

H. F. WIERUM.

METHOD OF OBTAINING VALUES FROM COPPER BEARING MATERIAL.

APPLICATION FILED DEC. 29, 1911. RENEWED OCT. 30, 1912.

1,063,486.

Patented June 3, 1913.

2 SHEETS-SHEET 1.

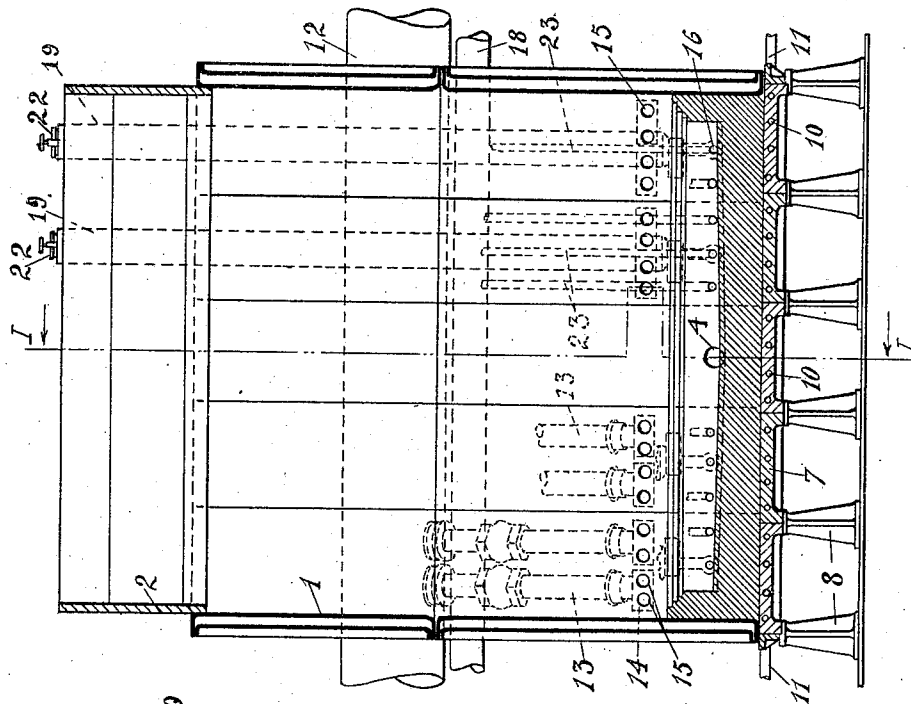


Fig. 2.

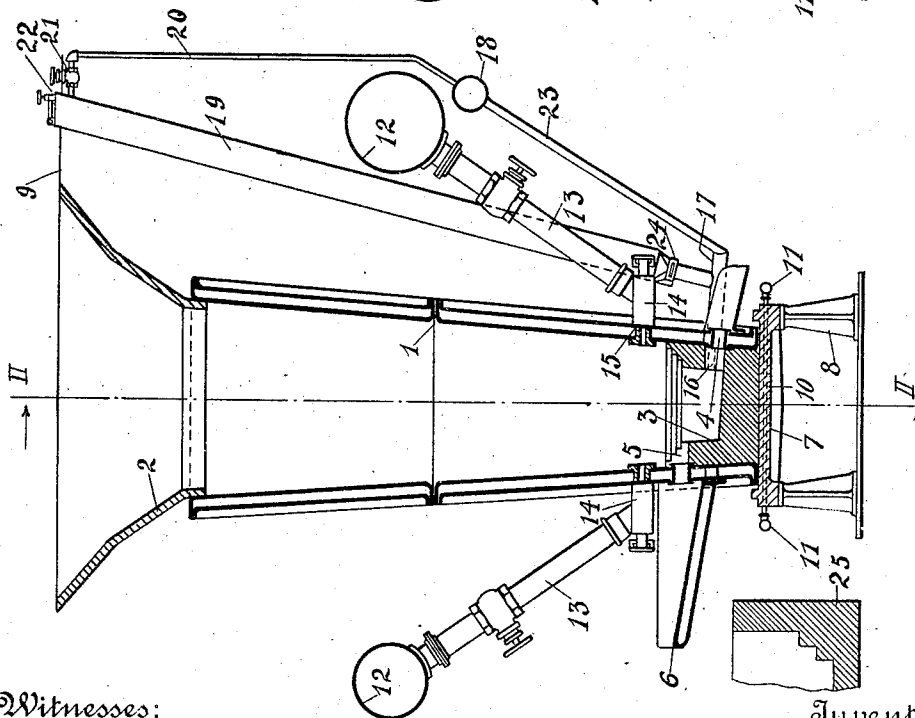


Fig. 1.

