

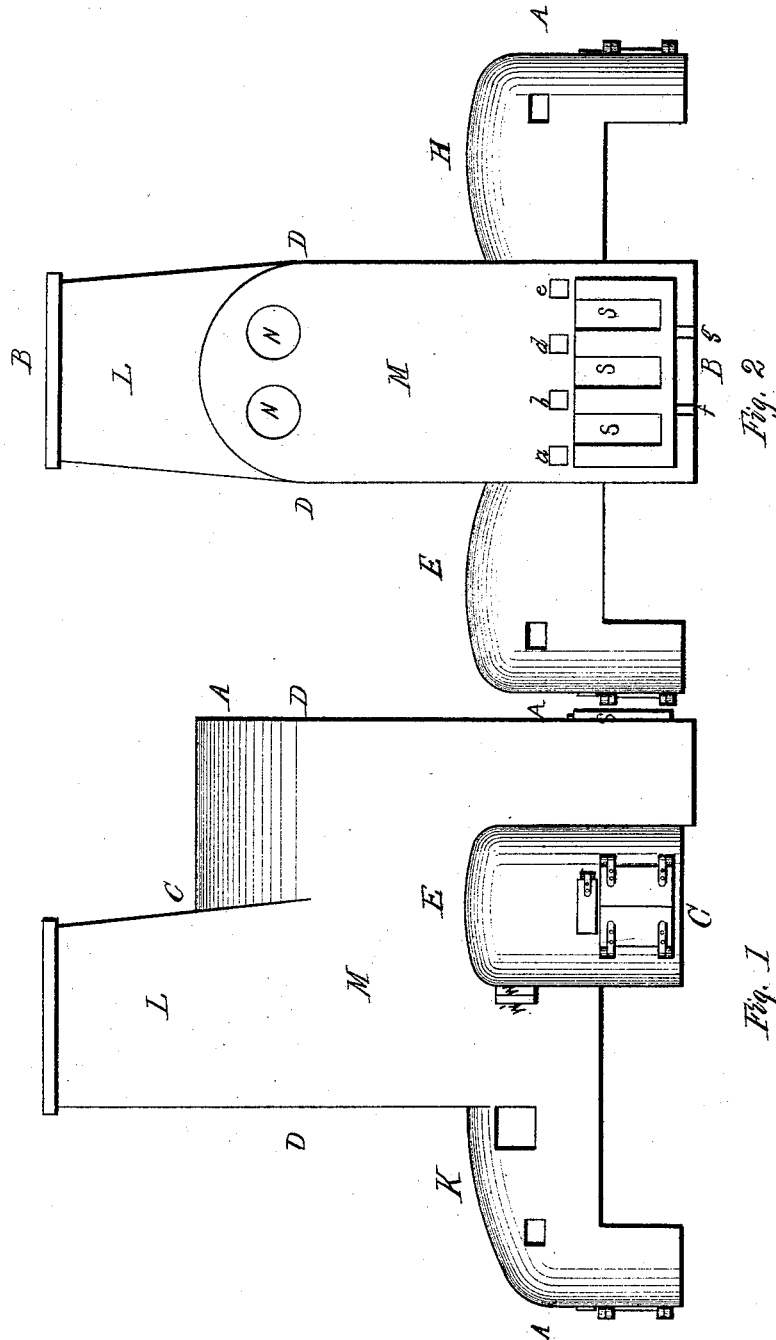
5. Streets. Sheet. 1.

5. Streets. Sheet 1.

*Deoxidizing Furnace.*

No. 102,173.

*Patented Nov. 15. 1870.*



WITNESSES

M.B. Fook  
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INVENTOR

J. H. Guiness

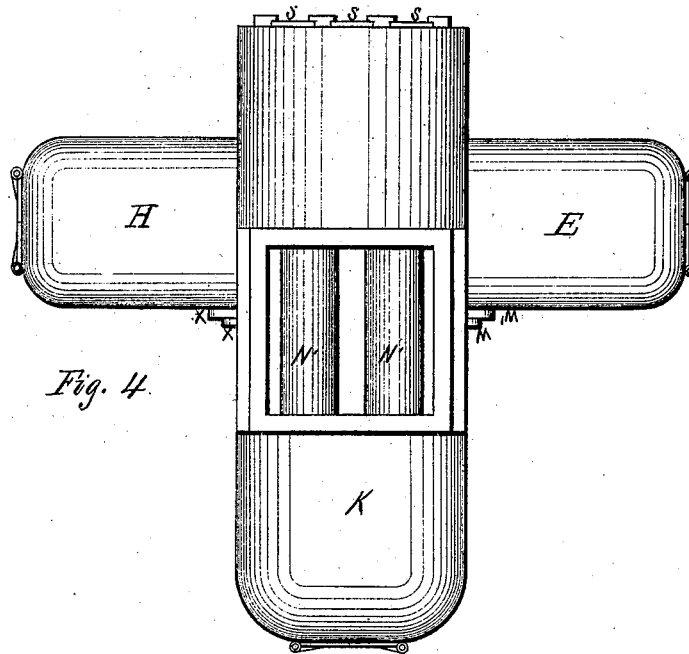
A. H. Brainerd.

