No. 677,812. Patented July 2, 1901.

T. SMITH.

FURNACE.

(Application filed Oct. 5, 1899.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 1.

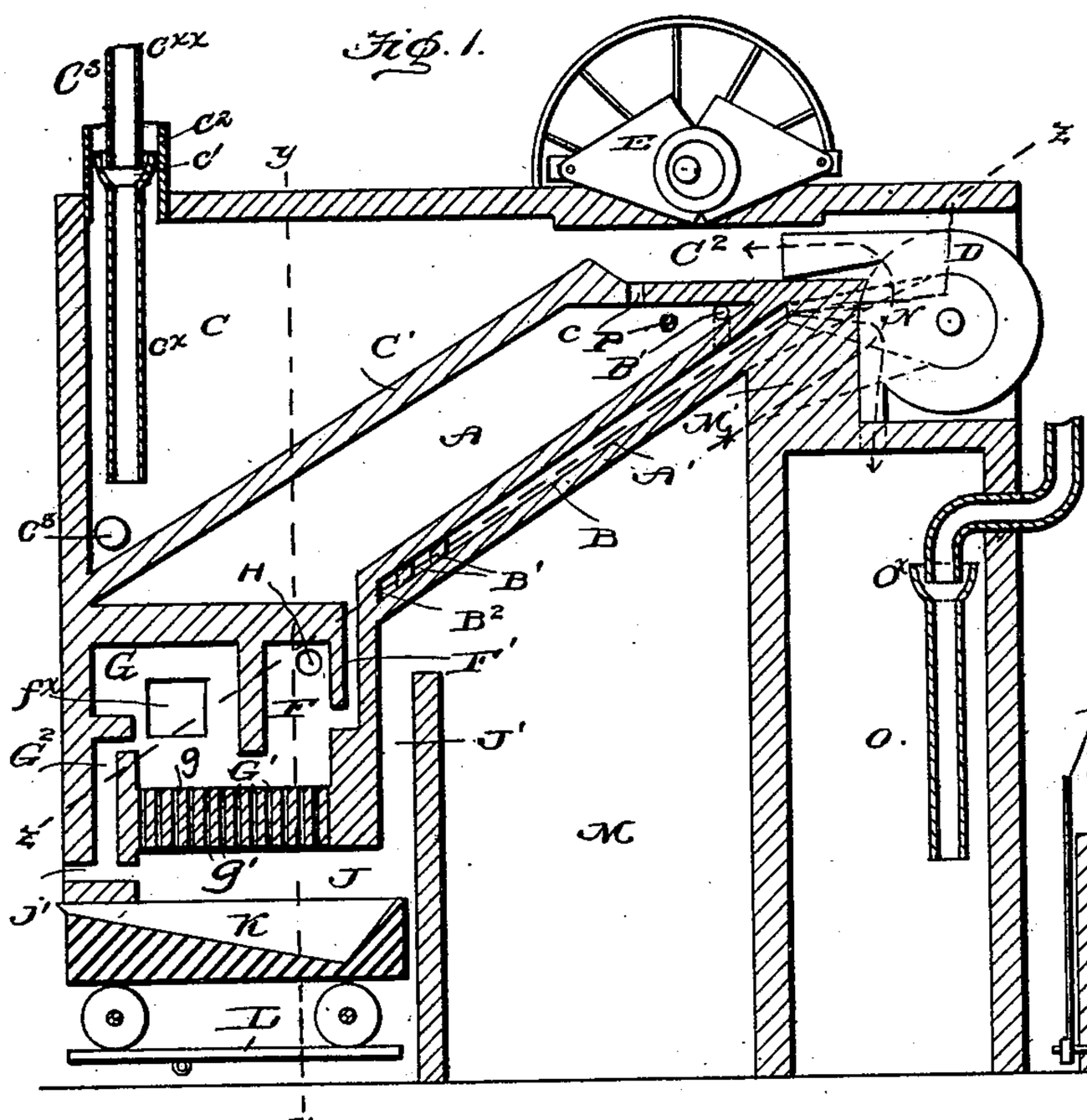

Fig. 2.

Fig. 3.

