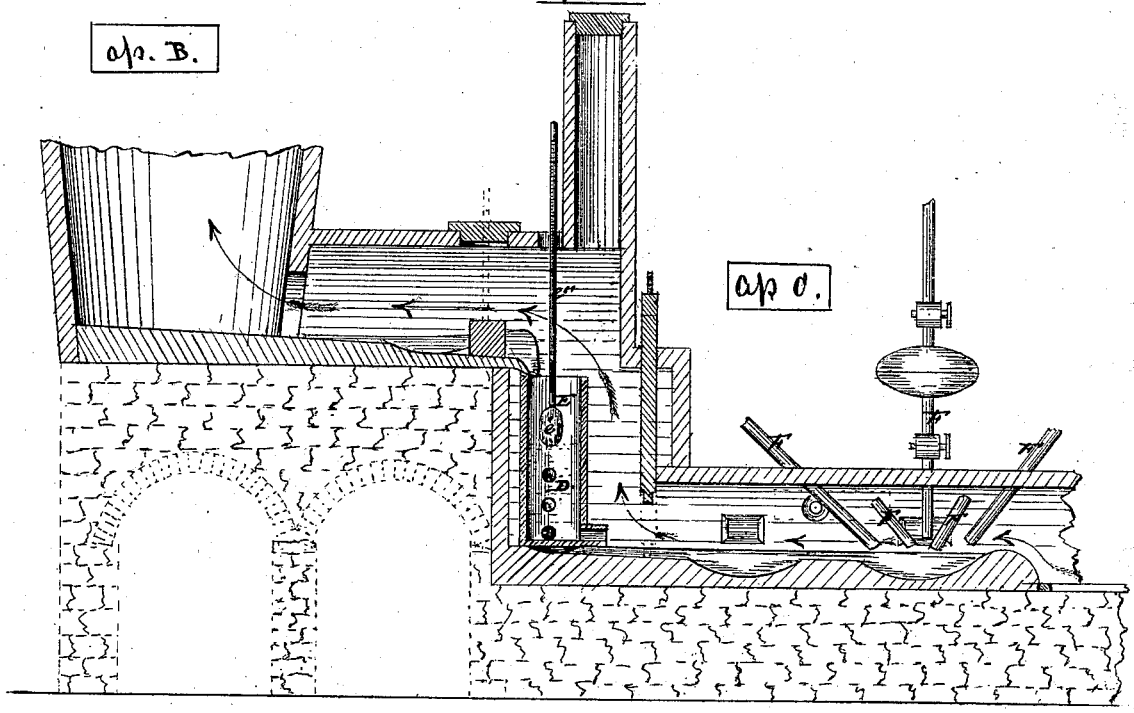
J. W. MIDDLETON.

3 Sheets—Sheet 1

ART OF PRODUCING REFINED IRON AND STEEL FROM THE ORE.

No. 110,990. Patented Jan. 17 1871.

Fig. 1.



