons daily. The cost is estimated at \$3,000,000 and the plant is expected to be in operation by July.

The Mining News

ALASKA

KENNECOTT (Kennecott)—Ammonia-leaching plant for tailings is to be enlarged. At the Beatson mine on Latouche Island, mill capacity being gradually increased to 1,000 tons; lately encountered a body of shipping ore carrying over 6% copper.

ARIZONA

Cochise County

MASCOT COPPER (Dos Cabezas)—Some high-grade copper ore, 4 ft. wide, exposed on 150-ft. level.

CALUMET & ARIZONA MINING CO. (Warren)—Has listed on New York Stock Exchange its 642,462 shares (par \$10). Listing statement shows total income for 10 months of 1916 to have been \$16,598,863; expenditures \$7,743,891; surplus \$18,748,634 of which \$8,764,971 represented net earnings of 10 months' period; investment account increased \$2,770,000 chiefly in acquisition of New Cornelia Copper bonds. Owns 2068 acres in Warren district; about one-half undeveloped; new shaft lately started on Regular claim, 2300 ft. from Junction shaft; has six working shafts; has blocked out 1,976,815 tons of direct smelting ore averaging 4.99% copper; also 831,000 tons averaging 1.75%. At Douglas, expending \$630,000 for enlargement of smeltery and \$800,000 for a 200-ton sulphuric acid plant. In New Cornelia mine at Ajo, 40,000,000 tons of 1.51% ore are reported developed.

Gila County

ARIZONA COMMERCIAL (Copper Hill)—Shipping about 180 tons daily, about one-half of which comes from 10th level; sinking shaft from 14th to 16th level; about 150 men employed.

OLD DOMINION (Globe)—About 1100 tons being hoisted daily; developing on 18th or lowest level; "K" shaft being sunk to this level. Pumping about 4,000,000 gal. per day. Milling about 900 tons daily, including some custom ore. Three blast furnaces operating. Flotation

concentrates being sent to International smeltery; flotation capacity at Old Dominion being increased to 900 tons.

IRON CAP (Copper Hill)—Cutting station at 1000-ft. level of Williams shaft; drifting on ore in winze already down to this level.

SUPERIOR & BOSTON (Copper Hill)—Cross-cutting at 1400-ft. level will be undertaken as soon as station at that level is completed. A 500-gal. pump is to be installed on the 12th level.

MIAMI MERGER (Miami)—Corner in this stock on New York Curb resulted in stock advancing in three days from 22c. to \$1.62½ on Jan. 24. Stated that William Sulzer, former governor of New York, will assume presidency on absorption of 30 additional claims which he controls on west of company's property; six other claims also added to holdings, making total of 106.

Mohave County

UNITED EASTERN (Oatman)—First cleanup will be made at mill about Feb. 3.

BIG JIM (Oatman)—Shaft down 580 ft. Station to be cut at 600 level and crosscut driven to vein.

ARIZONA MOLYBDENITE MINING (Yucca)—Company has begun construction of 150-ton flotation mill.

TOM REED (Oatman)—On 400 level from Aztec shaft, passed through 30-ft. vein; high-grade ore in raise on foot wall.

GOLD ROAD (Goldroad)—North branch vein opened in two places 400 ft. apart on tunnel level; will crosscut to vein 200 ft. deeper.

BULLION HILL MINES CO. (Chloride)—Organized by Knight interests of Provo, Utah, to develop property on Bullion Hill, near Tennessee mine.

Pima County

MILE WIDE (Tucson)—Crosscut on 200 level cut 10 ft. of chalcocopyrite ore; on 125-ft. level orebody was 25 ft. wide. Compressor and power plant ordered. H. G. Brown, superintendent.

NEW CORNELIA (Ajo)—Structural ironworkers returned to work Jan. 16, refusing to recognize longer the jurisdiction of Local 88, International Union of Mine, Mill and Smelter Workers (Western Federation of Miners). Over 700 men now at work.

Pinal County

MAGMA CHIEF (Superior)—Work begun on 1800-ft. tunnel; Charles Kumke, superintendent.

CHOLLA COPPER CO. (Miami)—Organized by E. R. Rice, of Inspiration Needles, and G. F. Shaw to develop Henry Owen group of 12 claims, 18 mi. from Hayden.

Yavapai County

ARIZONA POWER CO. (Prescott)—Construction begun on new auxiliary steam-power plant to be erected 3 mi. north of Clarkdale; will be connected up with company's other power lines. M. V. Watson, manager.

Yuma County

PARKER SYNDICATE (Parker)—Copper sulphides encountered by churn drills at 150-ft. depth.

CALIFORNIA

Amador County

PLYMOUTH CONSOLIDATED (Plymouth)—Milled 11,120 tons yielding \$56,500; working expenses \$28,700; development \$5840; surplus over working and development, \$22,100; capital expenditure, \$2100.

Calaveras County

SOUTH CAROLINA (Carson)—Contemplated refinancing reported. Property situated southeast of the Finnegan; developed by tunnels and gloryhole; the latter having caved, work has lately been confined to smaller veins.

QUAIL HILL (Milton)—Newman & Albertson, leasers, reported to have disclosed 7-ft. vein of copper ore at depth of 70 ft. Development includes 100 ft. of stoping. Equipped with 20-hp. hoist and 20-hp. compressor, which will be increased if development proves satisfactory.

TULLOCH (Carson)—New shaft now down 650 ft.; will be deepened to 800 ft., at which level it is reported a vein had been disclosed by diamond-drilling in the Santa Ana, an adjoining property.

Mariposa County

VIRGINIA (Coulterville)—Vein, worked nearly to surface, encountered in crosscutting at 500 level; 3 ft. wide, with high content in free gold. Shaft to be sunk another 150 ft.

Placer County

GLENN CONSOLIDATED (Towle)—Seven feet of snow covers mine workings and surface plant but snowsheds with connecting galleries were built early in season to continue development all winter. Sixty men at work on the several properties and none of them need go out of shelter. Housing in of mines in the higher elevations where the deep snows remain for several months is not so common in California, as in other mining states of high elevations.

