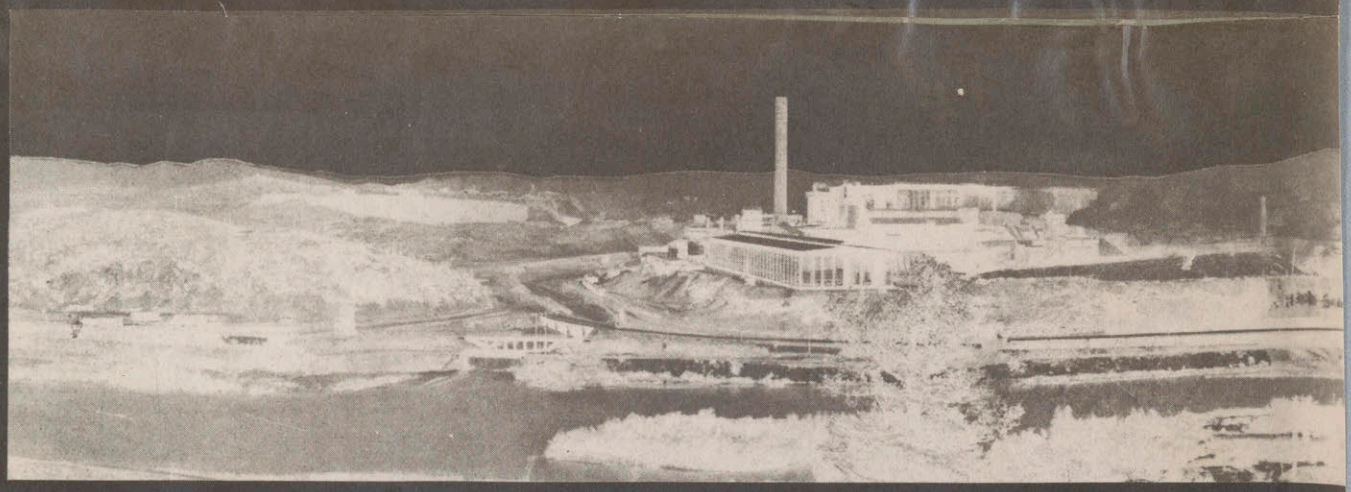


Tennessee Copper Works Toward Maximum Economy

From its massive sulphide ores it is recovering not only the copper and sulphur but also the long-wasted zinc and iron as commercial products and in addition sells considerable slag. . . . Only one blast furnace remains out of seven formerly used, and, with the roasters, it serves the acid plant

BOTH crude ore and copper concentrates are received at the Tennessee Copper Company smelter. The former is smelted in a blast furnace and the latter directly in the converter which treats the matte from the furnace as well as flue dust and certain scrap copper. Tonnage handled at present consists of 550 tons of ore and 80 tons of concentrates per 24-hour day. This is yielding a monthly output of 1,500,000 lb. of copper, which, save for approximately 300,000 lb. used monthly for making copper sulphate, is shipped to the Nichols refinery in Long Island City, New York.

Requirements of the sulphuric acid plant govern the smelter practice. Of the gas delivered to the acid plant, 60 per cent comes from the roasters, 25 from the blast furnace, and 15 from the converter. These figures are subject to change. It would be advantageous if blast-furnace smelting, formerly a much more important part of the plant practice than it is today, could be done away with altogether, inasmuch as the iron in the ore thus treated is thrown on the slag dump instead of being sold eventually as a sinter, as is done with the iron in the concentrates. Before this can be accomplished, however, it will be necessary to increase the respective capacities of the concentrator and the roaster plant, as well as to provide another way of smelting the copper concentrates, perhaps in a reverberatory.

