Sheet 1 - 5 Sheets.

C. Sanderson.

Iron and Steel Furnace.

No. 1,968. Patented Feb. 9, 1841.

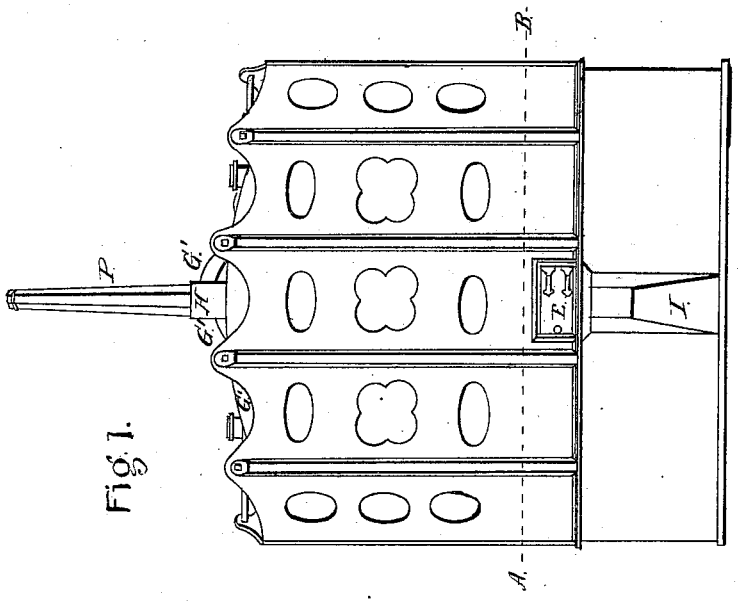


Fig. 1.

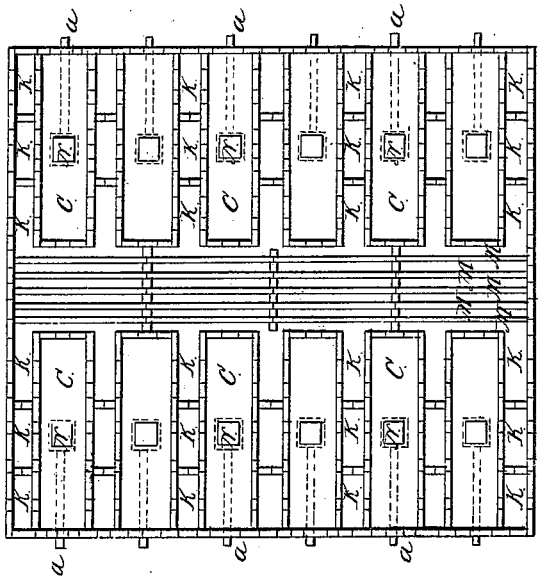


Fig. 3.

Witness.
Francis Scott
Not. Pub.

Inventor:
Charles Sanderson

Sheet 2-5 Sheets.

C. Sanderson.

Iron and Steel Furnace.

No. 1,968. Patented Feb. 9, 1841.

Fig. 13.

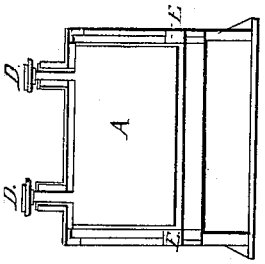


Fig. 3.

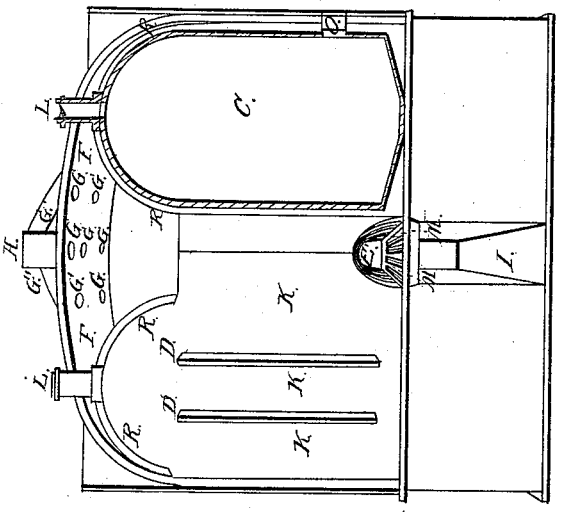


Fig. 11.

