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# G. J. & T. C. HINDE.

## Manufacture of Iron and Steel and Furnace and Apparatus therefor.

No. 88,480. Patented March 30, 1869.

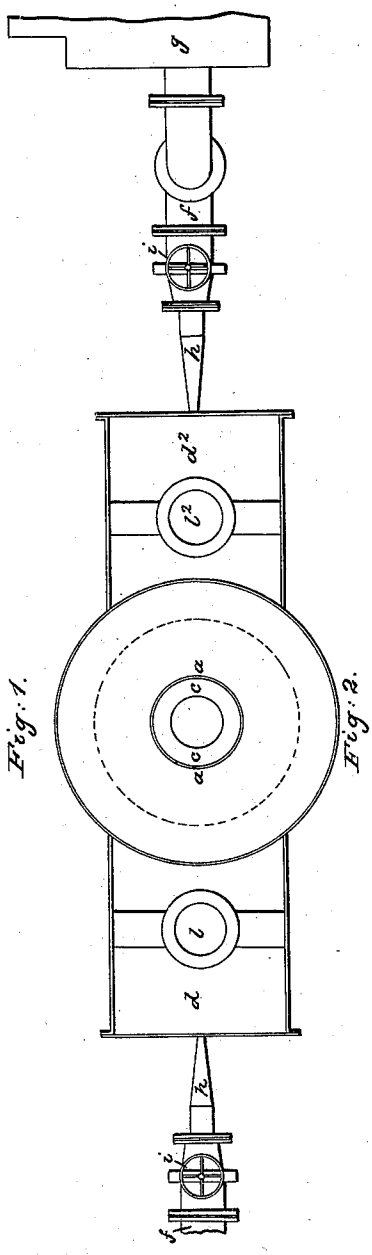


Fig. 1.

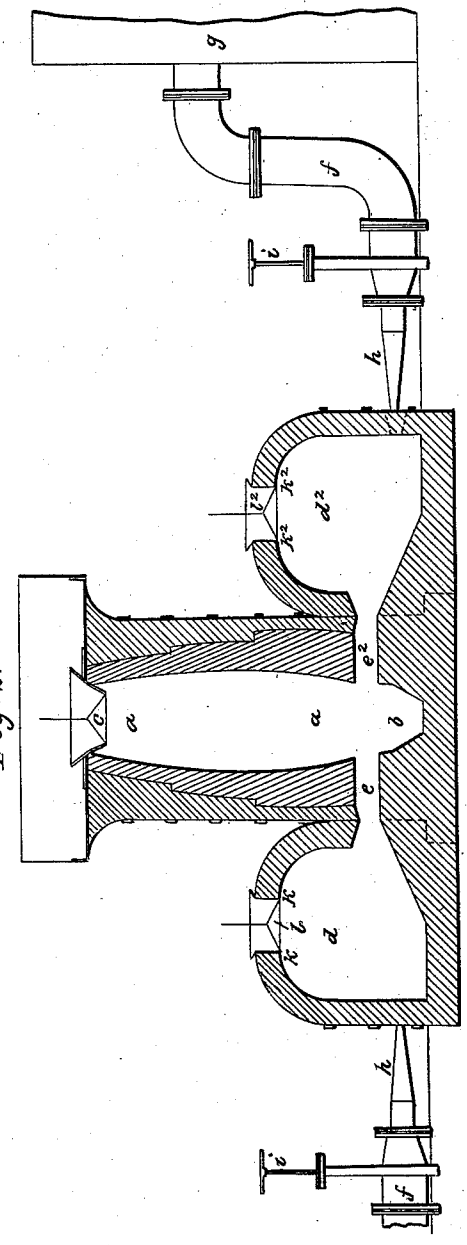


Fig. 2.

Witnesses:
George Shaw.
Richard Rivett.

Inventors.
George James Hinde
Thomas Callender Hinde

5 Sheets—Sheet 2.

# G. J. & T. C. HINDE.

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Fig: 3.

