(No Model.) 2 Sheets—Sheet 1.

# J. A. STEARNS.

## FURNACE FOR THE MANUFACTURE OF METALS DIRECT FROM THE ORE.

No. 298,426. Patented May 13, 1884.

Fig 1

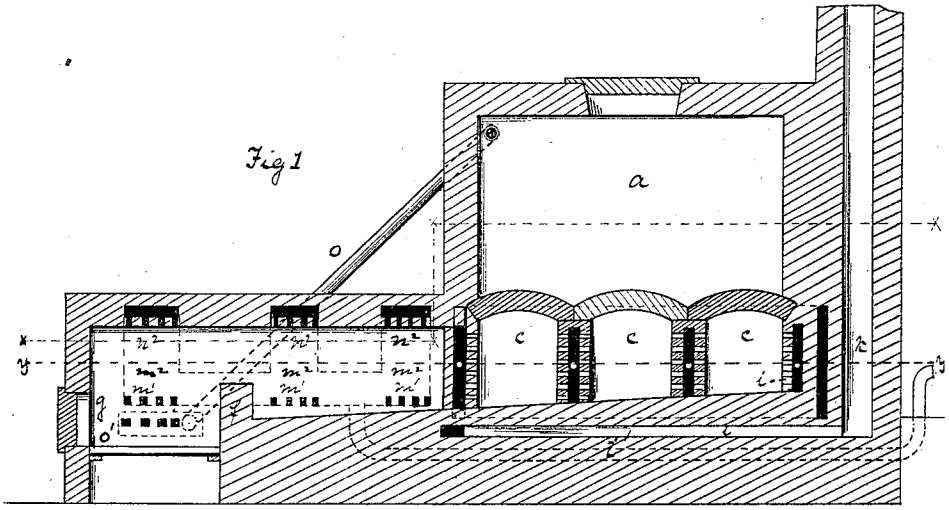



Fig 2.

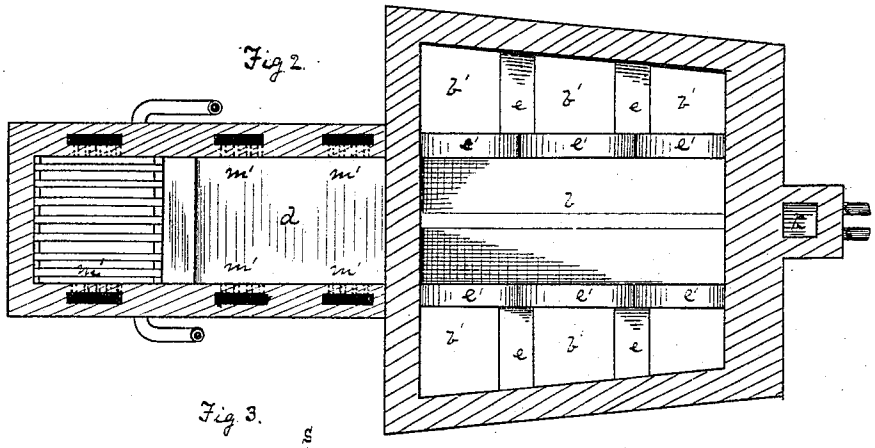
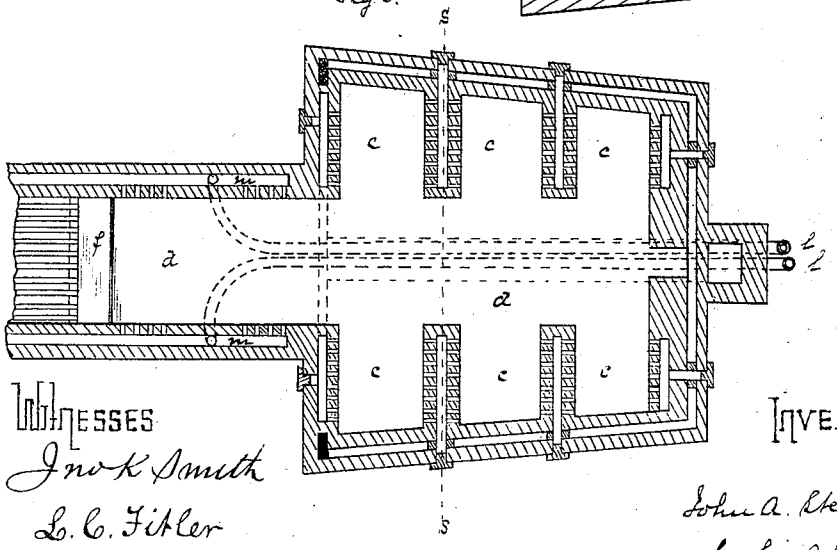



Fig 3.