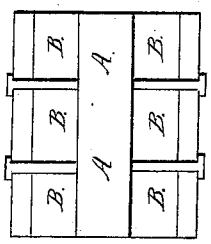


Fig. 2.

Witnesses:

James Rolle

Nat. Pride

Inventor:

Charles Sanderson

Sheet 3 - 5 Sheets.

C. Sanderson.

Iron and Steel Furnace.

No. 1,968. Patented Feb. 9, 1841.

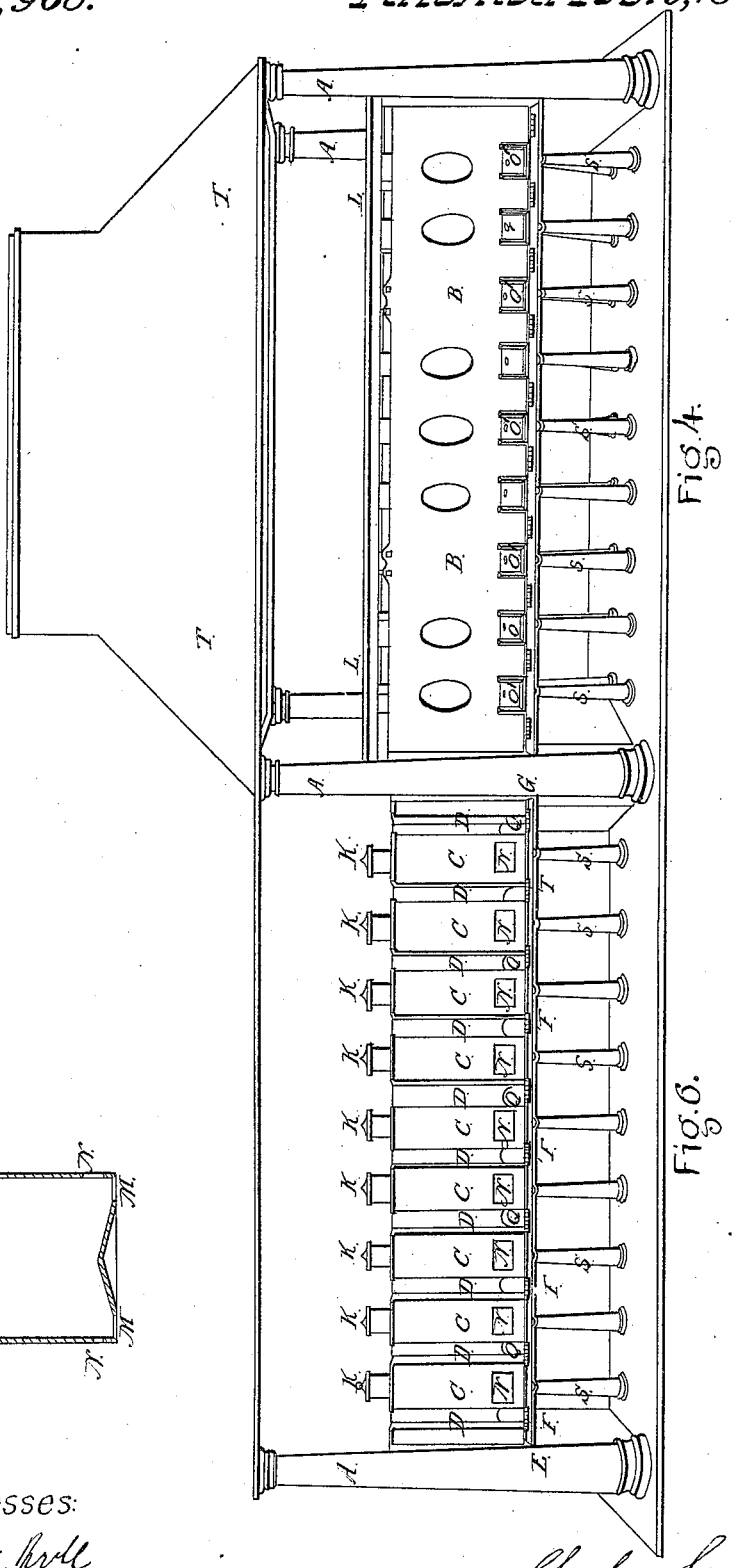


Fig. 4.