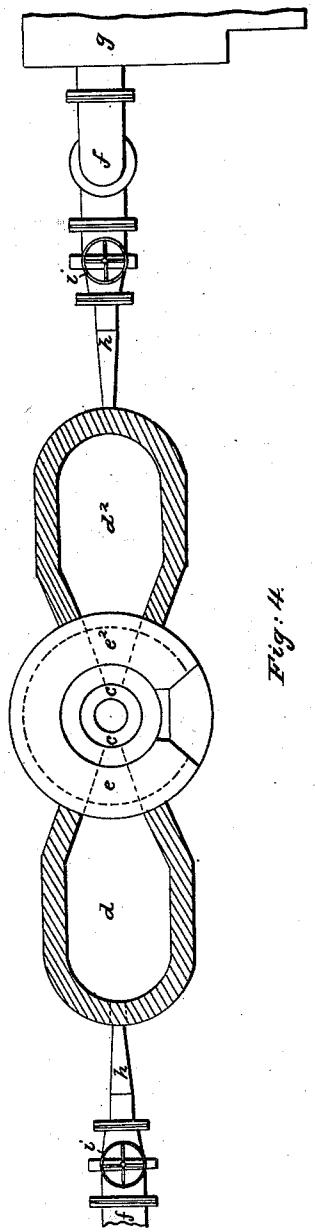
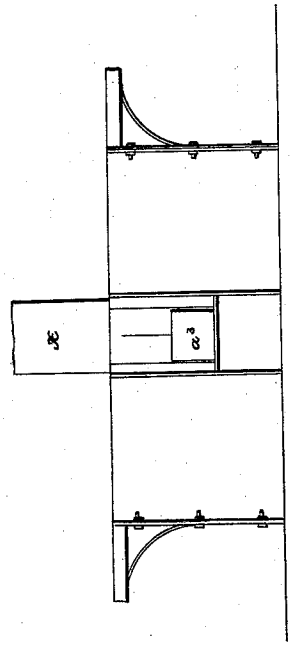



Fig: 4.




Witnesses:
Geo. Shaw.
Richard Rivett.

Inventors:
George James Hinde.
Thomas Callender Hinde.

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G. J. & T. C. HINDE.

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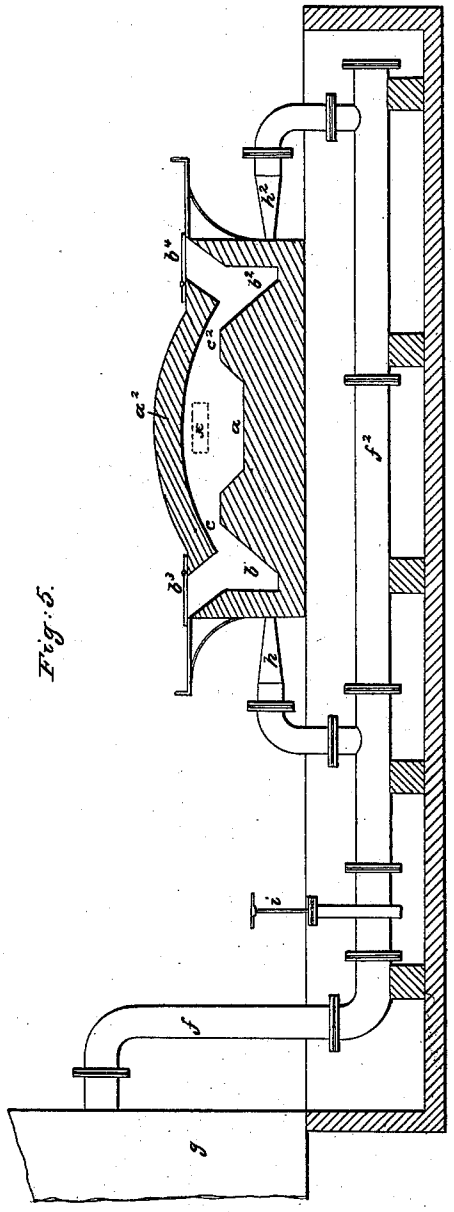

Fig. 5.