Plumas County

IN BLUE NOSE MOUNTAIN section of the Johnsville district, preparations for hydraulic mining in progress by a Los Angeles company. Crosscut tunnel being driven at north end of mountain to determine width of Neocene channel. Reopening of the old London tunnel also in progress. Construction of a 5-mi. ditch and 4000-ft. siphon contemplated to carry water from Nelson Creek, and a survey made for debris dam.

BETLE (Copperopolis)—Trask & Coffey who have bond on this mine on Surprise Creek, have lately made several shipments.

STARK (Indian Falls)—Stark & Williams recently made high-grade shipment from this copper-gold mine 2 mi. east of north arm of Indian Valley.

CRESCENT (Crescent Mills)—Reported bonded to Eastern men who will install pumps for unwatering shaft; abandoned 25 years ago at a depth of 400 ft.

Solano County

ST. JOHNS (Vallejo)—Reported that 75 flasks of quicksilver per month is being shipped to Japan; 35 men are employed at the mine and furnace. Clifford Dennis, manager.

COLORADO

Boulder County

UP TO DATE (Boulder)—Pockets of high-grade ore encountered in recent development.

ARGO (Jamestown)—Copper-lead ore disclosed in recent development. Trial shipments being made.

MOUNT PLEASANT (Jamestown)—Lead-copper ore opened; development under direction of L. R. Evans of Boulder.

WHITE RAVEN (Boulder)—Sinking to be resumed in main shaft now 550 ft. below tunnel level. Considerable ore opened recently in lower levels.

ALICE (Jamestown)—Ten men employed in development; and payable ore being opened. A block in west end being developed under lease by Robert Hasty of Cripple Creek.

GOLDEN TRIANGLE MINING CO. (Jamestown)—Development to be undertaken in this property on Porphyry Mountain. Small force of men now engaged in preliminary work. H. F. Linnenbrink, manager.

NIL DESPERANDUM (Boulder)—Developing under management of M. S. Brandt. Recent shipments of ore produced during development returned \$60 a ton in gold. Company will install additional mining equipment early in spring.

GOLDEN AGE (Jamestown)—Drainage and transportation tunnel being driven to cut vein at depth of 600 ft. Purchased Standard mill at Springdale and ordered additional milling equipment; electric power.

Clear Creek County

WALDORF (Georgetown)—Mill being remodeled by M. Lebrum. Additional equipment to be installed.

FRANKLIN (Idaho Springs)—Being developed under lease by John Peterson. Payable silver ore opened.

BIG FIVE (Idaho Springs)—Development resumed on Lake vein by Quigley & Moore. Ore opened in east heading from the tunnel level.

GEM (Idaho Springs)—Small body of rich ore opened in ground being developed by G. W. Ford, lessee. Trial shipments return \$50 a ton. Ore found in west heading, Smith lease.

Dolores County

RICO-ARGENTINE (Rico)—Leasers producing 20 tons daily in upper workings. At face of main tunnel in 800 ft., there is a 12-ft. face of ore said to assay 4% copper, 15 to 20 oz. silver and 15% lead; zinc absent in ore since going further into mountain; one shift producing about 25 tons daily in development. Will install 800-ft. tramway in spring and increase development. J. C. Jensen, manager. Mackintosh block, Salt Lake City, Utah; William McCullough, superintendent.

San Miguel County

LONDON BADGER MINING & MILLING CO. (Ophir)—Organized to develop Badger group near Ophir.

San Juan County

KITTIMAC (Silverton)—Additional equipment being installed, including 125-ton ball mill.

SUNNYSIDE (Eureka)—Negotiations pending with Terry family for purchase; rumored that American Zinc interests are prospective purchasers.

CHAMPION (Silverton)—Development in progress through Pittsburgh tunnel by Allan & Fator, lessees. Payable milling ore produced from development and shipped to Silver Lake custom mill for treatment.

BROAD GAUGE (Silverton)—A 7-ft. vein opened containing 18-in. streak of smelting ore. Company will install compressor plant, and construct new bunkhouse and additional ore bins. Adam Griesmer, general manager.

Summit County

RILLA MINING (Breckenridge)—On Feb. 5 petition will be heard in Boston, asking U. S. district court to order records produced in connection with charge of fraudulent use of mails in selling company's stock. This was formerly the O'Reilly Mining Co.

IDAHO

Boise County

ALPINE (Banks)—John A. Percival and associates, of New York, have optioned this old silver-lead producer and are developing by an adit to cut vein 150 ft. below old workings.

Shoshone County

ALAMEDA (Wallace)—Application made for rehearing of Alameda-Success apex case.

CONSTITUTION (Beeler)—The 100-ton flotation mill on Pine Creek will be completed in February. Now hauling 10 mi. to railroad about 200 tons crude ore per month. Ore available in stopes above main tunnel and drifts from bottom of 200-ft. shaft.

MARSH (Burke)—Water now 450 ft. below collar of shaft. One 100-gal. pump and two ballers with capacity of 900 gal. per min. working. When 550 level is reached, crosscuts will be run north and south, but unwatering will continue until lowest (900) level is reached, when it is probable shaft will be sunk 200 ft. farther.

TAMARACK & CUSTER (Wallace)—Deed to Frisco mill from Federal company filed. Instrument includes, besides old and new mill, Hardy claim and certain surface rights, office buildings, boarding houses, and all equipment used in operation of Frisco mine; consideration \$150,000. Tramway connecting Tamarack mine with Frisco mill, 2 mi. in length, completed; mill to be ready about Feb. 1.

LOUISIANA

A 6000-BBL. GUSHER brought in in the Ederly oil field by the Gulf Refining Co. on the Bright Penn lease at depth of 3100 ft.

MICHIGAN

Copper

INDIANA (Rockland)—Shaft now down 160 ft. **ALLOUEZ (Allouez)**—Sending about 2000 tons daily to mill.

MOHAWK (Mohawk)—Shipping about 2600 tons daily to mill (full capacity).

ADVENTURE (Greenland)—Work to be started immediately on last level recently unwatered. Shipping about 120 tons daily.