Ore received from the mine is stored in bins of 3,000 tons' capacity, from which it is drawn as required for making up the blast-furnace charge. The total burden is approximately 650 tons per 24 hours. Of this 500 tons is ore from the Burra Burra and Eureka mines, 50 tons ore from the Fontana mine, 6 per cent is coke, and the remainder quartz flux. About 80 per cent of the total is derived from the Burra Burra mine. The average charge runs approximately 2.5 per cent copper, 25 per cent sulphur, 33 per cent iron, and 18 per cent silica. Fontana ore is higher in grade than the other ore and averages about 7 per cent copper, 23 per cent iron, and 18 per cent sulphur. It contains talc, however, and is harder to smelt. The lime and magnesia will run about 7 per cent, compared with 1 per cent in the Burra Burra ore.

The single blast furnace, now the sole survivor of seven in 1916, is 22 ft. long and 4 ft. 8 in. at the tuyeres. Its capacity has been increased considerably above that of former years when more furnaces were in operation, and may be regarded as 1,000 tons per day maximum, this being the peak that was attained in the latter part of 1929. At present it is running with a 16-ft. column and a 30-oz. blast.

A copper matte running approximately 12 per cent copper and 24 per cent sulphur is made and is tapped in accordance with converter requirements from the 30-ton settler used, and is delivered to the converter department. Its further reduction will be discussed later.

Slagging proceeds continuously. Two practices are followed in respect to slag disposal: On two shifts the slag is washed and granulated in a launder which delivers it to an elevator that discharges into a tank from which it is hauled to the dump. Some of this is screened and sold for roofing and cement purposes. On the third shift, the slag is run hot to the dump in pots. Here, by means of spraying water on the face of the

LOOKING NORTH FROM GEORGIA at the smelter and acid plant of the Tennessee Copper Company at Copperhill, Tenn., situated on the boundary line between the states which are here separated by the Ocoee River. The latter's waters find their way into Hiwassee and thence into the Tennessee. A short distance east is the North Carolina line. In the distance, five miles to the north, is Ducktown, with the Burra Burra mine, the company's largest

dump, it is caused to break in coarse pieces, after which it is reclaimed with a power shovel, crushed in a jaw breaker, and screened.

The crude ore, which is smelted direct, as just described, is obtained by hand-picking from the run-of-mine ore (about 55,000 tons per month is hoisted) prior to concentration. The balance is concentrated in the company's two flotation plants at London and Isabella respectively. About 80 per cent of the total ore produced is thus concentrated, this including the total output from the Isabella mine. The two plants produce three concentrates, of copper, iron, and zinc, respectively. The zinc concentrates (containing 50 per cent zinc and made from heads running less than 1 per cent zinc) are sold, as made, to a plant in Pennsylvania. The iron concentrates are roasted to convert their sulphur into gas for acid-making, the resultant calcine then being sintered and sold in the Birmingham district in Alabama. Copper concentrates are smelted directly in the converter together with the matte made by the blast furnace.

Converting is done in one 12x25-ft. Peirce-Smith converter which runs continuously save for about two weeks in the year when it is shut down for relining. A Great Falls-type unit, which serves as a standby, is used while this is being done. The practice of smelting in the converter was begun in 1922, since which year there has been no fundamental change. Today, however, the concentrates thus treated run 20 per cent in copper, compared with 12 per cent at the outset.

Eighty tons of copper concentrates and 120 tons of matte are treated in the converter per 24-hour day on the average. In addition, approximately 20 tons of flue dust and 10 tons of scrap, such as the fines of the shot copper made for copper sulphate manufacture, are also charged. An approximate analysis of the concentrates is: copper, 20 per cent; iron, 35; sulphur, 35; SiO_2, 3.5; and zinc, 2 per cent. The matte, as previously stated, runs approximately 12 per cent in copper and 24 per cent in sulphur.

The cycle of operations is approximately as follows: Each morning, after pouring copper made in the preceding 24-hour run, 20 tons of matte is charged and blown for 20 minutes. Then four 4-ton charges of concentrates are added at 20-minute intervals. Then without waiting until all the concentrates are melted, 5 tons of quartz is added as flux. Two hours after this charge is melted, slagging begins. The operation described is now repeated about six to seven times, the white metal being steadily accumulated until the following morning, when the blister copper is poured. As the white metal builds up, less concentrates are charged by reducing the number of charges per cycle, so that the 16:20 concentrate-matte ratio falls. A blister copper of plus 99 per cent grade is made.

