No. 645,179. Patented Mar. 13, 1900.

C. W. MILES.

APPARATUS FOR REDUCING ZINC.

(Application filed Sept. 25, 1899.)

(No Model.) 3 Sheets—Sheet 1.

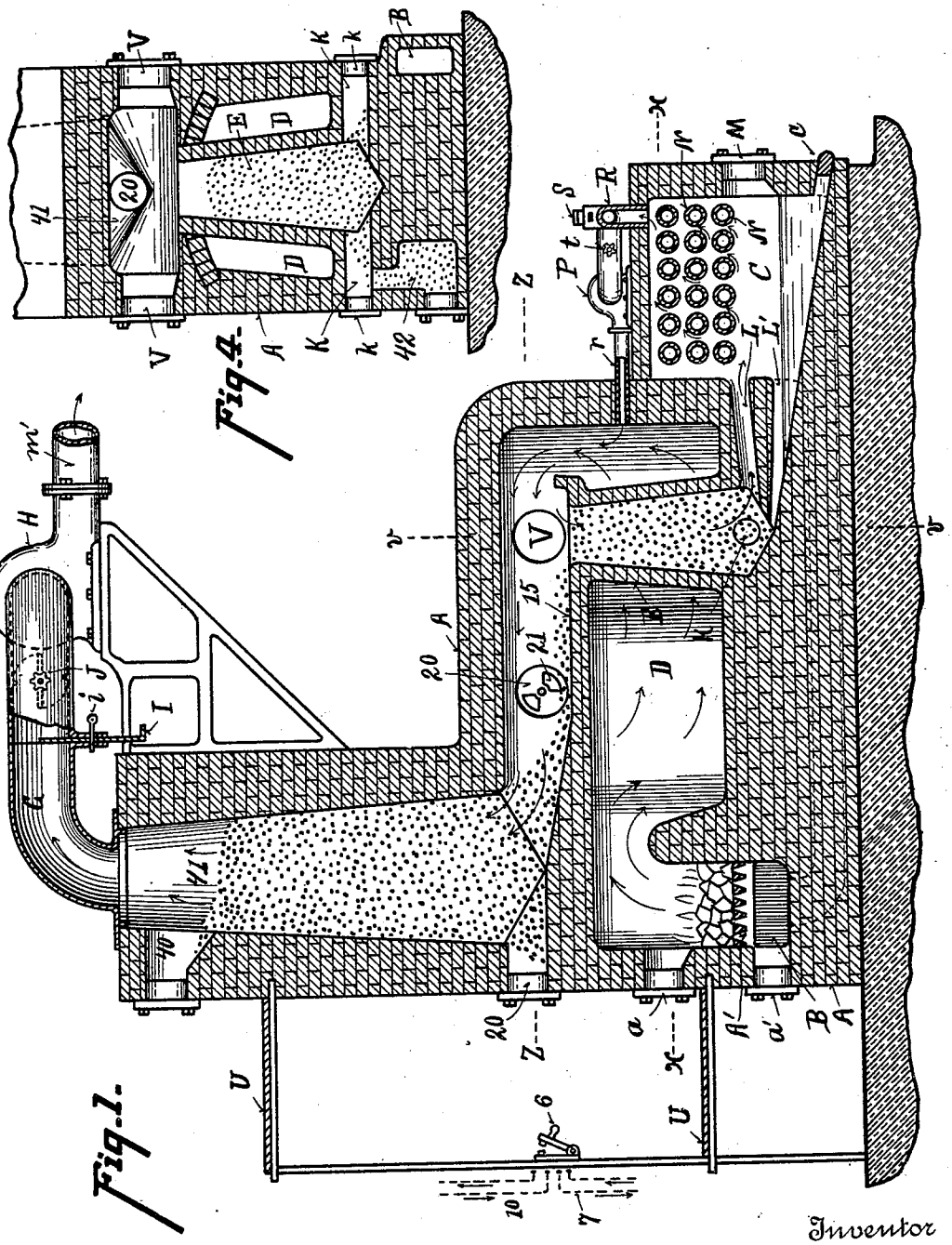

Fig. 4.