NORTH LAKE (Lake Mine)—Crosscutting to lode, passed through by diamond drill, suspended to drift on new unidentified lode.

MICHIGAN (Rockland)—Still encountering considerable mass copper, same being found on the three lodes, Evergreen, Ogimah and Butler.

WINONA (Winona)—Shipping about 600 tons daily to the mill. Exploratory drift being put through on 15th level, from No. 4 to No. 3 shaft.

OSCEOLA CONSOLIDATED (Osceola)—Producing up to capacity of mill 4700 tons daily. Cutting plat on 37th level of No. 1 shaft, North Kearsarge branch.

COPPER RANGE (Painsdale)—More uptodate boiler plant will be installed Champlon mill; four boilers of the Badenhausen type are to replace the nine boilers now in the plant.

INDIANA (Rockland)—Shaft down 140 ft.; formation opened bears no resemblance to Butler lode this shaft was to cut. Some copper encountered but rock is not of commercial grade.

KEWEENAW (Mandan)—Now shipping about 200 tons daily to its mill. The force of men is gradually increasing. Examination being made of the old Phoenix fissure—about 1100 ft. from shaft on seventh level.

NEW BALTIC (Houghton)—Blasting being done at night. Shaft still open; pump not yet arrived. The lode trending away from shaft; after sinking has progressed far enough to establish average dip, shaft will be adjusted.

Iron

PLYMOUTH (Wakefield)—Large electric shovel—first to be used in Michigan—has been purchased for use in this pit.

CLIFFS (Ishpeming)—Small steam shovel to be given a trial underground in an 8-ft. drift. Will load on a belt which will deliver into cars.

HOLMES (Ishpeming)—Shaft bottomed at 1056 ft. Drifting to the ore has started. Drift also being run from Section 16 mine to connect with the Holmes at 1000 ft.; will be finished in few weeks.

MONONGAHELA (Crystal Falls)—Shaft to be sunk on this property. Churn drill now at work to test formation. Some ore being taken out through the Carpenter shaft. M. A. Hanna Co., operators.

MAITLAND (Palmer)—Two small locomotives, a steam shovel, a 1000-cu.ft. angle compound compressor and a crushing plant ordered for this new openpit mine. Work will be started shortly. Crushing house will contain two No. 6 and one No. 12 crushers. Ore siliceous, running about 42% in iron.

MINNESOTA

Cuyuna Range

PENNINGTON (Ironton)—Since shipping season closed, 80,000 tons of lean ore and waste has been removed.

BARROWS MINING CO. (Barrows)—Has leased NW¼ of SW¼ and Lot 3, Sec. 9, 46-29, Crow Wing County.

HOCH (Ironton)—Has been taken over by Algoma Manganese Co. and will hereafter be known as the Algoma mine. Shaft sunk from the 110-ft. to the 160-ft. level and development is proceeding; one diamond drill operating. About 150 tons are being stockpiled daily; average analysis 30% Fe, 0.075 P, 20.4 Mn, 14.95 SiO₂ and 9.5% moisture.

Mesabi Range

BRUNT (Mountain Iron)—Stripping soon to be started. Drying plant will not be operated in future.

TROY (Nashwauk)—Drag-line excavator, Model 251 Marion with 115-ft. boom, will start stripping this openpit next month. Washing plant contemplated.

FRANTZ (Buhl)—Steam equipment replaced by new electric plant. New hoist, compressor and electric haulage installed. Mine was unwatered and extraction started in November.

BENNETT (Keewatin)—New pit is being opened by Longyear-Bennett interests near the present pit. It will be stripped by Butler Bros., who will use Model 225 B. Bucyrus shovel of 300 tons weight. About 1,000,000 yd. of overburden will be removed.

MISSOURI

Joplin District

C. S. & P. (Joplin)—Good ore in two drifts at 125 ft. level. Company now incorporated; Harry Stephens, Joplin, interested.

OTTAWA COUNTY LEASING (Miami, Okla.)—Organized for development of various tracts. Incorporated with \$30,000 capital. W. H. Smith, Webb City, president.

MOORE & CO. (Joplin)—Made rich drill strike on lease at Chitwood, apparently extension of rich run now being mined by St. Regis No. 2 mine. Shaft to be started soon and mill erected. George Moore, Webb City, interested.

CONSOLIDATED (Aurora)—After spending nine months in draining big tract, company has begun operation. One 250-ton electrically equipped mill now in operation and another contracted for. Ten sub-lessees at work on tract.

GATCH & BURNS (Baxter Springs, Kan.)—Contracted for 18,000 ft. of drilling on leases near this town. Elias S. Gatch, head of company, formerly general manager of Granby Mining and Smelting Co.

MIAMI ZINC AND LEAD (Commerce, Okla.)—Completing installation of steam-power plant to produce electricity to run its three mills. Company's three mills, the Lennon, Quapaw and Miami, combined, are producing more than 200 tons of concentrates weekly. Operations carried on at 330-ft. level; deepest in district. T. F. Lennan, Joplin, general manager.

Northern Arkansas

NORTH POLE (Rush)—Paradise and associates opened good ore lately. One car already shipped.

MARYHATTIANNA (Rush)—Mine worked 20 years ago in small way by A. A. Webber, being once more opened by him.

SILVER RUN (Rush)—Leased by J. F. Dillard to Sheriff Brewster, of Pine Bluff, Ark. Mr. O'Connor, of Joplin, to be superintendent.

SILVER HOLLOW (Rush)—Oreshoot opened in floor of tunnel some days ago proving large. Mill cannot be run full on account of lack of sufficient tables for slimes. Additional equipment will be purchased.

MONTANA

Broadwater County

ECLIPSE-ARGO (Argo)—President Goodale of Furnace Creek company on Jan. 23 announced that his company has secured controlling interest in option on property near Argo in Hell Gate Cañon of Missouri River. Furnace Creek company purchased 51% and E. B. Milburn and T. M. Lowry of Butte own 49% interest. Vein is from 18 in. to 2 ft. wide but is rich in cop-

per. Regular shipments past six months netted \$89.46 per ton. There is 50-ton mill to handle second-class ore.