Concentrates are charged with a Gar gun, the matte is charged molten from the ladle, and the quartz flux in a boat through the mouth. The flux, which is well-decomposed float quartz brought in and sold by farmers of the adjoining region, is first crushed in a jaw breaker. Such quartz is said to be more satisfactory than the freshly quarried quartz that was formerly used.

The converter slag contains approximately 1½ per cent copper, 21 per cent silicia, and 53 per cent iron. It is sent to the settler of the blast furnace.

A blast of 10 to 14 lb. per square inch is used on the converter. A constant-volume regulator is used to hold the amount of air to a maximum of 12,000 cu.ft. per minute, for the benefit of the acid plant. If tuyere resistance builds up, the volume may be less than this. The tuyeres are punched about three-quarters of the time.

The converter is lined with 13 in. of unburned magnesite, except for a strip 5 ft. wide along the tuyeres running the full length of the furnace, which is lined with 20-in. brick. On starting after relining, a magnetite lining is blown on top of the magnesite by blowing matte and oxidizing the sulphur until the magnetite freezes on the brick. The tuyere lining lasts approximately one year; the rest of the lining indefinitely.

On pouring—once a 24-hour day, as previously stated—the blister copper is cast in 350-lb. cakes, which are trimmed, sampled, and shipped to the refinery. The molds are carried on a steel frame supported on trucks, which passes under a water spray. Approximately a ladle and a half is thus cast daily.

Of the blister made, about 300,000 lb. per month is used to make shot copper for conversion into copper sulphate. Shot copper is made in the converter department by pouring the molten metal into a tank of water. The shot is discharged from the tank over a screen with ½-in. round holes. Undersize is returned to the converter.

Roasting the Iron Concentrates—The iron concentrates produced in the flotation plant are delivered to storage bins at the smelter. An approximate analysis is: Iron, 54 per cent; sulphur, 40 per cent. Roasting is done down to approximately 6.5 per cent sulpher in ten 22 ft. 6 in. seven-hearth Wedge roasters, which have each a drying hearth in addition. Rabbles revolve at 1 r.p.m. and have water-cooled cast-iron arms. Waste water from the acid plant is used for cooling. Maximum roasting temperature is 1,650 deg. F. The temperature on the seventh hearth is approximately 1,000 deg. F. The off-take gas has a temperature of about 1,200 deg. F. and contains 8 per cent SO_2.

At the moment of writing the roasters are not running at full capacity on account of the lack of adequate dust-collecting capacity. At present, dust is being collected only in flues and the maximum amount of dust is already going to the acid plant, where it not only gives trouble mechanically but causes a loss of acid, one ton of dust consuming something like 8 tons of acid. Three of the roasters are equipped with Sirocco collectors, but the rest discharge through a settling chamber to the flue. The dust re-

claimed in the Sirocco collectors goes with the calcine to the sintering plant.

At present the calcine is trammed by an electric locomotive to the sintering plant, where it is cooled from 1,000 deg. F. to 200 deg. F. in a 60-ft. rotary cylinder having spiral flanges on the inside surfaces. Water is sprayed on the calcine at the feed end sufficient to cool it, as stated, and give about 14 per cent moisture in the cooled calcine. A concurrent draft takes the steam up a stack at the discharge end. The cooled calcine is elevated to a 200-ton storage bin. A new means of handling the calcine is now being installed. It provides for washing the calcines into concrete tanks, where they will be dewatered by decantation and the calcine then removed by an overhead crane and clamshell and stored on the ground near by in the open. Storage room for 7,000 tons is planned. From this storage the calcine will be loaded by the clamshell on a conveyor that will run to the sintering plant.

