H. M. BAKER.

Manufacture of Iron and Steel.

No. 150,387. Patented May 5, 1874.

FIG. 1.

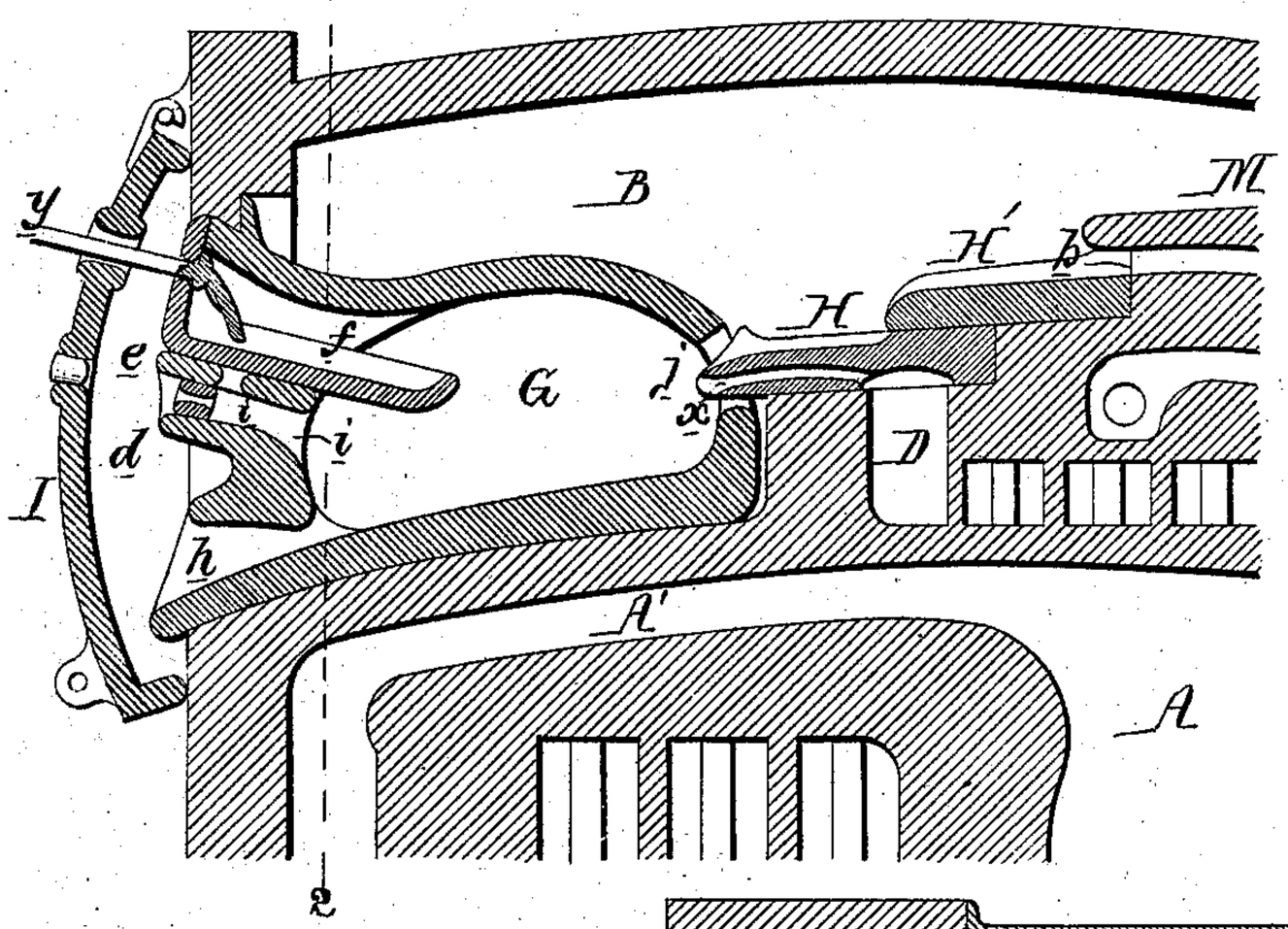


FIG. 2.

