2 Sheets—Sheet 1.

J. Y. SMITH.

CRUCIBLE FURNACE.

No. 104,219. Patented June 14, 1870.

Fig: 1.

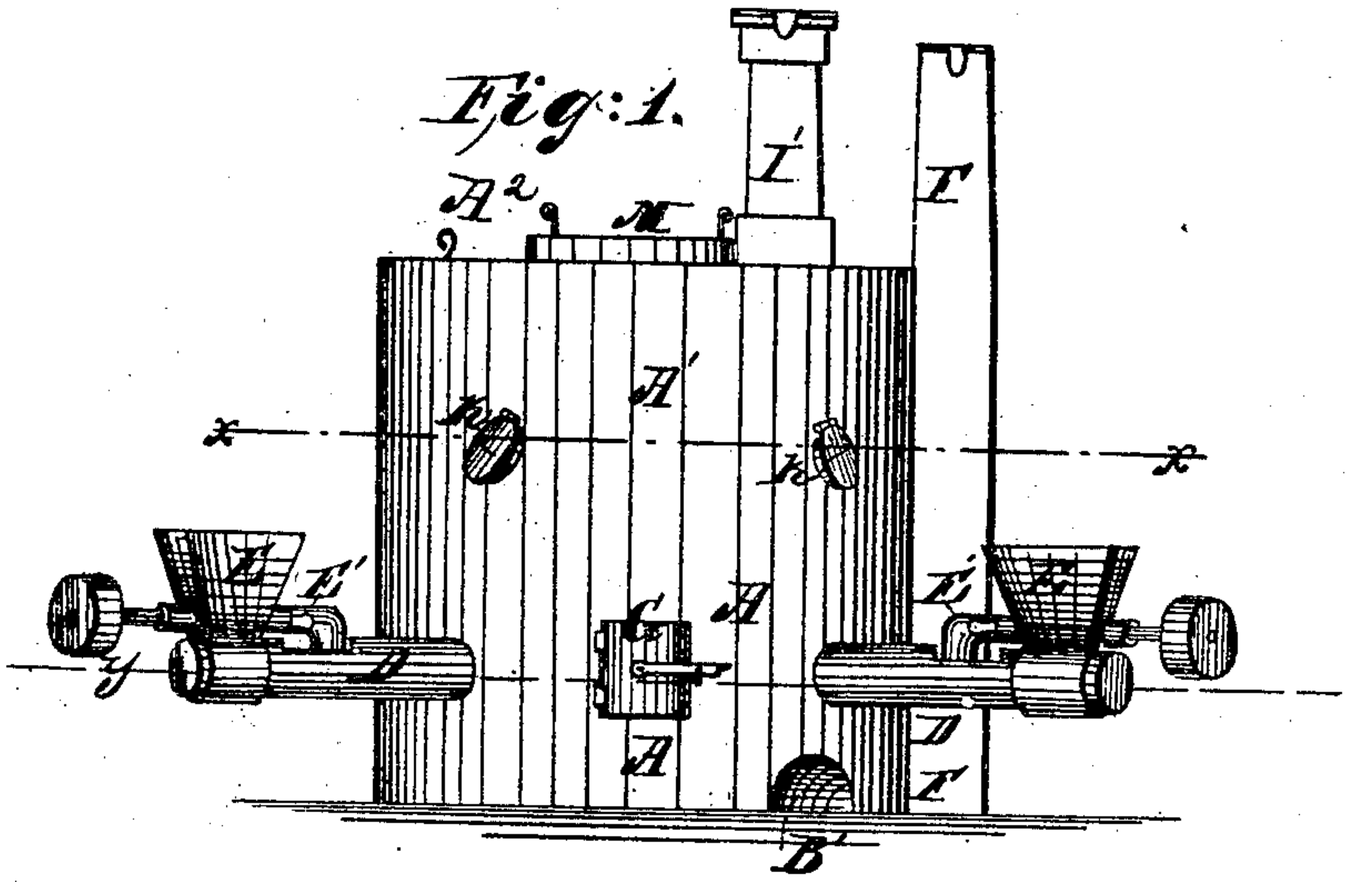
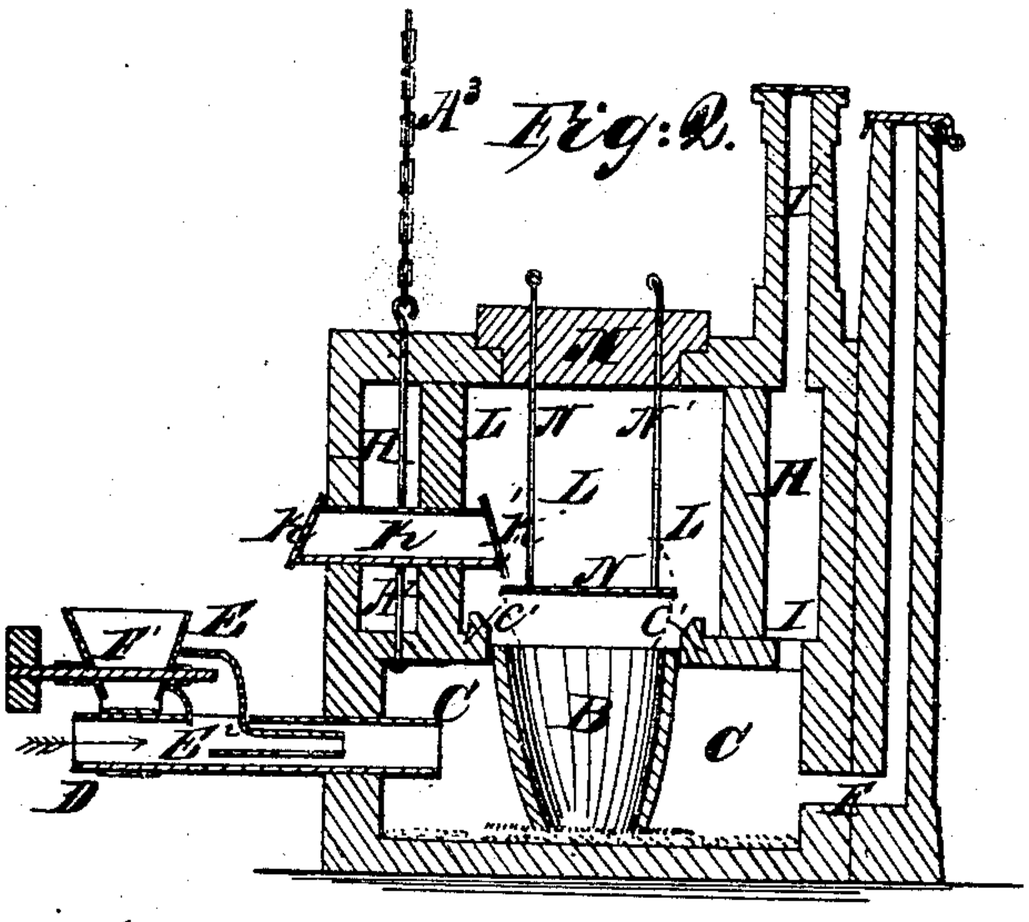


