No. 820,133. PATENTED MAY 8, 1906

E. RIVEROLL.

FURNACE FOR SMELTING ORES.

APPLICATION FILED OCT. 10, 1905.

2 SHEETS—SHEET 1

Fig. 3

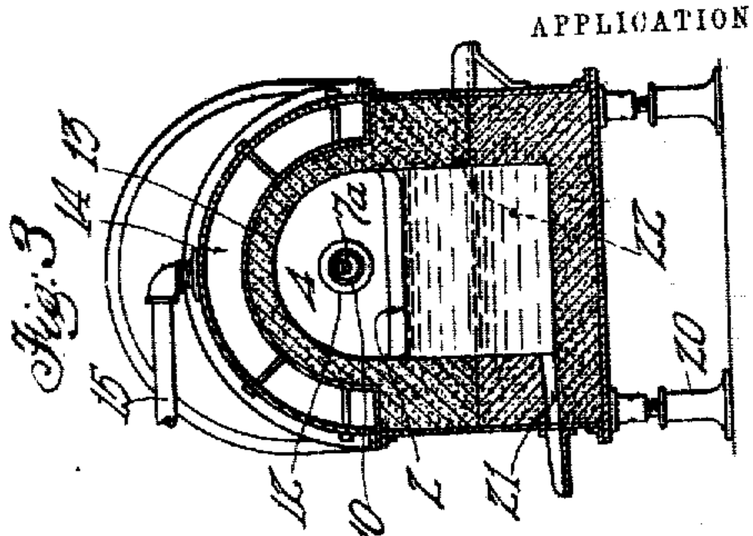

Fig. 1

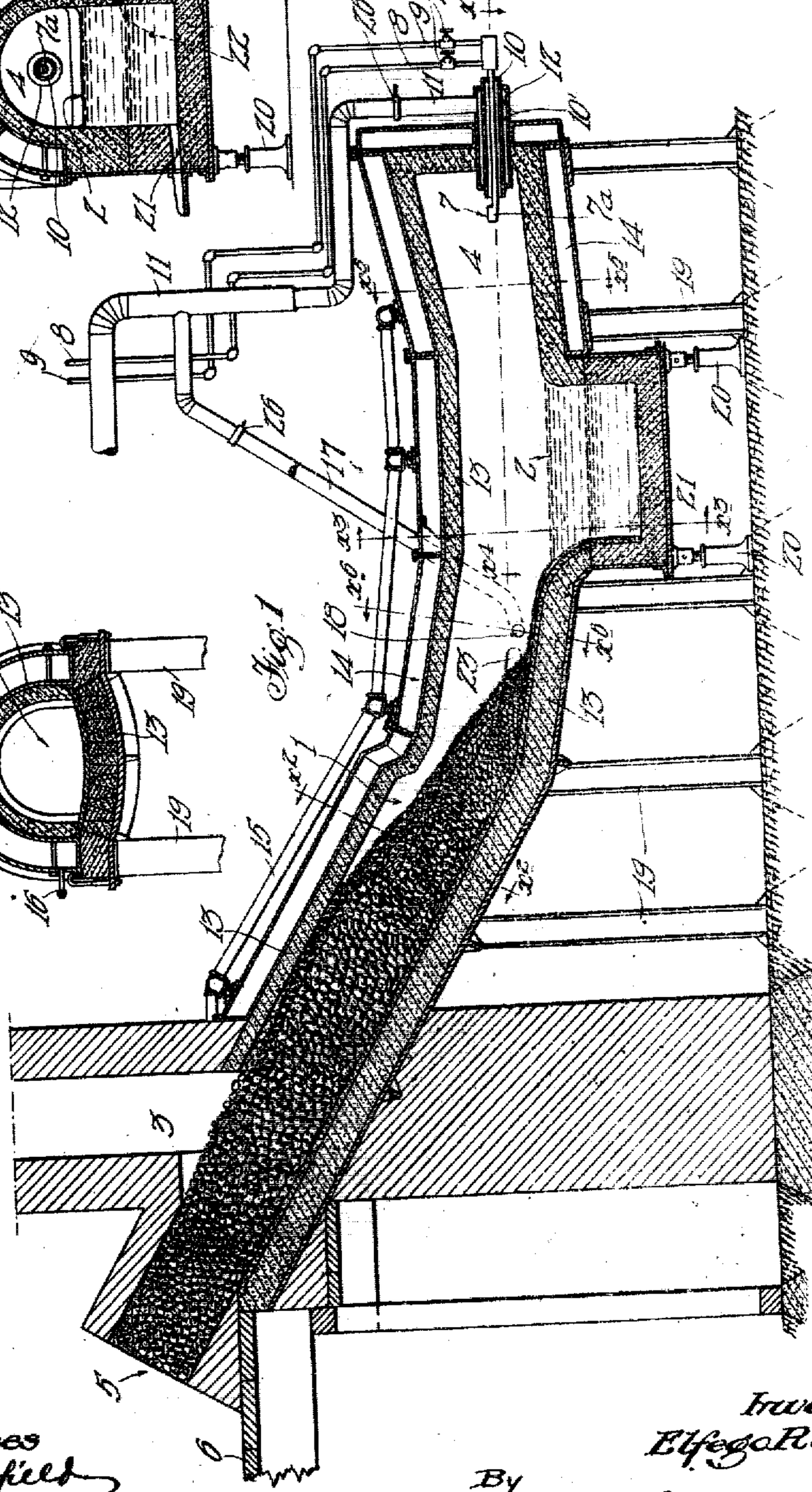

Fig. 2

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Fig. 4

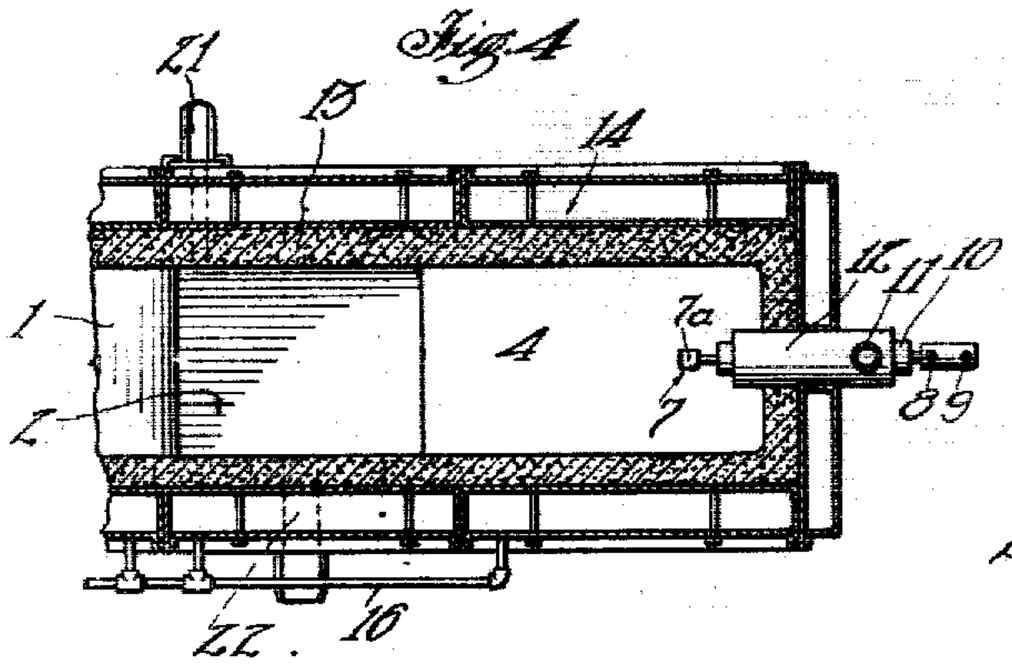


Fig. 5

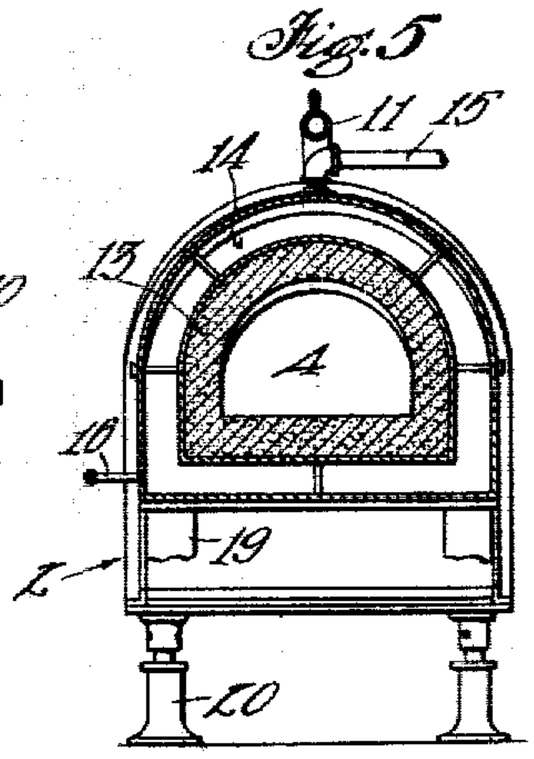
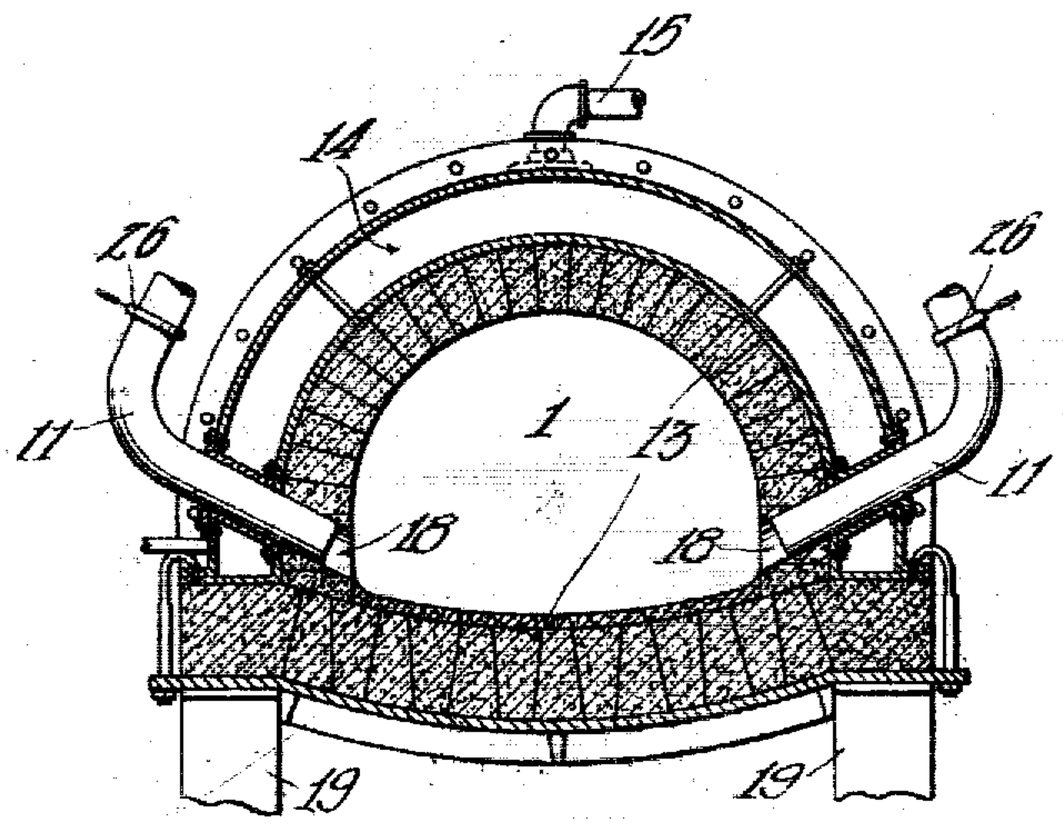


Fig. 6



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UNITED STATES PATENT OFFICE.

ELFEGO RIVEROLL, OF LOS ANGELES, CALIFORNIA.

FURNACE FOR SMELTING ORES.

No. 820,133. Specification of Letters Patent. Patented May 8, 1906.

Application filed October 10, 1905. Serial No. 282,097.

To all whom it may concern:

Be it known that I, ELFEGO RIVEROLL, a citizen of Mexico, residing at Los Angeles, in the county of Los Angeles and State of California, have invented a new and useful Furnace for Smelting Ores, of which the following is a specification.

An important object of the present invention is to provide a furnace for ore-smelting which will be continuous, or substantially so.

Another object of the invention is to provide a furnace for smelting ores by the use of fluid fuel, such as hydrocarbons or petroleum.

The furnace is particularly adapted for smelting of copper ores and is herein described in that connection, although it is applicable to some extent in connection with other ores.

An important feature of the furnace is that the smelting heat is applied to the ore by the combustion of fuel located externally of the ore instead of mixed with the ore. In the ordinary reverberatory furnace the heat is also applied by external means. In that case the ore is heated by radiation and conduction from above and difficulty is encountered in bringing the heat in effective contact with the ore. On the other hand, attempts to apply the externally-generated heat in a blast-furnace have failed on account of the clogging of the blast by melted material.