Fig. 1.

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(No Model.) 3 Sheets—Sheet 2.

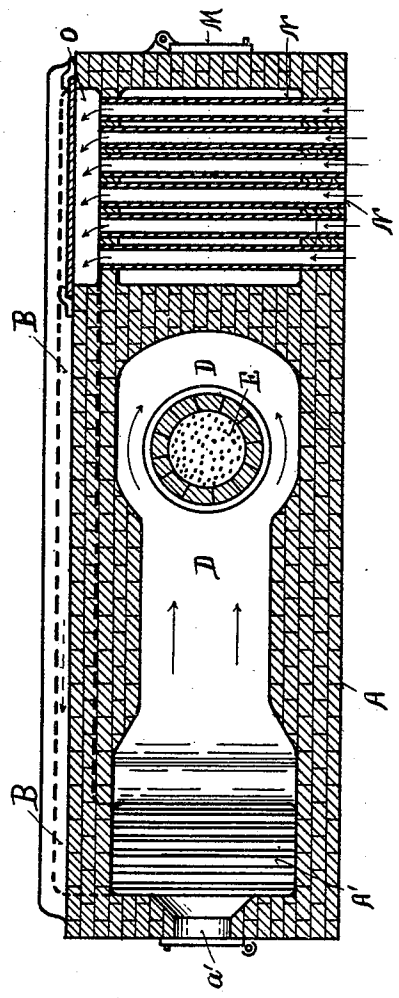

Fig. 2.

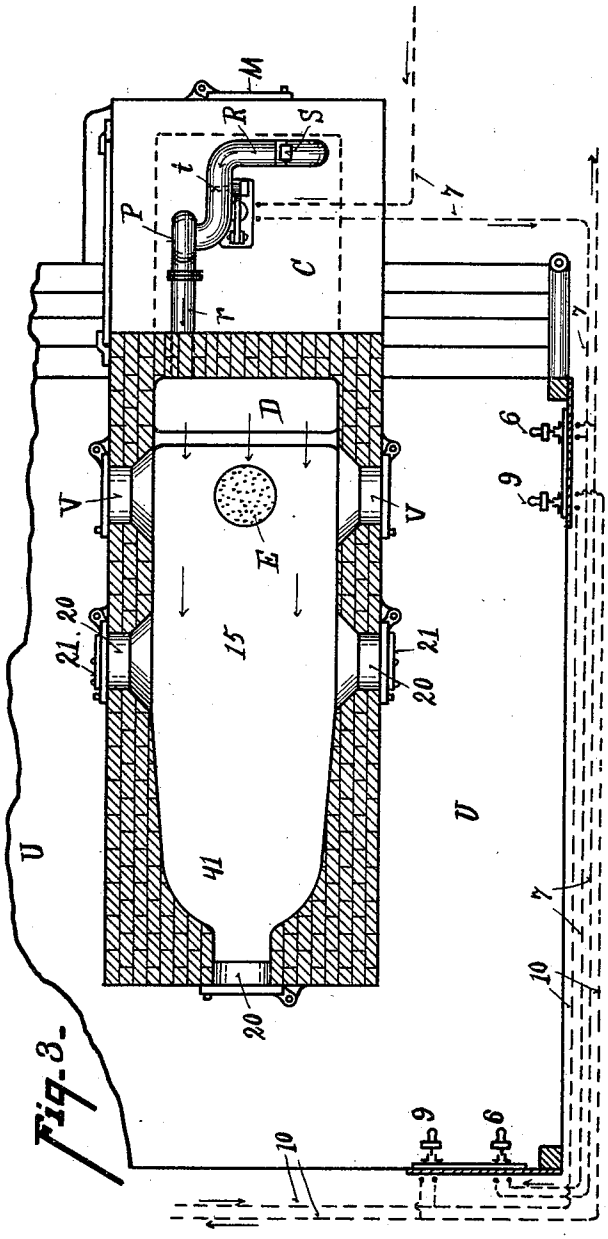

Fig. 3.