Fig: 2.



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2 Sheets—Sheet 2.

J. Y. SMITH.

CRUCIBLE FURNACE.

No. 104,219. Patented June 14, 1870.

Fig: 3.

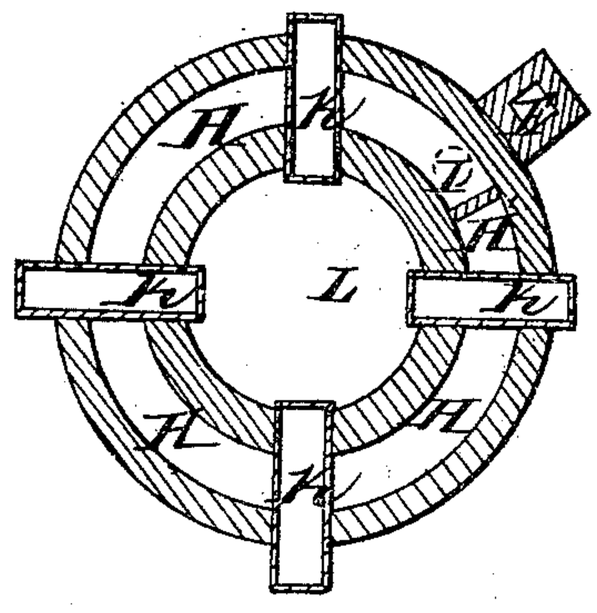
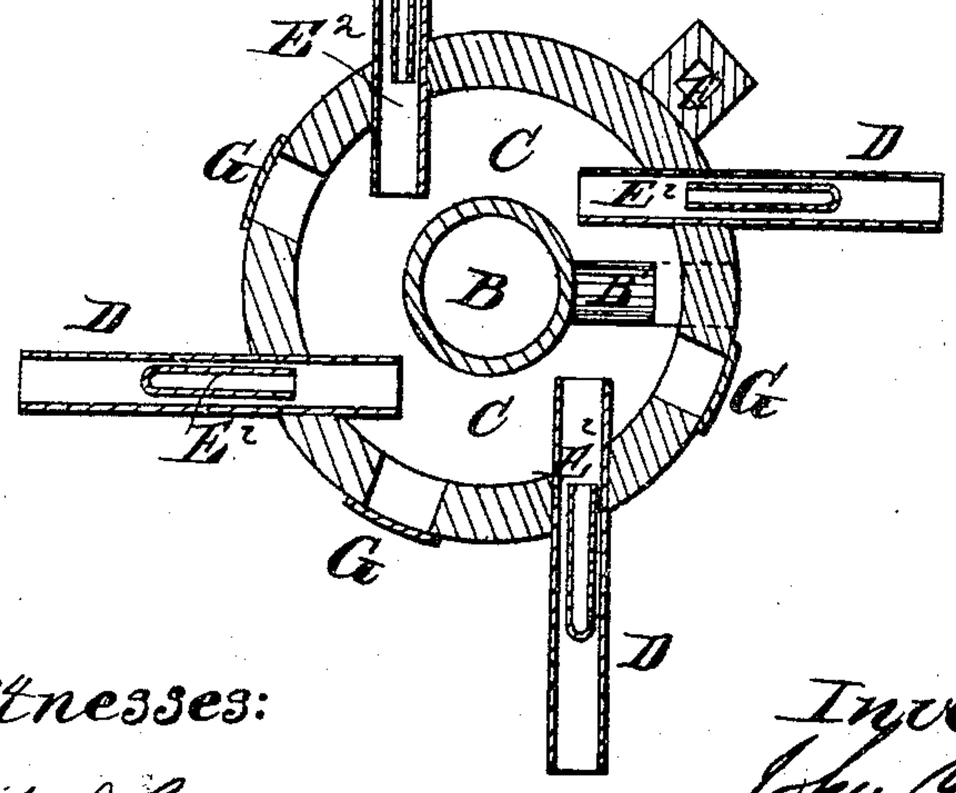


Fig: 4



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United States Patent Office.

JOHN Y. SMITH, OF PITTSBURG, PENNSYLVANIA.

Letters Patent No. 104,219, *dated June* 14, 1870; *antedated June* 3, 1870.

IMPROVED METALLURGIC FURNACE FOR IRON AND STEEL.

The Schedule referred to in these Letters Patent and making part of the same.

To all whom it may concern:

Be it known that I, JOHN Y. SMITH, of Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented an Improved Crucible Furnace, for treating magnetic and other ores of iron, and other substances; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the annexed drawing making part of this specification, in which—

Figure 1 is an elevation.

Figure 2 is a vertical section.

Figure 3 is a horizontal section on line *x x* of fig. 1.

Figure 4 is a horizontal section on line *y y* of fig. 1.

The same letters are used in all the figures to designate identical parts.

This invention relates to a furnace particularly adapted for the reduction of what are commonly known as sand ores, but which may be used for other metallurgic purposes; and, my improvements consist,

First, in reducing the ores in crucibles, arranged within a combustion-chamber, by the action of heat; the tweers being so directed as to generate a vortex within the combustion-chamber about the crucible, thereby saving the crucible from the injurious effect incident to the use of tweers radially disposed, so as to direct the blast against the crucible.