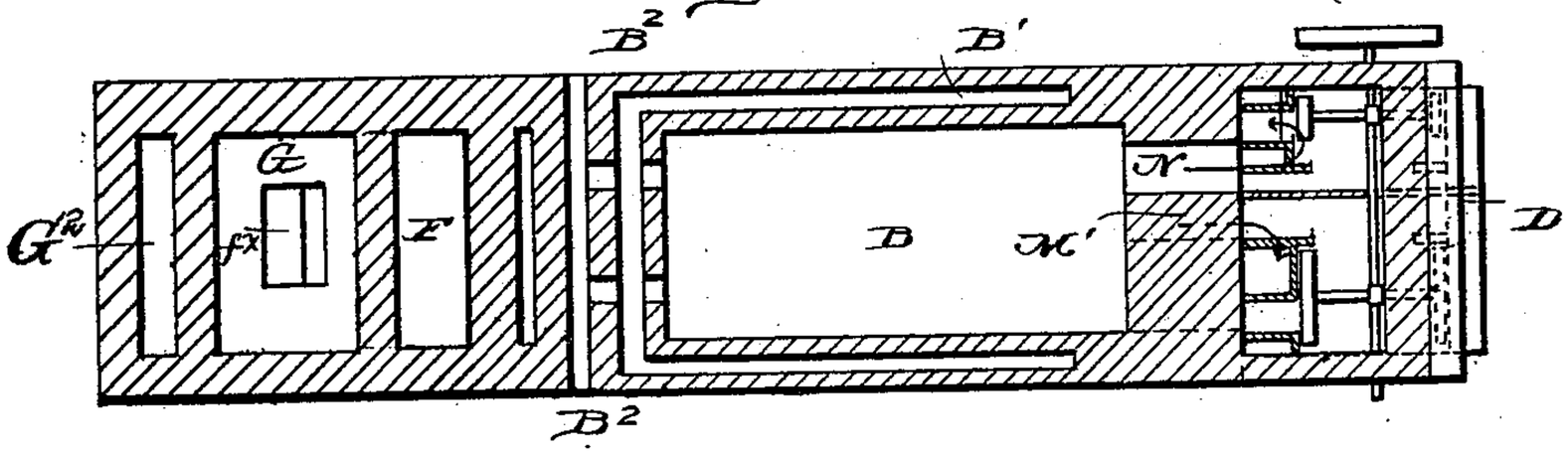

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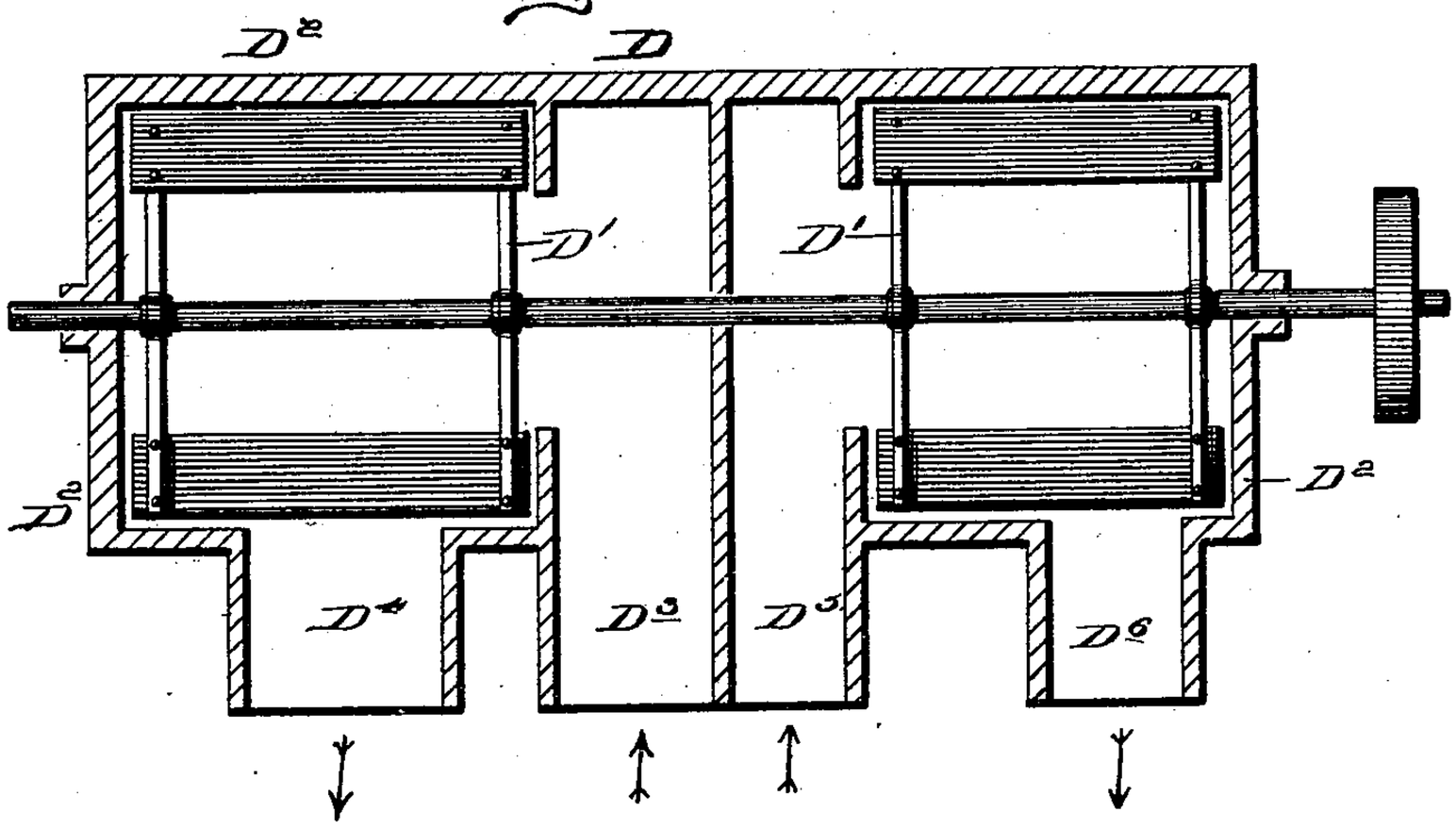
Fig. 4.