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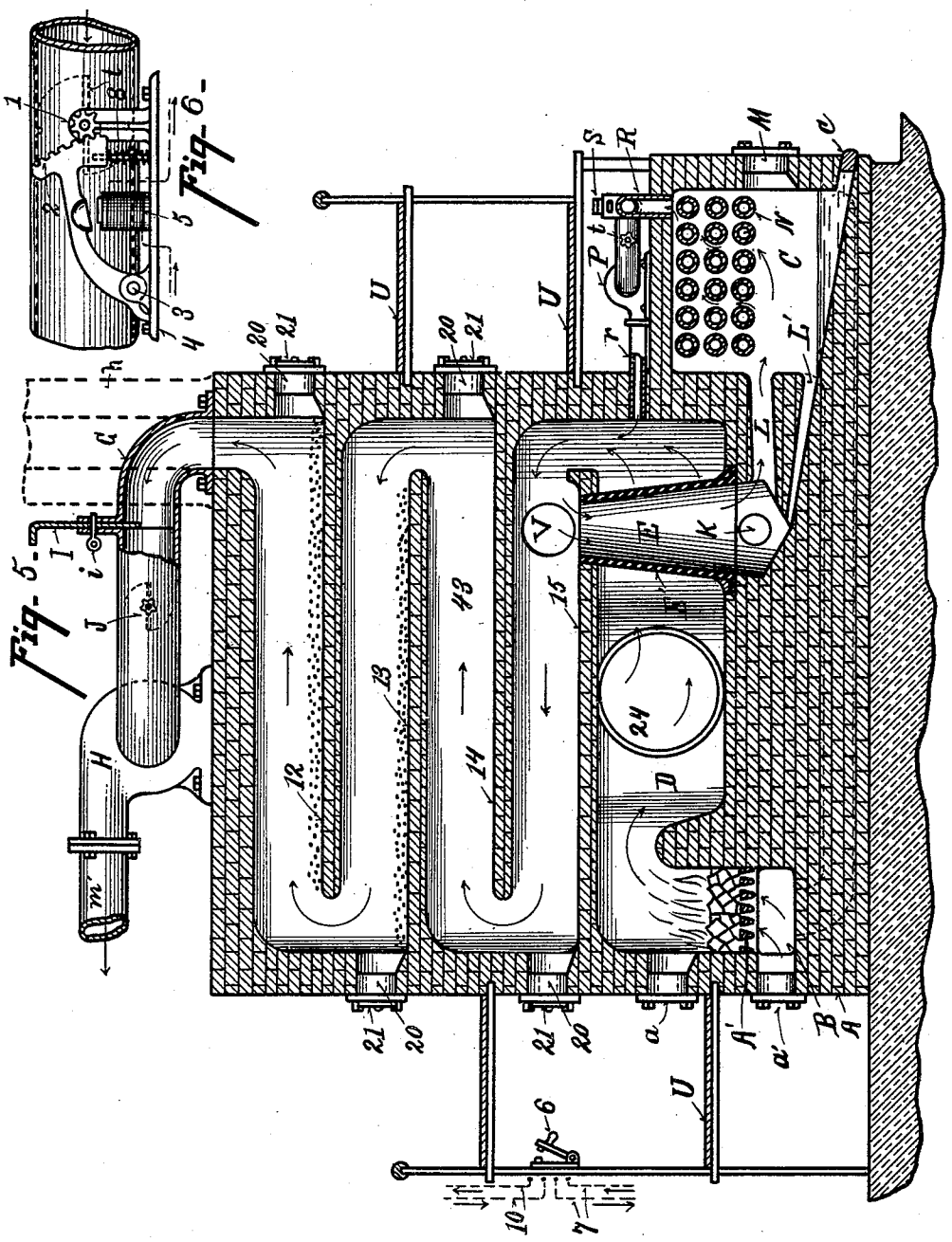

Witnesses
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UNITED STATES PATENT OFFICE.

