but sometimes this has come out as high as over 60% copper, having had much of the irony ore on the charge. I will mention in connection with making this high grade copper matte, an interesting fact I have noticed, that whenever the matte begins to come up to 53% copper, and above, the gold will "lock up" in the furnace on metallic copper bottoms formed. One week, making 58% to 63% copper matte, I got gold locked up to the value of $6,000 in the furnace bottom, next week I got sulphur ores that I could get the matte down to 45% copper, and then I got all the gold out in five days. Silver does not behave in this way.

The Mother Lode ore is exceptionally free from arsenic and antimony, and this ore behaves quite different in the furnace compared with the Silver King ore, which I used to treat at the Hall Mines smelter at Nelson, B.C., and which ore then carried quite an amount of As. and Sb., giving a nice colored purple-red smoke emanating from the chimney. When I was running the Silver King ore, I used to get metallic copper and speiss separated out as soon as the matte came up to 47% copper; this metallic copper and speiss used to raise the furnace bottom and settler bottoms, and cause all kinds of trouble in filling up the tap holes, threatening to plug up the furnace in this way. In Nelson I had on this account to change the trapped spout to the ordinary way of stopping up the tap hole with clay, and when the furnace bottom was rising up inside the tap jacket I used to blow the furnace for five minutes, the heat coming through here smelting its way through the metallics. With this Mother Lode ore I have made as high as 67% copper matte in the blast furnace, and using trapped blast too, without filling the tap hole with metallic copper.

For its size, 42-in. by 150-in. at tuyeres, I think this furnace has the largest record so far as large tonnage, and at the same time cleanness of slags made is concerned. The coarseness of the ore has more to do with tonnage, and to some extent clean slags, than anything else under similar circumstances. I found this out when we started to crush the ore to five inch size, having got a wrong crusher head before, crushing the ore to two and three inches. A couple of per cent. of silica, more or less, in the slag does not slacken these big furnaces up as quick as it does on small furnaces. Neither is high lime as bad. What I have found bad, and raising the copper in the slag, is if the iron in the slag comes up to 30% and 32%, and silica at the same time is low, say 28% to 30%, this makes a heavy slag and poor separation of the matte.

I will give here examples of some different kinds of slags made, with the corresponding tonnage and tenor of copper in the slag:

1901, Nov. 7th.—The slag went $SiO_2 = 42.7\%$, Fe 21.1%, $CaO = 20.0\%$ and Cu 0.33%; the matte went 44% Cu, and furnace smelted 393 tons of ore.

April 1st.—The slag went $SiO_2 = 33.8\%$, $Fe = 32.5\%$, $CaO = 25.7\%$ and $Cu = 0.25\%$; matte went 49% Cu, the tonnage 402 tons of ore. High lime has a tendency to make the slags clean in Cu.

July 7th.—The slag went $SiO_2 = 30.9\%$, $Fe = 32.5\%$, $CaO = 16.8\%$ and $Cu = 0.44\%$; the matte went 53% Cu, the tonnage 399 tons.

1902, Jan. 10th.—When the furnace put through 459 tons of ore, the slag went $SiO_2 = 37.8\%$, $Fe = 24.5\%$ and $CaO = 20.9\%$ and $Cu = 0.35\%$; the matte went 49% Cu.

June 25th.—Two furnaces put through 765 tons of ore. Slag went, silica, 43.3%; iron, 20.1%; lime, 18.5%; copper, 0.31%. Matte produced went 49% copper.

October 29.—No. 1 furnace put through 399 tons of ore. Slag went, silica, 46.5%; iron, 19%; lime, 19.5%; copper, 0.29%. Matte produced went 49% copper.

I have had the concentration varying from 15 to 70, but when the matte fall is below 2 per cent. the furnace does not work well, there is too little heat brought down in the crucible, this especially within a rather silicious slag, when the light goes out of the tuyeres, and the smelting zone raises.