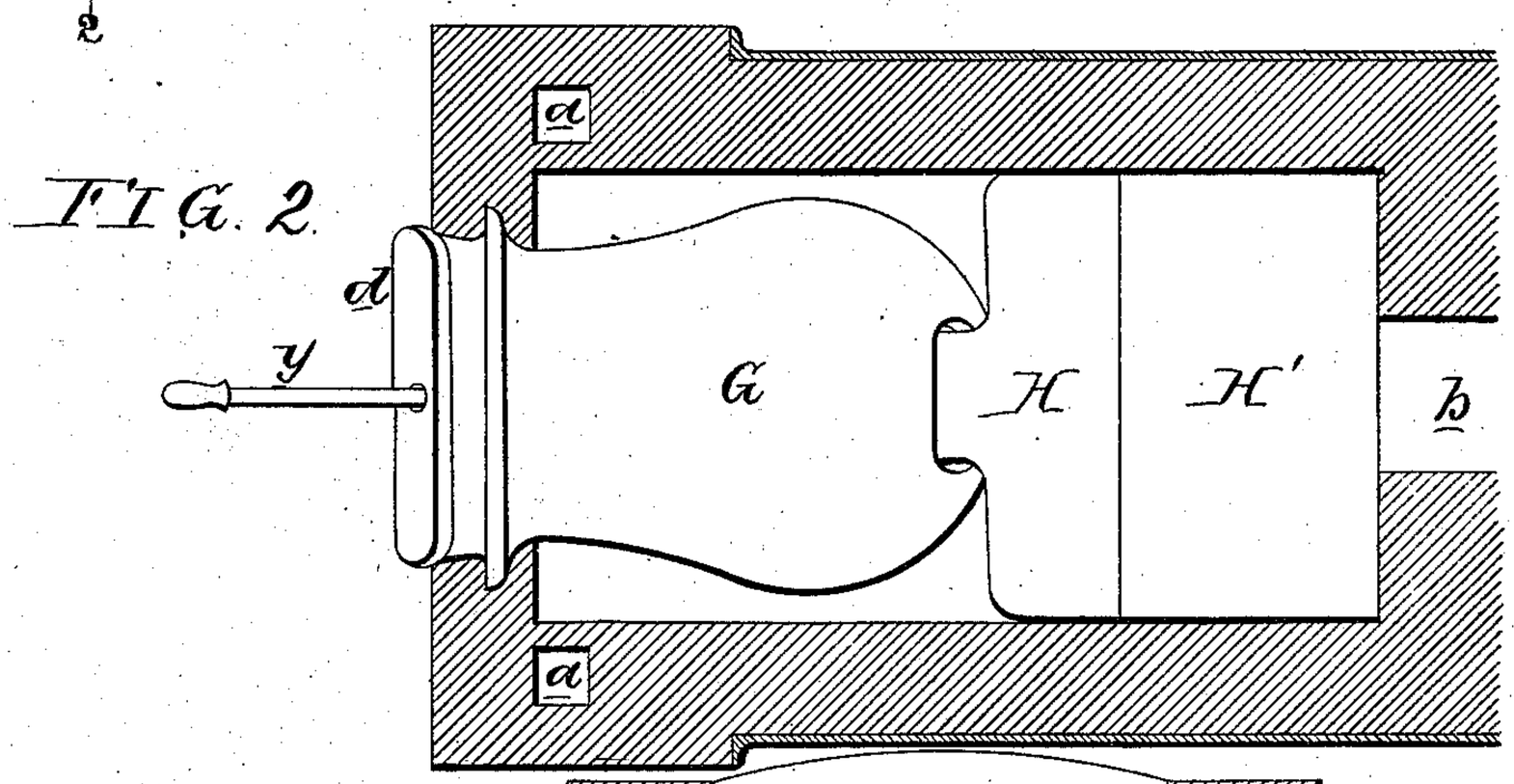


FIG. 4.