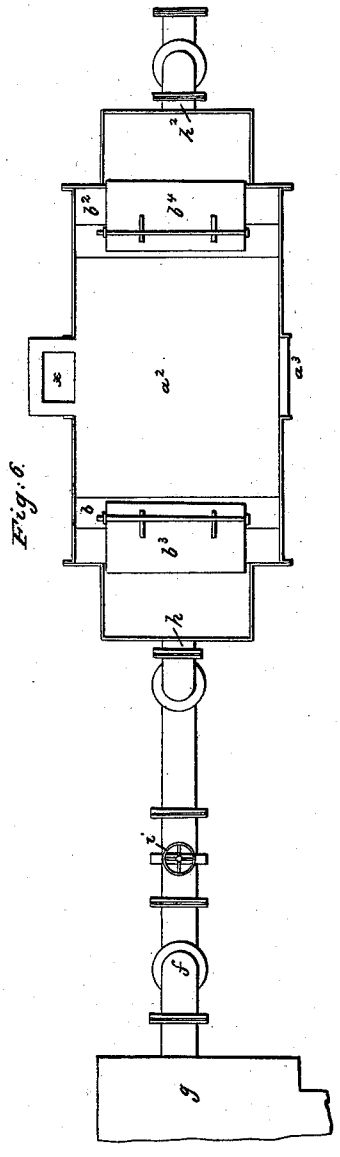

Fig. 6.

Witnesses:
George Shaw
Richard Kemitt.

Inventors:
George James Hinde
Thomas Callender Hinde.

5 Sheets—Sheet 4.

# G. J. & T. C. HINDE.

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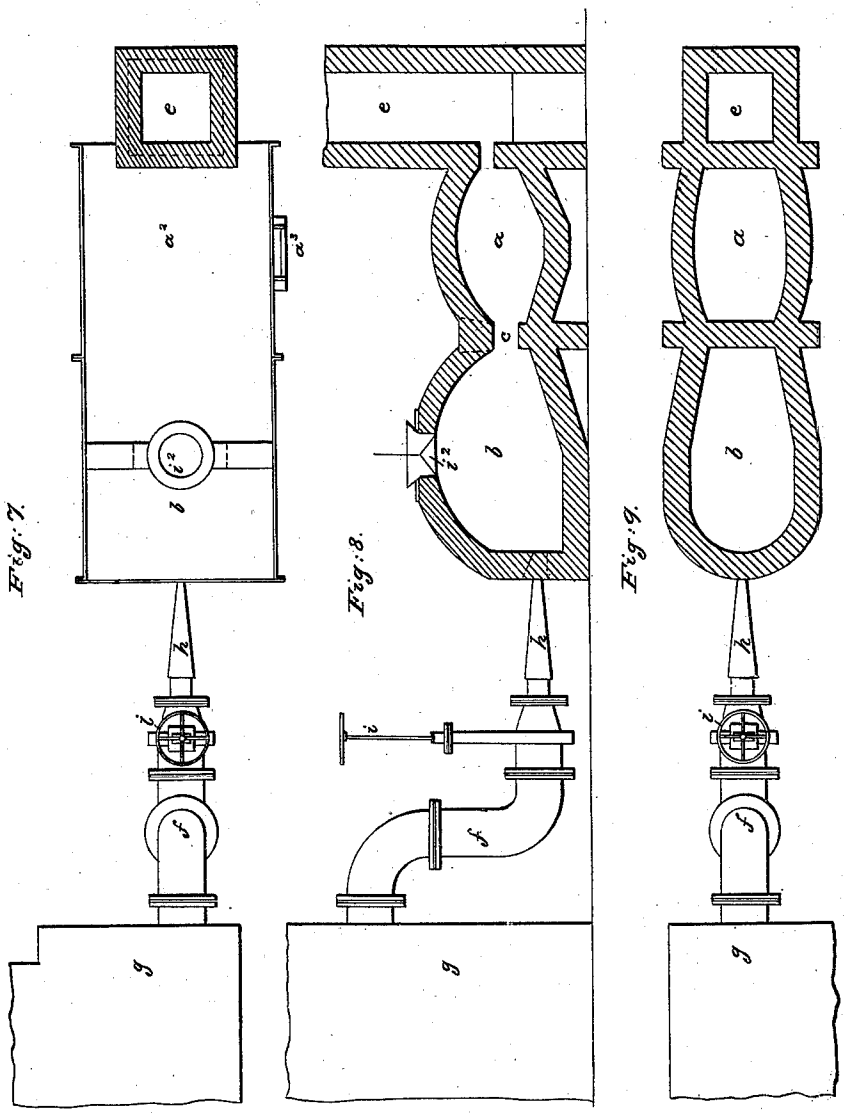



Fig. 7. Fig. 8. Fig. 9.