5. *Starts, Sheet 2.*

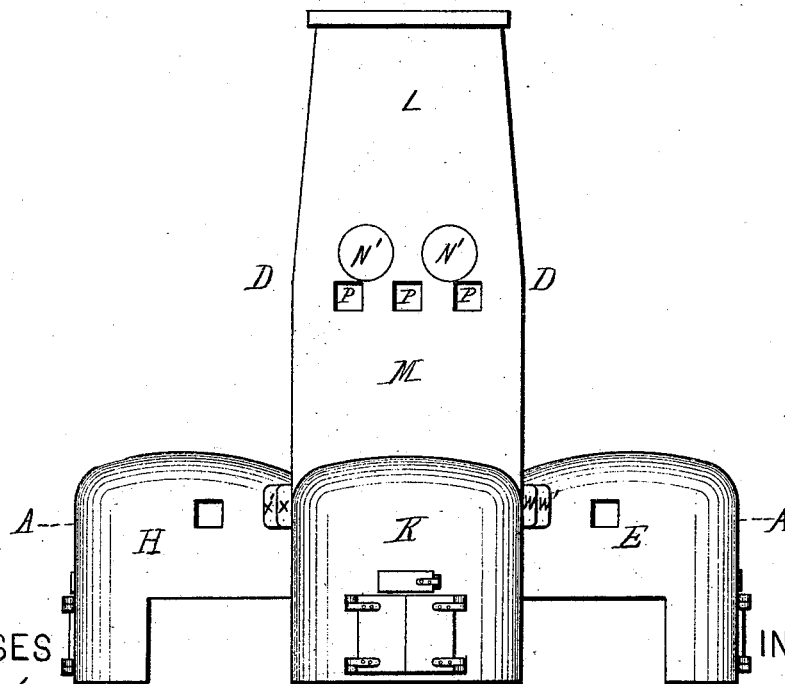
*Deoxidizing Furnace.*

*No. 109,173.*

*Patented Nov. 15, 1870.*



*Fig. 4.*



WITNESSES

*M. J. Fox*  
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*Fig. 5*

*A. H. Brainerd*