Fig. 6.

Fig. 9.

Witnesses:

Francis Rodl
Nat. pub.

Inventor:

Charles Sanderson

Sheet 4-5 Sheets.

C. Sanderson.

Iron and Steel Furnace.

No. 1,968. Patented Feb. 9, 1841.

Fig. 10.

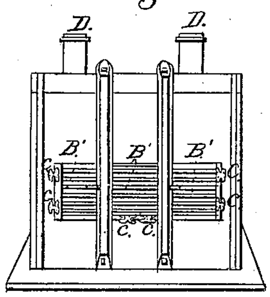
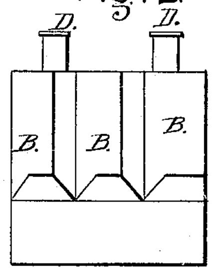


Fig. 12.



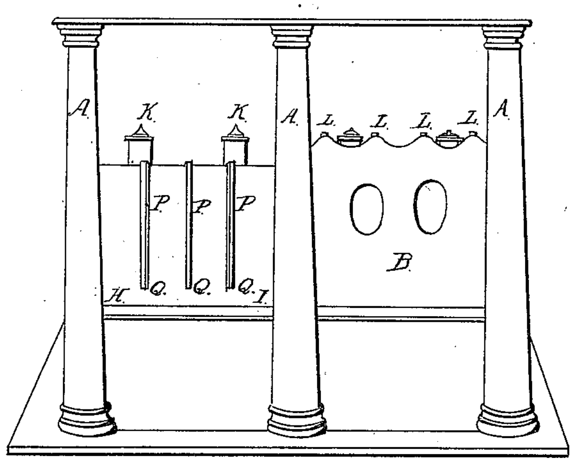


Fig. 8. Fig. 5.

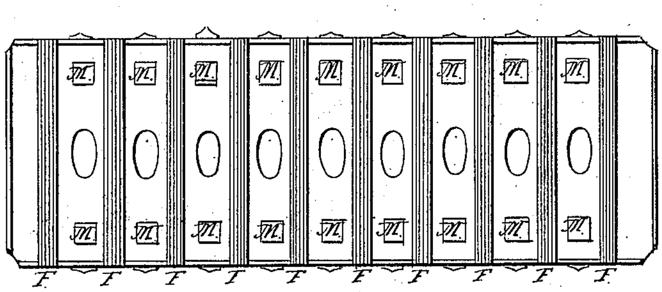


Fig. 7.

Witnesses:

Francis Riell
Not. Pub.

Inventor:

Charles Sanderson

N. PETERS, PHOTO-LITHOGRAPHER, WASHINGTON, D. C.

Sheet 5-5 Sheets.

C. Sanderson.

Iron and Steel Furnace.

No. 1,968. Patented Feb. 9, 1841.

Fig. 14.