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Waldo M. Chapin

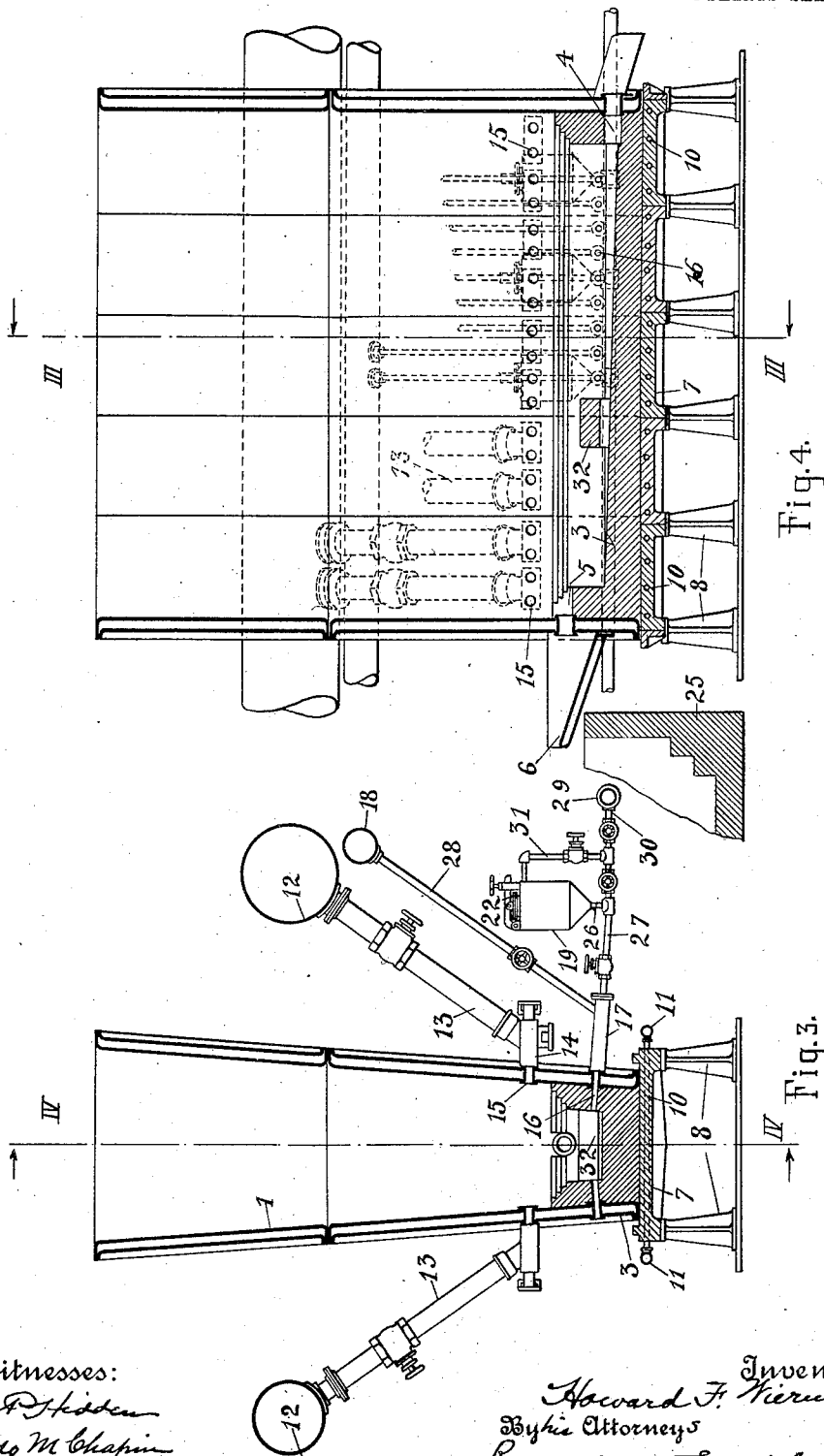
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UNITED STATES PATENT OFFICE.