Sintering is done on a 60-in. Dwight & Lloyd machine, 66 ft. long and having 89 pallets. A 7-in. bed is maintained. An oil-fired arch-type muffle having one high-pressure burner on each end serves for ignition purposes. The charge, which runs only 4 per cent sulphur (the calcine from the roasters runs 6.5 per cent), because of dilution with return sinter and fuel, is roasted in one operation to 0.05 per cent sulphur.

The charge for the sintering machine is made up from a series of five bins, three of which contain calcine, one contains return sinter, and one breeze coke which has previously been crushed in rolls to minus-10 mesh. Each bin delivers via a table feeder onto a conveyor that serves all the bins. All ingredients of the charge thus gathered are elevated to a barrel-type mixer having spiral flanges on its inner surface. The charge consists of 60 per cent calcine, 40 per cent return sinter, and coke equivalent to 5 per cent of the sintered product. The mixer discharge is screened, the oversize then going directly on the pallets with the finer material on top. Even distribution is secured by a swinging chute.

Near the discharge end of the machine a spike roll is suspended over the charge and so arranged that it can be pressed down into the sinter and break up the cake when a large proportion of fines is needed for return sinter.

A 24-x108-in. (diameter) fan driven by a 500-hp. motor serves the machine. Dust is collected in a cyclone. Dust that occurs in the discharge of the sinter rises by natural draft into an overhead scrubber.

The present sintering plant was built in 1935, replacing an older Greenawalt installation. A little harder sinter with less fines is obtained and less dust on dumping.

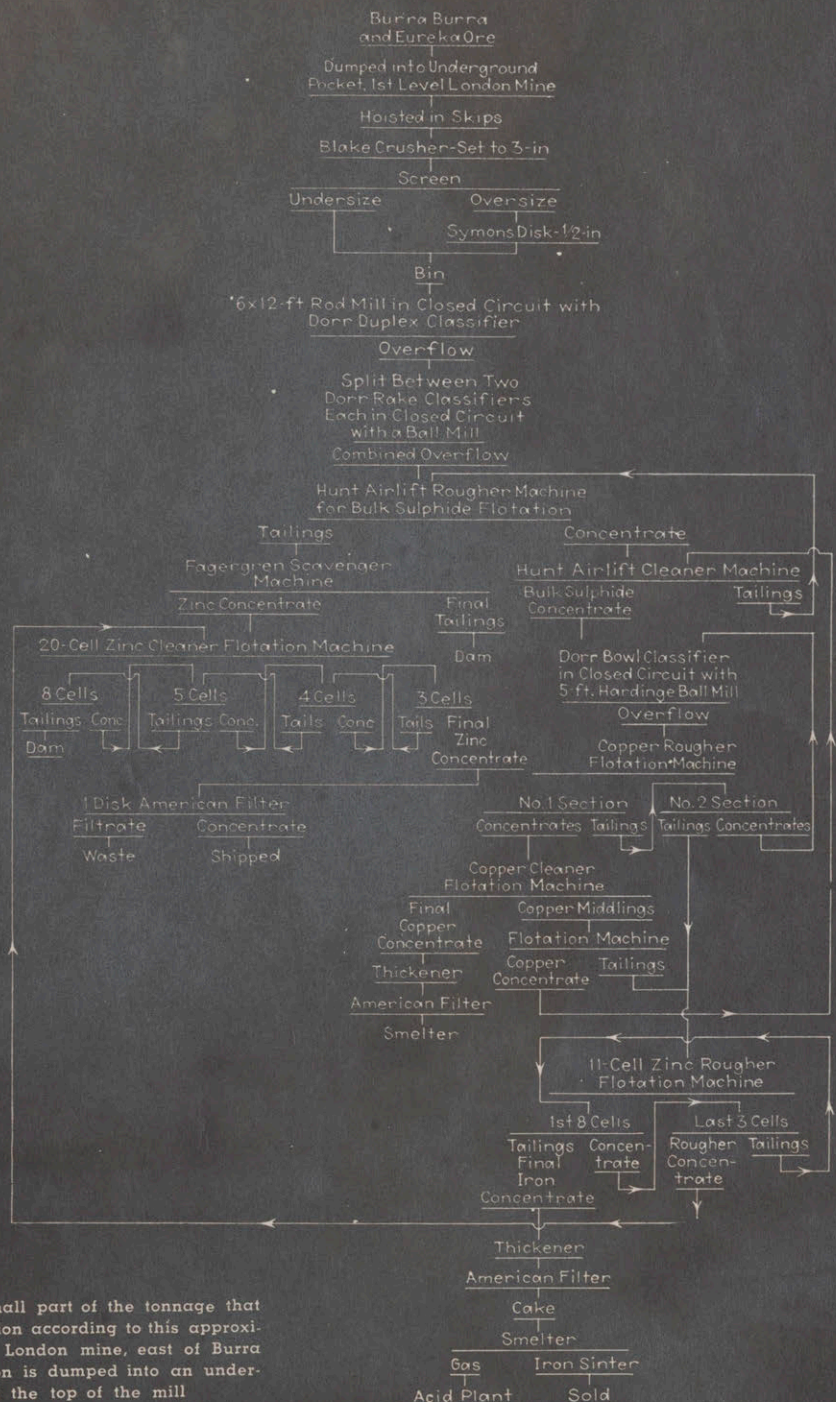
London Flotation Plant—Flotation as practiced by the Tennessee Cooper Company is best illustrated by the procedure at the London plant, which treats the ore from the Burra Burra (and Eureka) mine. From the heavy mixture of copper, iron, and zinc sulphides, three concentrates containing the respective metals are made, two of which are subsequently treated at the smelter, and the third—the zinc concentrate—is sold direct. The mill practice is shown in the accompanying approximate flowsheet. Tonnage milled is 1,250 daily. The plant operates six days per week.