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UNITED STATES PATENT OFFICE.

THOMAS SMITH, OF HOPEWELL, TERRITORY OF NEW MEXICO, ASSIGNOR OF ONE-HALF TO EUGENE G. E. JACCARD AND ARTHUR C. SWEET, OF KANSAS CITY, MISSOURI.

FURNACE.

SPECIFICATION forming part of Letters Patent No. 677,812, dated July 2, 1901.

Application filed October 5, 1899. Serial No. 732,671. (No model.)

To all whom it may concern:

Be it known that I, THOMAS SMITH, a citizen of the United States, residing at Hopewell, in the county of Rio Arriba and Territory of New Mexico, have invented certain new and useful Improvements in Furnaces; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to that class of furnaces designed to reduce to the metallic state the metals contained in the ore fed thereto.

Heretofore the processes of desulfurization, oxidation, and final reduction of the metal have been conducted separately, sometimes in detached furnaces, the long intervals between the stages of the different processes and the necessary hauling, resulting in the cooling, consequent waste of the material, unnecessary labor, and lack of economy. The separate processes of desulfurization or matting (partial desulfurization) when performed in a blast-furnace require subsequent treatment to produce the commercial metallic products, while in reverberatory furnaces the expenditure of time and power necessary in rabbling or turning, so as to expose all portions of the charge to the alternate action of the fire and air, make the process of desulfurization or oxidation extremely costly, while the subsequent processes of reduction are wasteful of both fuel and metal. In the blast-furnace the ore is placed in the stack in alternate layers, with the fuel and air forced in through the layers a little above the crucible. The heat generated by the combustion of the fuel between the layers forms a fusion zone at that point, the melted portions of the ore passing down into the crucible, while the volatile products of combustion pass upward through the interstices of the charge. This makes it necessary to first eliminate the hydrocarbons of the fuel, converting it into coke or charcoal, also reducing the use of finely-crushed ore in the charge, which is undesirable on account of its closing the interstices. Another ill effect is that the volatile metals and sulfurous gases after being separated in the fusion-zone pass upward through the interstices and recombine at the cooler zone above, zinc-sulfid thus re-forming from blend with such persistence that it is necessary to remove it from the top surface. Otherwise it would obstruct the passage of the gaseous product of combustion and freeze the furnace. Another source of waste in the blast-furnace in all copper-smelting is the utilization of the fact of the greater affinity of iron for sulfur than for copper, freeing the copper from sulfur, iron being introduced into the charge to combine with the sulfur and precipitated into slag in matte form.