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APPARATUS FOR REDUCING ZINC.

SPECIFICATION forming part of Letters Patent No. 645,179, dated March 13, 1900.

Application filed September 25, 1899. Serial No. 731,548. (No model.)

To all whom it may concern:

Be it known that I, CASPER W. MILES, residing at Cincinnati, in the county of Hamilton and State of Ohio, have invented certain new and useful Improvements in Apparatus for Reducing Zinc, of which the following is a specification.

My invention relates to apparatus for the reduction of zinc.

One of its objects is to provide an apparatus by means of which zinc or other readily-oxidizable metals may be continuously reduced in a reducing-chamber, into which the ore may be fed without interfering with or interrupting the process of reduction.

Another object is to provide an apparatus by means of which the ore may be continuously roasted and reduced in a single apparatus and at a single heat, whereby a great economy of fuel and labor is effected.

Another object is to provide improved and more economical apparatus for roasting the ore.

Another object is to provide improved means for condensing the metallic vapors and employing the heated air resulting therefrom for the initial combustion, whereby a higher temperature is obtained in the furnace.

Another object is to provide means, either alone or in connection with said condenser, whereby the carbon-monoxid gas produced in the reduction-chamber is returned to the furnace and consumed to furnish heat for the roasting process.

Another object is to provide means for accurately and independently controlling the circulation of the products of combustion through both the roasting and reduction compartments.

Another object is to provide means for removing the exhaust portion of the charge from the reduction-chamber without interfering with the roasting process and with only a momentary interruption of the reducing process.

In the accompanying drawings, forming part of this specification, Figure 1 is a central vertical longitudinal section through the preferred form of my apparatus. Fig. 2 is a horizontal section through the same on line *x x* of Fig. 1. Fig. 3 is a horizontal section through the same on line *z z* of Fig. 1. Fig. 4 is a vertical section through the same on line *v v* of Fig. 1. Fig. 5 is a view similar to Fig. 1, showing a modified form of apparatus. Fig. 6 is a detail view of one form of mechanism for shutting off the draft in either the reduction or roasting compartment. Fig. 7 is a detail view of the dampers.

A represents the furnace, built of fire-brick.

A′ represents a grate upon which is supported a body of coke or similar fuel to furnish the heat necessary for the reduction and roasting operations. The fuel is supplied through door *a* or by a mechanical stoker, if desired, and the ashes removed through a door *a′*. The air to support combustion may be supplied through door *a′*, but is preferably supplied in a heated state through a flue or passage B from the condenser C. From the fire-box the products of combustion pass through the heating-compartment D and envelop the reduction-chambers E, of which one or more may be employed, as desired. From the compartment D the bulk of the products pass through the roasting-chamber 41, in which is contained a bed of ore to be roasted or reduced to an oxid preparatory to its introduction into the reduction-chamber.

H represents a fan or blower which draws the air through the fire and through the bed of ore in the roasting-compartment and discharges the resultant products through pipe *m′* to a sulphuric-acid chamber or into the open air. Where the products are to be wasted, a chimney *h*, as shown in dotted lines, Fig. 5, may be substituted for the blower H, if desired.

I represents a valve or diaphragm in the pipe G, which may be adjusted by means of the pin *i*, and a series of holes in the diaphragm to reduce the pipe area to a greater or less extent, and thereby control the draft or rapidity of circulation through the furnace.

J represents a pivoted valve, which may be thrown by any suitable mechanism to temporarily shut off or stop the circulation through the roasting-compartment.