Missoula County

HIDDEN TREASURE (Clinton)—This copper group sold by Judge W. J. Stephens; new owners will begin work in February.

Silver Bow County

BUTTE & SUPERIOR (Butte)—Resumed operations in Black Rock shaft Jan. 27; fire damage confined to a few sets of timber.

ANACONDA (Butte)—Inability of Great Northern R.R. to handle traffic to Great Falls, account snowstorm, compelled closing on Jan. 29, of seven mines for two shifts.

NORTH BUTTE (Butte)—In 1916 shipped 551,797 tons yielding 24,498,181 lb. copper, 1,047,659 oz. silver and 1709 oz. gold. Copper production in 1915 was 19,234,960 lb. from 377,500 tons of ore.

BUTTE & ZENITH CITY (Butte)—Another vein cut on 1000 level making six veins so far encountered by the development. Company planning to sink to the 2000 level as soon as present work of crosscutting is completed.

BULLWHACKER (Butte)—Definite agreement reached Jan. 23 which will result in joint operation of Bullwhacker and Butte-Duluth properties by Mines Operating Co. It is proposed to sink Montgomery shaft to lower levels and to crosscut combined Bullwhacker and Butte-Duluth properties from that shaft at depth.

DAVIS-DALY (Butte)—Will develop Hibernia claim situated near Anaconda's Nettie claim. About a mile east of the Nettie and adjoining the Bonanza claim on which the Anaconda company is now sinking a 1000-ft. shaft, is the Britannia claim of which Manager Creden of the Davis-Daly owns controlling interest. He is at present unwatering Britannia shaft to prospect for zinc.

BUTTE & LONDON (Butte)—Mine shut down Jan. 20. Pumps have been pulled and mine will be allowed to fill with water. Evidently no agreement could be reached between Rainbow Development Co. and management of Butte & London to continue work. It is said Rainbow Development company expended \$400,000 in development work thereby obtaining 51% of Greendale Exploration Co. which holds title to the property.

TUOLUMNE MINING (Butte)—Without waiting to be served with summons or a copy of complaint, Tuolumne and Silver Bow Securities companies have filed answer to suit of Frank Clemons, a St. Paul minority stockholder, denying alleged collusion, wasting of ore and depreciation of equipment and asserting that steps to finance company were taken to the benefit and advance of stockholders. Details of the financing plan were explained.

EAST BUTTE (Butte)—Indications are that January's output will be considerably higher than that of December as smelting has been in continuous operation and conditions generally have been more favorable. Work of sinking main shaft and developing levels below 1800 level will be taken up within 90 days. Recent showing in lower levels of Anaconda mines may induce management to sink 1000 ft. below present depth and crosscut at the lower levels. Entire production of company's Pittsmt smeltery for 1916 amounted to 18,562,840 lb. copper and approximately 500,000 oz. silver.

NEVADA

Humboldt County

ROCHESTER COMBINED MINES CO. (Rochester)—Formed by L. A. Friedman to acquire and develop practically entire area between Rochester Mines and Nevada Packard properties; comprises over 800 acres. Mining equipment ordered and a small force at work; crew will be greatly augmented in spring, when extensive development will be begun.

Nye County

TONOPAH ORE PRODUCTION for week ended Jan. 20 was 9409 tons valued at \$169,362, comparing with 9396 tons. Producers were: Tonopah Belmont, 2841 tons; Tonopah Extension, 2380; Tonopah Mining, 1850; Jim Butler, 1050; West End, 746; Rescue Eula, 254; Halifax, 159; Montana, 29; Midway, 100 tons.

White Pine County

CONSOLIDATED COPPERMINES (Kimberly)—Tuning up machinery of 500-ton flotation mill.

NEW JERSEY

AMERICAN SMELTING AND REFINING (Maurer)—Strike ended at refinery on Jan. 25.

NEW MEXICO

Grant County

SHAFER (Pinos Altos)—This mine purchased by James H. Bell who will operate.

CARLISLE MINING (Steeplerock)—August Heckscher and Marcus Daly estate of New York reported to have purchased controlling interest; 125-ton flotation mill being erected.

EL PASO MINING CO. (Pinos Altos)—Lessees of Savanna copper property are remodeling Stauber & Wright mill, adding 80-hp. oil engine, ball mill and flotation equipment.

Sandoval County

SENRITO COPPER CORPORATION (Senorito)—Contract awarded to J. G. White Engineering Corporation, New York, for a Greenawalt leaching plant, 2-mi. tramway, power plant and mining equipment. Construction started; capacity of electrolytic-copper plant, 250,000 lb. monthly. Company will operate also small coal mine in vicinity.

OREGON

Grant County

STANDARD (Prairie City)—An 8-ft. vein of copper-silver-gold ore opened at this property 6 mi. north of Prairie City. Gustave T. F. Pinson, manager. Operations temporarily suspended on account of snow.

TEXAS

ANOTHER GUSHER in Sour Lake field brought in on Jan. 19 by Humble Gulf Co., about 75 ft. from the gusher, opened by the company on Dec. 5, 1916. New gusher, Well No. 15, Hardin County lease, was estimated at 15,000 to 20,000 bbl. per day and does not seem to be affecting the 7000-bbl. flow of the first gusher.

UTAH

Piute County

CRYSTAL ALUNITE (Marysvale)—Cropping of alunite vein uncovered for 40 ft. Claims adjoin those of Mineral Products Co.

DEER TRAIL (Marysvale)—Operation resumed and shipments of silver-lead-gold ore made during last months of 1916. Property controlled by Salisbury of Salt Lake. Idle for a long time. Near mouth of Cottonwood Cañon not far from potash mill of Mineral Products Co.

POTASH CO. OF UTAH (Marysvale)—B. H. Payne of San Francisco, president of company recently incorporated, visiting property. Development of alunite holdings to be done by tunnel driving instead of drilling as at first proposed. Reduction works being considered.

Salt Lake County

UTAH COPPER (Garfield)—December production, 13,976,533 lb.