Secondly, in making the top of the combustion-chamber fit neatly to the mouth of the crucible, so as to apply the heat of the combustion-chamber only to the exterior surface of the crucible, entirely excluding both the combustible material and the gaseous products of combustion from contact with the contents of the crucible.

Thirdly, in forming above the crucible a hot-air chamber from which the gaseous products of combustion are entirely excluded; said chamber being heated by the waste heat from the combustion-chamber, so as to maintain a high temperature above the materials under treatment in the crucible.

Fourthly, in the use of feeding-chambers in which the ores may be heated, and treated by admixture with such substances as may be needed, before being introduced into the crucible, and from which they may be transferred directly into the crucible without at any time being brought into contact with the gaseous products of combustion.

Also, in sundry matters relating to the details of construction and arrangement which will be designated and specified in the following specification and claims.

In order that persons skilled in the art may be able to construct and operate my improved furnace, I will now proceed to describe, first, its construction, and then, the mode of operating it.

In the annexed drawing I have shown one form of furnace as illustrating the principle of my invention, which may be modified to adapt it to the various conditions under which it may be desired to operate a furnace, merely by the skill of the builder changing the form and arrangement of parts, but still maintaining the principle.

The furnace here shown is built in two parts, the base A containing the combustion-chamber and crucible, and the top A^1, which contains the charging apparatus.

The upper part I propose to construct with stay-bolts A^2, built into the solid parts of the wall, to which may be attached chains A^3, by means of which the top of the furnace may be suspended, in whole or in part, from a suitable frame-work above it, so as to relieve the lower portion A from its weight. By this means, the wall of the combustion-chamber may be more cheaply constructed and conveniently removed; and the crucible, being relieved from the superincumbent weight, is less liable to be crushed by the yielding of its walls.

B is a crucible, built of any suitable refractory material, which rests upon a hearth, which I propose to make of powdered silex. The crucible I prefer to build without any bottom, the contents thereof resting upon the silex. The crucible may, however, be constructed with a bottom in the ordinary manner. The molten contents of the crucible may be drawn off through the pipe B′, from time to time, as iron is drawn from an ordinary cupola furnace.

C is the combustion-chamber, which is formed by the wall A, which I prefer to make circular, as shown, and is covered by the diaphragm C′, constructed with an opening or openings to receive one or more crucibles. The diaphragm is fitted to the crucible closely by plastering with a suitable refractory composition, so that the combustible and gaseous products of combustion are excluded entirely from contact with the contents of the crucible.

I prefer to use as a combustible, pulverized coal; but inflammable gases may be used instead; or, a fire built in the combustion-chamber. The pulverized combustible is introduced with the blast through the tweers D, and ignited immediately upon its entrance to the combustion-chamber.

If the tweers were arranged radially, as is commonly the case, the blast, impinging directly against the crucible, would soon destroy it. To avoid this, I introduce the tweers upon lines tangential to the surface of the crucible, or a circle described around it within the combustion-chamber, so that the flame of the burning fuel shall be swept in a vortex around the crucible, the greater pressure and consequent attrition being against the wall A, thus relieving the crucible as much as possible from the action of the blast.

The fuel is introduced with the blast. It is pulverized finely, and deposited in the hopper E, from which it is fed by the adjustable spiral feed-shaft E^1, operated by a pulley and belt, or in any other convenient manner. This shaft is twisted like an auger, and, as it is projected or drawn further into the hopper, the amount of combustible may be diminished or increased.

The combustible passes into the pipe E^2, which is extended so as to open in the direction of the tweer. The powdered combustible will be drawn from the pipe E^2, and delivered into the combustion-chamber by the force of, and together with the current of air or steam passing through the tweers.

G G are doors opening into the combustion-chamber, through which ashes may be withdrawn, or suitable instruments inserted for daubing the crucible, as it may become worn from use. I prefer to use, for this purpose, a plaster made from powdered silex.