The reduction-chamber E may be in the form of a square or circular tube extending up from the bed of the furnace, with an open mouth, into which the previously-roasted ore

and the requisite amount of coke or similar reducing agent may be fed.

K represents passages through which the spent portion of the charge can be removed from time to time.

L L′ represent passages from the lower portion of the reduction-chamber leading to a condenser-chamber C, in which the vapor of the metal is condensed to a liquid and drawn off through the port *c*. The metallic vapor and gases pass through the passage L to the condenser, while any metal condensed in the lower portion of the reduction-chamber will drain through passage L′ to the condenser-chamber.

M represents a door through which entrance may be obtained to clean the condensing-chamber and make repairs.

N represents a series of tubes, of porcelain or other suitable material, projecting from one wall of the condenser-chamber to the other and through which air is circulated to condense the metal. The air after passing through these condenser-tubes and being heated enters the chamber O, and thence through flue B is conducted to the ash-pit beneath the grate A′.

P represents a fan or blower connected by a pipe R with the condenser-chamber and discharging the collected gases through pipe *r* back into the heating-chamber. This pipe R is provided with a valve or diaphragm S, similar to valve I, to regulate the amount of gas supplied to the fan, and also with a pivoted valve *t*, similar to valve J, by means of which the circulation through the reducing and condensing chambers may be temporarily shut off.

V represents doors through which carbon can be introduced and mixed with the roasted ore in the reducing-chamber.

It is often necessary or at least advisable to temporarily shut off the circulation through the reducing and condensing chambers or through the roasting-compartment, or both, in order to remove the spent charge from the reducing-chamber or to feed fuel or ore or carbon, and in order to readily accomplish this I provide the pivoted valves J *t*, located, respectively, in the circulating-pipes, with means located near the several feeding and discharge doors for throwing said valves or either of them. In Fig. 6 I have shown one form of mechanism adapted to accomplish this purpose. 1 represents a gear-wheel located on the stem of the pivoted valve. 2 represents a segment provided with teeth meshing with said gear and pivoted at 3 to the bed-plate 4. 5 represents an electromagnet energized by closing any one of the switches 6 to make a circuit through the line-wires 7 and said magnet to draw down the segment 2 against the action of spring 8 and close the valve *t*. The switches 9 are connected through line-wire 10 with a similar mechanism for closing the valves J. I do not attach any importance to the particular form of mechanism employed to close these valves J and *t*, as various forms of mechanism can be satisfactorily employed for this purpose.

U represents platforms beneath the several doors to enable the operator to feed and attend to the furnace.

The mode of operation is as follows: A fire is started on the grate A′ and the fan H started. Ore is fed through the door 40 into the roasting-compartment 41 and thoroughly roasted, after which the lower portion of the chamber E is filled with crushed coke and the passages K closed and carefully luted. The door M and port *c* are also carefully luted, so as to prevent the introduction of any air through these openings. The ore is then drawn or forced out on the shelf 15 and there mixed with crushed coke and fed into the chamber E, or alternate thin layers of ore and coke may be fed into said chamber until it is nearly full. The fan P is then started and the draft regulated by valve S to feed or draw a portion of the products of combustion slowly down through the bed of ore and coke and through the condenser-chamber, whereby the oxygen still contained in that portion of the products of combustion which is drawn into the chamber E is combined with carbon, and thereby assists in further raising the temperature of the charge until the oxygen is wholly exhausted, and the metallic oxid finally reacts with the carbon, freeing the metal, which is conducted by the current of gases to the condensing-chamber and deposited, while the waste gases, together with the carbon monoxid formed in reducing the metal, are returned to the main flue, where the carbon monoxid is burned and its heat utilized for roasting. When the roasted ore upon shelf 15 is exhausted, a fresh supply is drawn from the compartment 41 by means of a suitable tool introduced through the door 20. The bulk of the products of combustion after externally heating the reduction-chamber are drawn by the blower H through the bed of ore in the roasting-compartment 41, where they are thoroughly utilized in roasting, heating, and drying the ore which is fed in from time to time through the door 40. The spent portion of the charge is removed from the lower portion of the reduction-chamber from time to time in the following manner: The valve *t* is first shut, after which the door or cap *k* is withdrawn and a tool introduced to withdraw the lower portion of the charge through the passage K, after which the door *k* is again closed and luted and the valve *t* opened. A small quantity of ash, &c., will work into the condensing-chamber, which is removed, when necessary, through door M.