The present invention provides for bringing the heat in effective contact with all parts of the ore and for maintaining the body of ore continually in condition to allow free passage of the heating agent therethrough. The heating and smelting agent in this case consists of the hot gases resulting from the combustion of hydrocarbon or oil with a suitable quantity of air, and by properly proportioning the amount of fuel and air said agent may be made of either an oxidizing, reducing, or neutral nature, according to the effect it is desired to produce on the ore.

The invention comprises a furnace having an inclined ore-chute, means enabling packing or filling the ore-chute with ore in such manner as to choke same or obstruct the passage of air between the top of the ore and the top of the chute, means for arresting the downward movement of the ore within the chute at a definite position in the chute, and means for directing into and through the body of ore in the chute a current of hot gases for melting or smelting the ore, the chute being of such inclination in the part thereof which contains and supports the ore as to permit downward gravitating movement of the ore and of such inclination at the part below the smelting zone or position of the rest of the ore as to enable draining or flowing away of the melted ore from the unmelted ore.

The accompanying drawings illustrate an apparatus suitable for carrying out the invention.

Figure 1 is a longitudinal vertical section of the furnace. Fig. 2 is a vertical section on the line x^2 x^2 in Fig. 1. Fig. 3 is a section on the line x^3 x^3 in Fig. 1. Fig. 4 is a section on the line x^4 x^4 in Fig. 1. Fig. 5 is a section on the line x^5 x^5 in Fig. 1. Fig. 6 is a section on the line x^6 x^6 in Fig. 1.

Referring to the drawings, 1 designates an ore chute or chamber, and 2 a well or receptacle at the lower end of said chute or chamber, the said chute or chamber extending upwardly at an inclination from said well and communicating at or near its upper end with a stack or flue 3.

4 designates a combustion-chamber at the side of the well 2 opposite the chute 1.

Means are provided for supplying ore into the upper end of the chute 1, said means consisting, for example, of a charging hole or passage 5, formed by an extension of the chute 1 beyond the stack 3, the ore being dumped or charged into said passage from a suitable source of supply—for example, a platform 6—the said passage being of sufficient size to enable the ore-chute 1 to be completely charged or filled at its upper end with the ore and the ore sliding down from the upper end by gravity toward the lower part of the chute. At or near the lower end of the chute means are provided for obstructing or arresting the downward passage of the ore. For this purpose the lower end of the floor of the chute is extended at an inclination to the upper part or main body of the chute, the inclination of this part of the chute being such that the ore will not pass forward thereon by gravity and will therefore accummulate or become checked in its downward movement.

7 designates a burner for supplying combustible fluid to the combustion-chamber 4, the said burner comprising a burner-head 7^a, connected to an oil-supply pipe 8 and a steam-supply pipe 9 in such manner as to inject or atomize the fluid fuel into the combustion-chamber. Air-supply means are also provided, consisting of a nozzle or inlet-pipe 10, surrounding the burner 7 and communicat-

ing with an air-supply pipe 11, the said pipe entering a drum 12, surrounding a rearward extension of nozzle 10, said extension being perforated at 10′ to enable passage of air into the nozzle, thereby producing an annular jet or blast of air surrounding the jet of atomized fuel. The fuel and air nozzles are preferably positioned so as to direct the jet of flame or hot gases therefrom on the lower end of the body of ore. The air-supply pipe 11 is connected to any suitable source of air-supply under pressure—for example, a blower or fan. (Not shown.) An auxiliary supply-inlet is provided at 18 in the sides of the ore-chute 1 at or below the smelting zone, this inlet being supplied by pipe 17, leading from the main supply-pipe 11.

The heat of the smelting operation being intense, it is necessary to line the combustion-well and ore-chamber with a refractory lining, (indicated at 13,) and in order to present sufficient mechanical support to said lining and prevent burning out thereof a water-jacket 14 is provided around these chambers, water supply and outlet pipes 15 16 being provided therefor.

The ore-chute and combustion-chamber are supported in a frame consisting of columns or piers 19, so arranged as to leave the bottom of the chamber-walls exposed for cooling by the air around the same. Well 2 may be removable, being supported on jacks 20.

21 designates the tap hole or spout in the well, and 22 the slag-hole. The ore-chute may be provided with poke-holes, (indicated at 23.) The oil-burner 7 and the air-pipe 11 are provided with valves or regulating means 25 26 to enable regulation of the fuel and air supply.