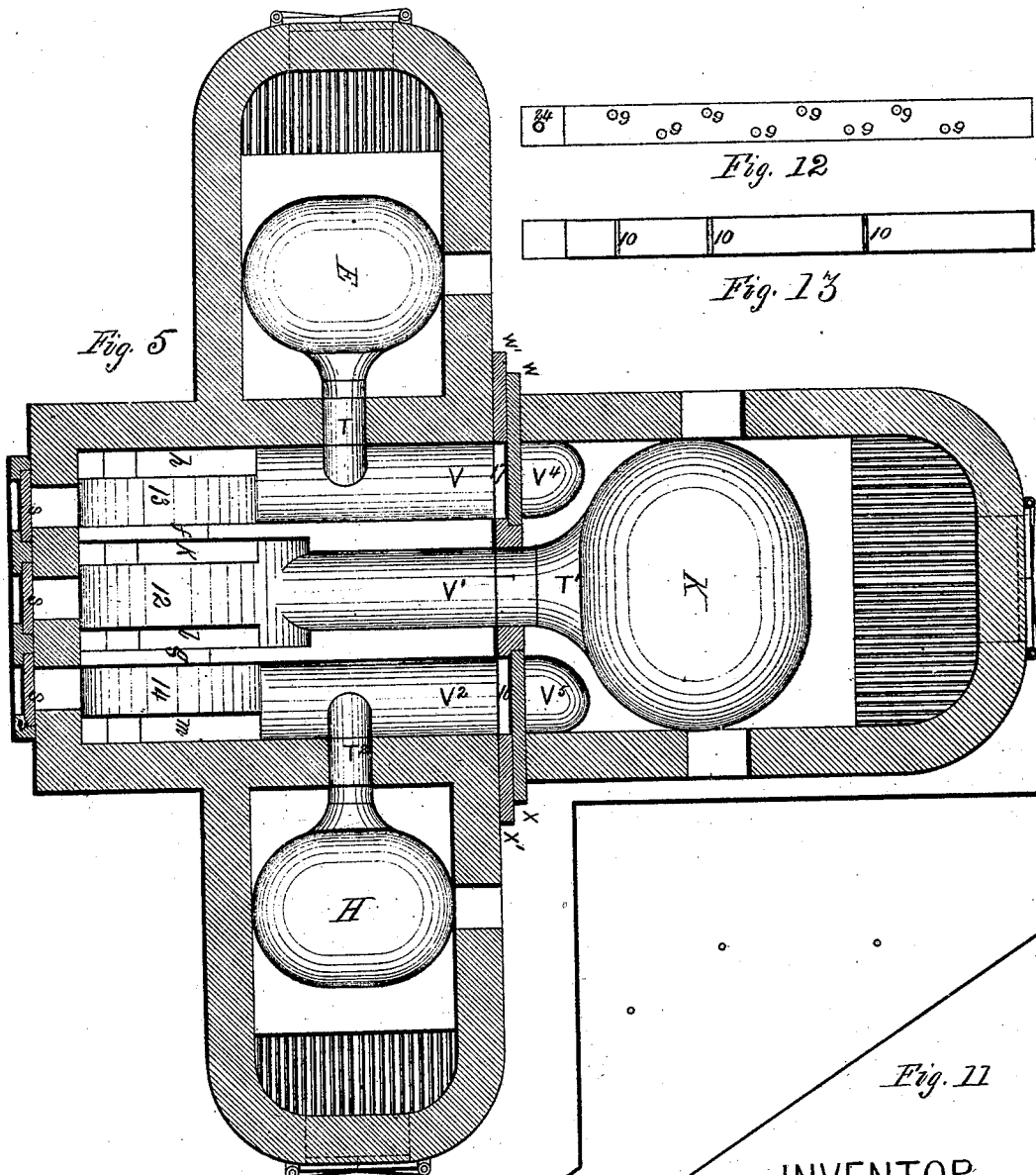
*A. H. Brainerd,*

*5, Sheets, Sheet 3.*

*Deoxidizing Furnace.*

*No. 109,173.*

*Patented Nov. 15, 1870.*



WITNESSES

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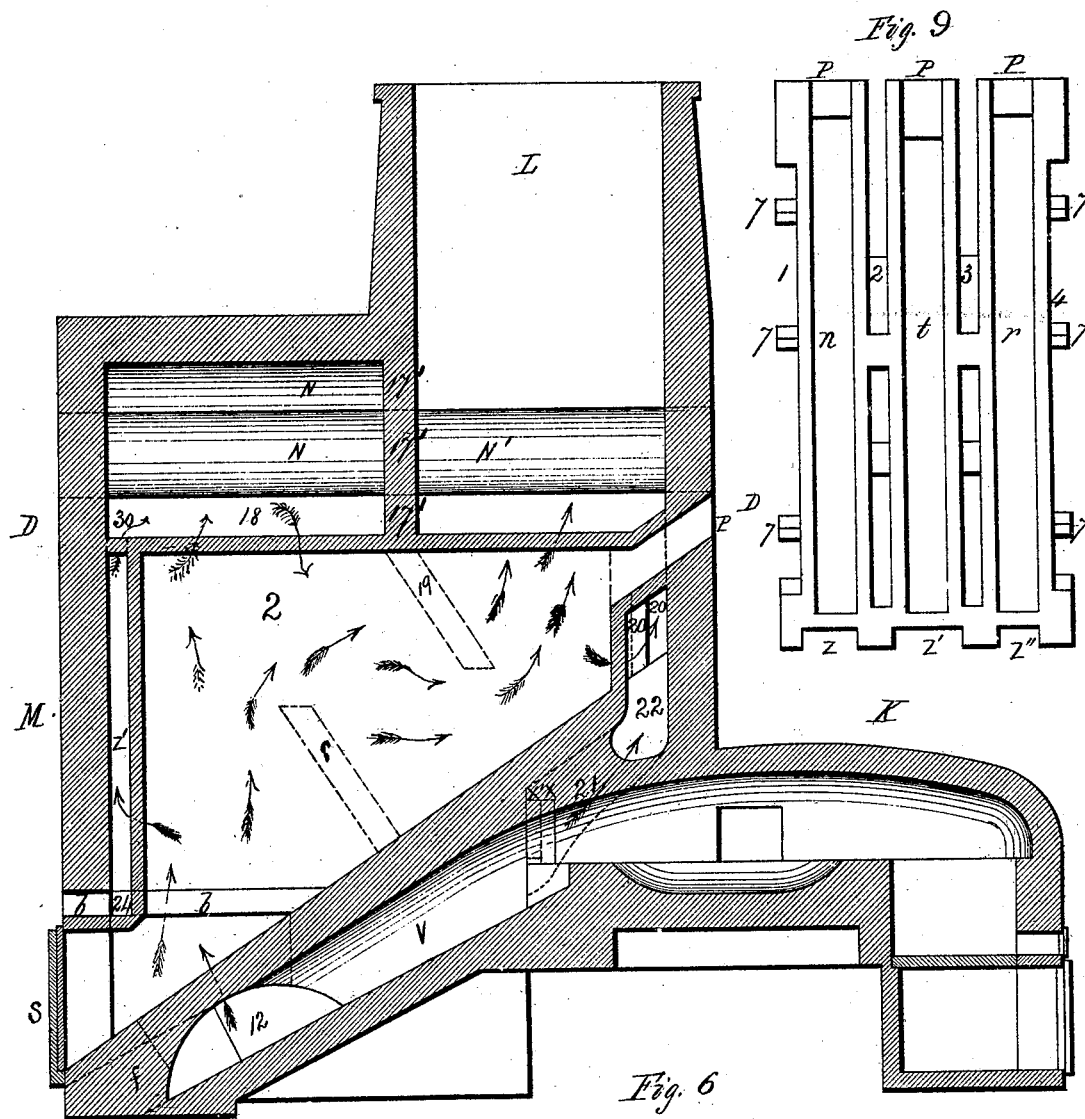
A. H. Brainerd

