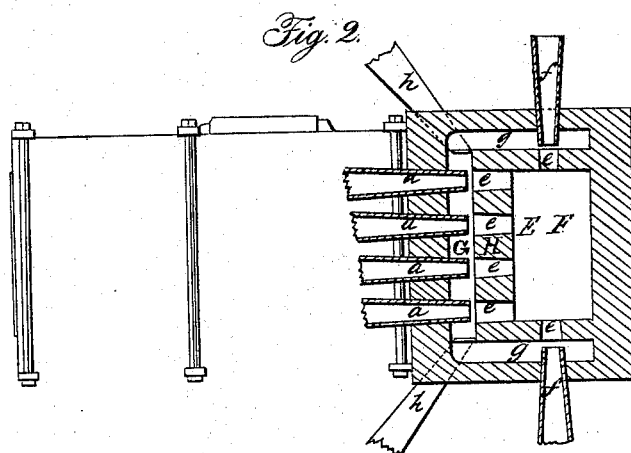
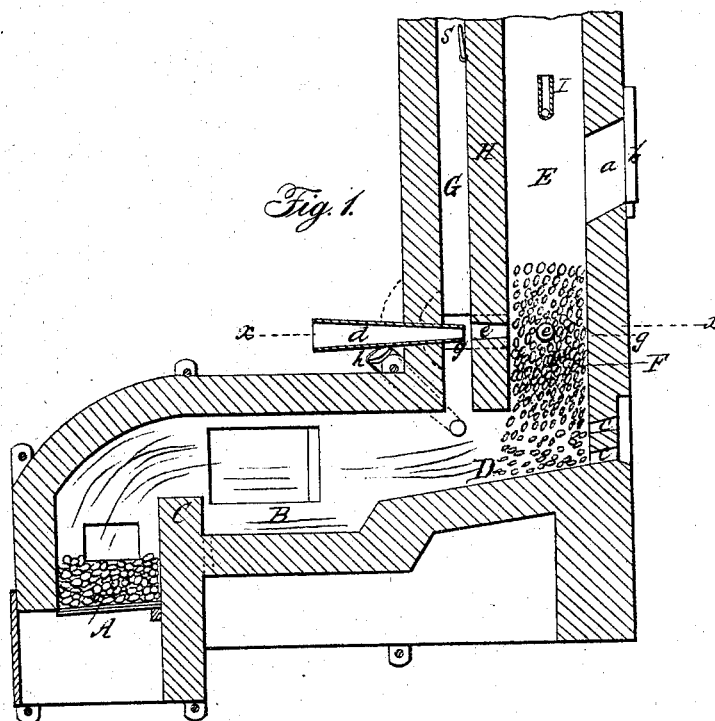


H. BOARDMAN.

Making Wrought-Iron Direct from Ore.

No. 48,478.

Patented June 27, 1865.



Witnesses:

*Henry T. Brown*

*A. F. Schlegel*

Inventor:

*H. Boardman*

# UNITED STATES PATENT OFFICE.

HORACE BOARDMAN, OF NEW YORK, N. Y., ASSIGNOR TO HIMSELF AND KELLY, DE MILT & CO., OF SAME PLACE.

## IMPROVEMENT IN THE MANUFACTURE OF WROUGHT-IRON FROM THE ORE.

Specification forming part of Letters Patent No. 48,478, dated June 27, 1865.

### *To all whom it may concern:*

Be it known that I, HORACE BOARDMAN, of the city, county, and State of New York, have invented a new and useful Improvement in the Manufacture of Wrought-Iron Directly from the Ore; and I do hereby declare that the following is a full, clear, and exact description of the same, reference being had to the accompanying drawings, forming part of this specification.

This invention consists in the construction of a smelting or reducing fire, in combination with a gas or combustion-chamber, with tuyeres for admitting atmospheric air, and provided with openings in the division-wall between the reducing-fire and a gas or combustion chamber, so arranged as to permit the ignited gases at a high temperature to act directly upon the ore while it is in contact with the carbonaceous fuel within the reducing-fire, the gases being at the same time aided in their passage through the openings in the division-wall by a vacuum in the upper portion of the reducing-fire, by means of a steam-jet or any equivalent device, of which there are many, to effect this result.

It also consists in combining this smelting or reducing fire with a reverberatory furnace and a balling-hearth, so that the converted ore in a metallic state can be separated from the cinder or slag and be balled, ready for the shingling-hammer, while the escaping gases from the grate of the reverberatory furnace, having been applied to heat the balling-hearth, are then conveyed to the gas-chamber, and after receiving a second portion of oxygen are made to aid in smelting and deoxidizing the ore, thus greatly reducing both the consumption of fuel and the labor in the process of making wrought-iron.