The draught may be directly through the up-take F, from the combustion-chamber, or, this being closed by a damper, and another, closing the opening I, being opened, it may be directed into the circular chamber H, in the upper section of the furnace. This chamber is divided by a partition H′, the opening H being on one side, and the up-take I′ opening from the other, so that the heated gases, arriving from the combustion-chamber, may be made to pass entirely around the chamber H before escaping into the air.

Within the annular chamber H, and separated from it by a tight wall, is the hot-air chamber L, which extends from the diaphragm C′ and crucible B to the top of the furnace, where it is closed by a cap, M.

The charges are introduced to the crucible by means of the retorts K, closed externally and internally by doors K′. These retorts pass across the annular draught-chamber H, and are directly exposed to the action of the heat. As they open into the internal hot-air chamber L, it follows that the contents of the retorts, while exposed to the action of the heat, are not exposed to contact with any of the gaseous products of combustion, either while in the retorts, or while being fed from the retorts into the crucible.

The door or valve N may be placed below the retorts, and above the crucible in the hot-air chamber L, and is so constructed that, when the charge has been pushed from the retort, it may be supported upon the valve until the latter is turned, so as to allow the charge to fall into the crucible. I have shown one mode of supporting and operating this valve. It is suspended upon three rods which may be used for the purpose of raising it out of the chamber, when the crucible is to be replaced by a new one; or by relaxing, or drawing up one or two of the rods, it may be so inclined that the materials on its upper surface will slide into the crucible.

The crucible, when worn out, may be broken up by rods passed through the doors G, and the pieces removed through the same openings, and then, on removing the cap M and valve N, a new crucible may be lowered into its bed, without displacing any of the permanent parts of the furnace.

When thus introduced, the joint between the rim of the crucible and the diaphragm must be closed by plastering with a refractory mortar, and the new crucible will be ready for use.

In operating this furnace, the hopper E being filled with finely-powdered coal, and fires kindled in front of the tweers, the blast is started and the pulverulent combustible blown against the fire; it will be instantly ignited, and the combustion-chamber be filled with a mass of flame sweeping around the crucible which occupies the center of the vortex, receiving the heat, but not exposed to the mechanical action of the blast.

The charge is inserted into the retorts K through the external doors K′, and allowed there to remain subjected to the action of so much of the heat as it is deemed advisable to admit through the opening I. This is regulated by valves in the top of the stacks.

If this charge is what is known as sand ore of iron, the ore may be mixed with such ingredients as may be desired, for fluxing or carbonizing the metal to the precise extent desired for making pig-iron, wrought iron, or steel.

When the ore has been properly treated, it is then passed into the crucible, either directly, or, if consisting in whole or in part of heavy pieces likely to injure the crucible, by receiving it first on the door or valve N, and then allowing it to slide into the crucible.

After the charge is reduced, the molten metal may be drawn off through the pipe B′, and run into such form as is desired. The slag may be drawn off through the same or another larger opening, when the crucible will be again charged. This arrangement makes it unnecessary to cool the crucible, which is so liable to cause it to crack.

The pulverized silex which forms the bottom receives the charge as it falls, and saves the crucible from the concussion; it also being soft, will allow the crucible to expand downward as it is heated.

When the fire is to be extinguished, it is only necessary to stop the blast, and it is instantly extinguished.

When a crucible is worn or burned out, it may be broken to pieces and withdrawn through the door G, and a new one let down through the chamber L.

This invention is distinguished from all other furnaces heretofore used for metallurgic purposes in the arrangement of the crucible, in relation to a vortex of flame, in the air-chamber, and its being permanently built into the furnace, so as not to require removal, as is necessary with the crucibles in common use in making steel, melting brass, &c., and in being surrounded by the flame and separated from the gases evolved in combustion, instead of having the flame thrown down into the crucible, as is done when crucibles have been used as a part of a reverberatory furnace.

I am aware that pipes or retorts have been used for preparing the charge without contact with the gaseous products of combustion, but in all such furnaces the charge has then been either drawn off into the air before being put into the furnace, or discharged directly into the furnace, where it is brought into contact with the gases evolved by the combustion.