5, Sheets, Sheet 4.

Deoxidizing Furnace.

No. 102,173.

Patented Nov. 15, 1870.



WITNESSES

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5. Streets, Sheet. 5.

No. 102,173.

*Patented Nov. 15, 1870.*

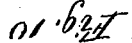


Fig. 8

WITNESSES

J. B. Good  
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# UNITED STATES PATENT OFFICE.

ALEXANDER H. BRAINERD, OF ROME, NEW YORK.

## IMPROVEMENT IN FURNACES FOR DEOXIDIZING IRON ORE.

Specification forming part of Letters Patent No. **109,173**, dated November 15, 1870.

*To all whom it may concern:*

Be it known that I, ALEXANDER H. BRAINERD, of the city of Rome, in the county of Oneida and State of New York, have invented a new and useful Furnace for the Deoxidation and Purification of Iron Ore; and also, a new and useful combination and arrangement of this deoxidizing-furnace with one or more puddling-furnaces, of all of which the following is a specification.

### *Nature and Objects of my Invention.*

The first part of my invention relates to such an arrangement and combination of the flues and dampers connected with the deoxidizing-cells and puddling-furnaces of my combined furnaces and deoxidizer that the operator of the same may be able to use one or more, or all, the furnaces in connection with any one or more of said cells, or to use any one or more of the furnaces in puddling, and at the same time prevent the fire and heat from the same passing through any of said cells, and in such a manner that the fire and heat of one or more of the furnaces may be used independently of the deoxidizer, and yet be passed through the same stack of chimneys, the object of this part of my invention being to control and utilize the heat of the furnaces, and also to utilize the chimney for the purposes of the deoxidizer and furnaces, or of the furnaces.

The second part of my invention relates to the combination and arrangement of a general reservoir and the puddling-furnaces, flues, and ore-cells, in such a manner that all of the heat from one or all of the furnaces can be collected in said reservoir, and can be distributed therefrom uniformly and gradually, in thin broad flames, throughout the flues around the ore-cells, in such a manner as to prevent the fire from burning and cutting the material composing the sides of the flues and cells, the principal object of this part of my invention being to enable me to put as many ore-cells as desirable in the deoxidizer.

The third part of my invention relates to such an arrangement of a boiler or boilers in the chimney-stack that the surplus heat from the furnace or furnaces, together with the ore-cells, or from the furnaces alone, may be directed and imparted to all or some of the said

boilers, the object of this part of my invention being to utilize all of the heat not used by the furnaces or by the deoxidizing cell or cells, thus obtaining a maximum of effect from a given amount of heat.

The fourth part of my invention relates to a mode of lining, if desired, a part or the whole of the inside of one or more of the ore cell or cells, to sustain the expansion of the ore when heated, and to thus prevent the spreading of the inside wall of said cell or cells.