Reagents used are as follows:

Bulk Flotation: potassium ethyl xanthate, Risor pine oil, and sulphuric acid.

Copper Flotation: Crude calcium cyanide, lime, both added to the regrind to depress the zinc and iron. Potassium ethyl xanthate, added to head of machine, to activate the copper. Enough oil is carried over from bulk flotation.

Zinc Flotation: Copper sulphate (to activate), lime, potassium ethyl xanthate, No. 5 steam-distilled pine oil, and No. 634 Barrett.



BURRA BURRA AND EUREKA ORE, save for the small part of the tonnage that is smelted directly at Copperhill, is treated by flotation according to this approximate flowsheet. The flotation plant stands at the London mine, east of Burra Burra and now shut down. Ore received at London is dumped into an underground pocket and hoisted up the shaft to the top of the mill

October 7, 1946

Mr. F. F. Russell:

CONVERTER OPERATIONS - OROYA

The following data were taken from the Metallurgical Reports.

YEAR	AVG. % SiO_2 in CONVERTER SLAG
1936	24.5 %
1937	23.7 %
1938	26.1 %
1939	26.8 %
1940	28.9 %
1941	26.8 %
1942	23.0 %
1943	22.3 %
1944	20.9 %
1945	21.7 %
1946 (7 months)	17.6 %

From the above data it would appear that we are not feeding as much silica flux to the converters in recent years as was done in 1938 to 1941. A large proportion of the silica for converter flux is normally supplied by Santa Ann Silica or its equivalent. With the present high price for silver, would it not be in order to treat all the Santa Ann ores possible in the converter?

We estimate that for the 7 months of 1946, had the converter slag carried 26.6% SiO_2 instead of 17.6% we could have treated about 1400 tons per month more Santa Ann Silica flux than we did and the silver production would have averaged about 14000 oz. more per month.