WASATCH MINES (Alta)—Car of ore from workings along Braine fissure shipped. Development being pushed in Flagstaff section, and new drain tunnel being continued.

MICHIGAN-UTAH (Alta)—Tramway operating and ore being hauled from terminus at Tanner's Flat to Wasatch. Up to 60 tons of ore per day, carrying lead, silver, and copper, being shipped.

ALTA CONSOLIDATED (Alta)—New directors elected, Jan. 13, are R. P. Morris, J. D. Lewis, John Dorius, W. E. Wire, and Robert Brown, consulting engineer. A. O. Jacobson, former president, resigned.

HOWELL (Salt Lake)—New drain tunnel being driven at this property adjoining Cardiff in Big Cottonwood; under same management. Tunnel to be 1000 ft. long, and will give depth of 300 ft. under old workings. Following west contact of limestone and quartzite. Cardiff orebodies found on east contact.

Summit County

JUDGE MINING AND SMELTING (Park City)—Current at new electrolytic zinc works turned on, Jan. 20.

KEYSTONE (Park City)—Recent report to stockholders states: Shaft being sunk on Crescent fissure, down 205 ft. below crosscut tunnel; to be continued and drifting done on fissure in search of orebodies. Adjoining ground in Silver King Coalition on same fissure productive. Property equipped with 1200-cu.ft. compressor, sinking pumps, station pumps, drills, etc. Modern boarding house built, and 25 men working. Property 2 mi. from railroad.

Wasatch County

AMERICAN CHEMICAL AND OZOKERITE CO. (Soldiers Summit)—This company owns 240 acres and refining plant here, and 80 acres and small mill about 3 mi. from Colton in Utah County. Mine superintendent reported 1,570,000 lb. of ozokerite developed in April, 1916. Stocks in America much depleted owing to Gallician supplies being cut off. Ward E. Pearson, of Pearson Engineering Corporation, 115 Broadway, New York, now president.

Washington County

ADAH (Saint George)—A 40-ton leaching plant under consideration by this company to treat oxidized copper ores in the Silver Reef district, in the southwestern corner of the state.

CANADA

Ontario

NATIONAL (Cobalt)—New 75-ton flotation mill, is being tested.

CREBUS (Munroe Township)—Plant destroyed by fire last summer has been duplicated and production resumed.

HARGRAVES (Cobalt)—High-grade ore, 6 to 8 in. in width, found on 375-ft. level; winze being sunk on the oreshoot.

WRIGHT (Porcupine)—Grassell Chemical Co., of Cleveland, Ohio, which has option, has contracted for 1000 ft. of diamond drilling.

HUNTON KIRKLAND (Kirkland Lake)—Electric-driven compressor and hoists ordered and camp buildings will be erected at once.

APEX (Porcupine)—Water difficulties overcome; diamond drilling in progress. Shaft unwatered and sinking will be undertaken.

KEORA (Porcupine)—Two veins are stated to have been cut by diamond drilling at 300-ft. depth; one for 2 ft. and the other for 5 ft.

McKINLEY-DARRAGH (Cobalt)—Shaft being continued to 400-ft. level to carry on exploration and development of new veins found from a winze last summer.

PORCUPINE CROWN (Timmins)—Annual statement shows operating profits for 1916 of \$270,430, as against \$299,116 for 1915. Surplus after paying dividends, \$297,882.

SLADE-FORBES (Porcupine)—Company has made its first shipment of asbestos—2300 lb.—from the property in Deloro township. Small plant en route to mine where 26 men are employed.

CROWN-RESERVE (Cobalt)—Annual report shows gross product from mining \$191,822; mining and milling costs \$188,849; net profit \$2973. Revenue from investments mainly Porcupine Crown stock, was \$145,413.

NEWRAY (Porcupine)—Shareholders have sanctioned capital increase from \$1,000,000 to \$1,500,000. Of the increased issue \$300,000 will remain in the treasury. A syndicate has underwritten remaining \$200,000 at par.

BUFFALO (Cobalt)—Report states ore reserves increased from 326,000 oz. in May, 1916, to 1,288,275 oz. on Oct. 1, with 1,600,000 oz. on hand and 180,000 in residues, which with bullion on hand of 800,000 oz., make a total of 3,868,375 oz.

TIP TOP (Kashabowie)—Light railway, 6½ mi. to mine, completed and mine is now shipping copper ore to Trail, B. C. A flotation plant is to be installed in the summer. Capt. T. H. Trethewey, formerly at the Silver Islet mine is superintendent.

McINTYRE (Schumacher)—Report for last quarter of 1916 shows gross production of \$356,504 and operating profits from McIntyre and customs ore of \$208,390, as against \$136,084 for preceding quarter. There were 39,369 tons of ore milled, yielding \$10.62 per ton; operating costs \$4.51 per ton.

VIPOND-NORTH THOMPSON (Timmins)—Merger now being arranged on following basis: New company to be capitalized at \$3,000,000, of which Vipond and North Thompson each receive 1,125,000 shares leaving 750,000 in treasury. Of latter North Thompson shareholders take 300,000 at 60c. per share. Of the Vipond shares 225,000 are given to Mr. Ward in exchange for his bonds at 40c. per share, leaving Vipond clear of all debts.

HELIN DEVELOPMENT CO. (Three Rivers, Que.)—This company has optioned four gold claims, 14 mi. north of Schreiber station on the Canadian Pacific Ry. An 8x8-ft. shaft is now down 45 ft. on a 4½-ft. vein in claim No. 1686 and a 6x6-ft. shaft is being sunk on a 11-ft. vein. About 25 men employed. Hennij Helin, Three Rivers, Que., president. Properties reached by dog train in winter over almost straight road on chain of lakes; in summer by canoe and portage. Ontario government will build wagon road next summer. About 100 claims located. Copper ore, carrying 2 to 9%, also found in this section.

Yukon Territory

CANADIAN KLONDYKE (Dawson)—Returns week ended Dec. 31: 681 oz. from 69,910 cu.yd.