The operation is as follows: Ore of any suitable character—for example, copper ore, either in the form of carbonates, sulfids, or oxids, or mixture thereof, or compound ore of any kind, such as chalcopyrite—is delivered on the platform 6 and is charged continuously or from time to time into the upper end of the ore-chute 1 through the feed-passage 5. The ore rolls and slides down the chute until it reaches the floor portion of less inclination, at which point it will accumulate and pile up in a manner somewhat as shown in the drawings, and this charging or filling operation is continued until the body or pile of ore completely fills or chokes the conduct of chute 1 and extends substantially to the upper end thereof. The front or lower end of this body of ore will then have an inclination to a horizontal, depending somewhat on the character of the ore, extending at its lower portion or foot toward the well 2 and receding therefrom upwardly. All the openings at the lower part of the combustion-chamber, chute, and well are closed. The burner having been turned on and ignited and the air-blast also having been turned on and the combustion-chamber, well, and lower part of the chute being closed against exit of air, the operation will proceed as follows: The jet or blast of combustible and air burns in the combustion-chamber and passing over the well enters the ore-chute and is directed on the body of ore therein. The ore is assumed to be of such a size that it will permit of the passage of the hot gases resulting from the combustion in the blast or jet to pass therethrough; but owing to the obstruction caused by the choking or blocking of the passage by the ore mass it is necessary to employ a substantial pressure to cause the hot gases to force their way through the ore to the stack. The charging-passage 5 may, if desired, be closed except when charging. It is found in practice that the ore as it ordinarily comes from the mine can be used in this manner and is sufficiently open to permit the passage of the hot gases; but in some cases it will be desirable to crush the ore to a more or less uniform reduced size, it being understood that the smaller the size of the lumps or particles of ore the more rapid will be the heating thereof as long as the passage for the hot gases is not unduly constricted. The intense heat of the combined jet or blast of fuel and air directed onto the ore eventually melts the ore at the lower end of the pile, and as the ore melts it flows away down the lower inclined floor, the inclination of which is sufficient to permit of this, although not sufficient to allow gravitative movement of the unmelted ore. The ore in the chute will then move down and take the place of the ore thus melted, and if ore is continually supplied at the upper end this operation will continue. The melted ore runs from the inclined table into the well 2, where it accumulates and is kept in melted condition by radiation and reflection from the blast and overlying walls of the chamber.

The operation has been described as a simple melting operation; but it will be understood that according to the character of ore it can be made a roasting or oxidizing or reducing or smelting operation, the effect being controlled according to the character of ore and product by varying the proportionate amounts of fuel and air admitted at the burner and blast. Thus in case of the chalcopyrite ore sufficient oxygen will be furnished in addition to that required for combustion of the fuel to roast or oxidize part of the sulfur, whereupon during fusion the usual reaction will take place between the oxidized portion and the unoxidized portion to form a matte more or less rich in copper, which will separate from the slag containing the iron, silica, &c. If it is desired to obtain the copper in reduced or metallic state, an excess of fluid combustible may be supplied to effect the reduction, and in some cases it may be necessary to provide for initial oxidation fol-

owed by reduction, this being provided for by the auxiliary blast at 18, which supplies at the fusion zone sufficient air to cause oxidation or roasting, the roasted or more or less oxidized material being then melted as it passes through the fusion zone and the melted product then passing down toward the burner and being subjected to a reducing flame therefrom.

As illustrating the efficiency of the process applied to low-grade ores the following results were obtained in practice, the charge consisting of iron ore and silicious ore of the following analyses:

Iron ore or flux.—Fe, 51.98; SiO_2, 15.62; S, 4.95; Cu, one per cent.; Au, 4.13.

Silicious ore.—Fe, 8.33; SiO_2, 81.43; Cu, 1.45; Au, 7.44. The initial charge was seventy pounds of iron to forty pounds of silicious ore and fifty pounds of lime, followed by a working charge of one hundred pounds of iron ore, fifty pounds of silicious ore, fifty pounds of lime, and fifty pounds of slag. There was formed at the bottom of the well a matte containing fifty-one per cent copper, besides a considerable portion—about ten per cent.—of black copper and metallic copper. The slag analyzed silica, 32.4; iron, 26.4; lime, 16.