W. C. Smith

WCS:RL

A-102 October 21, 1946

Mr G. P. Sawyer, Vice Pres.,
Cerro de Pasco Copper Corp.,
40 Wall Street, New York City 5

Dear Mr Sawyer: COPPER METALLURGY

I enclose photostat of an article on the practice at the plant of the Tennessee Copper Company referred to in my letter of October 9th.

Very truly yours,

A-94 October 9, 1946

Mr G. P. Sawyer, Vice Pres.,
Cerro de Pasco Copper Corp.,
40 Wall Street, New York City 5

Dear Mr Sawyer: COPPER METALLURGY

I should be much interested if you would take occasion to talk to Mr Merz about what might be called our sulphur balance in the copper plant and secure his comments. He brings a fresh point of view to an old p problem.

We differ from most plants in that we do a large part of our roasting in the converters. A 16% matte was originally planned to permit smelting a large quantity of revenue-bearing silicates at low cost. Why can we not carry this idea on to doing a lot of converter smelting of material other than silicates--- pacos-pyrite concentrates, for example, which will bring their own sulphur fuel as well as a nice silver contribution?

The Tennessee Copper Company, for instance, in a single 12' x 25' Pierce-Smith converter smelt daily 120 tons of 12% matte, 80 tons of copper concentrates, 20 tons of flue dust and 10 tons of scrap in addition to the necessary quartz flux.

Very truly yours,

A-342 October 14, 1935

Mr. C. V. Drew, Vice-Pres.,
Cerro de Pasco Copper Corp.,
44 Wall Street, New York City.

Dear Mr. Drew: COPPER&METALLURGY

I had a talk with Mr. Ralston as expected. It appears that Phelps Dodge shut the whole research department down on very short notice when they took over United Verde and let Ralston out. The work they have been doing is in the direction of smelting in the converter with little or no heat except that supplied by the sulphur, eliminating the other steps. I believe a pilot plant has been operating on a small scale.

A second part of the scheme is to recover sulphur from the gases. The converter as operated delivers a gas of practically sulphur dioxide plus nitrogen. This is mixed with hydrogen sulphide:

$$2SO_2 + 2H_2S = H_2SO_4 + 3S$$

The hydrogen sulphide is made with the sulphuric acid and "activated" copper matte.

I told Ralston that Cerro was not the place to try this on the dog. It would be only after large scale operations elsewhere that it would be of interest. Also the handicap of a large investment, present low smelting costs and partial converter smelting already in use made the applicability unlikely.

If the gas process would help avoid the contemplated Cottrell investment it would be of interest but I do not see that eliminating sulpur from the gases would help at all as the Cottrell is for collecting poisonous solids and this problem would remain.

Very truly yours,

A-183 August 22, 1931

Mr. C. V. Drew, Vice-Pres.,
Cerro dePasco Copps Corp.,
44 Wall Street, New York City.

Dear Mr. Drew: COPPER METALLURGY

The third paragraph of Mr. Kekich's letter states in a few words the substance of a dream that has attracted copper men for many years. In the E&MJ for May 12, 1904 Knudsen describes adding copper pyrites to a converter lined wuth dolomite and I believe there have been plenty of experiments since then but I do not know of a successful application.

Perhaps Kekich or Spilsbury have hit upon the trick but the novelty will lie in the metod or particular case rather than the general idea. The letter in question gives no information as to how former difficulties are to be overcome.

Very truly yours,

Ads

Cerro de Pasco Copper Corporation
44 Wall Street,
New York,

Office of C. V. Drew,
15th floor.
Telephone Beekman 3900-4

Cable Address:
"Cerrocop, Newyork,"
"Cerrocop, Lima."

August 20, 1931.

Dear Mr. Addicks:

I am enclosing, herewith, copies of correspondence with Mr. Thomas M. Kekich, who was formerly in our employ in Peru. I understand he is a practical, but not a technical man. What do you think of his idea? My recollection is that, what he proposes is just what they have planned to try in the new large converter recently purchased and shipped to Peru.

Yours truly,

C. V. Drew

Mr. Lawrence Addicks,
Bel Air, Md.