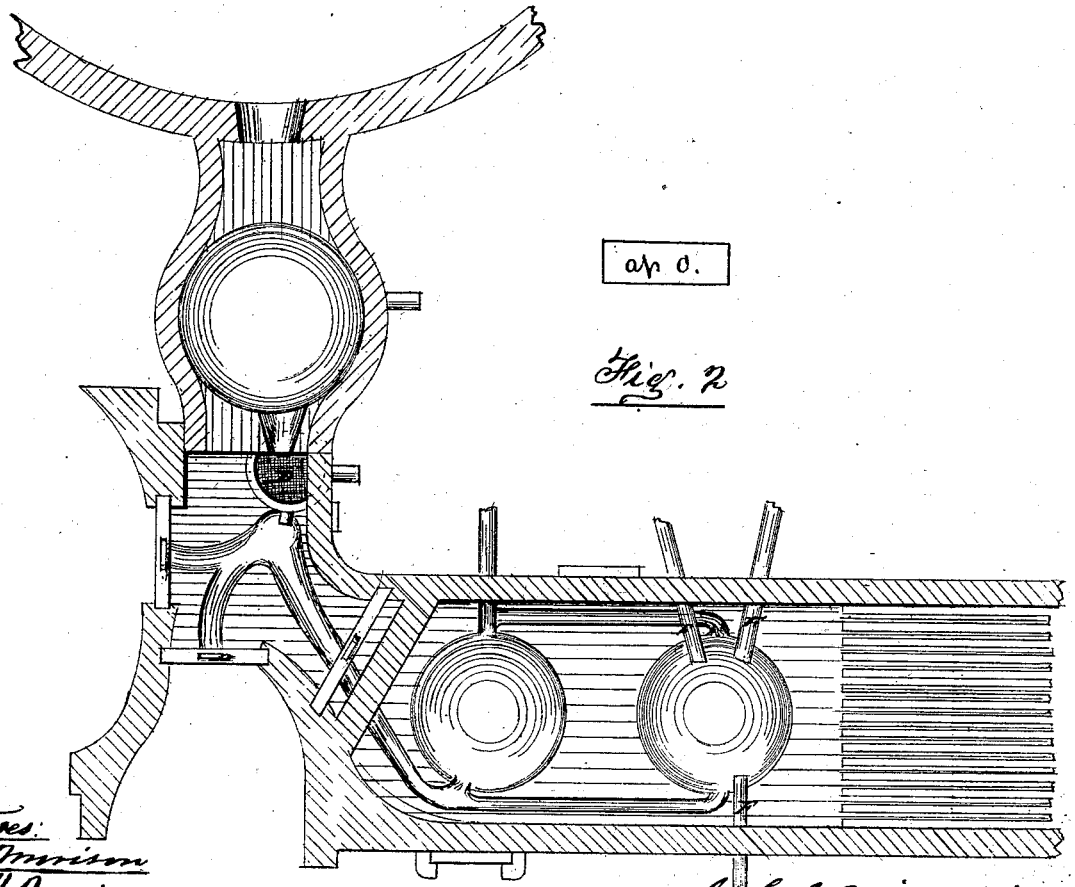


Fig. 2

Witnesses:
Thos Morrison
Wm H. Morrison.

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3 Sheets—Sheet 2.

J. W. MIDDLETON.

ART OF PRODUCING REFINED IRON AND STEEL FROM THE ORE.

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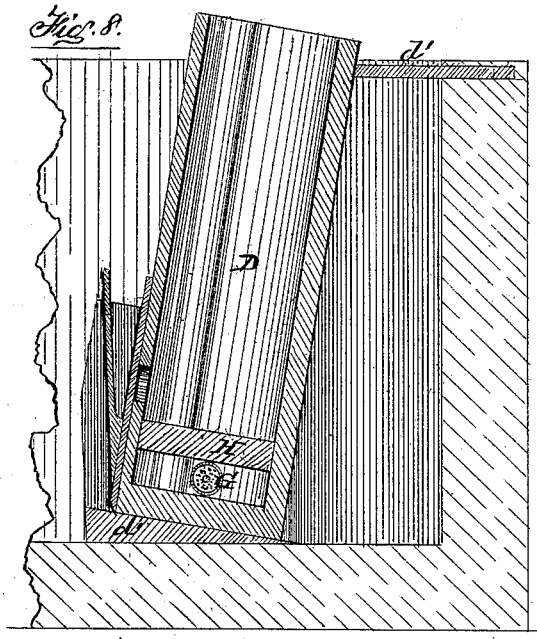
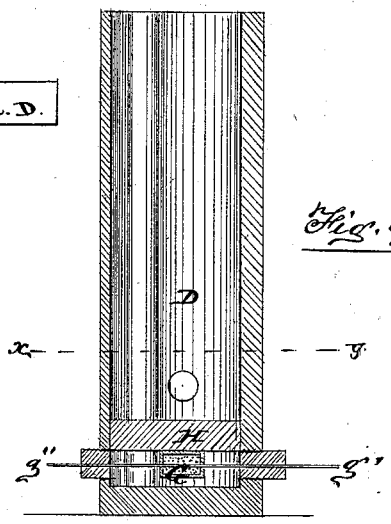
Fig. 8.



a|s. D.