### *Description of Accompanying Drawing.*

Figure 1, Sheet 1, is a side elevation of a structure embodying my invention. Fig. 2, Sheet 1, is that end of the same which is on the right hand in Fig. 1. Fig. 3, Sheet 2, is the other end of the same, which is on the right hand in Fig. 1. Fig. 4, Sheet 2, shows the top of my invention. Fig. 5, Sheet 3, is a transverse section of the combined furnace, made at points A A, see Figs. 1, 2, and 3. Fig. 6, Sheet 4, is a vertical section of my combined furnace, made through the center of same at points B B, Fig. 2. Fig. 7, Sheet 5, is a vertical section of the same, made at points C C, Fig. 1. Fig. 8, Sheet 5, is the cover of the ore-cells and flues, to be seen by cutting through my deoxidizing-furnace at the points D D, see Figs. 6, and 1, 2, and 3. Fig. 9, Sheet 4, is the top of my ore-cells and flues, showing their relative arrangement when the cover, Fig. 8, is removed. Fig. 10, Sheet 5, is a longitudinal vertical section through center of one of the flues, No. 1 or No. 4, which are alongside of the ore-cells. Fig. 11, Sheet 3, is a side elevation of the inside shell or lining of the ore-cells. Fig. 12, same sheet, is the top of this shell. Fig. 13, same sheet, is a section of this shell, showing its interior.

### *General Description.*

In the accompanying drawing, E, H, and K, Figs. 1, 2, 3, 5, 6, and 7, are puddling-furnaces. M, Figs. 1, 2, and 3, is that part of the combined furnace which contains the ore-cells and flues for heating these ore-cells. L, Figs. 1, 2, 3, 6, and 7, is the lower portion of the chimney-stack. N' N', Figs. 3 and 6, are boilers passing through or placed in the smoke-

stack. N N, Figs. 2, 6, and 7, are boilers extending over the upper part of the ore-cells. The presence of these boilers N N is not essential, however, to my invention. P P P, Figs. 3, 6, 7, 8, and 9, are orifices for feeding the ore-cells with ore. These orifices can be placed, if it should be found expedient, at the other end of the ore-cells, over the discharge-doors S S S.

S S S (see Figs. 1, 2, 4, 5, and 6) are the doors for discharging ore from the ore-cells. T T<sup>1</sup> T<sup>2</sup>, Figs. 5 and 7, are flues connecting the interior of the puddling-furnaces E, K, and H with their respective flues V V<sup>1</sup> V<sup>2</sup>. V V<sup>1</sup> V<sup>2</sup>, Figs. 5, 6, and 7, are fire-flues connecting the puddling-furnaces with their respective flues 13, 12, and 14, Fig. 5, or, when the dampers *f* and *g*, Fig. 5, are drawn, with the general reservoir 12, for which see Figs. 5 and 6.

In Figs. 1, 3, 4, and 5, X' is a large damper, with an opening, 16, in its center, a section of which is shown in Fig. 5. X, same figures, is a solid damper, sliding by the side of X'. W', same figures, is a large damper, with an opening, 17, in its center, a section of which is shown in Fig. 5. W, same figures, is a solid damper, sliding by the side of W'. The office of this damper is to prevent or allow the heat from one or more of the furnaces E, H, and K to go up the chimney-stack.

*a*, *b*, *d*, and *e* (see Figs. 2, 5, and 6) are other dampers, to control the direction of the heat in respect to the flues 1, 2, 3, and 4, Fig. 7. *f* and *g* (see Figs. 2 and 6) are dampers to keep the fires of V<sup>1</sup> within reservoir 12, and the fires of V within flue 13, and the fires of V<sup>2</sup> in 14, or to unite reservoir 12, with flue 14, or 12 with 13, or throw 12, 13, and 14 into one large reservoir. *h*, *k*, *l*, and *m* (see Fig. 5) are narrow openings, connecting their respective flues 13, 14, and reservoir 12, with the flues around the ore-chambers. *n t r* (see Figs. 7 and 9) are the cells or chambers for holding the ore while it is undergoing the process of deoxidizing.

The ore-cells and deoxidizer are constructed of fire-brick made for this special purpose, or other suitable material.

1, 2, 3, and 4 (see Figs. 7 and 9) are passages or flues for the heat, located alongside of the ore-cells *n*, *t*, and *r*. Z, Z<sup>1</sup>, and Z<sup>2</sup>, Figs. 6, 8, and 9, are flues at that end of the ore-cells which are above the doors S S S. The flue Z connects flue 1 and the space in which are the boilers, above the cover of the ore-cells. Flue Z<sup>1</sup> connects flues 2 and 3 with the space above the cover of the ore-cells. Flue Z<sup>2</sup> connects flue 4 and the space above said cover. These flues Z, Z<sup>1</sup>, and Z<sup>2</sup> are separated from each other through their whole extent by partitions, and the heat and flame in each of said flues can only unite after passing out of each of said flues into the space 18, Fig. 6, above the cover.

