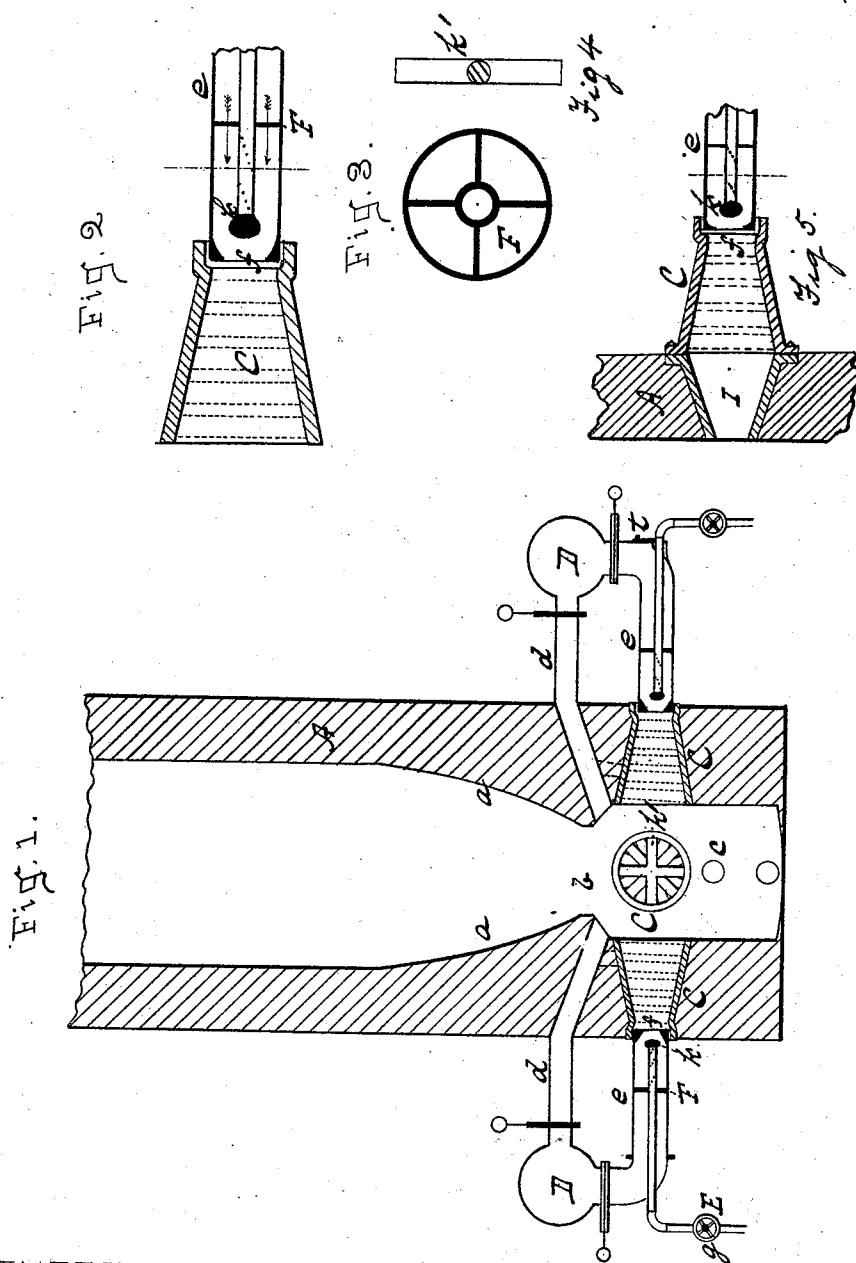


(No Model.)

J. T. MORGAN, H. F. HAYDEN & J. H. MORGAN.
PROCESS OF REDUCING AND SMELTING METALS AND APPARATUS THEREFOR.

No. 290,343.

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UNITED STATES PATENT OFFICE.

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PROCESS OF REDUCING AND SMELTING METALS AND APPARATUS THEREFOR.

SPECIFICATION forming part of Letters Patent No. 290,343, dated December 18, 1883.

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To all whom it may concern:

Be it known that we, JOHN T. MORGAN, residing at Selma, in the county of Dallas and State of Alabama, and HENRY F. HAYDEN and JOHN H. MORGAN, residing at Washington city, in the District of Columbia, citizens of the United States, have invented certain new and useful Improvements in Reducing and Smelting Metals and in Furnaces Therefor; and we hereby declare the following to be a full, clear, and exact description of the same, reference being had to the accompanying drawings, in which—

Figure 1 is a vertical section of the lower portion of a stack-furnace embodying the mechanical features of our invention. Fig. 2 is an enlarged central section of a burner and combustion-chamber used in conjunction with such furnace. Fig. 3 is a detached view of a spider for supporting the burner and centering it with the air-blast pipe and combustion-chamber. Fig. 4 is a side view, partly in section, of one of the crosses forming the checker-work or interrupted passages of the combustion-chamber. Fig. 5 is a longitudinal section of the combustion-chamber when provided with a contracted delivery-chamber to deliver the products of combustion, flame, &c., under pressure.