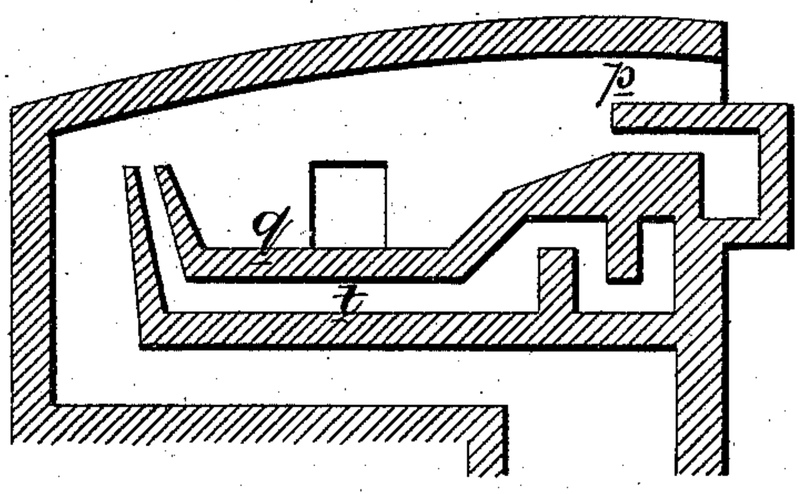
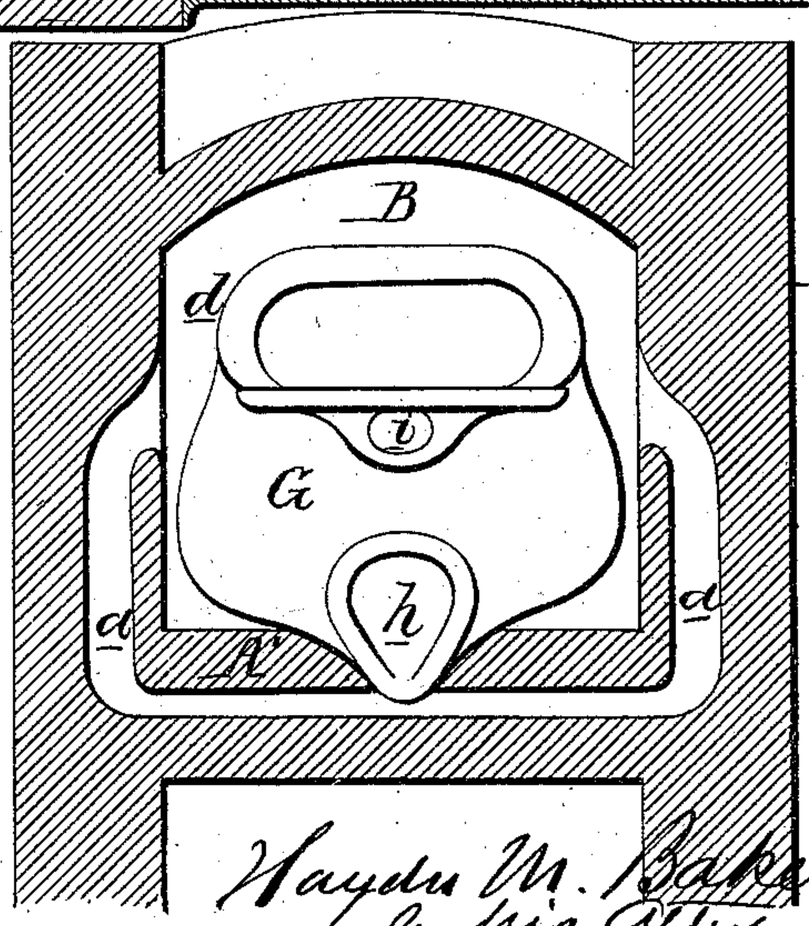


FIG. 3.



Witnesses,
John K. Rupertus.
Thomas McElvain

Hayden M. Baker
by his Attys
Howson and Son

UNITED STATES PATENT OFFICE.

HAYDN M. BAKER, OF WILLIAMSBURG, NEW YORK.

IMPROVEMENT IN THE MANUFACTURE OF IRON AND STEEL.

Specification forming part of Letters Patent No. **150,387**, dated May 5, 1874; application filed September 30, 1873.

To all whom it may concern:

Be it known that I, HAYDN M. BAKER, of the city of Williamsburg, county of Kings, State of New York, have invented Improvements in, and Apparatus for, Reducing and Converting Ores and Metals, of which the following is a specification:

The object of my invention is to rapidly and effectually convert iron ore directly into steel or wrought or cast iron, or to convert cast-iron into wrought-iron or steel, as well as to conduct other metallurgical processes; and this object I attain by the application, in the manner fully explained hereafter, of superheated volatile agents under pressure, and of a character adapted to the ore or metal to be reduced and converted; also, by the application of non-volatile agents, the apparatus, wherewith the processes are carried into effect, constituting an especial feature of my invention.