In Fig. 4 I have shown a closed ash-pit 42, into which the spent charge may be temporarily deposited until cooled and a quantity accumulated.

In the modification Fig. 5 I have shown a roasting-compartment 43, in which are built a series of arches or shelves 12 13 14 above the

shelf 15, thereby forming a long zigzag flue for the passage of the products of combustion to the blower H. Doors 20 are provided opposite these several shelves, with dampers 21, for the admission of air when desired. The ore in this modification is fed and spread out upon the top shelf, and when dry and heated it is pushed over the end of the shelf and falls upon the next lower shelf, where it is spread out and further heated and then fed to the successive lower shelves and then to the reduction-chamber. The doors 20, located as shown in Fig. 5, enable this operation to be performed by means of suitable tools, which are introduced through said doors. Either of these forms may be employed with good results. The form Fig. 1 is less expensive to construct and requires less labor in operation, while the form Fig. 5 gives a more perfectly and evenly roasted ore.

The reduction-chamber may be built up of brick, as shown in Fig. 1, or, as shown in Fig. 5, it may be composed of a tube or cylindrical shell E′ of fire-clay and other refractory material, which can be replaced from time to time when damaged. 24 represents a door for the introduction of new cylinders E′. The reduction-chamber is preferably made tapering, so that the upper portion is of smaller diameter than the bottom, to prevent the charge from choking therein.

It will be noted that the processes of roasting and reducing might be carried on in separate apparatus with advantage over the previous practice in substantially the manner herein set forth, and I do not wish to limit myself to the combination of said apparatus except as specifically set forth in the claims.

By means of the foregoing apparatus I am enabled to reduce readily-oxidizable metals by a continuous process with great economy of fuel and saving of labor, as well as first cost of the apparatus.

Having described my invention, what I claim is—

1. In a metallurgical furnace a fire-box adapted to sustain a body of combustible material; a reduction-chamber spanning the offtake from said fire-box and communicating therewith; means substantially as described for feeding a charge of ore and carbon to the reduction-chamber; and means for drawing a regulated fractional quantity of the products of combustion from said fire-box through the charge of ore in said reduction-chamber and an offtake-flue for the remaining products of combustion, substantially as specified.

2. In a furnace for reducing zinc, a fire-box adapted to sustain a body of combustible material; a reduction-chamber spanning the offtake from said fire-box and adapted to be externally heated by the products of combustion therefrom; communication from said offtake to one end of said reduction-chamber; means substantially as described for feeding a charge of ore to said reduction-chamber and removing the spent portion of the charge; a condensing-chamber communicating with the opposite end of said reduction-chamber, and means substantially as described for drawing a fractional portion of the products of combustion from said offtake through the reduction-chamber and condensing-chamber and an offtake-flue for the remaining products of combustion, substantially as specified.

3. In a metallurgical furnace, a fire-box adapted to sustain a body of combustible material and an offtake-flue for the products of combustion, a reduction-chamber spanning the offtake from said fire-box and communicating therewith at one end; means for feeding a charge of ore and carbon at the inlet of said reduction-chamber, and means for removing the spent charge at the opposite end of said reduction-chamber, a condensing-chamber communicating with said reduction-chamber; a port for drawing off the metal; condenser-tubes spanning said condenser-chamber; means substantially as described for drawing a portion of the products of combustion from the offtake-flue through the reduction-chamber; and a controlling-valve, whereby said circulation may be temporarily interrupted, and means for carrying off the remaining portions of the products of combustion, substantially as specified.