HOWARD F. WIERUM, OF UPPER MONTCLAIR, NEW JERSEY.

METHOD OF OBTAINING VALUES FROM COPPER-BEARING MATERIAL.

1,063,486.

Specification of Letters Patent.

Patented June 3, 1913.

Application filed December 29, 1911, Serial No. 668,507. Renewed October 30, 1912. Serial No. 728,731.

To all whom it may concern:

Be it known that I, HOWARD F. WIERUM, a citizen of the United States, residing at Upper Montclair, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in Methods of Obtaining Values from Copper-Bearing Material, of which the following is a full, clear, and exact description.

This invention relates to a metallurgical operation which involves the subjection to novel conditions of matte formed in a blast or smelting furnace for the production of copper, nickel, or other analogous metals, commonly obtained from sulfid ores.

The process, therefore, has for one of its objects the production of metallic copper, nickel, or similar metals, or the production of a higher grade matte (or white metal) than is ordinarily made in such blast or smelting furnaces.

Hereinafter reference will only be made to a copper blast furnace but it is intended to cover thereby any analogous blast furnace operation for the production of any metal which forms a matte or the matte of such metal.

Another object of my invention is to oxidize a larger proportion of the iron, present in the ore or otherwise introduced, to FeO , and further to oxidize a greater percentage of the sulfur present to SO_2 , than has heretofore been common nor even possible in copper blast furnace practice.

A further object is to conserve the heat produced by the oxidation of the iron and sulfur and to thereby save the expense of a portion of the carbonaceous fuel used in copper blast furnaces.

A still further object, and a very important one, is to enrich the gas, resultant from the smelting of copper and iron sulfids, to a higher percentage of SO_2 therein.

These and other objects of my invention will be hereinafter discussed and the novel means and process whereby they may be effected will be more particularly set forth in the appended claims.

In the accompanying drawings I have exemplified two forms of apparatus whereby my novel process may be effectuated, but I do not desire to be limited to the forms shown nor indeed to the process, other than as covered by the claims, since I am aware that various modifications and changes may

be made in both the apparatus and process without departing from the spirit of my invention.

In the drawings in which like reference characters designate like parts throughout the several views: Figure 1 is a vertical section of a copper blast furnace, the section being taken on line I—I of Fig. 2. Fig. 2 is a vertical section of said furnace, the section being taken on line II—II of Fig. 1. Fig. 3 is a view, similar to Fig. 1, of a modification, the section being taken on line III—III of Fig. 4. Fig. 4 is a section of the modified furnace taken on line IV—IV of Fig. 3.

Referring first to Figs. 1 and 2, the upright converting blast furnace therein shown comprises a water-jacketed stack or column 1, into the top of which is fed ore, matte, fuel and flux, which comprise an ordinary copper blast furnace charge. The baffle or feed plates for directing this charge into the furnace have been designated 2. In the bottom of the column is the crucible 3, preferably of magnesia brick or the like, it being desirable that the material which constitutes the walls of this crucible, or its lining, be basic in character.

The crucible is apertured on one side as at 4 to form a copper tap hole, and the opposite side is preferably recessed as at 5 to provide a slag tap hole, the latter delivering into the slag spout 6.

The column and its crucible are supported upon the usual sole plates 7, which in turn are carried upon the uprights 8, elevating the crucible a convenient distance above the ground. The baffle or feed plates 2 preferably just reach the charge floor level 9.