The furnace by which I prefer to carry my invention into effect is illustrated in the accompanying drawing, Figure 1 being a vertical section of the furnace and retort; Fig. 2, a plan view; and Fig. 3, a vertical on the line 1 2, Fig. 1.

A is the fire-place, the products of combustion from which pass through flues *a a* in the opposite side walls of the furnace into the chamber B, (see Fig. 3,) and thence through a passage, *b*, at the rear of the said chamber to the exit-flue *c*, communicating with the chimney. D is the termination of an-inlet passage, into which the volatile agents, referred to hereafter, are introduced under more or less pressure, the said agents becoming thoroughly superheated in traversing this passage before they reach its termination D. G is the crucible, supported on the arched roof A′ of the fire-place, this crucible having in front a mouth, *d*, to which is fitted a slab, *e*, and from the latter projects a shelf, *f*, into the interior of the crucible, in front of which there is also a tapping-hole, *h*, and an orifice, *i*, for a purpose explained hereafter. In the rear of the crucible there is an opening, *j*, through which projects the end of a shelf, H, into the interior of the crucible, the said shelf forming a continuation of the bed H′, onto which the charge of metal or ore is fed from the charging-bed M, immediately above the flue *b*. A passage, *x*, in, or beneath, the shelf H forms a communication between the inlet D and the interior of the crucible G.

We will suppose, in the first instance, that pig-iron has to be converted into steel in the above-described furnace. The charge of iron is deposited on the shelf H′ while the furnace is at its full heat, and as soon as the charge of iron approaches a melting-stage a superheated volatile oxidizing agent is introduced under pressure into the inlet D. This agent, which may consist of steam, air, or the vapor of nitric acid, is projected through the passage *x*, in the shelf H, and into the crucible, but the front of the latter being closed the agent will return from the crucible, and, in seeking the flue *b*, must impinge against the metal as it gradually flows from the charge on the bed H′, and down the shelf H into the interior of the crucible, and, as the metal flows over the edge of the shelf, it must be crossed by the oxidizing agent; hence, the latter must be brought into intimate contact with the metal both as the latter descends the shelf, and as it flows in broken streams therefrom into the crucible. When the charge of pig-iron has been exhausted, and is in a molten mass in the crucible, the volatile oxidizing agent may, by an increase of pressure, be projected from the passage *x* directly onto the molten mass in the crucible, thereby continuing the oxidizing process, but the pressure of slag on the surface of the mass tends to obstruct this forcible action of the agent; hence, I prefer to close the pipes communicating with the inlet D, and thus discontinue the application of volatile agents, and resort to that of non-volatile agents, in the manner which I will now proceed to describe. Prior to the introduction of the charge of pig-iron on the bed H′, a mass of oxide of iron, or of oxygen salts of iron, such as spiegeleisen or hematite, carbonate of iron, or chromate of iron, or any combination of two or more of these, has been placed on the shelf *f*, and while the above process of applying volatile agents was continued, this non-volatile agent had become heated to a temperature which rendered it most available for application to the molten mass in the crucible.

The introduction of this non-volatile agent should be gradual, and in quantities which the

character of the molten mass may suggest, an instrument, *y*, Fig. 1, the handle of which projects through the slab *e*, being used to push the material from time to time from the shelf *f*. The condition of the metal in the crucible may be ascertained by looking into the opening *h*, or by the aid of the well-known spectroscope, or by the examination of specimens withdrawn through the said opening, the results of these examinations determining the propriety of continuing or discontinuing either of the above operations.

If wrought-iron of a superior quality has to be obtained from the charge of pig-iron, precisely the same mode of proceeding which I have described is resorted to, the oxidizing process, however, being continued for a greater length of time, and the contents of the crucible being subjected to the usual puddling process by a suitable instrument introduced into the mouth *d*.

If iron ore has to be converted directly into steel, it is charged onto the bed H′ with an appropriate flux, and when the ore becomes heated volatile deoxidizing agents are projected through the passage *x* under such light pressure that they will turn abruptly, and, following the course of the draft, be brought into intimate contact with the charge of ore. The tendency of these volatile deoxidizing agents, which, in this instance, should be hydrocarbons, or oxygenated or nitrogenized hydrocarbons—such as petroleum, coal-tar, dead-oil, resin-oils, which are distilled by superheating—is to furnish carbon and hydrogen to the oxygen of the ore; in other words, the agents are volatile deoxidizers.