WITNESSES

Jno K Smith

L. C. Fisler

INVENTOR

John A. Stearns

by his attorneys

Bakewell & Kerr

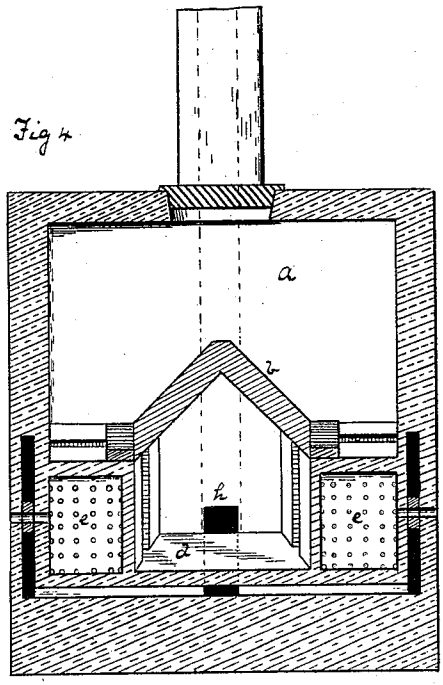
(No Model.) 2 Sheets—Sheet 2.

# J. A. STEARNS.

## FURNACE FOR THE MANUFACTURE OF METALS DIRECT FROM THE ORE.

No. 298,426. Patented May 13, 1884.

Fig 4.




Witnesses.
Jno. K. Smith
L. C. Fitler.

Inventor.
John A. Stearns
by his attorneys
Bakewell & Kerr

# UNITED STATES PATENT OFFICE.

JOHN A. STEARNS, OF JOHNSTOWN, PENNSYLVANIA.

## FURNACE FOR THE MANUFACTURE OF METALS DIRECT FROM THE ORE.

SPECIFICATION forming part of Letters Patent No. 298,426, dated May 13, 1884.

Application filed July 5, 1883. (No model.)

*To all whom it may concern:*

Be it known that I, JOHN A. STEARNS, of Johnstown, in the county of Cambria and State of Pennsylvania, have invented a new and useful Improvement in Furnaces for the Manufacture of Metals Direct from the Ore; and I do hereby declare the following to be a full, clear, and exact description thereof, reference being had to the accompanying drawings, forming part of this specification, in which—

Figure 1 is a longitudinal sectional view through the line *z z*, Fig. 2, of my improved furnace. Fig. 2 is a longitudinal horizontal section on the line *x x*, Fig. 1. Fig. 3 is a longitudinal horizontal section on the line *y y*, Fig. 1; and Fig. 4 is a vertical cross-section on the line *s s*, Fig. 3.

Like letters of reference indicate like parts wherever they occur.

My invention consists in the construction and arrangement of a furnace for the production of refined metals directly from the ore, in which furnace the ores may be reduced and the metal refined by a continuous operation; and the object of my invention is to simplify the process, to reduce and lessen the amount of labor and attention required, and to bring the reducing, smelting, and refining operation to a continuous process, and yet at the same time keep the separate actions or steps in the process from interfering with each other, so as to obtain the certain and complete reduction of the ore to the same extent as is now obtained in the common blast furnace, a complete separation of foreign matter, and at the same time prevent the recombination of gaseous matter with the ore or molten metal during the operation. To attain these results it is necessary, first, that the ore and metal during the operation be subjected to an evenly-increasing degree of heat; and, second, that the gases eliminated during the operation be conducted away from the superincumbent charge. In order, therefore, to comply with these requirements, I arrange the deoxidizing or reducing chambers on each side of and above the smelting and refining chamber, which reducing-chamber communicates with the rear end of the smelting-chamber, at the sides thereof, the lines of the openings being at right angles to the longitudinal line of and the direction of the draft in the smelting-chamber, the flue-opening for the passage of the gases and products of combustion situate in the rear wall of the smelting-chamber, the flue passing thence in the walls of the reducing-chamber around the sides of the same, and thence under the furnace, at the side of the air-blast pipes, to the stack, passing through which flues in the side of the reducing-chamber are air-inlets for conducting the air necessary for the deoxidization of the ore into the reducing-chambers.

I will now describe my invention, so that others skilled in the art may manufacture and use the same.

In the drawings, *a* represents the deoxidizing or reducing chamber, situate at the rear end of the furnace, above and at the sides of the smelting-chamber *d*, the smelting-chamber extending through the middle of the chamber *a*, and being separated therefrom by a dome-shaped roof, (or the roof may be the shape of an inverted V, as shown in the drawings,) while it is open at the sides, so as to communicate with the deoxidizing-chamber, the line of the openings being at right angles with the longitudinal line of the smelting-chamber.

In the chamber *a* on each side of the chamber *d* are the walls *e e e*, which extend from the side walls of the chamber *a* to the side walls of the chamber *d*, and in height to the level of the lower edges of the V-shaped roof, forming pockets *c c c*. In these walls *e* are perforations or openings extending into air-flues situated in the walls, and extending through the side walls of the chamber *a*, the purpose of which flues and perforations is to supply sufficient air to the pockets *c* and chamber *a* to effect the deoxidization of the ore. The partition-walls *e*, which form the pockets *c*, may be strengthened by arches *e' e'*.