The crucible may extend the entire length and width of the blast furnace, if desired, and may be of any suitable depth. It may be lined with basic brick, tile or rock, such as magnesia or chrome, and such basic lining may, further, be protected from fusing, melting, combining, or in any way disintegrating, by having water-jackets on the outside, or in contact therewith, these water-jackets being preferably the regular water-jackets of the blast furnace. I also may provide conduits 10 through the sole plates, which are connected to water pipes 11, so that the basic brick crucible or lining may be cooled from below as well as from the sides. The usual low pressure blast main

12 is provided, with down-comers 13 which deliver to the twyer boxes 14 of the smelting twyers 15.

Converting twyers 16 are disposed preferably below the smelting twyers, the boxes 17 of these converting twyers being in communication with a high pressure blast main 18, and also with preferably elongated receivers 19, which extend upwardly to the charge floor level 9. These receivers are normally filled, when in use, with silicious material, and their mode of operation and function will be hereinafter considered. Equalizing pressure pipes 20 extend upwardly from the high pressure main 18 to the tops of the respective receivers 19; each pipe 20 being provided with a valve 21; and each receiver being fitted with an air tight lid 22. A series of pipes 23 connect the main 18 with the respective twyer boxes 17; and the flow of silica from the receivers into said boxes is controlled by valves or regulators 24.

The operation of the furnace in question is as follows: Assuming the furnace to have been charged in the usual manner with preferably less carbonaceous material in the column than is customary in copper blast furnace practice, and that the blast has been delivered through the smelting twyers a sufficient length of time to have accumulated a suitable quantity of molten matte, rich in oxidizable fuel making constituents such as sulfur, iron, etc.; the converting twyers are now utilized and a blast from the high pressure main 18 is delivered there-through, bessemerizing the molten mass. The regulators 24 of the silica receivers, or a certain number of them, are opened the desired amount and the preferably finely divided (from $\frac{1}{4}$ " to 120 mesh) silicious or other fluxing material is injected into the body of molten matte by means of the blast delivered down the corresponding pipes 23. If desired, flue dust also may be injected directly into the body of molten matte in the crucible by means of some of the converting twyers, for example.

I am aware that it has been attempted to introduce flue dust into furnaces by means of a blast, but in so far as I am aware it has never been attempted to inject the flue dust below the surface of and directly into the body of molten matte or like material, in the crucible. The advantage of so introducing more or less pulverulent material is that it reduces "dusting", by reason of the fact that the molten liquid holds the dust once it enters such liquid, whereas if introduced above the liquid, a quantity of this dust is usually carried up through the furnace. I may add that the dust so introduced may be silicious in character, or in the nature of a flux; although dust or ores requiring flux may also be introduced in

this fashion; in which case I may mix the fluxing material with the relatively fine ore and feed the mixture in by means of a blast, or I may deliver such materials separately into the molten body. Ordinarily, I prefer to feed the fluxing material separately, and, as is herein pointed out, there are particular advantages in so delivering silicious material or the like directly into the molten matte when both the smelting and converting operations are conducted in a blast furnace. The iron oxidized by the blast entering through these same twyers and others, combines with the so introduced silica to form a silicate of iron, which rises to the surface of the liquid mass as slag. The sulfids present in the ore are oxidized, under the foregoing conditions, more completely than usual in copper blast furnaces, a portion, at least, of the heat necessary to properly decompose, oxidize and melt these sulfids being generated by the intense oxidation effected.

I am aware that attempts have been made to introduce silica into the bath of matte in the crucible of a blast furnace by providing such material in a column of ore which is supposed to gradually feed down into the molten matte. There are obvious difficulties, however, in the way of effecting an equable distribution or regular supply of silica into the bath by this method. By reason of the means employed for introducing the silica or silicious matter, according to the herein described process, however, it is possible to regulate the quantity supplied to a nicety, and furthermore to deliver it directly into the body of molten matte, exactly where needed.