We make slag samples for copper twice a day, but do not make it by the generally adopted calorimetric method, which as a rule gives too low results and fools the metallurgist, making him believe and tell others that he makes cleaner slags than he does. The slag samples are taken every hour, chilled in water, and day and night shift kept apart. Two grams are taken for the determination, dissolved in hydronitro-chloric acid evaporated with HSO_4, diluted and copper precipitated with hyposulphite of sodium solution, the Cu_2S dissolved in HNO_3, and titrated with KCy; this determination takes somewhat over two hours, making other work at the time, but it is correct and reliable, and it will check, which I have proved, to one hundredths of one per cent. = 0.01% of copper; and where you have very little copper on your charge, it is important to have accurate determinations of your slags, and to keep them low in copper, as 0.1 of one per cent. makes quite an item. These daily slags are then put together, and once weekly, the average of all the slags is made for gold, silver and also copper. The slags, as a rule, have been very clean, the copper varying between 0.30 and 0.037%; gold, 0.0025 and 0.0035 oz.; silver, 0.04 and 0.07 oz. Of course, you are allowed more copper in the slag, and considered doing good work making 50% Cu matte, than you have in making 30% Cu matte. An old rule was formerly that a man was considered doing good smelting, when he had only 0.1% copper in the slag for every 105 copper in the matte, thus making 30% Cu matte, allowing you 0.3% in the slag, etc.

The amount of coke used is from 11½% to 12% of the weight of the ore. The blast used is from a No. 7½ Connersville blower, making 155 revolutions per minute, and giving 80 cubic feet of air per revolution. The blast pressure averages 1¾-inch mercury, equal to 14 ounces. Feed height above tuyeres varies from 4 to 8 feet; when little sulphur or much coarse ore, feeding high; when much sulphur, or much fine ore, feeding low. The best feed height for good running I have found to be from 7 to 8 feet. As to the running of the furnace, charges of three tons are put in at the feed floor, by feeders and not by any mechanical device, which I have had occasion to find out is an institution that does not pay, but costs a whole lot of money in less tonnage and bad working of the furnace, and dirtier slags.

A charge comes down to the tuyeres in ¾ of an hour; slag and matte run together continuously through a trapped spout into a water-jacketed forehearth on wheels, inside dimensions being 8 ft. long by 5½ ft. wide by 3 ft. deep. The matte, having a specific gravity of 5 to 5.3, sinks to the bottom and the slag of a specific gravity of about 3.4 to 3.5 overflows at the furthest end into a large settling pot, and from this into the granulating flume. The matte is tapped at intervals into matte pots, and their contents poured into matte moulds 2 ft. wide by 5 ft. long by 4 in. deep, thus cooling off the matte quickly, and delivering it into the shape of cakes 1 to 1½ in. thick; these matte cakes when cooled are knocked on the top side with sledge hammers and broken up into 3 to 5 in. pieces, and shipped in this way in bulk in box cars, the lot averaging 30 tons. This does away with a crusher and sacking, and makes the matte pots last longer.

During the latter part of 1901 we started to double the capacity of the smelter, and to this end erected new sets of lower ore bins, twelve in number, with an increased storage capacity of 5,000 tons of ore, making a total storage capacity for the lower ore bins of 10,000 tons. Another 560 foot railway trestle has been built between the two previous ones in order to facilitate and make possible the handling of over a thousand tons daily of material for the smelter by the railway. The second furnace was put in and was started up during 1902, and a No. 7½ Connersville blower furnished the blast for the second furnace. With this second furnace the smelter has now a capacity of 800 tons of ore, and together with the coke and coal and matte shipped, the railway has to handle about a thousand tons of material daily. We figure on increasing the plant with two more furnaces, and will, when these are put up, also add converter works for making the matte into blister copper here on the spot, and thus save in not having to transport iron and sulphur in the matte, and get a better price for the copper in the blister copper, which will be an important item in cutting down the cost of handling the ore.