The smelting and refining chamber *d*, extending in front of the chamber *a*, is provided with a sloping floor, which may be lined with basic material, and a suitable top or roof, and side wall, the floor sloping from the rear end of the chamber to the bridge-wall *f* at the forward end of the furnace, and in front of which is the combustion or fire chamber *g*.

In the rear end wall of the chamber *d* is a flue-opening, *h*, which opens into a flue or flues, *i i*, extending along and inside of the rear and side walls of the chamber *a*, surround-

ing the air-passages leading into the pockets *c*, and passing thence downward to a point below the level of the chamber *d*, thence under the floor of the chamber *d* to the rear end of the furnace, where it enters the stack *k*. The purpose of this flue *i* is to heat the walls of the furnace, to heat the air passing into the deoxidizing-chamber, and also the blast-flues *l l*, which extend from the rear end of the furnace along and under the flues *i* to a point in front of the chamber *a*, thence into the flues *m m*, situate in the side walls of the chambers *d* and *g*, from which flues the air passes through opening $m'$ $m'$ into the fire-chamber *g* and refining-chamber *d*, also through openings $n^2$ $n^2$, the air passing thereto through the flues $m^2$ $m^2$. Leading from the top of the chamber *a* to flues *o'* in the walls of the chamber *g* are pipes *o*, the purpose of which is to conduct the gases from the top of the chamber *a* to the fire-chamber, where they are consumed.

The operation is as follows: A fire having been started in the chamber *g*, either gas or solid fuel being employed, the heat and product of combustion, passing through the chamber *d*, opening *h*, and flues *i*, heat the walls and air-flues of the furnace. At the same time the fire is started in the fire-chamber *g*, or after the furnace has become heated carbonaceous fuel is fed into the chamber *a* and pockets *c* through a suitable chute or opening in the roof of the furnace, and a slow combustion ensues, the air passing through the passages in the walls *e*, while the products of combustion pass into the rear portion of the chamber *d* and out through the opening *h*. Successive charges of ore, carbonaceous material, and flux are then fed into the chamber *a* in the same manner that the charge is fed into a blast-furnace. Under the action of the heat the ore in the chamber *a* is deoxidized, and that portion in the pockets *c* being reduced to a spongy mass is pressed out of the pockets by the superincumbent charge into the rear portion of the chamber *d*, where, being subjected to a greater degree of heat, it flows down the inclined floor in a shallow stream, and collects in front of the bridge-wall, being subjected during its flow to the heat and products of combustion from the fire-chamber *g*, and being thereby reduced to a molten mass, the impurities uniting with the flux rise to the surface, and this slag is drawn off through a suitable tap-hole, while the metal, after being allowed to remain subjected to the action of the heat until the required amount of carbon has been removed therefrom, is drawn from the furnace in a molten state through a suitable tap-hole; or the furnace may be so constructed as to enable the workman to bring the metal to nature and puddle it in the usual manner. This operation is carried on continuously, fresh charges from time to time being added to the chamber *a*. Owing to this construction and arrangement of the furnace, the ore and metal are subjected to a gradually-increasing heat as they pass from the top of the chamber *a* to the bridge-wall *f*. The ore and metal are carried through the different parts of the furnace automatically under the influence of heat and the force of gravity. The impurities are separated from the metal as it flows in a shallow stream over the sloping floor of the chamber *d*. The metal is not subjected to any check, either in its flow or in the degree of heat to which it is subjected. By the admission of heated air through the perforated walls *e*, the air being heated by passing through the walls, the ore is completely deoxidized, and the injurious gases evolved are drawn through the flue-opening *h* away from the superincumbent charge. Owing to the chamber *a* surrounding the rear end of the chamber *d* the air is prevented from gaining access to this part of the furnace, and an even heat is maintained therein; also, the heat is thereby more perfectly applied to the chamber *a*.

I am aware that furnaces have been employed for producing metal directly from the ore having deoxidizing-chambers communicating with the refining-chamber, the gases evolved from the ore being conducted away from the charge, and also that it is not new to heat the walls of a furnace by flues, nor to pass air for deoxidizing ore through passages heated by flues. I do not therefore claim, broadly, any of these elements of construction; but,

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

In a furnace for producing metals directly from the ore, the combination of a reducing-chamber situate on both sides of and above the rear end of the smelting and refining chamber, and communicating therewith at the sides, the line of the openings being substantially at right angles with the line of the draft through the furnace, partition-walls arranged in the reducing-chamber, and having air-passages and outlet-orifices arranged therein, a smelting and refining chamber having a floor or hearth sloping from the rear end to the bridge-wall, and a flue or flues leading from the rear end of the smelting-chamber around the walls of the reducing-chamber, substantially as and for the purpose specified.

In testimony whereof I have hereunto set my hand this 19th day of June, A. D. 1883.

JOHN A. STEARNS.

Witnesses:

W. B. CORWIN,

JAMES K. BAKEWELL.