Fig. 9



a|s. D.

Fig. 11.

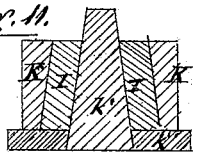


Fig. 10.

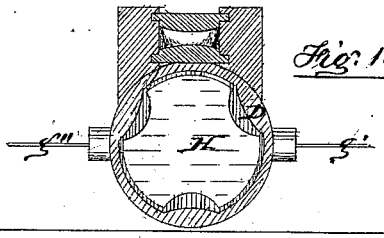


Fig. 3.

a|s. A.

Fig. 4

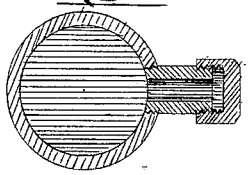
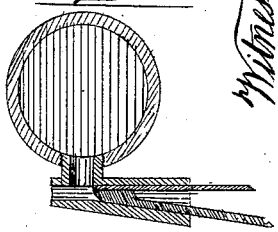


Fig. 5.



Witnesses:

Inventor— John W. Middleton

3 Sheets—Sheet 3.

J. W. MIDDLETON.

ART OF PRODUCING REFINED IRON AND STEEL FROM THE ORE.

No. 110,990. Patented Jan. 17. 1871.

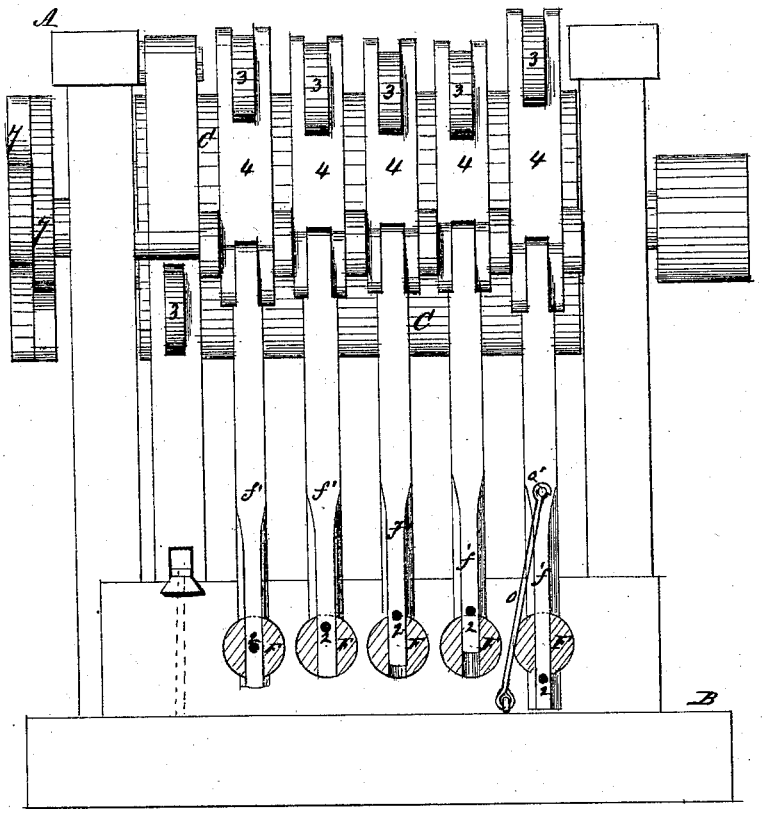


Fig. 6.