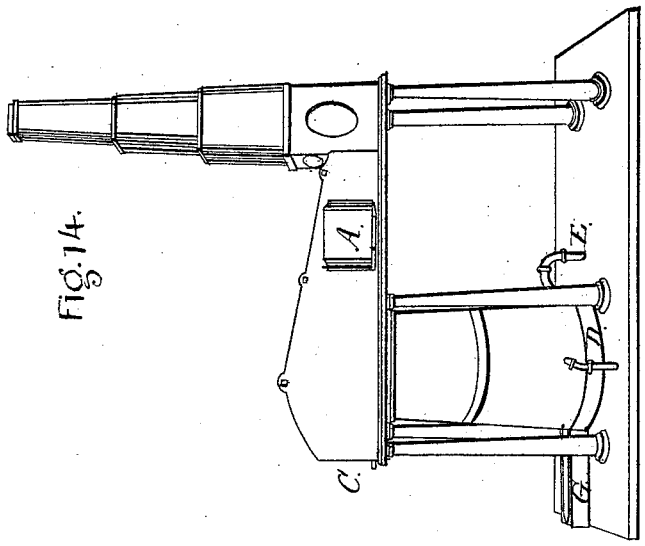
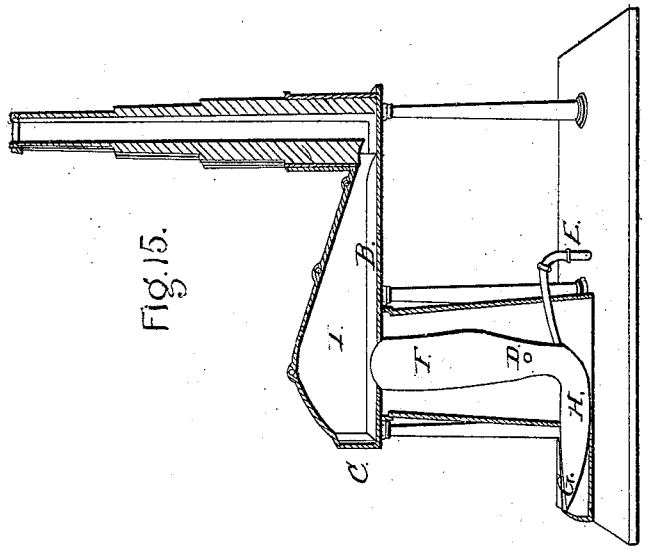


Fig. 15.



Witnesses.

Francis Boll
Not. Pub.

Inventor:

Charles Sanderson

UNITED STATES PATENT OFFICE.

CHARLES SANDERSON, OF SHEFFIELD, ENGLAND.

IMPROVEMENT IN THE ART OF SMELTING IRON ORES AND IN CERTAIN FURNACES APPLICABLE THERETO.

Specification forming part of Letters Patent No. **1,968**, dated February 9, 1841.

To all whom it may concern:

Be it known that I, CHARLES SANDERSON, of Sheffield, in the county of York, in England, gentleman, a subject of the Queen of Great Britain, have invented or discovered new and useful Improvements in the Art or Process of Smelting Iron Ores and in Certain Furnaces Applicable Thereto; and I, the said CHARLES SANDERSON, do hereby declare that the nature of my said invention and the manner in which the same is to be performed are particularly described and ascertained in and by the following description thereof, and by reference being had to the drawings hereunto annexed, and to the letters and figures marked thereon—that is to say:

The object of my invention for certain improvements in the art or process of smelting iron ores is to separate the scoria, slag, or other earthy or extraneous matters from the metallic parts of such ores in a better and more economical manner than is commonly practiced in the smelting of iron ores; and the invention embraces a novel or improved process or manner or method of treating or operating upon such ores, whereby I am enabled to separate and remove the scoria or earthy matters contained therein from the metallic parts without the necessity of carbonizing the metallic parts so thoroughly as to cause them to melt together into a fluid state, as they do in the common blast-furnace; but my method consists in carbonizing the metallic parts to that extent which will enable them to separate from the scoria during the process of melting, whereby I am enabled to separate the metallic parts from the scoria without the necessity of melting both at the same time into a fluid state and running off the fluid iron from the scoria or slag, as is the usual practice in the blast-furnace—that is to say, I so treat and operate upon the ore that I reduce the scoria or other extraneous matters contained therein to a fluid state, so that the same will separate from the metallic parts and run off, leaving the metal without its changing into a fluid form, but in a sort of pasty consistency, and in a fit state to be removed from the furnace, and applicable to various purposes, particularly to the making of bar-iron.

In the ordinary mode of smelting iron ores it is known that the ore is first roasted in order to drive off the noxious volatile matter which it may contain, and also to disintegrate the mass, and thereby render it easier of reduction in the blast-furnace. When roasted, it is charged in given quantities into the top of the furnace along with a quantity of such flux as may be found necessary to add and a quantity of coke (in some instances coal) as fuel. These descend gradually, and during such descent the ore undergoes all those chemical and physical changes which are requisite for the production of the metal, for when it has descended about two-thirds down the furnace it has become carbonized, after which, as it descends, the earthy matters and flux unite and liberate the metal, which continues to imbibe carbon. As it passes the blast, it sinks through the scoria by its specific gravity and deposits itself in a fluid form at the bottom of the furnace, the scoria, as it is formed, running away from the surface of the iron, while the metal, being fluid, is run out from the furnace into any form which may be required, whereas by my improved process it will be shown that the slag or scoria only is rendered fluid and runs away from the metallic part, leaving it behind in the furnace in a state of pasty consistency.