MEXICO

MINING DECREE providing forfeiture of nonoperating mines extended from Jan. 14, to Feb. 14; further postponement asked. Art. 33 of new constitution, requiring foreigners to renounce nationality and treaty rights before acquiring property, withdrawn on Jan. 30 for reconsideration and amendment by the Constitutional Assembly in Queretaro.

COMPAGNIE DU BOLEO (Santa Rosalia, Baja Calif.)—December copper production 1092 long tons; average grade of ore 3.69%.

SANTA GERTRUDIS (Pachuca, Hidalgo)—Milled in December 4641 tons; estimated profits \$1580. Mill operation curtailed owing to lack of cyanide; shipment en route.

AMERICAN SMELTING AND REFINING (120 Broadway, New York)—Smelting plant at Monterey has not yet been started as has been reported. Arrangements are being made, however, to start as soon as conditions will permit.

COLOMBIA

PATO MINES, LTD., (Zaragoza)—Gross returns period ended Jan. 8: \$16,017 from 35,016 cu.yd.

PERU

CERRO DE PASCO (Lima)—Constructing a new hydro-electric plant at Pachachaca on the Central Ry. between Morococha and Oroya. It consists of two units as against three at the Oroya plant, which it supplements. The new plant is up the Rimac Valley from Oroya; the water after being used in the Pachachaca plant is returned to the stream and again utilized at Oroya.

The Market Report

Metal Markets

SILVER AND STERLING EXCHANGE

Jan.	Sterling Exchange	Silver		Jan.	Sterling Exchange	Silver	
		New York, Cents	London, Pence			New York, Cents	London, Pence
25	4.7575	76½	37 3/16	29	4.7580	76½	37 3/16
26	4.7580	77	37 1/16	30	4.7580	76½	37 3/16
27	4.7580	76½	37 1/16	31	4.7580	76½	37 3/16

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

Jan.	Copper		Tin		Lead		Zinc
	Electrolytic	Spot	N. Y.	St. L.	N. Y.	St. L.	St. L.
25	29 1/2	45.000	7.75	7.70	9 1/2	9 1/2	9 1/2
26	29 3/4	45.100	7.90	7.75	9 1/2	9 1/2	9 1/2
27	30	45.100	7.95	7.80	10	10	10
29	30 1/2	45.375	8.00	7.90	10 1/2	10 1/2	10 1/2
30	31	45.500	8.05	7.90	10 1/2	10 1/2	10 1/2
31	31	46.000	8.25	8.10	10 1/2	10 1/2	10 1/2

The above quotations 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. Electrolytic copper is commonly sold on "regular terms" (r.t.), including freight to the buyer's works and is subject to a discount for cash. The difference between the price delivered and the New York cash equivalent is at present about 0.25c. on domestic business. The price of electrolytic cathodes is 0.05 to 0.10c. below that of electrolytic. Quotations for spelter are for ordinary Prime Western brands. We quote New York price at 17c. per 100 lb. above St. Louis.

Some current freight rates on metals per 100 lb. are: St. Louis-New York 17c.; St. Louis-Chicago, 6.3c.; St. Louis-Pittsburgh, 13.1 cents.

LONDON

Jan.	Copper		Tin		Lead		Zinc
	Standard	Electrolytic	Spot	3 Mos.	Spot	3 Mos.	Spot
25	132	128	143	188 1/2	190	30 1/2	47
26	132	128	143	190	191 1/2	30 1/2	47
27	132	128	143	191 1/2	192 1/2	30 1/2	47
29	132	128	143	192 1/2	193 1/2	30 1/2	47
30	132	128	143	193 1/2	194	30 1/2	47
31	134	130	145	193 1/2	194	30 1/2	47

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 4.80. £15 = 3.21c.; £20 = 4.29c.; £30 = 6.43c.; £40 = 8.57c.; £60 = 12.85c. Variations, £1 = 0.21 1/2c.

NEW YORK, Jan. 31, 1917

The conditions reported in our review last week continued, the freight delay becoming a major factor to an even greater extent. On the other hand, troubles at the refineries in the vicinity of New York abated, the strike at Perth Amboy having been settled, and repairs having been made at other works. Copper continued phenomenally strong, as also did lead. Zinc advanced sharply and then weakened.

Copper, Tin, Lead and Zinc

Copper—On Thursday and Friday business to the amount of five or six million pounds was reported by producers, a larger volume than has been recorded in most of the days of the recent weeks of dullness. This business was in the

main for second-quarter delivery. There was considerable variation in prices in view of the absence of competition among sellers. Since Saturday very little has been done. The major market, such as it is, is for second-quarter delivery. Near-by copper is wanted, but it cannot be supplied except for occasional small lots that may be picked up here and there. The price paid for such may be anything. The scarcity of near-by copper is such that consumers who ordinarily use electrolytic only now consider the substitution of high grade casting if they can get it. Casting copper for near-by delivery realized 30c. on Jan. 29, and 31c. on Jan. 30.

Exports from Baltimore during the week included 2,612,757 lb. of copper for France, and also 213,606 lb. of brass for France and 50 tons of brass disks, sheets and wire to Italy.

Copper exports from Atlantic ports for the week ended Jan. 25, were 2747 tons. Since Jan. 1 they were 20,678 tons.

Copper Sheets—Base price for copper sheets continues unchanged. The quotation is 42c. for hot rolled and 43c. for cold rolled. Wire is quoted on a base of 37c. f.o.b. mill.

Tin—The price advanced on comparatively light business, together with the strength of the London market and the strong statistical position here. At the beginning of the week spot was 45c., and futures, 43 1/2c. At the close, spot was 46c. and futures, 44c. The remarkably strong statistical position of tin in this country is shown by the following statistics:

Supplies in January:		Tons
Stock, Jan. 1,	{ Store 1565	3,515
	{ Landing 1950	
Arrivals Atlantic ports.....		4,316
Arrivals Pacific ports.....		1,977
Available.....		9,808
Exports.....		9
Net available.....		9,799
Stock Jan. 31:	Tons	
Warehouse.....	1,097	
Landing: "Rotti".....	1,000	
Manhattan.....	525	1,525
Total deliveries: A.P. 5,200		
P.P. 1,977		7,177

Lead—Some large transactions were made in the early part of the week at advancing prices. On Jan. 27, a round tonnage was sold at 8c., March-April delivery. On Jan. 29, the American Smelting and Refining Co. advanced its price to 8c., New York, which was necessary to bring it more into tune with the market. On the same day, lead for February shipment was sold at 8.10c., St. Louis, while February lead in New York realized 8 1/4c., and up to the close, the market continued about on that basis, but the amount of business reported for shipment was less than in the early part of the week and there were some indications of an easier tendency. On the other hand, anybody requiring lead on the spot in New York might have to pay any kind of a premium. If he wanted more than a small quantity he simply could not get it, for the reason that it is not here.