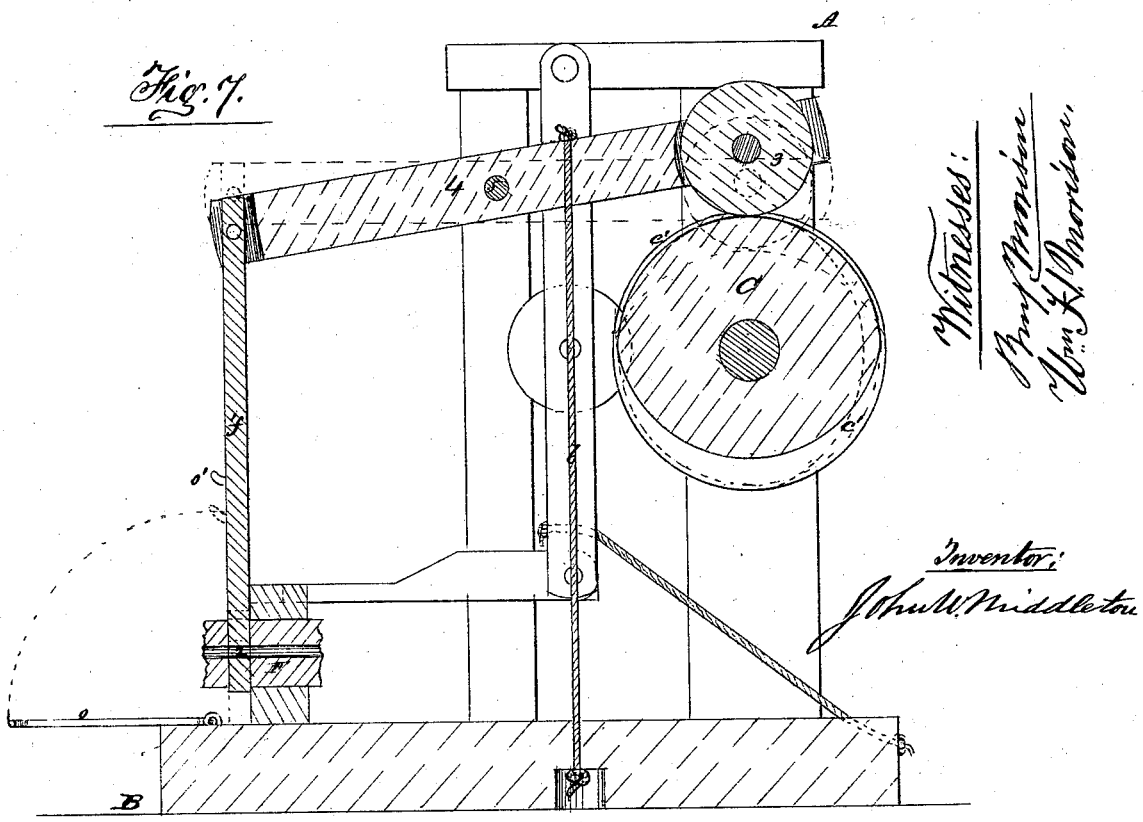


Fig. 7.

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Wm. H. Morrison.

Inventor:
John W. Middleton

United States Patent Office.

JOHN W. MIDDLETON, OF PHILADELPHIA, PENNSYLVANIA.

Letters Patent No. 110,990, dated January 17, 1871; antedated January 8, 1871.

IMPROVEMENT IN PRODUCING REFINED CAST-IRON, STEEL, AND MALLEABLE IRON.

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

I, JOHN W. MIDDLETON, of the city and county of Philadelphia, in the State of Pennsylvania, have invented certain Improvements in the Art of Producing Refined Cast-Iron, Steel, and Malleable Iron direct from the ore-reducing furnace by one continuous operation, and in the Apparatus therefor, of which the following is a specification.

Nature and Objects of the Invention.

My present invention relates back to three prior applications now before the Patent Office, the first one of which was "allowed" on the 8th day of April, the second on the 25th day of March, and the third "filed" on the 25th day of March, all in the year 1870; and for brevity in referring herein to the same, I propose to indicate them respectively by the letters A B C, the present being application D, as all of the processes and apparatus therein and herein described are intended to be connected, and thus to constitute the one continus series of operations and apparatus, for the purposes specified.