I will now proceed to describe the manner of carrying these improvements into effect, referring to the drawings hereunto annexed—that is to say:

I take iron-stone of the argillaceous description of iron ores, or any other description of iron ores, be the same rich or poor in metal, or containing more or less of any earth or substance foreign thereto, (commonly called the "matrix.") These ores I subject to a process of calcination, the object of which is to drive off all noxious volatile matter which they may contain, and to disintegrate the mass by rendering it more porous, and thus in a fitter state to be carbonized. In the usual process of calcination or roasting, the ore is stratified with the cheapest fuel to be obtained, and is allowed to burn in an open space; or it is in some cases burned in ovens or kilns, stratified in like manner. In both cases, however, the heat which is evolved or given out during such process is lost. By my improved process this heat is made available and useful by applying it to the process of preparing or carbonizing the ore, as hereinafter described. The ore so calcined or roasted is placed in a chamber

along with any carbonizing material—such as charcoal, coke-dust, or any other convenient substance which possesses the property of giving out carbon in quantities which will vary according to the nature of the ore. I consider, however, that ten per cent. or ten pounds of carbonizing material to every one hundred pounds of the calcined ore is the best proportion. When this chamber is filled, it is to be closed air-tight, so as to prevent the entrance of the atmospheric air. Heat is then to be applied to the exterior of this chamber and continued until the ore has become completely carbonized, the time varying from thirty hours to three days, according to the kind and richness of the ore which is operated upon. The furnace having become cool, the ore is then discharged from the chamber, and in this state it is ready to be removed to the melting or reducing furnace. Should the ore in its natural state contain earthy matters in such proportions as will cause or produce their fusion at the lowest degree of temperature at which such earths so compounded do fuse, then no flux will be required; but should the ores contain or be composed of earths in such unequal proportions as will not melt at the lowest temperature at which such earths, if differently compounded, can be made to melt, then a flux is to be added in such quantities as shall remedy this inequality, and thereby render the earthy matter contained in the ore capable of being rendered fluid at the lowest degree of temperature, my object being to effect a complete fusion of the earthy matter or matrix of the ore at as low a degree of temperature as possible, while the metallic parts remain in a state of pasty consistence, and not so fluid as to run from the furnace in which the separation is effected. The ore or mixture of ore and flux is then to be placed within a separating or reducing furnace of the description (or construction) hereinafter mentioned and described, in which furnace sufficient heat is applied so as to melt the ore or ore associated with the flux, so that the scoria which is formed may become fluid, and in that state separate itself from the metallic part, the scoria being allowed to run from the furnace, and thereby separate itself from the metallic part, which is left behind in the reducing-furnace, and may be extracted therefrom in any convenient manner. Should the ore contain any mattter deleterious to the production of a good quality of iron—such as sulphur, arsenic, or phosphorus—I propose to add such substances as are known to counteract these defects with the ore or ore and flux in the reducing-furnace with a view of removing, wholly or in part, these deleterious agents, and thereby improving the quality of the iron produced. From the foregoing it will appear that the ore being carbonized, the metal is obtained out of the reducing-furnace in the state of a pasty consistence, (almost entirely freed from the scoria,) and not in a fluid form, as it is when produced by the common blast-furnace, besides the metal so produced being purer and in a better state for being converted into bar-iron.

The foregoing being a general description (or explanation) of the process, I shall next refer to the kind of furnaces which I make use of for producing the above effects, for the purpose of more clearly elucidating the manufacturing process and the particular manner of carrying my improvements into effect.

