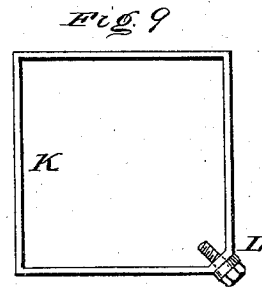
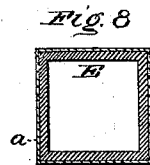
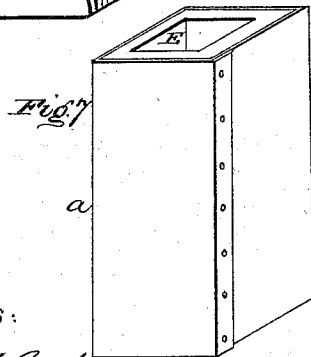
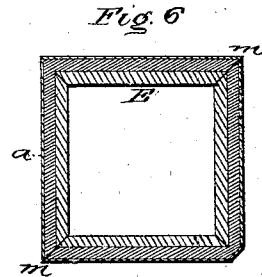
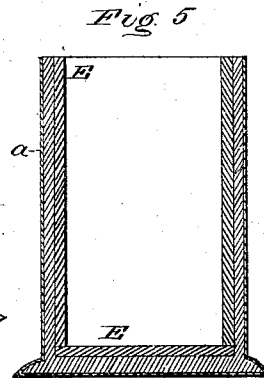
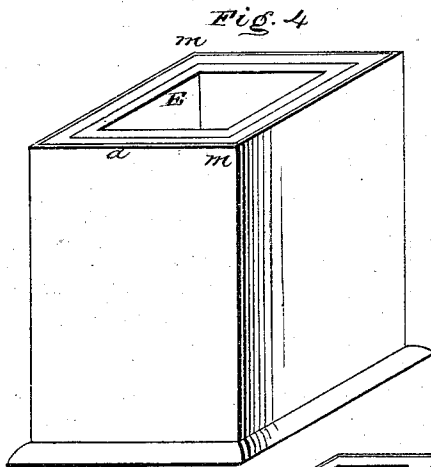
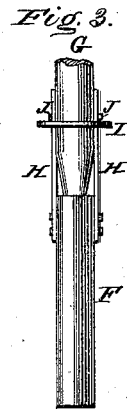
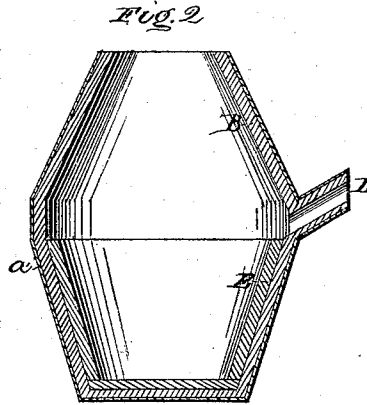
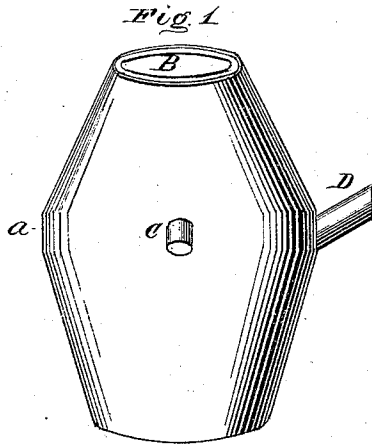


W. BUSHNELL.

Manufacture of Iron and Steel.

No. 147,819.

Patented Feb. 24, 1874.



Witnesses:

John Bushnell
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Inventor:

William Bushnell

UNITED STATES PATENT OFFICE.

WILLIAM BUSHNELL, OF NEW YORK, N. Y.

IMPROVEMENT IN THE MANUFACTURE OF IRON AND STEEL.

Specification forming part of Letters Patent No. **147,819**, dated February 24, 1874; application filed January 14, 1874.

To all whom it may concern:

Be it known that I, WILLIAM BUSHNELL, of the city of New York, in the State of New York, being aware that various attempts have heretofore been made to convert crude cast-iron into wrought-iron and into steel, by combining with it, when in a molten state, iron ore and other oxygen-bearing substances, have been led to investigate and endeavor to ascertain why those attempts have not been successful, and the result of my investigation is the discovery—