Witnesses:
George Shaw
Richard Kenitt.

Inventors:
George James Hinde
Thomas Callender Hinde.

5 Sheets—Sheet 5.

G. J. & T. C. HINDE.

Manufacture of Iron and Steel and Furnace and Apparatus therefor.

No. 88,480. Patented March 30, 1869.

Fig: 10.

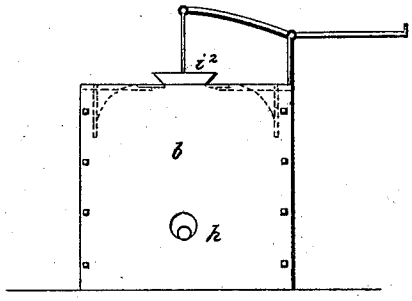
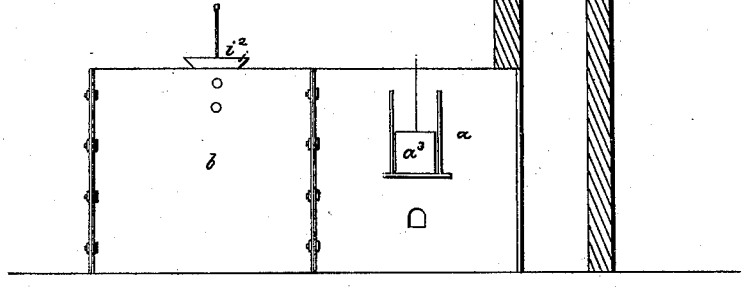



Fig: 11.




Witnesses:
Geo. Shaw
Richard Knotts.

Inventors:
George James Hinde
Thomas Callender Hinde.

# United States Patent Office.

GEORGE JAMES HINDE, OF WOLVERHAMPTON, ENGLAND, AND THOMAS CALLENDER HINDE, OF YNISPENLLWCH, NEAR SWANSEA, WALES.

*Letters Patent No.* 88,480, *dated March* 30, 1869.

## IMPROVEMENT IN THE MANUFACTURE OF IRON AND STEEL, AND IN FURNACES AND APPARATUS THEREFOR.

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

*To all to whom it may concern:*

Be it known that we, GEORGE JAMES HINDE, of Wolverhampton, in the county of Stafford, England, manager of works, and THOMAS CALLENDER HINDE, of Ynispenllwch, near Swansea, in the county of Glamorgan, Wales, colliery-proprietor, subjects of the Queen of Great Britain, have invented or discovered certain new and useful Improvements in the Manufacture of Iron and Steel, and in Furnaces and Apparatus Used in the said Manufacture; and we, the said GEORGE JAMES HINDE and THOMAS CALLENDER HINDE, do hereby declare the nature of the said invention, and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement thereof; that is to say—

Our invention consists of the improvements hereinafter described, in smelting iron-ores, and producing therefrom, as required, either wrought-iron, steel, or cast-iron, and in furnaces and apparatus used for these purposes.

In smelting iron-ores according to our invention, we construct blast-furnaces, having chambers for the fuel, for generating the requisite heat and forming the reducing-agent, which chambers we term the gas-chambers; and other chambers for the reduction of the ores and carbonization of the iron, which latter chambers we term the smelting-chambers.

The gas-chambers are constructed of different sizes, according to the scale on which it is proposed to operate, and the number and size of the tuyeres through which the blast is to be forced into them. They may be square or circular, the shape not being material.

The depth may vary somewhat, according to the character of the fuel used, but it should in all cases be sufficient in thickness to convert the fuel into carbonic oxide.

A suitable opening in each chamber, through which the fuel is charged from an adjoining hopper, is made, and kept closed by a fire-brick door, or slide, except when opened for supplying fuel.

The blast is blown in near the bottom. No grates or bars are requisite, the ashes of the fuel being fluxed by putting a little lime among the fuel, from time to time; and the cinder formed by the melting of the ashes and flux together is allowed to flow out through a small aperture made for the purpose. Or the ash and clinker may be removed through a door near the bottom, in the ordinary way of clearing a blacksmith's fire.

Closely adjoining to, and communicating with these gas-chambers by suitable openings, we construct the smelting-chambers.

The construction of these chambers varies, according to whether it is intended to pass the heated reducing-gases through and among the iron-ores, or over them only.