In the drawings or plans hereunto annexed, marked Plan No. 1, Figure 1 is a front elevation of a carbonizing-furnace plated on the outside with cast-iron, for the purpose of strengthening the same. Fig. 2 is a side elevation of the same furnace; Fig. 3, a horizontal section thereof in the line A B of Fig. 1; and Fig. 3bis is a vertical section of the upper part of the furnace from side to side, or rather two vertical sections in different planes, parallel to the front. The left-hand half is a section through a flue-space, along which the flame and heated air from the fire pass between the respective carbonizing-chambers, K K K being the flue-spaces, which are supported and divided by cross-walls D D, that serve not only as stays to the sides of the chambers, but also to distribute the heat more equably on the exterior of the carbonizing-chambers than would be done by one wide-open flue-space. The right-hand portion is a section through one of the carbonizing-chambers C, between which carbonizing-chambers the flues K K K are situated. The number of carbonizing-chambers and of flues may be varied; but in the drawings I have represented a furnace containing six chambers.

Where like parts are represented in these four figures they are designated by the same letters of reference.

I is an ash-pit extending from front to back of the furnace.

E, Fig. 1, is a door opening into the fire-room, E′, Fig. 3bis, which is furnished with grate-bars M M in the ordinary way.

In the section, Fig. 3, C C C are the carbonizing-chambers, with the flues K K between them, D D being their dividing or stay walls. The flame and heated air ascend through each of these flues, heating the carbonizing-chambers. Each of these chambers is arched over, as shown at R R, an opening to each being left in the crown of the arch, as shown at L L, through which they are to be charged with the roasted ore, accompanied with the proper quantity of the carbonizing material, after doing which these openings are to be closely stopped. At the bottom of each of the chambers there is an opening, N N, Fig. 3, through which the carbonized material is to be discharged. This, during the operation, is closed by a metal plate or sliding shutter, which is opened after the process is completed and the furnace has been allowed to cool. These discharge-openings are within and over the space J J, (seen in the side elevation, Figs. 2,) *a a a* being the ends of rods by which the metal

plates or sliding shutters closing the openings N N may be governed. I also make lateral openings into the chambers, as shown at O, Fig. 3bis, for the purpose of detaching any part of the ore which may accidentally adhere to their sides. These lateral openings are closed by air-tight shutters, as shown at O′ O′, Fig. 2.

F F, Fig. 3bis, is an arch of fire-brick covering the furnace, and which confines the heat as it ascends. Into this arch the respective flues on the sides of the carbonizing-chambers all open. G G G are apertures through this arch into flues G′ G′ G′, all of which lead into one common horizontal flue, H H, which extends along the crown of the arch and terminates in the high chimney P.

The only kind of fuel which is applicable to this furnace is such as burns with flame—as bituminous coal and wood—for such fuel, being placed in the fire-room E′, not only gives out heat by its direct contact, but the flame passes from its surface along the flues K K, and, rising into the vaulted arch F F, reverberates against it and is reflected back to the carbonizing-chambers. Any convenient number of such chambers may be placed in one furnace, and their dimensions may be varied at pleasure, the main object being so to arrange them as that they shall contain as much ore as possible and be perfectly exposed to the heat, the flues and arches being so constructed as to render all the heat effective.

The carbonizing-furnace next described is to be used with fuel which does not produce flame, and a delineation thereof is contained on the sheet of drawings hereunto annexed and marked Plan No. 2.

Fig. 4 is a front elevation of a preparing or carbonizing furnace applicable to the combustion of coke, anthracite, or other fuel that does not produce any notable portion of flame, but which communicates heat by being in direct contact with the sides of the carbonizing-chambers and by radiation. Fig. 5 is an end elevation of this furnace. A A A A are four columns forming its corners and sustaining its hood, cap, or chimney T T, the brick-work being bound together by plates of cast-iron B B. Fig. 7 is a plan of the bottom of the furnace, taken in the line E G, Fig. 6. This bottom is composed of iron plates and of grate-bars F F F, for the admission of air to the fuel. It is supported by the iron columns S S S, and the body of the furnace is divided into alternate carbonizing-chambers and fire-spaces or receptacles for the fuel. Fig. 6 shows the interior construction of this furnace. C C C are the exterior walls of the carbonizing-chambers, between each of which chambers there is a fire-space, D D D, the part of the wall forming the fore ends of these spaces being removed for the purpose of exhibiting the interior. Fig. 8 is a vertical section from front to back through one of these fire-spaces, which is shown as divided into four parts by the stays or cross-walls P P P. These several parts communicate at the lower ends, Q Q Q, of the stays. The fire-spaces are open at top, and through the arched or covered tops of the carbonizing-chambers there are openings K K K, similar to those marked L L in the first-described furnace. Fig. 9 is a vertical longitudinal section through one of the carbonizing-chambers in a plane parallel with the section, Fig. 8. M M in this figure and in Fig. 7 are of the same kind and for the same purpose with those marked N N, Fig. 3, being provided and governed in like manner. N N, Fig. 6, are openings into the carbonizing-chambers similar to those marked O, Fig. 3bis, O′ O′ O′, Fig. 4, being their covers.