The novelty and the great advantage of my arrangement is that at no time after the charge has been introduced into the retort, is the ore subjected to the chemical action of the gases evolved from the fuel.

The chemical constituents of the ore having been definitely determined, in the process of reduction it is exposed only to the chemical action of such materials as may be introduced for the purpose of effecting desired results, whereas in all other furnaces, the ore, while under treatment or reduction, is exposed to the injurious effect of deleterious gases, materially affecting the result, and involving this result in uncertainty, whereas in my furnace definite results are insured by the use only of known substances in regulated quantities.

In case a fire should be built upon grate-bars in the combustion-chamber, the tweers would be modified in construction and arrangement to suit the new conditions, or combustible gases may be introduced through the pipe E^2; but in either case I prefer to use the tangentially-disposed tweers in the upper part of the combustion-chamber, for the purpose of creating a vortex of flame around the crucible.

I am aware that, in the ordinary process of manufacturing steel, the crucibles are fitted with a temporary cover, for the purpose of excluding the combustible material and the gaseous products of combustion, but, as the crucible is buried in the coal, this protection is insecure, and requires to be removed when the

crucible is lifted from its bed, and my invention is distinguished from this old method in this: That the crucible is built into the walls of the furnace, so as to permanently separate its interior from the combustible and its products, and may be charged and emptied without displacement, and that an air-chamber is formed above the crucible, the temperature of which, as well as that of the combustion-chamber, may be regulated at discretion, thus rendering all parts of the process certain, and insuring homogeneous products in as may different crucibles or furnaces as may be employed.

Having fully explained the principle and mode of constructing and operating my improved furnace,

What I claim as my invention, and seek to secure by Letters Patent, is—

1. The combination of the combustion-chamber, a crucible or crucibles, and a tweer or system of tweers, so arranged, in relation to each other, that the blast shall form a vortex in the combustion-chamber, around the crucible or crucibles, substantially as set forth.

2. In combination with a combustion-chamber, a tweer or system of tweers, and a hopper or hoppers, or pipe or pipes, for introducing pulverized or gaseous combustible matter, so arranged that a vortex of flame shall be formed by the action of the blast within the combustion-chamber, upon the ignition of the combustible, substantially as set forth.

3. A metallurgic furnace, combining in its construction a combustion-chamber and a crucible, so constructed and arranged that a continuous heat may be maintained, and the crucible charged and emptied without the contents of the crucible being allowed to come in contact with the gaseous products of combustion, substantially as set forth.

4. The combination of the combustion-chamber C, the crucible B, and the diaphragm C', substantially as set forth.

5. The combination of the combustion-chamber, tweers, crucible, and diaphragm, and the adjustable openings I and F, for regulating the escape of the gases, substantially as set forth.

6. The arrangement of the combustion-chamber, diaphragm, crucible, annular chamber H, and retorts K, substantially as set forth.

7. The arrangement above the crucible and diaphragm C', and within the annular chamber H, of a hot-air chamber, L, through which the crucible may be charged and a new crucible introduced, substantially as set forth.

8. A crucible resting upon a bed of pulverized silex, to permit of its expansion, substantially as set forth.

9. The combination of the retorts and crucible and intermediate chamber, so arranged, in relation to the heating-chamber or chambers, that the charge shall not be exposed to contact with the gaseous products of combustion, either in the retorts or crucible, or in its passage from the former to the latter, substantially as set forth.

10. The combination of the hopper, the tweer, and the pipe E^2, arranged substantially as set forth.

11. In combination with the crucible and retorts, an intermediately-placed door or valve, for first receiving and then discharging the charge into the crucible, substantially as set forth.

12. A crucible-furnace, constructed in two parts, and having the upper section suspended so as to relieve the lower section from its weight, substantially as set forth.

13. In combination with the crucible, an adjustable feed, for regulating the temperature in the combustion-chamber around the crucible, and the chamber above the crucible with an adjustable damper, for regulating the temperature above the crucible, substantially as set forth.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

JOHN Y. SMITH.

Witnesses:

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R. MASON.