In the former case, we construct the smelting-chambers with sides inclined at a considerable angle, widening upward, and with a hearth, or crucible-part having upright or nearly upright sides.

The communication of these smelting-chambers with the gas-chambers before described is made through suitable openings in the smelting-chambers, near the top of the crucible, or hearth-part of them.

When it is intended to pass the heated reducing-gases over the iron-ores, the smelting-chamber is constructed with a hearth and a reverberating arch. The heat is reflected from the arch on the iron-ores placed beneath.

A preparatory portion, or extension of this chamber is formed, in which the ores may be gradually operated on before being placed in the full heat of the hearth-part.

For the more convenient removal, or descent of the ores from this portion of the smelting-chamber to the hearth, the bottom of it may be formed with one or more steps, or at an angle rising from the hearth-part upward.

If it should be desirable, in smelting refractory ores, to increase the heat of the reducing-gases by external means, this may be done by interposing a system of fire-clay pipes between the gas-chambers and the smelting-chambers. The reducing-gases, in passing from the gas-chambers through this system of fire-clay pipes, may then be superheated, by external means, to any required degree.

This superheating may be effected, either by ordinary furnaces, or by the combustion of the waste gases which are evolved from the smelting-chambers.

The waste gases may either be utilized in this manner or in generating steam, or used for any other suitable purpose.

The fuel to be supplied to the gas-chambers may be charcoal, coke, coal, or peat.

In order to facilitate the smelting of the iron-ores, we prefer to crush or grind them to such degree of fineness as may be economically practicable. Generally speaking, the finer they can be ground or crushed, the better.

This crushing or grinding-operation affords, at the same time, a convenient opportunity, with inferior ores, of separating much of the earthy and pyritous impurities from them, by dressing and washing them in any of the well-known ways of dressing and washing metallic ores.

The ground or crushed ores are now to be mixed with such a proportion of lime or other flux as their chemical composition shows to be needed; and we prefer to mix with them a portion of pulverized carbonaceous matter, such as charcoal, coke, or coal-dust, taking care to select these materials as free from sulphur or other impurities as possible.

When it is intended to smelt the ores in the smelting-chambers first described, it will be requisite, in order to enable the gases to pass freely through, to incorporate the iron-ores, flux, and carbonaceous matter, together with water, pitch, a small portion of bituminous coal or other suitable medium, into bricks, or blocks, and dry or heat these bricks, or blocks sufficiently to make them so far coherent that they will bear handling and moving about without disintegration.

This incorporation into bricks, or blocks, will not be needed when smelting-chambers of the second description are employed, as the heated reducing-gases, having merely to pass over the mixture of ores, flux, and carbonaceous matter, these materials may be charged into the smelting-chamber in their dry, pulverized condition, either simultaneously or separately, and at such intervals as may be desirable during the progress of the operation.

The gas-chambers being properly charged with their complement of fuel, and the smelting-chambers with the mixture of ores, flux, and carbonaceous matter, either incorporated into bricks, or blocks, or in the pulverized state, as before described, and a due supply of fuel to the gas-chambers, and of ore and materials to the smelting-chambers, being constantly kept up, operations now proceed thus:

Currents of atmospheric air, either cold or heated by any of the well-known apparatus for that purpose, are forced, by any of the usual blowing-machines, through the ignited fuel in the gas-chambers, and intense combustion thereby produced.

The oxygen of the atmospheric air, by its passage through the stratum of burning fuel, is converted into carbonic oxide. This carbonic oxide, and the nitrogen of the air, pass, at a very high temperature, from the gas-chambers, either directly through the smelting-chambers, or intermediately through the series of fire-clay pipes, already described as being, in some cases, interposed between the gas-chambers and the smelting-chambers.

In the latter case, the gases are superheated by external means to any required degree, and then pass through the smelting-chambers.

By the passage of these highly-heated gases through the smelting-chambers, the mixture of ores, flux, and carbonaceous matter is raised to a correspondingly high temperature, and, partly from the action of the intensely-heated reducing-gases, and partly from the action of the carbon contained in the mixture, the iron contained in the ores is reduced to the metallic state.

By continuing the operation, more carbon is taken up by the metallic iron, and, according to the proportion of carbon thus combined with the iron, the product is either steel or cast-iron, as may be required.