Like letters refer to like parts wherever they occur.

Our invention relates, first, to the method of smelting and reducing metals; and, secondly, to the construction of gas-furnaces for such purposes.

In the ordinary manner of operating stack-furnaces, the flux and the fuel, either charcoal or coke, as the case may be, are charged together with the ore into the stack, and the heat for melting the metal is developed by the consumption of the fuel as it approaches the hearth. The presence of the fuel (coke or charcoal) in the body of the stack is considered essential for two reasons, first, to prevent the compacting of the ore and scaffolding; and, secondly, to carburize the metal; and for these reasons heretofore, so far as we are advised, the smelting of metals in a stack by the use of gaseous or vaporous fuel alone has been considered and found to have been impracticable.

The object of the present invention is to

render gaseous fuel available in stacks for smelting metal, and to this end we charge, with the ore and flux, pieces or blocks of wood of suitable size, which serve first to support the ore, render it pervious, and prevent scaffolding, and, when carbonized by the heat, as a carburizing agent, which finally is consumed in the lower portion of the stack, thereby assisting the gaseous fuel in the smelting operation.

In order to insure the proper initial admixture of the hydrocarbon vapors or gas and the air, we center the gas-pipe with the air-blast pipe and perforate the burner spirally; and to insure complete combustion, we substitute for the tuyere an expanding combustion-chamber filled with a checker-work of refractory material. Finally, we admit an additional supply of air to the combustion-chamber at a point near the hearth, or into the hearth near the combustion-chamber, either or both, as circumstances may render advisable.

We will now proceed to describe our invention more specifically, so that others skilled in the art to which it appertains may apply the same.

In the drawings, A indicates the stack, which may be constructed in the usual or any approved manner, and is provided above with the usual bell and hopper for charging the ore, flux, &c. The interior of the stack is so shaped as to gradually increase the lateral pressure upon the charge as it descends, as shown at *a*, and is contracted somewhat more than usual at the junction with the hearth, as at *b*, so as to form shoulders, which will support the charge and in a measure keep the hearth *c* free from the ore.

c indicates the hearth, which is, proportionately to the body of the stack, somewhat larger or more capacious than usual, and is provided with the usual tapping and slag ports. Arranged within the walls of the stack, and delivering into the hearth just below the shoulders *b*, are a series of combustion-chambers, C, each supplied with its burner and air and vapor or gas supply pipe.

D indicates an air-main, which is supplied from a blast-engine through suitable blast-pipe

with either hot or cold air, as the case may be. This main partially encircles the stack, and has a series of valved branch pipes, *d*, which deliver into the hearth just above the combustion-chambers C and below the shoulders *b*, or into the inner end of the combustion-chamber next the hearth, as indicated by dotted lines. A second series of branches, *e*, from main D supply the combustion-chambers C, and these latter branches are contracted slightly at their outlets, as at *f*, to maintain the pressure in the branches *e*, and to permit of quick expansion of the gases, &c., as they enter the combustion-chamber.

E indicates the combustible vapor or gas supply pipe, provided with a suitable valve, as at *g*. This pipe is centered with the air-supply pipe, and is retained in position by one or more annular spiders, F, fitted within the air-pipe *e* and secured in any suitable manner. It terminates in an oval knob or expansion, *k*, centered with the contracted end *f* of the blast-pipe *e*, and is perforated spirally just back of the enlargement *k*.

C indicates the combustion-chamber, which is preferably of the general form of the frustum of a cone, or expands from the receiving end toward the delivery end. This gradual enlargement accommodates in a measure the expansion or increase in volume of the gases; but in order to interrupt the flow of the gases, and to break up and retard the same until complete combustion takes place, the interior of the combustion-chamber C is broken up and interrupted by a checker-work of crosses, *k'*, of refractory material, which may be composed of single columns arranged across each other; but are preferably molded in a single piece, with arms round in cross-section, as indicated in Fig. 4. These crosses gradually increase in size as the diameter of the combustion-chamber increases, may be set two or more inches apart, as indicated by dotted lines in Figs. 1 and 2, and are relatively arranged, so that when the combustion-chamber is filled thereby the line of vision through the combustion-chamber will be obstructed, as is clearly shown by the end view of the middle combustion-chamber in Fig. 1.

The combustion-chamber hereinbefore described is that commonly employed when no great pressure is required in the hearth; but if it is desired to deliver the flame, &c., into the hearth under pressure, we construct the combustion-chamber with a reversely-arranged funnel or gradually-contracting delivery-chamber, I, (see Fig. 5,) which is embedded in the walls A of the stack, the combustion-chamber proper being then located without the walls, and preferably surrounded by a non-conducting covering or sand-jacket. An equivalent construction might be obtained by connecting the combustion-chamber C directly with the usual tuyere of the blast-furnace.