The objects of my invention are, among other things, to provide for the elimination of all deleterious gases of the reverberatory furnace and the utilization thereof for generating a hot blast and for precipitating and utilizing the gaseous products; to provide for carrying on desulfurization, oxidation, and reduction to metallic form as a continuous operation; to so construct the furnace as to permit the use of finely-crushed ore without endangering the blowing over or choking resulting from the intense heat of the blast, and to provide means whereby the volatile metal may be desulfurized, the sulfurous gases utilized as fuel for the continuation of the process, and the resultant oxids reduced to the metallic form by the retorting process, while the other metallic oxids contained in the ore are subjected to a subsequent treatment and recovered in the metallic form.

To these ends the invention consists in the novel constructions and combinations of parts hereinafter more fully described and claimed, and illustrated in the accompanying drawings, in which—

Figure 1 is a central vertical longitudinal section through the furnace. Fig. 2 is a section on line Y Y, Fig. 1. Fig. 3 is a section on line Z Z, Fig. 2. Fig. 4 is a detail view of a fan.

Referring to said figures by letters of reference, A is the roasting-chamber, having the inclined preferably double-tiled hearth A′, having a chamber B communicating with said roasting-chamber through passages B′, which also communicate at the point of outlet of

said chamber B, near the lower end thereof, with air-supply ports B^2, as shown in Fig. 3. Above the chamber A is a dust-chamber C, likewise provided, preferably, with an inclined bottom C', with its flue C^2 communicating with a fan D, said chamber having a gas-outlet C^3. This outlet comprises a pipe $c^\times$, suitably supported within and extending continuously to the bottom of the chamber, and a second short pipe $c^{\times\times}$. The upper end of the pipe $c^\times$, which has an inverted conical portion c', extends up into a dome c^2 on the casing of the chamber C, and the pipe $c^{\times\times}$ projects through the top of the dome c^2 and has its lower or inner end dipping into the conical portion c', with a surrounding space between it and said latter portion. This arrangement provides for passing the dust, &c., into the conical portion c' through the surrounding space between said pipe and the latter, it then being returned through the pipe $c^\times$ to the bottom or the lowest portion of the chamber C, whence it escapes through the dust-outlet c^3, provided in the chamber-casing adjacent to the lower end of said pipe $c^\times$. Above said flue is mounted a suitable ore crusher or pulverizer E, while within the bottom of said flue is a passage *c*, which communicates with chamber A, said bottom being preferably inclined upwardly from the passage on the side farthest from the fan D. Below the chamber A is a reduction-chamber F, connected thereto at one side by a passage F', and adjacent to said reduction-chamber is the fire box or chamber G, whose door $f^\times$, not being luted, permits access of sufficient air for the partial combustion desired in said chamber. Said door is left open until the hearth is heated, when the hydrocarbon gases of the fuel driven off by the heat are taken therefrom by the fan D through the flue G^2 and are burned in chamber J. These two chambers F and G are connected by a passage G' at their bottoms. H is a flue extending from said reduction-chamber, near its top, to a point above a crucible H', mounted upon wheels *h*, traveling upon a track I, which is pivotally held in place and may be tilted by means of a lever, as I'. A flue G^2 effects connection between the chamber G and the combustion-chamber J thereunder, interstices *g'* also being provided in the continuous bottoms of chambers F and G, while said combustion-chamber J is provided with an air-inlet *j'*. Within the combustion-chamber J is placed a crucible K, preferably of the form shown in Fig. 1 and provided with wheels mounted upon a tilting track L, operated by means of a lever L'.

Extending upward from chamber J and opening into a large oxid-chamber M is a flue J', said oxid-chamber communicating by means of a flue M' with a fan D, in turn communicating with the dust-flue C, above described. Said fan has pipe or flue connection N with chamber B, said pipe or flue also connecting with a flue N', exhausting into a chamber O thereunder, also having a gas-outlet $O^\times$ in all particulars substantially the same as the gas-outlet C^3 of the chamber C.