First, that in order to insure success in the use of iron ore as a decarbonizing agent in such a process, the ore must, while in contact with the molten metal, be sufficiently reduced or smelted to set free and combine its oxygen with the carbon of the iron, and thereby form a carbonic oxide, and thus decarbonize the crude iron to the requisite extent to convert it into wrought-iron, or into steel, as may be desired; second, that, to accomplish this purpose, the temperature of the molten cast-iron must be fully maintained while it is acting upon and reducing the iron ore; and, also, in order to maintain the requisite fluidity of the molten cast-iron, as decarbonization progresses, the temperature must be proportionally increased, or the mass of combined iron and ore will become pasty and adhesive in its nature, and thus render the pouring or discharging of it from the decarbonizing-vessel a difficult if not an impossible task; third, that it is utterly impossible to maintain the temperature of the molten cast-iron if it be poured or drawn into vessels or molds made wholly of iron, or lined with any ordinary refractory material, without the addition of fuel, or of atmospheric air, as in the bessemer process; and, to introduce within the decarbonizing-vessel or mold either mineral coal or charcoal will, of course, defeat the conversion of the cast-iron into wrought-iron or into steel, because of the excess of carbon which the coal will impart to the molten iron; fourth, I have discovered and invented the means of overcoming the difficulties above named, and have thereby made an important improvement in the manufacture of iron; and I hereby declare the following to be a full description and specification of my said discovery and invention,

reference being had to the accompanying drawing making a part and parcel of this specification, in which—

Figure 1 presents an external view of a vessel to be used for converting large charges of crude molten iron into wrought-iron, or into steel, and which I call a decarbonizing and purifying vessel. Fig. 2 represents a vertical section of the same vessel, showing the outer casing or shell, letter A, the fire-brick lining, letter B, and the wooden lining, letter E. Fig. 3 represents a blast or blow pipe, the lower portion of which, letter F, is made of wood, and the upper portion, letter G, being made of iron. Fig. 4 represents a smaller decarbonizing-vessel or bloom-mold, made of cast-iron, letter A, with a wooden lining, letter E. Fig. 5 represents a vertical section of the same vessel or bloom-mold, showing more clearly the bottom and side lining, letters E E. Fig. 6 represents a transverse horizontal section of the same vessel or bloom-mold, showing how simply and firmly the wooden lining, letter E, may be fitted in the vessel. Fig. 7 represents another small decarbonizing-vessel or bloom-mold, made of common sheet-iron and lined with wood, in same manner as Fig. 4. Fig. 8 represents a transverse horizontal section of the same small sheet-iron vessel or bloom-mold, showing more distinctly the wooden lining, letter E. Fig. 9 represents an iron band, intended for clamping and binding the two halves of the cast-iron vessel, Fig. 4, together when in use.

Similar letters of reference indicate corresponding parts in all the figures.

The outer casing or shell of the large decarbonizing and purifying vessel, Fig. 1, and which is intended for converting large charges of molten cast-iron into wrought-iron, or into steel, I make of boiler-plate, properly fashioned, and well riveted together. The smaller vessel or bloom-mold, Fig. 4, I make of cast-iron, and make it in two equal vertical sections, the dividing line being through opposite diagonal corners, as represented in letters *m m* in Figs. 4 and 6, this division of the vessel being intended to facilitate the removal of the bloom when properly converted from crude iron, and sufficiently cool to be put under the hammer or for reheating; not confining myself,

however, to any particular shape or form of mold, but I make them square, round, or oval, as may be found best adapted for the purpose designed. These cast-iron vessels are intended for making any desired size and weight of blooms, from one hundred pounds to one thousand pounds, or more, and must be made heavy and strong, capable of being used a great many times.

The small sheet-iron vessel or bloom-mold, Fig. 7, is intended for producing but a single bloom of ordinary size and weight; wherefore, in its construction I use common sheet-iron, properly seamed or riveted together.

The shell or casing of the large decarbonizing-vessel, Fig. 1, I line, first, with a fire-brick lining, letter B, and within such lining I place a wooden lining, letter E, of from one to three or more inches in thickness, according to the comparative fire-resisting qualities of the wood used.

The smaller vessels or bloom-molds, Figs. 4 and 7, I line with wood only, and use such thickness thereof as may be best suited to the precise character or quality of the product sought for.

The large decarbonizing and purifying vessels I arrange so that they may be handled and moved with the aid of a crane, or other labor-saving or assisting device; and so arrange them that they may be tipped or tilted at any necessary angle for receiving the crude molten metal, and for pouring out from the spout D, or discharging from the upper end of the vessel the converted metal into molds or forms, or upon heavy fluted or grooved cast-iron plates, the flutes or grooves of such plates being of sufficient width and depth to divide and form the mass of converted metal, while it is still liquid or semi-liquid, into ingots or blooms suitable for reheating, or for passing directly through the squeezers, or under the hammer, or through the rolls, as may be desired. The cast-iron vessels or bloom-molds, Fig. 4, may be arranged with a ring or staple cast into the upper end of each of the two divisions, which will facilitate the handling of them. The small sheet-iron bloom-molds need not be provided with any special means for handling, as they are intended to retain the decarbonized and converted metal until it is sufficiently cool to pass the mass, the vessel itself included, into the squeezers or under the hammer, or the mass may be laid by for reheating. The cooling of these molds and their contents may be accelerated by dashing the outside with water when the lining shall be nearly or quite burned out.