The converting twyers should of course be made of sufficient size to readily deliver the blast of mingled air and silica or the like, and in practice I prefer to make these twyers of from $\frac{1}{2}$ " to $1\frac{1}{2}$ " diameter. They are preferably arranged horizontally and at a sufficient distance below the smelting twyers to bring them below the surface level of the liquid matte. The blast delivered therethrough may be of from, let us say, six to fourteen pounds per square inch. I am aware that attempts have been made to use this combination of smelting and converting twyers and I do not claim such combination broadly. To the best of my knowledge however metallurgical processes of the character in question, and involving the use of both smelting and converting twyers have never been completely successful, and this I believe to be due to the fact that the iron oxid formed by the blast has not been fluxed off properly. There are distinct advantages to be gained by utilizing in a blast furnace this arrangement of smelting and converting twyers in conjunction with the introduction of silicious or acid matter by

the converting blast. This provision in a copper blast furnace of smelting twyers, converting twyers and means for introducing silicious or acid matter into the bath, through the converting twyers, is believed, further, to be broadly new.

The smelting and converting operations may be successive or continuous, and in fact even practically simultaneous; and the provision of the water cooled basic lining in connection therewith, is, it may here be noted, particularly beneficial.

The slag as it accumulates may be drawn off from the slag spout 6 and allowed to settle in the settler 25, while the copper or rich matte may be tapped off, as usual, from the tap hole 4.

The receivers 19 may be filled with silicious material directly from the charging floor and the said material descends by gravity through these tubular structures until it falls into the twyer-boxes 17. The blast delivered through the pipes 23 is sufficiently high to forcibly eject such of the material as falls into said twyer boxes immediately into the body of molten matte. The equalizer pipes 20 serve to balance the upward pressure of the converting blast upon the column of silicious matter so that it is free to fall when the valves or gates 24 are opened.

In Figs. 1 and 2, the furnace is substantially symmetrical with respect to the section lines I—I, II—II, which in this instance are also center lines. In Figs. 3 and 4, however, I have illustrated a furnace which is not so symmetrical. Herein, the parts designated by like characters to those shown in Figs. 1 and 2 need not be discussed since they perform substantially identical functions. The silica receivers are, in this instance however, merely tank-like containers 19' which deliver into nipples 26, which in turn open into injector pipes 27. The high pressure main 18 delivers its blast via pipes 28 directly into the twyer boxes 17, but in the present case this blast does not inject the silica; a supplemental blast being provided, the compressed air main 29 of which is in communication by means of pipes 30 with the injector pipes 27. Equalizing pipes 31 are here also preferably provided, and for similar reasons. The furnace too is constructed somewhat differently in that in this form of apparatus a bridge 32 of refractory brick, or the like, preferably basic, spans the crucible from one side to the other thereof, which substantially confines the converting to one end, *i. e.*, the copper tap hole end of the furnace, as shown in Fig. 4, no converting twyers being located between this bridge and the slag hole.

The passage under the bridge permits the enriched matte or copper to flow through and gradually accumulate adjacent the cop-

per tap hole while any slag which will be formed in the copper tap hole end of the furnace will flow over the bridge to the slag tap end. This construction is a particularly advantageous one, in that it permits of a continuous and practically even flow of slag toward the slag spout, if desired, the disturbance due to the converting blast not materially affecting this flow, and the absence of all disturbance due to the converting blast,—at the slag tap end,—giving opportunity for any included shots of matte to settle out, to a certain extent, before the slag is discharged from the furnace. It may be further stated that the intense heat generated by the converting, being imparted to whatever slag is immediately superincumbent on the bath of matte being converted, renders this slag unusually fluid and favorable for settling purposes. Finally, I desire to particularly direct attention to the enrichment of the gases given off from the furnace. It frequently happens in furnaces of this description and with the ores obtainable, that the amounts of sulfur gases, such as sulfur dioxid and tri-oxid, formed in the usual manner (largely above the mass of matte) when mingled with the other gases evolved are so diluted as to be too poor to be available for economical utilization. A considerable amount of sulfur remains in the matte which might be used to enrich this gas were it but possible to obtain it. This enrichment is rendered possible by the introduction of the silicious or fluxing material in the manner described and, if desired, practically or nearly all, of this residual sulfur may be oxidized *in situ* and the sulfur gases thus formed may be allowed to pass upwardly through the melt to mingle with the regularly formed gases.

By this process therefore even ores poor in sulfur may be made to yield gases during their treatment in the blast furnace which are sufficiently rich to warrant subjecting the same to known processes, where necessary, for producing sulfuric acid and the like, for use in certain metallurgical processes, such as sulfating, and for use in the sulfite wood pulp business.