The fan D may be of any preferred construction, that shown comprising two rotary suction-fans D', arranged upon and driven by a common shaft suitably belted to a motor and inclosed within a common casing or housing D^2, having an inlet D^3 and an outlet D^4, connecting with parts N and O, respectively, and arranged in connection with one fan. The other fan has a similar arrangement of an inlet D^5 and outlet D^6, connecting with the parts M' and C^2, respectively, hereinbefore referred to. The course of the gas after passing into the chambers C and O it is not thought necessary to be stated herein, as a difference in the treatment of the average ores would require modifications thereof, the general design being by condensation and absorption or chemical neutralization of deleterious gases before exit into the atmosphere. By passing the gases through suitable outlets wherein lime hydrate is exposed to the action of the gases the carbonic acid and sulfurous acid can be eliminated or converted into lime carbonate or sulfate without appreciable vitiation of the surrounding atmosphere.

In operation fuel is placed in the fire-box G and a light fire started in crucible K. The bottom or hearth G is thereby heated and the gaseous hydrocarbons of the fuel liberated. These gases pass down through the flue G^2 into the combustion-chamber J, where they mix with the air admitted through ports *j'* and are consumed. The products of combustion are drawn off through flue J' and chamber M into flue M' by the fan D and are forced through flue C^2 into chamber C, forming a hot blast, whereby the silica is separated from the metallic particles of the crushed or pulverized ore falling from the crusher or pulverizer E, the heavier particles passing into the roasting-chamber A through passage *c*, while the lighter silicious portions are blown over into the dust-chamber as tailings. Any metallic particles thus blown into the latter chamber can be subsequently treated, according to the amount of metal the ore may contain, by the conversion thereof into soluble sulfates or chlorids, leaching, and precipitation. The heated pulverized metallic concentrates falling into the roasting-chamber A are still further heated upon the hearth thereof, giving up their sulfur. Water is then sprayed into the roasting-chamber through a nozzle P, which being converted into steam attacks the sulfur in the sulfid ores, the oxygen uniting with a portion thereof and forming sulfurous gas, while the hydrogen converts the remaining portion of the sulfur into hydrogen sulfid. These gases are conducted through flues B' into chamber B, where they are mixed with air admitted through air-inlet ports B^2. This mixture is heated to incandescence by the tiling of

chamber B and burned, forming sulfurous anhydrid or sulfurous acid gas. This may then be hydrated or changed to sulfuric acid in this chamber; but its principal use is to prevent the recombination of the sulfurous gases with the metallic products in the furnace. The sulfurous gas formed in the chamber B is drawn off through flue N and expelled into chamber O. After the extraction of the sulfur from the material within the roasting-chamber the oxidized metal passes downward into the reduction-chamber F, where it is dropped into the incandescent carbon of the fuel, which not having access to the free oxygen combines with the oxygen in the oxids, leaving the metal free. If zinc or other volatile metal be combined in the ore with the heavier metals, it is drawn off through the flue H, the temperature thereof being maintained at a lower point than the heat of volatilization, the metals, therefore, passing therethrough being allowed to condense and form a partial vacuum, inducing a current through said flue and causing the depositing of the metallic constituents in molten form in the crucible H′. The heavier metals in chambers F and G pass downward through interstices *g′* of the hearth *g* into crucible K. The clinker of the coal, with the ash, are combined with the slag formed by the slight percentage of silica left after concentration and also pass through the interstices *g′* into the crucible, preventing the complete oxidation which would take place if the metal were exposed to the heat of the combustion-chamber without such protection. The oxids formed in the combustion-chamber are carried over by the products of combustion into oxid-chamber M, where they are precipitated and from whence they may be taken and reduced in the reduction-chamber F whenever requisite.

It will be obvious that the carbon of the fuel is gradually changed by the reduction of the metallic oxids to carbon monoxid, which in the gaseous state is burned in combustion-chamber F.

Heretofore crucibles have been made by tamping them in solid and cutting a tap-hole therethrough, which is stopped up with fire-clay and opened subsequently. In making repairs the fires must be abated and a new crucible be tamped by workmen getting within the furnace. By employing a crucible of my construction, being portable, as above intimated, it may be readily withdrawn when repairs are necessary and replaced by another one. Also by employing a tilting track the metal may be readily poured from the crucible without in any manner straining the same or cracking the bottom thereof.