These or equivalent means having been provided, will be operated as follows: Pieces of wood of any available character, but prefer-

ably yellow pine, and a foot or so in length, but usually of a length not to exceed the width of the stack at the boshes, are mixed and charged into the furnace with the ore and such flux as may be employed. The air-blast is then turned onto the branch pipes *e* and gas, or, preferably, vaporized hydrocarbons, and steam or vapor fuel admitted through the pipe E, and issues through the spirally-arranged perforations back of protuberance *k*, where it is caught up by the air-blast. The mixture of air, hydrocarbon vapor, and steam is then ignited by passing a torch through the firing door or port *t*, and the ignited vapors, &c., being forced by the pressure around the protuberance *k* and through the contracted throat *f*, suddenly expand upon entering the combustion-chamber C, where they meet the obstructing crosses *k'*, are broken up, intermingled, and have their flow retarded, until finally they issue from the combustion-chamber with a gyratory motion, complete combustion having taken place. If for any reason a greater supply of air is demanded in the hearth than can be introduced through the combustion-chamber, the valves of pipes *d* *d* are opened, and air delivered either into the inner end of the combustion-chambers or directly into the hearth. The flame, &c., projected from the combustion-chamber into the hearth acts upon the ore, &c., at the base of the stack, melting the same, and then the heated gases and products rise through the ore, wood, and flux in the stack, the wood as it descends with the ore being first dried, or having its vapors and acids driven off, is next charred, and after assisting in the deoxidation and carburization of the ore, finally reaches the lower part of the stack, where it can become ignited by the gas-flame in the hearth, and is then consumed, aiding the vapors or gaseous fuel in smelting the ore. The molten metal collects in the hearth below the combustion-chambers, and may be treated therein or drawn therefrom and subsequently refined or otherwise treated, as preferred.

The advantages of our invention are that we are enabled to use a gaseous or vaporous fuel in a stack for reducing and smelting ores, we avoid the use of the ordinary fuels and consequent liability of introducing impurities into the molten metal; and, finally, our process for the reduction and smelting of ores in stack-furnaces can be conducted in localities where suitable solid fuels cannot be readily or cheaply obtained.

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

1. The method herein described for reducing and smelting ores, which consists in subjecting a mixture of ore, flux, and wood to the action of a melting and carbonizing flame of gaseous or vaporous fuel, substantially as and for the purposes specified.

2. The combination, with a stack-furnace for reducing and smelting ores, of a combustion-chamber arranged in the base of the stack

and delivering into the same below the boshes, said combustion-chamber having its interior obstructed by a checker-work of refractory material, and its diameters gradually increasing from its receiving to its delivery end, and an air and a gas supply pipe delivering into the combustion-chamber, substantially as and for the purposes specified.

3. The combination, with the air-blast pipe having a contracted outlet, of the gas or vapor supply pipe having a protuberance upon its extremity and centered with the contracted outlet of the air-supply pipe, substantially as and for the purposes specified.

4. The combination of the air-pipe having a contracted outlet, and a gas or vapor pipe having a protuberance at its extremity, which is centered with the contracted outlet of the air-pipe and perforated in spiral lines back of the protuberance, substantially as and for the purposes specified.

5. The combination, with a stack for reducing and smelting ores, of a combustion-chamber arranged in the base of the stack and delivering into the same below the boshes, said combustion-chamber having its interior obstructed by a checker-work of refractory material, and having its diameters increasing gradually from its receiving end to its delivery end, a delivery-chamber interposed between the combustion-chamber and hearth, which delivery-chamber gradually decreases in diameter from its receiving end to its point of discharge into the hearth of the stack, and air and gas supply pipes delivering into the

combustion-chamber, substantially as and for the purposes specified.

6. The combustion-chamber having the form of a frustum of a cone, and having its interior interrupted by a series of cruciform bricks or tiles of refractory material, substantially as and for the purposes specified.

7. A combined combustion and delivery chamber which tapers from the center in both directions and has its interior obstructed by a series of cruciform bricks, whereby the products of combustion are first permitted to expand, and then compressed and forcibly delivered, substantially as and for the purposes specified.

8. The combination of stack A, combustion-chamber C, having its interior obstructed by refractory checker-work and arranged in the base of the stack, so as to deliver into the hearth thereof below the boshes, air and gas supply pipes delivering into the combustion-chamber, and a supplemental air-blast pipe which delivers into the hearth or the combustion-chamber near the hearth and below the boshes, substantially as and for the purposes specified.

In testimony whereof we affix our signatures, in presence of two witnesses, this 7th day of September, 1883.

JOHN TYLER MORGAN.

HENRY FRANKLIN HAYDEN.

JOHN HARDIE MORGAN.

Witnesses:

C. O. L. DILLAWAY,

J. HINCKLEY, Jr.