The first part of my present invention relates back to application C, and consists of an apparatus to be put in connection with the tuyere-pipes F F, shown in said application C, (see figs. 1 and 2 of the herewith accompanying drawing,) and operated so as to open and close the communication between a main blast-pipe and the respective tuyeres in the sudden or quick periodical manner described in the said application C.

The second part of my present invention relates back to application B, and consists in the employment of a floating metallic indicator within the vessel D of said application B, (see the herewith accompanying drawing, fig. 1,) said indicator to be of such specific gravity and construction as to sink down through the slag and scoria, and float upon the fluid metal beneath, in the said vessel D, the object of said floating indicator being to show the height of the top surface of the metal in the said vessel.

The third part of my present invention relates to the employment, on the bottom of a deep vessel containing melted iron, of a disk of porous burnt clay, saturated either with hydrocarbons, acid, or alkaline solutions or water, and confined in the bottom of said vessel, so that when the melted iron is run into the said vessel the heat of the said iron will gradually expel the substances previously absorbed by the said clay disk, and thus cause them to pass upward through the melted iron, the object of this part of my invention being to subject the melted iron to the gradually and slowly-developing exhalations of the disk, in order that sufficient length of time be afforded for the chemically-purifying action of the same upon the impurities in the melted mass of iron in the vessel.

The fourth part of my present invention relates to the employment of a torpedo or torpedoes in a suitable case or cases, containing chemical reagents, and secured firmly on the bottom of a deep vessel containing melted iron, the said cases being also in connection with respective conducting-wires, so that the said torpedoes can be exploded separately or in succession, when desired, and the reagents contained in the respective cases liberated, the object of this part of my invention being to apply sudden and rapidly-acting purifying reagents to the melted iron in the vessel, as the presence of any particular impurities may require.

Description of the Accompanying Drawing.

Figures 1, 2, 3, 4, and 5 represent the apparatus described in the prior applications referred to herein as applications A B C, and, therefore, need not be further explained herein.

Figure 6 is a front view of the apparatus, herein described, for opening and closing the series of tuyeres described and represented by the drawings in application A.

Figure 7 is a vertical transverse section of fig. 6.

Figure 8 is a vertical section, representing one of the vessels for receiving the melted metal, as insulated by means of glass supports in a heated chamber or oven, and provided with the small torpedo and electric conducting-wires, and the disk of clay and carbon.

Figure 9 is a vertical section of the vessel in fig. 8, cut in a plane at right angles to the said figure.

Figure 10 is a horizontal section of the said vessel below the dotted line $x\ y$ of fig. 9.

Figure 11 is a vertical central section of the hollow ingot of iron or steel, and the mold in which it is cast.

General Description.

The apparatus represented by figs. 6 and 7 consists of a frame, A B, of any suitable construction, through the lower part or base of which the series of tuyere-pipes F F pass, in connection with suitable enlargements or bosses, each having a large smooth cylindrical or otherwise-shaped opening through it, and cutting the bore of the tuyere-pipe transversely.

Into each of these openings a stem, f' f', having a hole, 2, corresponding with the bore of the tuyere-pipe, is adjusted to slide, so that the passage-way for the air or gas to be forced, under pressure, through the respective pipes F F, may be suddenly closed and opened alternately by the movements of the said stems f'.

The required movements of the said stems f' are effected by means of a rotating cylinder, C, provided

with a series of transverse grooves, *c' c'*, corresponding in number with the tuyere-pipes F, and in each of which grooves a friction-wheel, 3, rolls, (as the said cylinder rotates,) its axis being in the end of a lever, 4, of the first clsss, which is supported upon its fulcrum, 5, and its weight end articulated to the stem *f'*, which fits in the boss of the tuyere-pipes.

Each of the grooves *c'* in the cylinder is varied in its depth, so as to produce or serve as an eccentric, which will cause the stem *f'* to be moved so that its hole 2 will be periodically and suddenly brought into juxtaposition with the bore of the tuyere-pipe F, and thus open and close alternately the passage-way for the air or gas into the puddling-furnace to which the apparatus is to be applied, the suddenness or quickness of the opening and closing of the bore of the tuyere-pipe being in accordance with the velocity at which the grooved cylinder C is rotated.