What I claim is—

1. An ore-smelting furnace comprising an inclined ore-chute having a charging-opening at its upper end and an outlet-stack opening from the chute below the upper end thereof, a combustion-chamber communicating with the lower end of the cnute and closed to permit pressure to be developed therein, means for supplying combustible under pressure to said chamber, means for supplying air under pressure to said chamber, the inclination of the chute being such as to enable downward movement of the ore therein by gravity, means for arresting such downward movement of the ore at a definite position in the chute, the chute being unobstructed between said arresting position and the ore-charging inlet at the upper end of the chute, to permit the ore to feed by gravity in solid state from the upper end of the chute to said arresting position, and means for drawing away the fused ore at the lower portion of the chute.

2. An ore-smelting furnace comprising an inclined ore-chute having a charging-opening at its upper end and an outlet-stack opening from the chute below the upper end thereof, a combustion-chamber communicating with the lower end of the chute and closed to permit pressure to be developed therein, means for supplying combustible under pressure to said chamber, means for supplying air under pressure to said chamber, the inclination of the chute being such as to enable downward movement of the ore therein by gravity, means for arresting such downward movement of the ore at a definite position in the chute, the chute being unobstructed between said arresting position and the ore-charging inlet at the upper end of the chute, to permit the ore to feed by gravity in solid state from the upper end of the chute to said arresting position, means for drawing away the fused ore at the lower portion of the chute, and a supplementary air-blast means directed into the ore-chute from a point between the combustion-chamber and the stack.

3. An ore-smelting furnace comprising an inclined ore-chute having a charging-opening at its upper end and an outlet-stack opening from the chute below the upper end thereof, a well at the lower end of the chute to receive the fused material from the chute, a combustion-chamber communicating with the lower end of the chute and extending above the well, a burner directed to project its blast through the combustion-chamber over the well and into the lower end of the chute, said combustion-chamber being closed to permit pressure to be developed therein, means for supplying air under pressure to said chamber, the inclination of the lower end of the chute being such as to arrest movement of ore thereon by gravity and the inclination of the chute above said arresting portion being sufficient to enable movement of the ore thereon by gravity so that the ore can be charged into the chute to choke the same and to accumulate on the lower portion thereof in the path of the blast from the burner-jet.

4. An ore-smelting furnace comprising an inclined ore-chute having a charging-opening at its upper end and an outlet-stack opening from the chute below the upper end thereof, a well at the lower end of the chute to receive the fused material from the chute, a combustion-chamber communicating with the lower end of the chute and extending above the well, a burner directed to project its blast through the combustion-chamber over the well and into the lower end of the chute, said combustion-chamber being closed to permit pressure to be developed therein, means for supplying air under pressure to said chamber, the inclination of the lower end of the chute being such as to arrest movement of ore thereon by gravity and the inclination of the chute above said arresting portion being sufficient to permit movement of the ore thereon by gravity so that the ore can be charged into the chute to choke the same and to accumulate on the lower portion thereof in the path of the blast from the burner-jet, and air-blast means opening into the chute at the point thereof of less inclination.

5. An ore-smelting furnace comprising a well, an ore-chute extending upwardly at an inclination from one side of said well and having a charging-opening at its upper end and an outlet-stack between said charging-opening and the well, a combustion-chamber extending over the well and to one side thereof

opposite the ore-chute and in line therewith, forming an unobstructed chamber extending from one side of the well and over the well and into the chute on the other side, burner means directed to project its blast through said chamber, over the well and into the lower end of the chute, said lower end of the chute having its floor at such inclination as to arrest movement of solid ore thereon, but to allow melted material to flow therefrom into the well, and the upper part of the chute being of greater inclination to enable ore to pass down thereon until it is arrested by the portion of less inclination so as to present the lower end of the ore in the path of the blast from the burner, the said combustion-chamber being closed to permit pressure to be developed therein, and means for supplying air under pressure to said chamber and directed to project a blast of air in the same direction and along with the burner-blast.

6. In an ore-smelting furnace, an inclined ore-chute, having an upper part of greater and a lower part of less inclination, the upper part of the chute having an ore-charging opening to enable the chute to be choked with ore, and the lower end of the chute being formed with a well and a combustion-chamber closed to retain gas under pressure, and with burner and blast means for supplying and directing a hot blast within said chamber over said well and toward the body of ore in the chute, the fuel and air supply means being regulable to control the oxidizing or reducing action of said blast, and a supplementary air-blast means directed into the ore-chute.

In testimony whereof I have hereunto set my hand, at Los Angeles, California, this 30th day of September, 1905.

ELFEGO RIVEROLL.

In presence of—

ARTHUR P. KNIGHT,

VERNA A. TALBERT.