The blast or blow pipe, Fig. 3, is more especially designed for use in the large decarbonizing and purifying vessels; but it may also be used to great advantage in converting the charges in the smaller vessels from cast-iron into wrought iron, or even into steel, as, by its use, much less solid decarbonizing matter will be required to make the conversion, and a purer metal will consequently be produced.

It may also be used for converting the molten cast-iron into wrought-iron or into steel, without the addition of any solid oxygen-bearing substance, substantially as in the bessemer process. The wooden part of this blow-pipe I make of any good sound stick of timber of suitable size, by boring a hole longitudinally through its center, as for an ordinary pump-log, graduating the size or diameter of the bore according to the quantity and force of blast I intend to pass through it. The bore in the upper end of this pipe I ream out in a flaring shape, so that the lower end of the iron pipe, letter G, by being cast tapering, may be readily thrust into it and make an air-tight joint, as shown in Fig. 3. The two portions of the blow-pipe are then, when prepared for use, firmly anchored together by means of the iron straps H H, which are properly spiked or fastened to the wooden pipe, and which pass upward and through the flange, letter i, of the iron pipe, and are there keyed fast by the keys J J.

The object of using a wooden blow-pipe is, of course, the same as in using a wooden lining in the vessels and molds—to preserve, and, if possible, to increase the temperature of the liquid metal. The wooden lining and the wooden part of the blow-pipe will necessarily be destroyed in converting a single charge of molten cast-iron, but the expense of such lining and such blow-pipe is very trifling in comparison with the advantages gained by their use.

The mechanical arrangements for commencing the converting of iron being completed, and the ore being properly prepared and crushed to a size not coarser than ordinary grains of buckwheat, (the finer the better,) I charge the large decarbonizing and purifying vessel with the proper quantity of molten cast-iron, drawn direct from a blast-furnace or from a cupola-furnace, and at same moment insert the wooden blow-pipe vertically in the liquid metal, carrying the lower end of the pipe down to within a few inches of the bottom of the vessel, and apply the blast with a force and pressure sufficient to overcome the specific gravity of the liquid iron, and to force the air out among the particles of, and up through the surface of, the iron, and at same moment commence gradually introducing into the vessel, and commingling with the molten crude iron, such quantity of the prepared iron ore as may be necessary, in connection with the blast of atmospheric air, to decarbonize and convert the crude iron into wrought-iron, or into steel, as may be desired. A small portion of the iron ore intended to be used in the charge may be deposited in the bottom of the vessel before charging it with the molten cast-iron, and the balance introduced as first stated.

The object of combining a blast of atmospheric air with the iron ore, in this decarbonizing and converting process, is for the double purpose of increasing the temperature of the liquid metal as decarbonization progresses,

and for assisting, by means of its oxygen, such decarbonization, and consequent conversion of the mass of crude iron and iron ore into wrought-iron and into steel, as may be desired.

Substantially the same procedure will apply to the conversion of molten cast-iron into wrought-iron blooms in the smaller vessels, Figs. 4 and 7, in case the blow-pipe is used in them; but in case it is not used, then an extra percentage of iron ore will be required to perfect such conversion. The blast of air, in the large vessels, will sufficiently incorporate and mingle the iron ore with the crude iron, without other device. But when the blast is dispensed with, in the smaller vessels, it will be needful that the ore shall be commingled with the iron by means a small wooden rabble; or a small wooden paddle will answer.

No precise weight or percentage of iron ore can be fixed upon for use in all cases in this process, because of the variable percentage of oxygen found in different ores; but, as an approximation, it may be stated that of or-

dinary magnetic oxide of iron, yielding from sixty to sixty-five per cent. of metallic iron, from twenty-five to thirty per cent. may be advantageously used in converting molten cast-iron into wrought-iron, and from ten to twenty per cent. for converting the same grade of molten cast-iron into an ordinary steel.

Having thus described my invention and improvement, what I claim as new, and for which I desire to secure Letters Patent, is—

1. Wooden-lined vessels and molds for improving, purifying, and refining molten crude iron, and for converting the same into wrought-iron and into steel.

2. A wooden blast or blow pipe, for conveying and blowing a blast of atmospheric air into molten crude iron, as and for the purposes herein specified.

WILLIAM BUSHNELL.

Witnesses:

JOHN J. BUSHNELL,
T. D. BUSHNELL.