J. W. Middleton,

Manf. Iron & Steel.

No. 112,828. Patented Mar. 21. 1871.

Fig. 1.

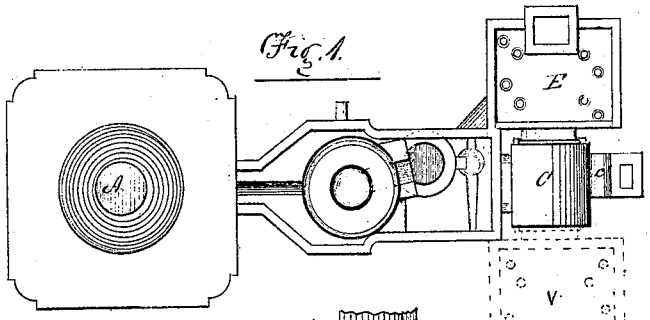


Fig. 4.

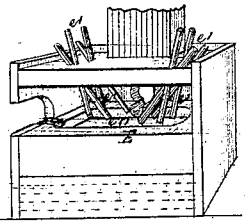


Fig. 2.

Fig. 5.

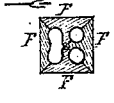


Fig. 6.

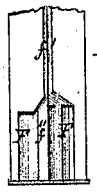


Fig. 7.

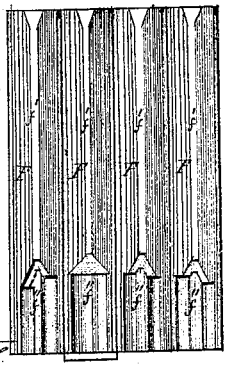
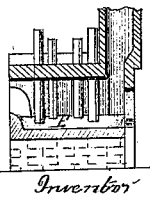


Fig. 3.



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IMPROVEMENT IN THE MANUFACTURE OF IRON AND STEEL.

Specification forming part of Letters Patent No. **112,828**, dated March 21, 1871.

I, JOHN W. MIDDLETON, of the city of Philadelphia, in the State of Pennsylvania, have invented certain further Improvements in the Process of Manufacturing Iron and Steel direct from the ore, and the apparatus therefor, of which the following is a specification:

Nature and Objects of the Invention.

The first part of my invention relates to the combined arrangement of a deep crucible or "hearth," having a vertical series of tuyere or blast holes through its sides, and adjustable tuyere-pipes, with an ore-reducing furnace, so that as the fluid iron and slag or scoria, which run down into the said crucible, rise in the same, the entrance of the blast can be raised higher accordingly until the crucible be filled; the object of this part of my invention being to separate the fluid slag and iron in the said crucible by gravitation, and thus permit the iron to be drawn off more free from the slag, and, therefore, in a more suitable state for making castings direct from the reducing-furnace, and for the further purification and refining of the same by a one-heat process acting continuously from the said reducing-furnace to the usual flattening or straightening plate, on which the finished article is left to cool.

The second part of my invention relates to the construction of the interior of an ore-reducing furnace with a contraction so made as to form a burden-supporting projection around in the inner side of the stack, in combination with a spherical chamber between the said projection and the crucible; the object of this part of my invention being to diminish the pressure of the burden upon the pasty or partially-melted metal, which is supported by the boshes, and to afford or allow a more general and effective action of the blast in liquefying the metal and slag before they enter the crucible or hearth, and also to prevent the usual wedging action of the burden upon the pasty mass, whereby the blast is liable to be shut off.

The third part of my invention relates to the employment of a hot-blast channel, flue, or chamber around and under the crucible or hearth of an ore-reducing furnace, the said channel, flue, or chamber being constructed in such a manner that a blast of waste heat or gas, or the heat of special fire, or of the usual blast on its way to the said reducing-furnace, will pass into and through the said channel, or around and under the crucible or hearth, and keep the latter, at all times during the operation of the furnace, in a strongly-heated condition; the object of this part of my invention being twofold—first, to prevent the possibility of the melted iron and slag in the said crucible or hearth from becoming "chilled;" and, second, to keep the contents of the said crucible at all times in the most fluid condition possible, and therefore in the most advantageous state for the separation of the iron and slag therein, by gravitation, preparatory to casting in flasks or molds, or to the further refinement or decarburization of the iron without cooling or the loss of its heat.

The fourth part of my invention relates to the construction and relative arrangement of the heat-generating furnace, the ore-reducing furnace, and the intervening chambers, for separating the iron and slag by gravitation in a refining-vessel, purifying, decarburizing, working, or kneading automatically the iron, and thus producing malleable iron or steel, so that in driving the hot-blast continuously through from the heat-generating furnace to the ore-reducing furnace the portion of the blast which may from time to time be required in the purifying, decarburizing, and puddling or kneading chamber shall pass, with the exhalations or impurities derived, in a different direction, or so as not to re-enter the reducing-furnace, but may be used for heating blast, generating steam, and calcining ore; the object of this part of my invention being to use the blast for both reducing and refining without returning the expelled impurities into the reducing-furnace.