From the foregoing description it will be seen that this furnace is substantially the same in construction and operation with that first described, with no other difference than that which is necessary to adapt them to the particular kinds of fuel to be employed in them, respectively.

This furnace being ready to be charged, the tops K of the carbonizing-chambers are to be opened, and the ore having been properly prepared by roasting and mixed with the proper portion of carbonizing material, is put into a small wagon or car having a door at the bottom, and this is run along the railway L L, Figs. 4 and 5, until it arrives directly over one of the openings K. The ore and carbonizing material are then discharged into the chamber by opening the door at the bottom of the wagon, and this operation is continued until the whole of the chambers are filled. The openings K are then to be closed air-tight, a small portion of burning fuel is put into each of the fire-spaces, which are then to be filled with coke, anthracite, or other analogous fuel, and this becoming gradually ignited from bottom to top, and being in direct contact with the sides of the carbonizing-chambers, the necessary heat will be communicated to the materials which they contain, and this is to be continued until the ore has become completely carbonized. The furnaces are then to be allowed to cool gradually, and the ore is to be discharged through the proper openings. Any ore, also, which may adhere to the sides is to be detached and removed, and the chambers are then ready to receive another charge.

I sometimes so construct my furnace as to carry on the operations of roasting the ore and of carbonizing a separate portion of roasted ore at the same time, using the heat disengaged in the former of these processes to effect the latter. In Figs. 10, 11, 12, and 13 on plan No. 1 of the accompanying drawings this furnace is delineated. Fig. 10 is a front elevation, and Fig. 11 a plan, thereof. In this latter figure, A A is the carbonizing-chamber, which is constructed in the same way with those already described. This chamber extends from side to side of the furnace, and is situated between the compartments B B B, in which the ore is to be roasted. These are shown as divided into three compartments on each side of the carbonizing-chamber; but this number may

be varied at pleasure. The division-walls serve as stays to those of the carbonizing-chamber. B′ B′ B′ in Fig. 10 are grate-doors opening into the roasting-compartments, admitting the air necessary to the carrying on of this process, and, being hinged at C C, allow, when opened, of the discharge of the roasted ore. Fig. 12 shows the interior of the compartments B B, the front being removed for that purpose. Fig. 13 is a longitudinal and vertical section through the carbonizing-furnace. D D are the openings through its top for charging the chamber, and E E openings through which the carbonized ore may be discharged; or, in addition to these openings, there may be openings into an arch below this chamber, for the discharge of the ore, as in the other modifications thereof already explained.

After the carbonizing-chamber has been duly charged with the prepared ore and carbonizing material, a small quantity of burning fuel is to be put into each of the compartments B, and then a proper quantity of raw iron-stone or ore is added, and upon this is placed a portion of fuel, and so on until each space is filled. It is then left to burn in the usual manner, and the heat disengaged in this roasting operation taking place in contact with the walls of the carbonizing chamber or chambers will heat the materials contained therein, so as completely to effect the purpose intended, the roasting operation being continued until this is accomplished. The furnace is then allowed to cool, the roasted and carbonized ores are removed, and the furnace is ready to repeat the same operation.

My next improvement consists in the manner in which I reduce the carbonized ore to the metallic state. This I effect by means of a small cupola-furnace of a novel construction, and by the use of which the process of reduction is greatly economized in the quantity of fuel and labor employed, and a metal uniform in quality and much superior to pig-iron for the manufacture of bar-iron is at once obtained. There also arises a great saving from the manner in which I construct my furnace, as I thereby render it unnecessary to erect large blast-furnaces with their expensive steam-engines and blowing apparatus, such as are now used in England and elsewhere.