For the purpose of keeping the friction-wheels 3 of the respective levers 4 4 in close contact with the cylinder C, their power-ends of the said levers may be weighted, or a suitable spring, 6, (see fig. 2,) may be attached in preference, as a spring will act more quickly.

The eccentrics in the grooves are intended to be arranged respectively, so as to open and close the tuyere-pipes of the series in succession, or two, three, or more of them simultaneously, and, in cases where the eccentric would, by its length, too long protract the movement of the stems *f'*, two or more toes or lifters, 7, may be substituted, and the strength of the spring 6 increased so as to cause the said stems to open and close the tuyere-pipes with the greatest available velocity the occasion may require. Any of the stems may be held down out of its connection with the operating cylinder C by means of a tension-rod, *o*, which may be readily hitched over the hook or pin *o'* in the stem.

The floating indicator E (see fig. 1) consists simply of an egg-shaped or globular body, *e'*, and a stem, *e''*, of thin sheet-platina filled solidly with cast-iron, and the stem marked in regular divisions to indicate the position or depth of the surface of the melted metal in relation to the top edge of the vessel D containing them, so that the attendant can readily ascertain the quantity of metal which may be at any time below the slag or scoria.

The small torpedo G, and its attached wires *g' g''*, (see figs. 8, 9, 10,) are constructed and applied at the bottom of the vessel, insulated (by glass supports *d' d'*) in a suitable oven, so that an electric spark will be discharged within the torpedo on the passage of a current of the electric fluid from a suitable battery, and thus, by explosion of the torpedo, remove its necessary protective covering of clay, further separate the wires *g' g''*, and permit the electric current to pass continuously upward through the mass of melted iron in the insulated vessel so long as its action may be required.

The disk H, of compacted clay and carbon, and also the porous burnt brick or disk (to be saturated or impregnated either with water, hydrocarbons, acid, or alkaline fluids) are intended to be prepared beforehand, and the required one securely fixed on or near the bottom of the inside of the purifying vessel, so that when the melted iron is run into the latter the heat thereof will gradually liberate the carbon from the clay in the one case, or the hydrocarbons, water, acid, or alkaline solutions, or other volatile or vaporizable substances, from the porous burnt disk or brick in the other case, and thus permit the products of either to pass gradually upward through or into the mass of melted metal above.

After the malleable iron has been purified, refined, or recarburetized in the said vessel, it is intended either to be immediately conveyed to the squeezer, and then to the rolls and elongated into bars, or by increasing the heat, run into molds which will form it into solid ingots of the T, H, L, U, or V, or other solid forms, or into hollow conical frustums, to facilitate by said forms the production of railway rails or hollow shafts or bars by elongating the ingots between rolls for the purpose.

In fig. 11—

I represents a half-section of the hollow conical ingot, cut longitudinally;

K, the shell of the mold in which it is cast;

k', the removable base of the mold; and

k'', the removable core.

When the ingot has become sufficiently set, the core *k''* can be readily knocked out, the base *k'* removed, and the ingot released by separating the halves of the shell K, made in two separable parts for the purpose.

My "improvements in the art of producing refined cast-iron, steel, and malleable iron, and forming the same into either first quality castings or bars, or ingots to be elongated into bars by rolls or otherwise, direct from the ore-reducing furnace by one continuous operation and in the apparatus therefor," commences with the processes and apparatus described in my former applications A B C, and concludes with the process and apparatus herein described and set forth; and, for the purpose of rendering the whole more clear as a unity, I will proceed to describe, briefly, the whole operation from the ore-producing furnace to the rolls.