Fig. 8 is the cover, fitting closely on the top

of the chambers *n*, *t*, and *r*. In this cover, 5 5 5, &c., same figure, are holes or ventilators. 6 6<sup>1</sup> 6<sup>2</sup> 6<sup>3</sup>, same figure, are narrow openings in the cover over the flues 2 and 3. 6<sup>4</sup> 6<sup>4</sup> are openings at the side of the cover near the feed-orifices, one 6<sup>4</sup> being over flue 4, and the other 6<sup>4</sup> over flue 1. 17, Fig. 6, is an air-tight partition over a part of the deoxidizer, to create a proper circulation of the heat between and around the ore-cells. 19, Fig. 6, is a continuation of this partition 17' down into flues 2 and 3, or, if desired, also into flues 1 and 2, and giving proper direction to the heat.

Fig. 10 shows side of flue No. 1 or 4, in which side 7 7 7, &c., are stays or braces to sustain the sides of the flues. These stays are usually inserted in each flue in any number desired. 8, same figure, is a division-piece or partition, to give a desired direction to the flame passing through the flue. In flues 2 and 3 there is not only this division-piece 8, as shown in Fig. 6, but there is also a second piece, 19, Fig. 6, springing from the top of the flue and running obliquely downward and parallel to piece 8, to give direction to the draft.

In Fig. 11 is a shell to fit closely within the ore-cell. This shell is of boiler-iron or any suitable material. It is inserted within the ore-cell to stiffen the sides of such cell, and thus protect them from expansion. Within this shell stays 10 10 10, &c., Fig. 13, cross from one side to the other. These stays are used, first, to secure in place the sides of the shell, and, secondly, to resist undue lateral expansion of the heated ore, which would otherwise tend to break out the sides of the ore-cells. This shell may extend the whole or a part of the distance from the top to the bottom of the ore-cells, or, if found expedient, may be dispensed with.

Fig. 12 is the top of this lining or shell, in which top 9 9 9, &c., are holes through the top of the cell for the escape of gas and heated air and the like from the ore within. 24, Figs. 6 and 12, is a hole or vent which is in each of the ore-cells at this point, connecting the ore-cells with its respective flue, 1 or 2, 3 or 4. 13, Fig. 5, is a continuation of flue V. 14 (see Fig. 5) is a continuation of flue V<sup>2</sup>. 12 (see Figs. 5 and 6) is a general reservoir for all the heat from furnace H; or, when the dampers *f* and *g* are pulled out, then 12, 13, and 14, together form a large reservoir for the heat from the three furnaces E, H, and K. 15, Fig. 10, is an air-tight partition running along the top of the flue, to prevent the hot air from the side flues 1 and 4 from passing directly up into the space. 21 is a flue (like which there is another upon the other side of the furnace) which conveys the heat from the furnaces to flue 22 when prevented from passing around the ore-cells. 22 is a flue connecting 21 with flue 20. 20 is a flue connecting flue 22 with the smoke-stack, and also affording an outlet to the heat

and flame when passing between and around the ore-cells, through flues 1, 2, 3, and 4.

#### *Mode of Operation.*

I will explain the mode in which my combined furnace operates when all of the puddling-furnaces are in use.

The puddling-furnaces E, H, and K are first filled with fuel, and with already deoxidized and purified ore. This ore may be mixed with scraps or other old iron, if desired. The fuel in the several furnaces is then lighted, and the process of puddling the deoxidized ore begins. The dampers X X' W W' being closed, (see Fig. 5,) the flame and heat of furnace H pass through flue T<sup>2</sup> into V<sup>2</sup>, and thence into flue 14; that of furnace K through flue T<sup>1</sup> into flue V<sup>1</sup>, and thence into reservoir 12; that of furnace E through flue T into flue V, and thence into flue 13. While the damper *f* is closed the heat in flue 13 goes directly up through the narrow opening *h*, and if damper *a*, Fig. 2, be open, goes directly up into flue 1, Fig. 7. If damper *f* is opened the heat in 13 distributes itself through reservoir 12. The fire in flue V<sup>1</sup> passes into reservoir 12, and when dampers *f* and *g* are shut it then passes up into flues *k* and *l*. If dampers *b* and *d* are open the fire then passes into the flues 2 and 3, Fig. 7. If damper *d* is shut and *b* is open all of the fire will pass into flue 2. If damper *b* is shut and *d* open all the fire from this reservoir will pass up into flue 3.

The fire in flue 14, when the damper *g* is closed, passes up into flue *m*, and, if damper *e* is open, then up into the flue 4, Fig. 7. If the damper *g* is opened the fire in 14 is distributed in part into reservoir 14. This arrangement of dampers enables me to concentrate the fires from one or more, or all, of the furnaces into any of the flues. Thus, by opening the damper *g* and closing damper *e* all of the heat from flue 14 is thrown into reservoir 12, and thence up into *k* and *l*; and if at the same time damper *f* be opened and damper *a* be shut, all the heat in flue 13 is thrown into reservoir 12, and thence up into flues *k* and *l*. If damper *d* be then closed, all of the heat of the three furnaces will be forced up into flue *k*, and thence into flue 2; or, if damper *b* be closed and *d* opened, all heat will pass up into flue *l* into flue 3.