4. In a furnace for reducing zinc a fire-box adapted to sustain a body of combustible material and an offtake-flue for the products of combustion, a reduction-chamber communicating with the offtake from said fire-box, means for feeding a charge of ore at the inlet of said reduction-chamber; and means for removing the spent charge at the opposite end of said reduction-chamber, a condensing-chamber communicating with said reduction-chamber; a port for drawing off the metal; condenser-tubes spanning said condenser-chamber, and a flue leading from one end of said condenser-tubes to the fire-box; means substantially as described for drawing a portion of the products of combustion through the reduction-chamber and condenser-chamber, and a controlling-valve, whereby said circulation may be temporarily interrupted, substantially as specified.

5. In a metallurgical furnace a fire-box adapted to sustain a body of combustible material, a reduction-chamber communicating at one end with the offtake-flue from said fire-box; an opening in the wall of said flue through which said reduction-chamber may be charged; a passage near the opposite end of said reduction-chamber through which the spent charge may be removed; means substantially as described for drawing a fractional portion of the products of combustion through said reduction-chamber; and a controlling-valve for temporarily interrupting the circulation through said reduction-chamber; an offtake-flue above said reduction-chamber through which the remainder of the products of combustion pass, said flue being formed into a roasting-compartment, where-

in the ore may be roasted by the spent gases from the reducing-furnace, and the ore fed in a heated state direct to the reduction-chamber, substantially as specified.

6. In a metallurgical furnace a fire-box; a reduction-chamber spanning the offtake therefrom, and communicating at one end therewith; an opening in the wall of the offtake-flue through which said reduction-chamber may be charged; a passage near the opposite end of said reduction-chamber through which the spent charge may be removed; means substantially as described for drawing a fractional portion of the products of combustion through said reduction-chamber; an offtake-flue above said reduction-chamber through which the remainder of the products of combustion pass, said flue forming a roasting-compartment; and means substantially as described for controlling the circulation through said roasting-compartment, substantially as specified.

7. In a metallurgical furnace a fire-box; a reduction-chamber spanning the offtake-flue and communicating at one end therewith; an opening in the wall of said flue through which said reduction-chamber may be charged; a passage near the opposite end of said reduction-chamber through which the spent charge may be removed, means substantially as described for drawing a fractional portion of the products of combustion through said reduction-chamber; a controlling-valve for temporarily interrupting the circulation through said reduction-chamber; an offtake-flue above said reduction-chamber forming a roasting-chamber, one or more roasting-shelves formed in said roasting-chamber, and a door opposite each of said shelves, whereby the ore is successively roasted and reduced at one heat and in a single apparatus substantially as specified.

8. In a metallurgical furnace a fire-box; a zigzag flue leading from said fire-box; a reduction-chamber spanning one section of said offtake-flue, and communicating with the succeeding section of the flue; a door in the wall of said flue through which the reduction-chamber may be charged a passage near the opposite end of said reduction-chamber for the removal of the spent charge; a condenser-chamber communicating with said reduction-chamber; an exhaust-fan and valve-controlled pipe for circulating a portion of the products of combustion through said reduction and condensing chambers; a series of shelves located in the flue above said reduction-chamber; feeding-doors opposite said several shelves; and means substantially as described for regulating the circulation over said roasting-shelves, whereby the ore is first fed upon the upper shelf, and from there successively over the several shelves, where it is subjected to a gradually-increased temperature and roasted, and finally mixed with carbon and fed in its heated state to the reduction-chamber and reduced in one continuous operation in a single apparatus, substantially as specified.

In testimony whereof I have hereunto set my hand.

CASPER W. MILES.

Witnesses:
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EDWD. T. ALEXANDER.