The fifth part of my invention relates to the combination, with the hot-blast of an ore-reducing furnace, of a special heat-generating furnace, in such a manner as to enable the workmen to readily superheat or intensify the heat of the said hot-blast on its passage through the special furnace to any degree required; the object of this part of my invention being to enable the workmen to melt out either cast or malleable iron when the same

has become chilled in the said ore-reducing furnace, thus avoiding the great expenditure of time, labor, and money heretofore required in clearing out the said chilled or consolidated mass.

The sixth part of my invention relates to the combination, with the hot-blast ore-reducing, of a special blast-superheating furnace in a close channel, communicating directly with the said ore-reducing furnace, and containing a vessel for refining by gravitation; the object of this part of my invention being to produce refined cast-iron, or malleable iron and steel, in a condition to be formed into ingots and bars, direct from the ore by and during a single or continuous heat.

Description of the Accompanying Drawing.

Figure 1 is a plan view of the ore-reducing furnace, in connection with the heat-generating furnace, the intervening chamber and gravity-vessel for separating the slag and iron, and the chamber for refining and converting the cast metal into steel and malleable iron. Fig. 2 is a vertical longitudinal section of Fig. 1. Fig. 3 is a vertical transverse section of the refining and decarburizing chamber detached, with its pool and jet-pipes or tuyeres for working or kneading the metal automatically. Fig. 4 is a perspective view, showing the interior of said refining and decarburizing chamber detached, and its pipes or tuyeres opening in slanting directions into its pool. Fig. 5 is a horizontal section, showing the lower portion of one of the ingot-molds as closed. Fig. 6 is a vertical section, showing one-half of the mold as divided in a vertical plane between two diagonally-opposite cones of the same. Fig. 7 is a representation of the four parts of the said mold opened.

General Description.

The crucible A is a deep cylindrical chamber, extending vertically downward from the boshes a^0, and provided with a vertical series of tuyere or blast holes, a' a'. Around and beneath the crucible A the chamber, flue, or channel B is constructed, and arranged so that a portion of the hot-blast from the heat-generating furnace C will enter or pass through the same, and thus keep the walls and bottom of the said crucible or hearth highly heated.

The blast from the heat-generating furnace C enters the run-out at the bottom of the crucible A, as connected in the drawing; but, with the ordinary blast-furnace blast and this improved purifying-crucible and heated chamber, as the melted metal rises in the crucible the opening is to be stopped, and the blast introduced through the hole to be then opened next above, and so on, in succession, with all the holes until the crucible is filled with the melted iron and slag. The said external blast is introduced through the several tuyere-holes, each of which is provided with a pipe, a'', which passes through the surrounding hot channel or chamber B. All the said holes are, of course, to be kept stopped, except those through which the blast is driven.

Immediately above the crucible A there is a large spherical chamber, a''', the upper part of which opens through the contraction a^4, which produces an annular projection, a^5, for supporting the heavy burden of the furnace in such a manner that the pasty mass in the spherical chamber a''' below will be sufficiently relieved to allow the blast to penetrate it, and thus more rapidly reduce the same to the fluid state for running into the crucible A below, and at the same time permit a more diffused action of the blast upon the pasty mass, and thus avoid that narrow, concentrated, and consequently intensely hot and cutting action of the blast, which reduces the calcium, silicon, or other metallic elements which are contained in most of the ores and fluxes, and render the iron impure or unsuitable for some purposes.

The heat-generating furnace C has a large fuel-magazine, c', with air-tight fittings, so constructed and applied as to hold the day's supply, or more, of the fuel, and feed it to the blast by gravitation, as the combustion of the fuel may require, and at the same time prevent the ingress and egress of air through the magazine.

The fuel rests upon a grate if cold-blast be used for its combustion, or on the bottom of the furnace if hot-blast be used; and the blast is driven into it at this point so as to produce a rapid combustion, and drive a steady and powerful current of the intensely-heated products of combustion upward and onward through the passage-way D and the crucible A of the ore-reducing furnace.

A fluxing substance may be used with the fuel, if necessary, and the slag let out through a tap-hole in the bottom of the furnace C.

The refining, puddling, and automatically-kneading chamber E is arranged at one side of the direct-draft chambers D D, and communicates therewith through an opening, e', which is fitted with a sliding door, so that when this chamber E is not in use, or needs repairs, or any temporary cessation of its operation, the same can be closed, and the blast thus prevented from entering. The object in putting this chamber aside from the line of the direct draft is to use a sufficient portion of the latter for refining, puddling, &c., without sending the impurities separated in the said chamber E back again into the ore-reducing furnace—a result which would necessarily follow if the said purifying-chamber were placed in the direct line of the blast from the heat-generating chamber to the ore-reducing furnace.

The general structure of the chamber E, with its tuyere-pipes e' e', pool e'', and the apparatus for causing air or gas to be driven through the said tuyere-pipes in short, rapid, air-gun-like shots, which will knead the contents of the pool automatically, having been

described in a prior application, (D,) now before the Patent Office, a further description need not be here made, except to say that each of the series of said tubes is intended to make a shot per second of time, and in such succession as to keep the whole contents of the pool in rapid and thorough agitation.