Figure 1 is a longitudinal vertical section, showing the means of carrying out my invention applied to a reverberatory furnace, substantially such as is commonly used for balling iron. Fig. 2 is a horizontal section in the plane indicated by the line *x x*, Fig. 1.

Similar letters of reference indicate corresponding parts in both figures.

A is the grate at one end of the reverberatory furnace, and separated from the balling-hearth B by the bridge-wall C in the usual manner.

At the opposite end of the balling-hearth to that at which the grate A is arranged there is a second hearth, D, which is elevated above and inclined downward toward the balling-hearth.

Above the rear end of the hearth D is the reducing-fire F, communicating with a chamber, E, above and in front of the said fire and chimney, and nearer to the balling-hearth is the upright gas chamber G, separated from the reducing-fire F and chimney E by a partition-wall, H. The chimney E and chamber G may be of any height necessary to obtain a proper draft, and the chamber G is furnished at the top with a damper, S.

Into the upper part of the chimney E there is introduced a steam-pipe, I, for the introduction of a jet of steam, to create the necessary draft in the reducing-fire without making it of great height. In the back of the chimney E, at a suitable height, there is an opening, *a*, for the introduction of the ore and the fuel necessary for its deoxidation and reduction, said opening being furnished with a shutter, *b*, which is only opened for the introduction of the ore and fuel. In the lower part of the back of the reducing-fire there are suitable working-holes, *c c*.

At a short distance above the top of the reverberatory furnace any suitable number of tuyeres *d d*, connected with a blowing apparatus, are inserted into the front wall of the gas-chamber G, opposite to holes *e e* in the partition-wall H. On a level with these tuyeres passages *g g* are formed in the side walls of the reducing-fire F, communicating with the chamber G, and into these passages are inserted tuyeres *f f*, opposite to holes *e' e'*, which, like *e e*, communicate with the reducing-fire F. Just below the chamber G tuyeres *h h* enter the furnace in an oblique direction, pointing toward the lower part of the reducing-fire. The tuyeres *d d*, *f f*, and *h h* may be all supplied with air from one blowing apparatus.

The operation is as follows: Coke, charcoal, or bituminous coal is introduced through the opening *a* and piled up on the back part of the hearth D and until it fills the reducing-fire F up to the holes *e e'*, and above this point the fire is filled up nearly to the opening *a* with ore and fuel, mixed or in alternate layers, the ore being pulverized or broken into small pieces.

The shutter *b* is then closed. Fire is made and lighted in the grate *A* to heat the reverberatory furnace, and the fuel in the reducing-fire *F* ignited. The fuel in the fire *F* serves the two purposes of holding up the ore in a position to be acted upon by the gaseous products of combustion from the grate *A* to act upon it, and also supplying carbon to operate in connection with said gases upon the ore while all are at a high temperature. While a portion of the highly-heated gases from the fire *A* passes up through the fuel and the ore in the fire *F*, the remainder passes up into the chamber *G*, where it is met by the jets of air from the tuyeres *d d*, and the combustible portions thereby ignited, and a part of them carried with the air through the holes *e e'* into the reducing-fire, and thus by intensifying the heat of the said fire made powerful aids in both deoxidizing and melting the ore. Fresh ore and fuel are supplied from time to time through the opening *a* as the volume of the ore and fuel previously introduced diminishes. The air introduced by the tuyeres *h h* meets any portion of the unconsumed fuel that may come down with the ore, and its action upon this and the gases passing off from the reverberatory furnace intensifies the heat at this point and also assists in forcing the said gases into the reducing-fire.

The working-holes *c c* at the bottom of the reducing-fire enable a workman, with a suitable implement, to move forward the stock toward the balling-hearth *B* as fast as it arrives in a deoxidized and melted state upon the hearth *D*, and to work down the ore from above.

The deoxidized and melted ore is pushed forward along the hearth *D* to the balling-hearth *B*, on which the balling process is conducted, in the usual manner.

It may be desirable to enlarge the chamber *G*, as shown in red lines in Fig. 1, at the point where the tuyeres *d f* are inserted, in order to provide for the ignition, by the air entering from the tuyeres, of the gases passing up the said chamber-flue *G* before they enter the fire *F*.

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

1. The reducing-fire *F*, combined with the gas-chamber *G* and its tuyeres, substantially as described, for the purpose set forth.

2. The combination and arrangement of said reducing-fire with a reverberatory furnace and balling-hearth, in the manner described, so that escaping combustible gases from the said furnace or hearth can be used, when ignited by blasts of atmospheric air, for deoxidizing and smelting the ore in the said reducing-fire, as herein set forth.

3. Subjecting the ore in a reducing-fire while mixed or in contact with carbonaceous fuel to the action of the escaping gases from the fire on the grate *A*, the gases being ignited by the introduction of atmospheric air, substantially as herein described.

H. BOARDMAN.

Witnesses:

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