Having thus fully described my invention, what I claim, and desire to secure by Letters Patent, is—

1. In a furnace of the character described, the combination with a reduction-chamber and fire-box, a combustion-chamber, and a grate between the combustion-chamber and the reduction-chamber and fire-box, of a portable crucible within the combustion-chamber, and a base therefor.

2. A furnace of the character described, having a roasting-chamber provided with an inclined hearth, means for discharging the gases from said chamber, a reduction-chamber communicating with the roasting-chamber, a fire-box adjacent to, and communicating with, the reduction-chamber, a combustion-chamber beneath the fire-box and reduction-chamber and communicating with said fire-box through a flue, the bottom of the fire-box provided with interstices, and a crucible within the combustion-chamber.

3. In a furnace of the character described, the combination of a roasting-chamber, a reduction-chamber communicating therewith, a fire-box communicating with, and adjacent to, the reduction-chamber, a combustion-chamber beneath the fire-box and reducing-chamber and having a flue between the combustion-chamber and the fire-box, and means for utilizing the products of combustion from the combustion-chamber for heating the hearth of the roasting-chamber.

4. In a furnace of the character described, the combination of a dust-chamber, a flue passing thereto, an ore-supply and a roasting-chamber both communicating with said flue, a reduction-chamber, a fire-box adjacent thereto and communicating therewith, a combustion-chamber connected to the fire-box by a flue, a grate above the combustion-chamber, and means for utilizing the products of combustion from the combustion-chamber for heating the hearth of the roasting-chamber and as a hot blast into the flue of the dust-chamber.

5. In a furnace of the character described, the combination with a dust-chamber and its flue, a roasting-chamber communicating therewith, and a hearth in the roasting-chamber provided with a chamber and an oxid-chamber, of a fan communicating through flues with each of said chambers and with said oxid-chamber, whereby the burned gases from the combustion-chamber are utilized for a blast into the dust-chamber flue and the burned gases of the hearth-chamber are discharged into the oxid-chamber.

6. A furnace having a roasting-chamber, a hearth therefor provided with a chamber having an exit, and an oxid-chamber, said roasting and hearth chambers connected by a passage, whereby gases are conducted from the roasting-chamber to the hearth-chamber, lateral air-inlet ports for the hearth-chamber, and an air-blast generator communicating with said oxid-chamber, substantially as set forth.

7. In a furnace of the character described, the combination with the roasting-chamber, of a reduction-chamber communicating therewith, a fire-box adjacent to and communicating with the reduction-chamber, a combustion-chamber, a flue connecting the fire-box

and combustion-chamber, a flue extending from the upper portion of the reduction-chamber, and a crucible beneath the outlet of said flue, adapted to receive volatilized metals from the flue.

8. In a furnace of the character described, the combination of a dust-chamber, a flue passing thereto, an ore-feed above the flue, a roasting-chamber communicating with the flue, inlets for admiting air and water to the roasting-chamber, whereby desulfurization of ore is accomplished, a hearth to the roasting-chamber having a chamber therein, a passage connecting the roasting and hearth chambers adapted to conduct the sulfurous gases to the hearth-chamber to be utilized for heating the hearth, and a fan at one end of said flue, and communicating with the hearth-chamber, adapted to force pure air upon the ore as fed to the furnace and to discharge the burned gases from the hearth-chamber.

9. In a furnace, the combination of an ore-crusher, arranged above the furnace, a dust-chamber having a flue just below said ore-crusher, a reducing-chamber, a roasting-chamber communicating with said dust-chamber, said reducing-chamber arranged in communication with said roasting-chamber, a flue between said roasting-chamber and dust-chamber an air-blast generator or fan arranged to pass an air-blast through said last-referred-to flue and the furnace, and means for heating said air-blast, substantially as set forth.

10. In a furnace, the combination of an ore-crusher, a dust-chamber, having a flue just below said ore-crusher, a reducing-chamber, a roasting-chamber, communicating with said reducing-chamber, a flue between said roasting-chamber, and dust-chamber, an air-blast generator or fan arranged to pass an air-blast through said referred-to flue to and through the ore, and means for heating said air-blast, substantially as set forth.

In testimony whereof I affix my signature in presence of two witnesses.

THOMAS SMITH.

Witnesses:

EUGENE G. E. JACCARD,

ARTHUR C. SWEET.