The vessel d' in the chamber D, for more perfectly separating the slag and iron by gravitation, having been described in a prior application, (B,) need not be further described here.

The ingot-molds (see Figs. 5, 6, 7) are made in long sections F F F F, which can be readily adjusted and held together by a slip-band or otherwise, so as to afford an upright ingot-mold with a long slender throat, f', whereby a head-pressure can be given to the melted contents poured into the mold through the mouth and neck, and thus the ingot be more effectually condensed, and so, also, that when the metal has set the mold can be quickly opened, the ingot cut from the stem, and then taken out and elongated between the usual rolls or under the hammer without reheating.

By the use of a core, f'', two, three, or more ingots may be cast in a mold having but the one mouth and throat f', and the same condensing result produced by head-pressure.

Between the heat-generating furnace C and the ore-reducing furnace numerous air-tight doors, and flues with well-secured dampers and valves, as may best suit convenience, must be arranged, for access to and inspection of the different chambers.

Two or more of the refining-chambers E may be connected with the direct-blast chamber D in the same manner as indicated by the dotted lines V in Fig. 4.

To sum up briefly, I will say that, by means of the processes and apparatus described in my previous applications, (A, B, C, D,) in connection with the improvements herein described, castings, steel, and malleable iron can be produced from the ore with more economy of fuel, (it being a single-heat process,) with less labor, and in less time, and better qualities in the metal produced from the same kind of materials than any other hitherto-known mode.

Commencing with the tunnel-head of the ore-reducing furnace herein described, either with or without the heating-flue around and under the crucible, or, beginning with the liquid scoria and iron, from any ore-reducing, one or more of the portable gravitation-vessels described in application A will enable the operator to obtain a better article of iron, direct from the furnace, for pouring into molds or flasks for casting; or, commencing with the liquid iron and slag as made by a continuous stream or periodically from any furnace, the fluid running through the passage to the iron and slag pool, a large portion of the slag can be drawn off, if desired. Then tap the iron and slag into the vertical gravitation-vessel in the hot chamber below, wherein may be placed chemicals in a box to be opened by a torpedo, as described in application D, and the iron thus purified and poured into molds, producing first-class castings.

For steel or malleable iron, continue the process from the gravity-vessel, the liquid iron, which can be entirely freed from slag and many impurities, running along its gutter into finery, boiling, puddling, or as automatically kneaded by means of the apparatus described in application D, whereby numerous air-gun-like shots of air, superheated steam, or hot-blast driven into the iron in the pool. The said shots are intended to be let off and continued from each tuyere-pipe about every second of time, and each shot made consuming one-tenth to five-tenths of a second, thereby more thoroughly working out most of the impurities and decarburizing it for steel, or continuing it for malleable iron without the use of the "squeezers," then casting the liquid malleable iron or steel into molds placed in a hot chamber for gravity-condensed ingots, as described herein, and when sufficiently set rolled into bars of any sizes desired.

If preferred, in place of casting into ingots, the liquid iron or steel can be sufficiently cooled in the furnace where decarburized, and then made into balls and shaped into blooms by the squeezers, and finally rolled or hammered into bars and laid upon the straightening-plate to cool.

Claims.

I claim as my invention—

1. The combination, with a hot-blast ore-reducing furnace, of the deep crucible A, the adjustable tuyere-pipes a'' a'', and the vertical series of tuyere-holes a' a', the said parts being constructed and arranged substantially as described, for the purpose of more effectually causing the separation of the metal and slag in the crucible, and allowing the tuyere-holes in the latter to be successively closed with facility, as the melted metal and slag rise in the said crucible, until the same be full.

2. In an ore-reducing furnace, the annular shoulder or contraction a^4 a^5, in combination with the spherical chamber a''' and the crucible A, substantially as and for the purpose hereinbefore described and set forth.

3. The hot-blast chamber, channel, or flue B around and under the crucible A, substantially as and for the purpose hereinbefore described and set forth.

4. The arrangement of the purifying, decarburizing, and kneading chamber E, aside from and in relation to the direct-blast passage-way D D, substantially as and for the purpose hereinbefore described and set forth.

5. The combination, with the hot-blast of an ore-reducing furnace, of a special heat-generating furnace, C c', substantially as described, for the purpose of intensifying the heat of the blast sufficiently to enable the workmen thereby to melt either cast or malleable iron when the same has at any time become chilled or solidified in the said ore-re-

ducing furnace, and thus avoid the great expenditure of time, labor, and money heretofore required in clearing out such chilled or consolidated mass.

6. The combination, with a hot-blast ore-reducing furnace, of a special blast-superheating furnace, C c', in a close channel, D, which communicates with the said ore-reducing furnace and contains a vessel, d', for refining by gravitation, substantially as described, for the purpose of producing refined cast-iron or malleable iron and steel direct from the ore in a condition to be formed into ingots, and finally into bars, by the usual rolls or hammer during the same heat, as hereinbefore set forth.

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Witnesses:
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