Beginning at the ore-reducing furnace, the melted iron and slag run from an inclined or level hearth in a gutter less inclined into a first pool, which allows the coarser slag to run off by a suitable side gutter in one direction, and the remaining iron and slag flow another suitable gutter provided with a removable adjustable stop, to run into a vertical stationary removable reservoir, in which the said iron and are allowed to separate by gravitation, and the iron be afterward withdrawn for castings, if desired; or, by a continuation of the gutter into a pool or pools inside of a puddling, refining, or boiling furnace, and decarburetized therein by means of the heat of the furnace thereof in combination with the agitating and kneading operation of the powerful jets of hot air or gases, either with or without chemically-acting powders ejected by sufficient pressure upon a main through the tuyere-pipes, (described in application C, and represented by figs. 1 and 2 in the present application,) governed by a suitable apparatus operating cut-off valves in the series of tuyere-pipes, substantially as herein described, and represented by figs. 6 and 7; and when decarbonized and (if necessary, still more highly heated) run into molds which will form it into ingots suitable in form for immediately elongating between rolls adapted for railway or other solid bars, or into hollow ingots by means of the mold represented in fig. 11, for being immediately elongated into hollow shafting or bars between suitable rolls.

But if further purification be first desired, or the iron be required to be recarburetized or converted into steel, it is run from the pool directly into the insulated vessel D, (see figs. 8, 9, 10,) and subjected accordingly either to the action of electricity and the chemical action of the impregnated porous burnt brick or disk, or, if steel be desired, to the carburetizing action of the carbon liberated from the condensed block or disk H of clay and carbon previously described herein, and thus run into the ingot-molds, and finally elongated between the rolls.

The carboniferous block or disk H should be of such a thickness and area as will furnish the specific amount of carbon required for the particular quantity of iron

in the carburetizing vessel D. This mode of recarburetizing the purified melted iron is believed to be more certain in respect to the proper amount of carbon to be furnished to the iron for converting it into steel than that of adding "speigelisen," as adopted by Bessemer.

The whole passage-way from the grate-bars of coal-furnace and blast-pipes to the blast-furnace should be so constructed as to be readily made air-tight, and especially so to keep the receiving-vessel D therein sufficiently heated.

Adjustable windows or peep-holes are intended to be arranged at different places, to enable the manager or workman to observe the operations going on in the furnace when the blast is shut off, and at other times when practicable.

Several different-sized or shaped furnaces for decarburetizing or otherwise purifying the iron, or for the special purpose of heating the blast and intensifying it before it enters the ore-reducing blast-furnace, are intended to be located and connected with it, either singly or in gangs, thus diminishing the quantity of fuel usually put into the tunnel-head.

Particular care should be taken in the application of all the doors or openings, so that they may be readily made perfectly air-tight when desired.

The jet of air or gas must be driven through the tuyere-pipes E suddenly, and with sufficient force to drive through the metal to the very bottom of the pool, in whatever direction intended, and the duration of each jet controlled from one-tenth of a second to any length of time that experience may determine as the most suitable.

During the foaming condition of the fluid metal ng decarburetized in the pool under the action of jets of air or gas, the ends of the tuyeres will be der the metal, and therefore the distance between the said end and the cut-off valve should be as short and straight as possible, and special care should be taken in adjusting the directions of the several tuyeres so that full rotary motion of the fluid metal around the center of the pool may be effected as well as the transverse action on the same.

Several air-pressure gauges are intended to be applied at different parts of the passage-way, to enable the manager or workmen to judge of the propriety of increasing or diminishing the quantity of air or gas passing through the same.

Claims.

I claim as my invention—

1. An apparatus for opening and closing a series of tuyere-pipes connected with a puddling, boiling, or refinery furnace, when the said apparatus is constructed to operate substantially as and for the purpose hereinbefore set forth.

2. The employment of a floating metallic indicator, E, constructed substantially as and for the purpose hereinbefore set forth.

3. The employment of a disk of porous burnt brick clay, secured on the bottom of a deep vessel containing melted iron, the said disk being saturated either with water, hydrocarbons, acid, or alkaline solutions, substantially as and for the purpose hereinbefore described and set forth.

4. The employment of a small torpedo, G, in the bottom of the insulated vessel containing melted iron or steel, in combination with the electric wires g' g'', and arranged to explode the said torpedo by an electric spark, substantially as and for the purpose specified.

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WM. H. MORISON.