In the appended claims I have termed any metal, such as copper, which is capable of forming a matte when smelted, a matte forming metal; while the term sulfur gas is intended to cover any gas containing sulfur as a constituent thereof.

Having described my invention, I claim:

1. The process of operating a blast furnace which comprises smelting a mass containing a matte forming metal therein to form matte and treating this matte in the same receptacle with silicious material by injecting said material directly into the molten body of the matte by fluid pressure.

2. The metallurgical process which com-

prises smelting a mass containing a matte forming metal to form matte, subjecting this matte to the action of a converting blast while in the same receptacle and introducing fluxing material into the molten body of matte by fluid pressure.

3. The metallurgical process which comprises smelting a mass containing a matte forming metal to form matte, subjecting this matte to the action of a converting blast while in the same receptacle, and introducing fluxing material into the molten body of matte through the instrumentality of said converting blast.

4. The metallurgical process which comprises smelting a mass containing a matte forming metal to form matte, and simultaneously subjecting said matte to a converting blast laden with fluxing material.

5. The metallurgical process which comprises smelting a mass containing a matte forming metal to form matte and simultaneously subjecting said matte to a converting blast laden with silicious material.

6. The metallurgical process which comprises smelting a mass containing copper to form copper matte, and in the same receptacle subjecting this matte to a converting blast laden with fluxing material.

7. The metallurgical process which comprises smelting a mass containing copper to form copper matte, and in the same receptacle subjecting this matte to a converting blast laden with a material of greater density than that of the fluid of the blast.

8. The metallurgical process which comprises smelting a mass containing a matte forming metal to form matte, bessemerizing this matte by subjecting portions only of a bath of the same to a converting blast, establishing separate and oppositely flowing streams of slag and molten material containing said metal in said bath and maintaining said streams separate and distinct by spacing them apart for a portion of their length.

9. The process of operating a furnace which comprises smelting a mass of ore therein, introducing by fluid pressure a substance, capable of reacting with a constituent of said mass, into the melted portion of said mass, below the fluid level of said portion, effecting a reaction in which the said constituent of the mass and said substance participate whereby to produce an enriching gas, and enriching the other gases from said furnace by admixing the said gas therewith.

10. The process of operating a smelting

furnace which comprises smelting a mass of sulfid ore therein, introducing by fluid pressure a fluxing material, capable of reacting with a constituent of said mass, into the melted portion of said mass, below the fluid level of said portion, effecting a reaction in which the said constituent of the mass and said material participate whereby to produce a sulfur gas, and enriching the other sulfur gases from said furnace by admixing the said gas therewith.

11. The process of operating a smelting furnace which comprises smelting a mass of sulfid ore, introducing by fluid pressure a silicious material capable of reacting with a constituent of said mass, into the melted portion of said mass, below the fluid level of said portion, effecting a reaction in which the said constituent of the mass and said silicious material participate, whereby to produce a sulfur gas, and enriching the other sulfur gases from said furnace by admixing said gas therewith.

12. The process of operating a smelting furnace which comprises smelting a mass of sulfid ore therein, introducing by a converting blast a fluxing material, capable of reacting with a constituent of said mass, into the melted portion of said mass, below the fluid level of said portion, effecting a reaction in which the said constituent of the mass and said material participate whereby to produce a sulfur gas, and enriching the other gases from said furnace by admixing the said sulfur gas therewith.

13. The metallurgical process which comprises smelting a mass containing a matte forming metal to form matte, subjecting this matte to the action of a converting blast while in the same receptacle and introducing fluxing material into the molten body of matte, below the surface of said matte, by fluid pressure.

14. The metallurgical process which comprises smelting a mass containing a matte forming metal to form matte, subjecting this matte to the action of a converting blast while in the same receptacle, and introducing fluxing material directly into the molten body of matte, and below the surface thereof, through the instrumentality of said converting blast.

In witness whereof, I subscribe my signature, in the presence of two witnesses.

HOWARD F. WIERUM.

Witnesses:

WALDO M. CHAPIN,
WILLIAM C. LARY.