When smelting-chambers of the first-described construction are employed, and wrought-iron or welding-steel is required as the product, the malleable iron or welding-steel, formed as first described, is removed in masses, or blooms, by mechanical means, from the smelting-chambers, through a doorway, or breast, formed in the hearth-part for the purpose.

These masses, or blooms, either with or without being reheated in ordinary heating-furnaces, are hammered, squeezed, or rolled, in the ordinary manner, into the shapes and sizes required.

The void caused by the removal of these masses, or blooms from the hearth of the smelting-chambers, is filled by the descent of a further portion of the already-heated and partially-reduced ores from above, into the hearth, where their reduction is fully completed, and the temperature of the resulting malleable iron or welding-steel raised to the welding-heat requisite for the hammering, squeezing, or rolling-processes.

When cast-steel or cast-iron is intended to be the product from smelting-chambers of the first-described construction, the mixture of ore and materials having been subjected to a proportionately longer exposure to the action of the heated gases, as before mentioned, the molten steel or cast-iron resulting from the operation runs into the hearth, or crucible-part of the smelting-chambers, and is tapped therefrom through an aperture made for the purpose.

The molten cinder formed by the union of the flux with any earthy matter associated with the ores, flows from the smelting-chamber through an orifice formed at a suitable height therein.

The descent of the mixture of ores and materials from above proceeds, as the portions contained in the hearth are smelted and removed. Fresh supplies of the mixture of ores and materials are constantly fed in at the top of the smelting-chamber, and the smelting of the ores and the production of the metal proceed without intermission.

When smelting-chambers of the second-described construction are employed, and wrought-iron or welding-steel is required as the product, the welding-steel or malleable iron produced, as before described, by the action of the gases on the mixture of ores and materials, is removed, in masses, or blooms, by ordinary mechanical means, from the hearth, through a doorway for the purpose, and either with or without being reheated in ordinary heating-furnaces, hammered, squeezed, or rolled into the shapes and sizes required.

When cast-steel or cast-iron is required as the product of this second-described smelting-chamber, the mixture of ores and materials having been subjected to a proportionately longer exposure to the heated gases, as before described, the molten steel or cast-iron resulting from the operation runs down into the hearth, and is tapped therefrom through a suitable aperture for the purpose.

The molten cinder formed by the union of the flux with any earthy matter associated with the ores, flows from the smelting-chamber through an orifice formed at a suitable height therein.

The descent, or removal of the mixture of ores and materials from the extension or preparatory part of the smelting-chamber, proceeds, as the portions contained in the hearth are smelted and removed. Fresh supplies of the mixture of ores and materials are constantly fed into the extension, or preparatory part of the smelting chamber, and the smelting of the ores and production of the metal proceed without intermission.

Figure 1 represents, in plan,

Figure 2, in vertical section, and

Figure 3, in horizontal section, a furnace and apparatus for the manufacture of iron and steel, arranged according to one of the methods constituting our invention.

The same letters of reference indicate the same parts in each figure of the drawings.

*a* is the chamber in which the prepared ore and carbonaceous matter and lime or other flux are introduced, and in which the smelting-operation takes place.

The lower part, *b*, of the said chamber *a*, constitutes a crucible, or hearth, in which the smelted metal is received, and from which it is removed by the ordinary method of tapping, or otherwise, according as malleable iron, or steel, or cast-iron is produced.

The materials are introduced at the top of the chamber *a*, which top may be opened or closed at pleasure, by raising or lowering the conical cover *c*.

On either side the smelting-chamber *a* are gas-chambers $d$ $d^2$, communicating with the chamber *a* by the passages $e$ $e^2$.

*f f* are blast-pipes, which convey blasts of air either from the hot-air ovens *g g*, or direct from the blast-engine, when it is not required that the blast should be heated.

The said blasts of air pass from the pipes *f f*, through the tuyeres *h h*, into the gas-chambers *d* $d^2$.

*i i* are valves for regulating the blast.

The gas-chambers *d* $d^2$ are filled with the fuel by the openings *k* $k^2$, at their tops, which openings are, after the introduction of the fuel, closed by the covers *l* $l^2$.