To concentrate the heat upon one of the side flues, say flue 1, the dampers *f* and *g* are opened, and dampers *b*, *d*, and *e* are closed, and damper *a* is opened.

To concentrate the heat into flue 4, dampers *f* *g* are opened, dampers *a*, *b*, and *d* are closed, and damper *e* is opened.

Enough particular illustrations of the method in which these dampers operate have been given to exhibit the principle upon which they operate, and to enable a mechanic to concentrate the heat of the furnaces, as desired.

We next proceed to consider the method by which the heat from the furnace is applied to

the ore-cells, and the operation of feeding and discharging the ore-cells, and of deoxidizing the ore. It is immaterial in this regard whether dampers *f* and *g* are open or closed.

The ore-cells *n*, *t*, and *r* are filled with ore through the feed-orifices P P P. (See Figs. 6 and 7.) The dampers *a*, *b*, *d*, and *e* are then opened. The heat and flame from the furnaces pass up into the flues 1, 2, 3, and 4.

In either of the side flues, as, for instance, the flue 4, (see Fig. 10,) there being only one division-piece, 8, to control the direction of the heat, the heat will circulate as follows: It first passes up through the flue *m*, Fig. 5, through open damper *e*, Fig. 2, into flue 4, and then distributes itself throughout the flue in the direction shown by the arrows, a part passing around behind the flue into the long vertical flue Z<sup>2</sup>, (see also Fig. 9,) and thence passes up said flue and out through orifice 30, Figs. 6 and 10, into space 18 above the ore-cells.

Another part of the heat and flame passes up over division 8, and, being prevented from going directly up over into space 18 or chimney by an air-tight partition, 15, passes along until it passes up through 6<sup>4</sup>, Figs. 10 and 8, and also around the end of ore-cell through opening 20, and from thence it passes up around the boilers N' N' into the smoke-stack. The heat circulates in a similar manner through side flue 1. The heat circulates through the two middle flues 2 and 3 as follows: The heat from reservoir 12 divides and passes up through flues *k* and *l*, the heat passing through the open damper *b*, and thence into flue 2. The rest of the heat from the reservoir 12 passing through *l*, passes up through the open damper *d*, and thence into flue 3.

As flues 2 and 3 are constructed exactly alike, a description of how the heat circulates within flue 2 will suffice for both flues 2 and 3.

The heat passes from reservoir 12 up into flue *k*, and then through open damper *b* into flue 2. It then (Fig. 6) distributes itself throughout the flue, a part passing off to the rear of the flue, and then around into flue Z<sup>1</sup>, thence up through opening 30, Fig. 6, into the space 18 above the ore-cells.

Another part of the heat passes up through the flue over division-piece 8, and directly through opening 6<sup>3</sup> into the space 18 above the ore-cells.

Another part of the heat passes down under division-piece 19 and then divides, a part passing directly up around the boiler into the smoke-stack, and a part passing around in front of the ore-cell, and thence through 20 up around the boilers and out into the smoke-stack.

In describing the circulation of that part of the heat of these various flues which passed up into the space 18 above the ore-cells I have not stated how this heat found egress. This heat escapes as follows, viz: All the heat gathered in space 18, after delivering a portion



of its warmth to the boilers N N, being unable to pass directly into the smoke-stack on account of the air-tight partition 17', Fig. 6, passes down through openings 6 and 6<sup>2</sup> in cover, Fig. 8, and by opening 6 into flue 3, and by opening 6<sup>2</sup> into flue 2. In both flues 2 and 3 the heat then passes down under division 19, Fig. 6. A part of this heat passes directly up through openings 6 and 6<sup>2</sup>, Fig. 8, around boilers and into the chimney, and a part into flue 20 at the front of the ore-cells, thence up around the boilers N' N', to which it imparts its surplus heat, and then passes off through the smoke-stack. It will therefore be seen that the circulation of heat is very complete; that it passes completely around the ore-cells, and, owing to the immense amount of heated surface over which the heat passes, that very little of said heat is wasted, but almost the whole of it utilized.

The ore-cells are first filled with raw ore, mixed with common charcoal. As the fire passes around the cells filled with ore so mixed, it gradually deoxidizes and purifies the ore. The sulphurous and other gases then thrown off from the heated ore pass from the cells through holes 5 5 5, &c., Fig. 8, and 24, Figs. 12 and 6, in the lower projecting part of shell, and, mingling with the fire passing around and above the cells, ignite, thereby assisting combustion and increasing the heat.