Encs.

COPY

334 South Westlake Ave.,
Los Angeles California
August 14, 1931.

Mr. C. V. Drew,
Cerro de Pasco Copper Corporation,
44 Wall St.,
New York, N.Y.

Dear Sir:

In response to your letter of July 13, it is believed that my letter of July 6, wasmisunderstood or was overlooked. The estimate which I have made, 3-1/2¢ per lb. of copper, covers the cost of mining, smelting and converting at the smelter.

With reference to other advantages and the information of the process on which you wish to secure further information, it may be said here that the process has many advantages over the present emthods of smelting and converting, doing away with present reverberatory blast furnace and converting practice as now commonly practiced in smelting ores.

The process may be described as the smelting and converting of raw, unprepared pyritic ores or similar natural or artificial sulphides direct in the converter or in the reverberatory furnace, by means of the heat generated from the rapid oxidation of certain constituents of the ores or substances themselves, and with the addition, if necessary, of siliceous or calcareous fluxes only. No carbonaceous fuel is used. The raw, unprepared ore is smelted and converted to blister copper in one furnace and in one single operation, without anytransfers of the matte. No flue dust results - and the slag is finally drawn off in a perfectly clean state.

The greatness of the invention consists in its simplicity, which is likely to be overlooked or misunderstood by those who are notmetallurgists of long experience and liberal mind. A study of these will, I hope, make the method clearer.

Referring to your remarks in your letter of July 13 in which you state that the corporation is always looking for better and cheaper methods of smelting, if this is so, I would be willing to give to Cerro de Pasco Copper Corporation one-half interest in the Peruvian patent provided the Cerro de Pasco Copper Corporation is willing to take out a Peruvian patent to cover and finance the same within the next thirty days by which time I intend to apply for Peruvian Patent/

Trusting to receive your earliest reply, I am,

Sincerely yours

(Sgd) Thos. M. Kekich

July 13, 1931.

Mr. M.T.Kekich,
334 South Westlake Ave.,
Los Angeles, California.

Dear Sir:

We have your favor of July 6a The Corporation is always looking for better and cheaper methods of smelting.

Your estimated cost of 3-1/2 cents per lb. of copper for your process we understand covers the cost from ore and concentrates at the smelter to blister copper at the smelter and if so offers insufficient inducement to warrant spending $15,000. for demonstration. However, if your process can produce copper at considerably lower cost than 3-1/2 cents per lb. which you estimate or if your process has other advantages we will be pleased to secure additional information relative to it.

Yours very truly,

P.S. We wish to correct a false impression which you have -our smelter in Peru has been in continuous operation except for one month last fall when it was shut down due to political unrest.

COPY

334 South Westlake Avenue,
Los Angeles, California
July 6, 1931.

Mr. CV Drew,
Cerro de Pasco Mining Co.,
404 Wall St.,
New York, N.Y.

Dear Mr. Drew:

I have been informed that Cerro de Pasco Mining Company was forced to close their smelter on account of the present low price of the metal and therefore the writer and the inventor of the new smelting and converting method wishes to inform you that with the new process, copper can be produced for 3-1/2¢ a pound at Cerro de Pasco smelter. This is for your confidential information and it would cost the company $15,000.00 to make the test. The test can be made in any smelter if your company takes advantage of this opportunity.

The method will disrupt the present smelting industry and when launched, will quickly and irrevocably prove to be of almost incalculable value to the mining industry. It will eliminate roasting cintering cyanide and the leaching processes in the future. The sulphide ores can be smelted and converted to metalic by the heat generated by their own oxidation and without the aid of extraneous heat such as carbonaceous fuel, the electric arc, etc.

Much more of course can be said, and viewed as a whole, the process may be termed a synthetic concentrate of forty years smelting experience, - it accomplishes everything at one operation.

Now, Mr. Drew, this is only for your confidential information and I await your pleasure.

Sincerely yours,

(Sgd) Thos. M. Kekich