The situation is produced by the traffic troubles. There is an immense quantity of lead in transit. Consumers, falling to receive what they had previously bought and expected to have by this time, have apparently placed additional orders on the theory that the more they had coming to them, the better would be their chances of getting some of it. Of course, this is likely to be bad for the market later on, when deliveries by the railways become more rapid. At the moment, it seems to be easier to get shipments from St. Louis than from Omaha. Some producers seem to be making a point of selling as far ahead at present high prices as they can, while others are more reserved in their policy.

Zinc—Apparently the traffic situation was recognized as likely to play a part in the zinc business, just as in lead, for the market which looked rather soft a week ago turned strong on Thursday, and advanced sharply to 10 1/2c., both on speculative buying and on some buying by domestic consumers. Producers who had stocks of near-by metal continued to withhold them and the market was in a position to respond quickly to relatively small buying. Spelter was offered right along for second-quarter delivery at sharp concessions, but producers could not find buyers to any such extent as they would like. The advance culminated on Monday. On Tuesday, February spelter was offered in large quantity from second hands at 10 1/2c., early in

the day, down to 10 1/4c. at the close, without finding buyers, while on Wednesday it was offered at 9 1/2c.

Zinc Sheets—No change has been made in the market price of zinc sheets. Quotation is \$21 per 100 lb., f.o.b. Peru, less 8% discount.

Other Metals

Aluminum—The aluminum market continues quiet, with buyers scarce. Nominal quotations are at 58@60c. per lb. for No. 1 ingots, New York.

The official selling price in London of aluminum ingots, 98-99% has been fixed by the ministry of munitions at £225 per ton, freight paid to consumers' works. Maximum price must not be exceeded but a lower one may be fixed by agreement between seller and buyer. Prices took effect Jan. 1, 1917.

Antimony—Owing to a heavy demand and a scant supply there was a sharp advance in the market. Sales were made as high as 25c. and today 26c. is quoted. Buyers have long been bearish and shippers would not ship except on contract, so that shipments decreased and the market has been slowly gleaned of spot metal. As usual, everybody started buying at once, when the scarcity became apparent, with the to-be-expected result. Higher prices are freely predicted. February-March shipments from China 14@14 1/2c., c.i.f., New York, duty unpaid.

Nickel—No change appears in nickel quotations. Price remains at 45@50c. per lb., with electrolytic commanding an additional 5c.

Quicksilver—The London price having been advanced by 15s. per flask, the price at New York was raised to \$84. San Francisco reports, by telegraph, \$82, demand fair.

Gold, Silver and Platinum

Gold—The sum of \$825,000 in gold coin has been withdrawn from the subtreasury, New York, for shipment to South America.

Silver—Silver has been very steady the past week. Demand has been good at current prices, but there is no disposition to advance prices. The English government being the chief buyer, without much competition price may advance some but not materially.

Under date of Jan. 18, Samuel Montagu & Co., London, report that the free selling, which has been rather a feature of late, disappeared when the price fell back to 36d. on the 12th inst. and offerings became more normal. On the 17th some buying orders from the Indian Bazaars and elsewhere came into the market and revealed the paucity of supplies.

Mexican Dollars—Jan. 25, 59@62c.; 26, 59@62c.; 27, 59 1/2@62 1/2c.; 29, 59 1/4@62 1/4c.; 30, 59 1/4@62 1/4c.; 31, 59 1/4@62 1/4c.

Platinum—The advance continued on further buying by jewelers. At the close the market is quoted at \$97 1/2@100.

Palladium—Quoted at \$85.

Zinc and Lead Ore Markets

Platteville, Wis., Jan. 27—Blende, basis 60% Zn, medium grade, \$80. Fancy ores realize a premium and low-grade ores sell at a discount. Lead ore, basis 80% Pb., \$90.

Shipments for the week, 2601 tons zinc ore, 30 tons lead ore and 475 tons sulphur ore. For the year to date, 10,346 tons zinc ore, 347 tons lead ore and 1882 tons sulphur ore. Shipped to separating plants during the week, 3652 tons zinc ore.

Joplin, Mo., Jan. 27—Blende, basis 60% Zn., medium grade, \$85@87.50. Fancy ores realize a premium and low-grade ores sell at a discount. Calamine, basis 40% Zn., \$50. Average selling price, all grades of zinc ore, \$84.46 per ton. Lead ore, basis 80% Pb., \$94@98. Average selling price all grades of lead ore, \$92.54 per ton.

Shipments for the week; blende, 9065 tons; calamine, 540 tons; lead, 1470 tons. Value, all ores for the week, \$948,270; the month, \$3,036,090.

The demand by smelters of large quantities of Western ore for the ores of the district was increased this week. While premium ore was advanced but \$5 per ton, there was a general advance of \$7 on all other grades. The heaviest demand is for ores of 58 to 60% Zn. Lead prices were stiffly advanced this week, but the average increased only \$4.

Other Ores

Tungsten Ore—More business transacted during last week than in any other week this year, well

over 300 tons being reported done. Several contracts closed at \$17. Cold weather in the West and traffic congestion and freight embargoes make bright outlook for ore prices in the East.

Molybdenum Ore—Market firm at \$1.80 per lb. of molybdenum sulphide for concentrates containing 85% MoS₂ free from copper. Ore containing 80%, is quoted at \$1.70. These are New York prices, and owing to the freight uncertainties, buyers are averse to entering into contracts for shipments from the West.