When the furnace and apparatus are in action, the smelting-chamber *a* is kept filled or nearly filled with the prepared ore, carbonaceous matter, and flux, and the gas-chambers *d* $d^2$ are kept filled with coke.

The coke in the gas-chambers *d* $d^2$ being ignited, and blasts of air from the tuyeres *h h* passing through the ignited coke, a mixture of heated carbonic oxide and nitrogen-gas passes from the gas-chambers, through the passages *e* $e^2$, into the smelting-chamber *a*, where, by its heat and the reducing, or deoxidizing-property of the said carbonic oxide and carbon in the smelting-chamber *a*, the ore in the said chamber *a* is heated and reduced, or deoxidized.

The reduced metal and scoria, or cinder, fall into the crucible, or hearth *b*, from whence they are, from time to time, removed.

Figures 4, 5, and 6, represent another arrangement of furnace and apparatus, constructed according to our invention, for the manufacture of iron and steel, fig. 4 being an end elevation, fig. 5, a longitudinal vertical section, and fig. 6, a plan.

In this arrangement of our invention, the smelting-chamber is formed with a hearth, *a*, and a reverberating arch, $a^2$, the ore and materials being charged into the hearth of the said chamber, the heated air and gases from the gas-chambers *b* $b^2$ playing against the arch $a^2$, and being reverberated, or reflected therefrom down upon the ore and materials in the hearth of the said chamber.

The products of combustion pass away by the flue, or chimney *x*.

The blast from the blast-pipe *f* is delivered by the tuyeres *h* $h^2$ into the gas-chambers *b* $b^2$, and the carbonic oxide produced, mixed with the nitrogen of the air, is conducted by the passages *c* $c^2$ into the chamber, or furnace *a*.

The ore and materials are introduced into the hearth *a* of the smelting-chamber, and the reduced metal is removed therefrom by the door $a^3$.

Fuel is introduced into the gas-chamber *b* $b^2$ by the doors $b^3$ $b^4$.

The blast from the pipe *f* is conveyed to the tuyere $h^2$ by the pipe $f^2$, which passes under the furnace, for the sake of convenience.

Figures 7, 8, 9, 10, and 11, represent another arrangement of furnace and apparatus, according to our invention, for the manufacture of iron and steel, fig. 7 being a plan, fig. 8, a longitudinal vertical section, and fig. 9, a horizontal section. Fig. 10 is an end elevation, and fig. 11, a side elevation.

In this arrangement, the smelting-chamber *a* has a reverberating arch $a^2$, and is provided with only one gas-chamber *b*, of large size, from which the mixture of heated carbonic oxide and nitrogen passes through the passage *c*, into the chamber *a*, at one end only, and after passing over and operating upon the ore and materials in the said chamber *a*, escapes, by the passage *d*, into the chimney *e*.

*f* is the blast-pipe, and *h*, the tuyere.

The gas-chamber *b* is filled through an opening in its top, which may be opened and closed at pleasure by the cover $i^2$.

The ore and materials are introduced into the chamber *a*, and iron or steel removed therefrom by the opening $a^3$.

Instead of passing the gases directly from the gas-chambers into the smelting-chamber, as described and illustrated, the said gases may be superheated before being passed into the smelting-chamber.

Having now described the nature of our invention, and the manner in which the same is to be performed, we wish it to be understood that we do not limit ourselves to the precise details herein described and illustrated, as the same may be varied without departing from the nature of our invention; but

We claim as our invention—

1. The improvements in the manufacture of iron and steel hereinbefore described; that is to say, smelting iron-ores, and producing therefrom either malleable iron, steel, or cast-iron, by subjecting a mixture of the iron-ores and flux, either with or without carbonaceous matter, to the action of a mixture of highly-heated carbonic-oxide and nitrogen gases, such mixture of gases being produced by passing atmospheric air through a stratum of ignited fuel, the said fuel not being mingled with the ores to be smelted, substantially by the means and in the manner as above described.

2. The arrangements of furnaces and apparatus to be used in the manufacture of iron and steel, substantially as hereinbefore described, and illustrated in the accompanying drawings.

GEORGE JAMES HINDE. [L. S.]
THOMAS CALLENDER HINDE. [L. S.]

Witnesses:

GEORGE SHAW,
*7 Cannon Street, Birmingham.*
RICHARD SKERRETT,
*7 Cannon Street, Birmingham.*