The interior of the furnace having approached the melting-point of steel the charge will become semi-fluid when the further admission of the volatile deoxydizing agent should be discontinued, and the metal will find its way into the crucible, from whence the steel may be withdrawn by tapping. Should the steel, however, in the crucible be too highly carbonized non-volatile oxidizing agents should be added from the shelf *f*.

It may be remarked here that the metal on the bed H[1] first, as it assumes a semi-fluid mass, is really wrought iron, and may be puddled on the bed by appropriate instruments; but if I desired to produce wrought-iron direct from the ore I should not adhere to the precise construction of the furnace above described, but should adopt that shown in the diagram, Fig. 4, where *p* represents the inclined shelf for receiving the charge, *q* the bed of the furnace, and *t* a hollow bridge, through which pass the volatile agents.

It will be observed that one of the features of my invention is carried out in this structure—that is, the directing of superheated volatile deoxidizing agents onto the ore, and placed on a shelf or bed, down which the metal can flow into the body of the furnace.

In making pig-iron from ore all that is necessary is to force the volatile deoxidizing agents under greater pressure, and consequently in greater quantities, through the passage *x*.

An important feature of my invention is the manner of arranging the crucible within the furnace. The base of the crucible is adapted to the inclined or curved top of the roof A[1] of the fire-place, so that after the removal of a few bricks which retain the crucible in its place, the latter can be easily withdrawn to make way for a new crucible without disturbing either the furnace or the shelf H. Should there be a slight leak of the crucible no serious loss can take place, as the metal will be retained within the furnace below the outlet of the flues *a a*. (See Fig. 3.) The upper end of a door, I, is hinged to the front of the furnace, and is so arranged as to inclose the front of the crucible; but it is not necessary to close this door excepting when the furnace has to be cooled for repairing and other purposes, in which case the closing of the door will prevent such rapid cooling of the crucible as might tend to crack it.

Although I have described the furnace as applied to the reduction of iron and the conversion of cast-iron into steel or wrought-iron, it should be understood that the furnace and crucible may be used for the conducting of other metallurgical processes.

In reducing ores I sometimes dispense with the superheated volatile agents and charge the shelf *f* with bituminous coal, the gases from which, passing through the rear opening *j* of the crucible, are necessarily brought into intimate contact with the charge of ore on the bed H′, and induce deoxidization.

I claim—

1. The process of converting cast-iron into steel by subjecting the molten metal first to the action of a volatile agent, by which it is partly decarbonized, and then treating it with a solid or liquid agent, as set forth.

2. In the manufacture of iron and steel direct from the ore, subjecting the latter and the metal flowing therefrom to a volatilized deoxidizing agent, passing in a current over and in contact with the metal, and impinging on the ore.

3. In the manufacture of iron and steel, subjecting the ore and the metal flowing therefrom to volatilized hydrocarbons passing in a current over the metal to the ore.

4. The combination, in a furnace, of a bed or spout, H, and passages arranged as described, so that a current of gas may flow from beneath, across the end of and over the spout, as set forth.

5. The combination, in a furnace, of a crucible, a spout projecting into the latter, and a passage arranged to direct a stream of gas across or through molten metal passing from the spout, as described.

6. The combination, with a furnace, of a crucible, G, having its base adapted to the inclined or rounded bed of a furnace, as set forth, for the purpose specified.

7. The combination of crucible G, contained

within a furnace with a shelf, H, forming part of the furnace, and projecting into an opening in the crucible, all substantially as specified.

8. In combination with the shelf H and with the opening in the crucible, into which it projects, the passage *x*, in or beneath the said shelf, for the purpose specified.

9. The combination, with the crucible G, of a detachable shelf, *f*, adapted to the opening *b* of the crucible, as specified.

10. The within-described crucible, having an opening, *j*, at the rear and in front a mouth, *d*, orifice *i*, and tapping-hole *h*.

11. The combination of the crucible G with the chamber B of the furnace, and flues *a a*, as shown in Fig. 3.

12. The combination of the crucible G, with the door I of the furnace.

13. The charging-shelf H′, arranged in respect to the flue *b*, as specified.

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

HAYDN M. BAKER.

Witnesses:
CHS. T. GROTJAN,
H. A. SPEARS.