Antimony Ore—High-grade ore is quoted at \$1.85 per unit.

Iron Trade Review

Still beset by traffic troubles, the steel trade has had one of the quietest weeks in many, says "Iron Age," though January ends with even more assurance of full operations far into the year than existed at its opening.

PITTSBURGH—Jan. 30

Transportation conditions are slightly improved. While the restriction in coke shipments is practically as great as ever, on account of car shortage, some of the embargoes have been lifted, at least temporarily, allowing finished steel to reach buyers who greatly needed it. All the New York Central embargoes in the Youngstown district are to be removed tomorrow. Finished steel is still accumulating at mills to an extent, even though production has been curtailed somewhat, and the congestion at mills is more embarrassing. Complete relief is not expected before March or April, if then.

Strictly new buying in steel products is limited, as there is very little tonnage for sale for the next six or nine months and buyers are indisposed to take hold for the later deliveries the mills could offer. Specifications against old contracts are in the main satisfactory, being approximately equal to shipments, except in the case of steel bars, the specifications for bars having dropped off very materially since the first of the year.

Steel prices are firm all along the line, and some commodities show an advancing tendency. Since the Carnegie Steel Co.'s advance of \$3 a ton in shapes and plates a week ago the independents, who had not previously advanced, have adopted the new prices, deliveries at mill convenience being now quotable at 3.25c. for shapes and 3.75c. for plates, bars remaining at 3c. Ship plates for prompt shipment continue to bring 6c. and higher from the small mills which are not loaded so far ahead.

Consumers of steel are more fortunate than ever for better deliveries and the common prediction is that steel will be still scarcer two or three months hence. Most observers expect some easing off in the pressure at some time during the last four months of the year, provided the war does not end earlier. After the price readjustment that must come eventually the demand for steel in both the domestic and export markets is expected to be very heavy. For a year or so after the war steel exports will probably be regulated exclusively by ocean shipping conditions.

Pig Iron—Pig iron production continues to be restricted by the coke scarcity. The large steel interests are drawing upon their reserves. Consumers who buy their iron are hard pressed in many instances and are forced to buy prompt lots at relatively fancy prices. A shortage is presumably accumulating but the condition does not bring buyers into the market for late deliveries and they are evidently in a very conservative mood. The local market continues to present the anomaly of southern iron being far cheaper than northern, yet the northern price stays up and the market is not equalized by consumers buying southern. Thus for second half shipment southern foundry is quotable at \$23, Birmingham, or \$27.55 delivered Pittsburgh while Valley foundry is quoted at not under \$30, or \$30.95, delivered Pittsburgh, a divergence of \$3.40. Bessemer is perhaps not altogether as strong as it was. We quote: Bessemer, \$35; basic, \$30@31; foundry and malleable, \$30@32, f.o.b. Valley furnaces, 95c. higher delivered Pittsburgh.

Ferroalloys

Ferromanganese—Spot ferromanganese has become very scarce and it is claimed none is available under about \$200. Contract continues to be quoted at \$164, seaboard, for imported and \$175, delivered, for domestic.

Ferromolybdenum—Quoted at \$4 per lb. of molybdenum content.

Chemicals

Arsenic—White arsenic is firm at 9 1/2 c. per lb. in car lots. Small lots bring 10@10 1/2 c. per lb.

Strontium—Nitrate is quoted at 26@28c. per lb. packed in 910-lb. casks, f.o.b. Eastern points. Standard runs about 98% Sr(NO₃)₂. Presence of barium, sodium and cadmium salts reduces the value.

Sulphur—Commercial sulphur quoted at \$1.35@ \$1.45 per 100 lb.

Copper Sulphate—Quoted 12@13c. per lb., car lots.

STOCK QUOTATIONS

Table with columns: N. Y. EXCH.†, Jan. 30, BOSTON EXCH.* Jan. 30. Lists various stocks like Alaska Gold M., Am. Sm. & Ref., etc.

N. Y. CURB† Jan. 30

Table listing various commodities and their prices, including Buffalo Mines, Butte & N. Y., etc.

SAN FRAN.* Jan. 30

Table listing various stocks and commodities in San Francisco, including Alta, Andes, Best & Belcher, etc.

TORONTO* Jan. 30

Table listing various stocks and commodities in Toronto, including Bailey, Beaver Con., Chambers Ferland, etc.

STOCK QUOTATIONS—Continued

Table with columns: COLO. SPRINGS Jan. 30, LONDON Jan. 18. Lists stocks like Cresson Con., Doctor Jack Pot., etc.

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

MONTHLY AVERAGE PRICES OF METALS

Table showing monthly average prices for Silver and Copper in New York and London from 1915 to 1917.

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

Table showing monthly average prices for Copper in New York and London from 1915 to 1917, categorized by Electrolytic and Standard.

Table showing monthly average prices for Tin in New York and London from 1915 to 1917.

Table showing monthly average prices for Lead in New York, St. Louis, and London from 1915 to 1917.

Table showing monthly average prices for Spelter in New York, St. Louis, and London from 1915 to 1917.

New York and St. Louis quotations, cents per pound. London, pounds sterling per long ton. † Not reported.

Table showing monthly average prices for Pig Iron in Bessemer, Basic, and No. 2 Foundry from 1915 to 1917.

† As reported by W. P. Snyder & Co.

The Mining Index

This index is a convenient reference to the current literature of mining and metallurgy published in all of the important periodicals of the world. We will furnish a copy of any article (if in print) in the original language for the price quoted. Where no price is quoted the cost is unknown. Inasmuch as the papers must be ordered from the publishers, there will be some delay for the foreign papers. Remittance must be sent with order. Coupons are furnished at the following prices: 20c. each, six for \$1, 33 for \$5, and 100 for \$15. When remittances are made in even dollars, we will return the excess over an order in coupons if so requested.

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- 4784—ALASKA—Alaska Treadwell-Mexican-United Report. (Eng. and Min. Journ., Jan. 20, 1917; 4 pp.) Report of the president to the boards of directors of the above mines, Oct. 20, 1916, dealing with present conditions and future work. 20c.
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LEAD AND ZINC

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