It now remains to describe the operation of the dampers X X' and W W'.

It may be desirable to divert the fire of one or more furnaces from the ore-cells, and to use the said furnace or furnaces alone. Whenever such is the case the dampers are operated as follows: To divert the fire of furnace H, it will be necessary to close damper *g*, Figs. 6 and 7, and also damper *e*, Fig. 2. Damper X' is kept closed while damper X is opened. The fire of furnace H then, finding no opening in the direction of flue 14, passes through the open damper X', and through V<sup>5</sup> out into flue 21, Fig. 6, then out through this flue into flue 22, thence into flue 20, and thence up around the boilers N' N', and out of the chimney.

In regard to furnace E, by closing dampers *f* and A and opening damper W and closing damper W', the fire of furnace E will pass through damper W' and through V<sup>4</sup> out flues 21 22 20, up around boilers N' N', and then out through the smoke-stack.

In diverting the fire of furnace K alone, it will be necessary to close dampers *f* and *g*, and also dampers *b* and *d*, and to open damper W' far enough to permit an egress for the fire of furnace K, but not so far as to open an egress for fire from furnace E into flue 21, unless that is desired, when, if so, its appropriate damper A must also be closed. The damper X' may also at the same time be opened the same distance that damper W' is, with like result. The fire of K then passes through its only places of egress past the ends of the open dampers W' and X' into flue 21,

thence into flue 22, into flue 20, thence up around boilers N' N', and out into the smoke-stack.

To divert the fire of all the furnaces it will be necessary to close all the dampers *a b d e*, and then open dampers X' W' to their full extent, when the fires of all the furnaces will pass into flue 21, thence, as before, up through successive flues around the boilers out through the smoke-stack, the heat thus passing out of furnaces through the one smoke-stack of the combined furnace, but without passing through the flues of the ore-cells.

From this short description of the dampers it will be seen that they form a very perfect system, and enable the heat from the furnaces to be controlled and concentrated upon any one or more of the ore-cells, or to be diverted from the ore-cells and thrown directly up the smoke-stack independently of the ore-cells.

#### Claims.

I claim—

1. The combination and arrangement of the dampers *a b d e* and the flues *h, k, l*, and *m*, substantially as described, and for the purposes hereinbefore mentioned.

2. The combination and arrangement of the dampers *f* and *g* and the flues 12, 13, and 14, substantially as described, and for the purposes hereinbefore mentioned.

3. The combination and arrangement of the flues V V<sup>1</sup> V<sup>2</sup> and flues T T<sup>1</sup> T<sup>2</sup>, substantially as described, and for the purposes hereinbefore mentioned.

4. The combination and arrangement of dampers X with X' and W with W'; also the combination and arrangement of the dampers X and X' or their equivalent with flues V<sup>1</sup> and V<sup>2</sup> and flue 21; also, the combination and arrangement of dampers W and W' or their equivalent with flues V and V<sup>1</sup> and flue 21, all substantially as described, and for the purposes hereinbefore mentioned.

5. The combination of flues 21, 22, and 20 and smoke-stack, substantially as described, and as and for the purposes hereinbefore mentioned.

6. The combination and arrangement of flues 21, 22, and 20, substantially as described, and as and for the purposes hereinbefore mentioned.

7. A general reservoir, 12, in connection with one or more furnace-fires, and with or without one or more adjacent flues, as 13 and 14, substantially as described, and for the purposes hereinbefore mentioned.

8. The combination and arrangement of the lining, Figs. 11, 12, and 13, when made substantially as described, and the ore-cells for deoxidizing ore, substantially as described, and for the purposes hereinbefore set forth.

9. A chimney, or one or more stacks of chimneys, for both deoxidizer and puddling furnace or furnaces, arranged in such a manner that the said chimney or stacks of chim-

neys may be used as a chimney for the puddling furnace or furnaces independently of the deoxidizer, and without the fire or heat from the said furnace or furnaces passing through the deoxidizer, substantially as described.

10. The combination and arrangement of one or more of the dampers *a*, *b*, *d*, and *e* and one or more of the flues 1, 2, 3, and 4 alongside of the ore cell or cells, substantially as described, and for the purposes hereinbefore mentioned.

11. The steam generator or boilers *N' N'*,

when arranged within the smoke-stack, so that all the heat from the puddling furnace or furnaces, whether passing through the flues of the ore cell or cells, or passing directly up from the furnace or furnaces into the chimney and without passing through the flues of the ore cell or cells, shall, in any event, pass under the boilers.

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