The separating or reducing furnace which I am now about to describe may be variously modified, while its construction and the principle upon which it operates may remain substantially the same; but the form in which I have represented it in the accompanying drawings is that which I prefer.

In Plan No. 3 of the drawings hereunto annexed, Fig. 14 is a perspective view of, and Fig. 15 a vertical section through, my small cupola furnace. A, Fig. 1, is a door through which the carbonized ore, either alone or mixed with flux, as its nature may dictate, is to be introduced, so as to lie on the bed B, Fig. 15, of the furnace, where it is heated and prepared for being raked into the body F of the cupola. At the end C of the reverberating arch or top I of this furnace is the door C, by which the fuel is to be introduced. A proper quantity of this having been supplied and ignited, the furnace is to be filled with alternate layers of fuel and of the prepared and heated ore, and these are to be acted upon by a blast from three tuyeres, two of which, D D, Figs. 14 and 15, are placed about eight or ten inches above the third, E. The tuyeres D D serve to give the blast by which the ore is melted, while the third, E, is so situated and employed as to keep the scoria in a fluid state, and thus to facilitate the complete separation of the iron from it.

I will now recapitulate and describe the manner of operating upon the ore so as to produce the metal.

The ore, having been carbonized in either of the carbonizing-furnaces, is introduced into the within-described cupola by the door A, along with the flux, should any be required, the fuel being put in by the door C. The ore or ore and flux, after having become duly heated in the arch, is raked into the mouth of the cupola F and intimately mixed with a sufficient quantity of fuel to reduce it as it descends. The carbonized ore is thus subjected to a simple melting, and flux is added, if it is required, in such proportions as shall facilitate the complete fusion of the earthy matter contained in the ore. The scoria being thus rendered fluid runs away over the dam-stone G, while the metal is left behind in a mass of a pasty consistence at the bottom H of the furnace, whence it may be removed by tongs, or in any other convenient mode known to founders. It will then be found in a more suitable state to be manufactured into bar-iron than when prepared in the ordinary way.

Having thus fully described the nature of my improvements and shown the manner in which I carry the same into operation, I do hereby declare that I do not claim as my invention the carbonizing of the ore in a furnace separate from that in which the smelting and reduction thereof are effected, the same having been before done or attempted, but in a manner differing in certain important particulars from that adopted by me.

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

1. The particular manner of constructing and of operating with the respective furnaces, as herein described—that is to say, I claim the manner of constructing, arranging, and combining the carbonizing-chambers, fire-room, flues, charging and discharging openings, and arches, as represented in Figs. 1, 2, 3, and 3bis, and described in the foregoing specification, in which the carbonizing-chambers consist of close compartments, with charging-openings at the top, furnished with close-fitting stoppers, and otherwise formed so as to adapt them to fuel which burns with flame,

and operating in all respects substantially in the manner herein set forth.

2. The manner of constructing and arranging the carbonizing-furnace in which anthracite, coke, or other flameless fuel is employed to heat the carbonizing-chambers, said furnace being provided with a carbonizing chamber or chambers similar to those used under the first modification, and constructed substantially in the manner or on the principle represented in Figs. 4, 5, 6, 7, 8, and 9, and fully described in the references thereto.

3. The manner in which I have combined the operations of roasting the ore and of carbonizing that which has been previously roasted, employing carbonizing-chambers of the same kind as under the two preceding modifications, and otherwise arranging and operating with the respective parts as represented in Figs. 10, 11, 12, and 13, and herein fully made known.

4. The manner of constructing, arranging, and combining the respective parts of the furnace for reducing the prepared iron ore, as represented in Figs. 14 and 15, and herein fully described, said construction, combination, and arrangement consisting in the manner in which I have combined the cupola with the arch I, its bed B, for heating the ore, the provision for feeding in the ore and fuel, and the manner of introducing the blast, by which construction and arrangement the slag and scoria alone are rendered perfectly fluid and run away from the metallic part, said slag and scoria escaping over the dam-stone G, leaving the metallic part in the bottom of the furnace in a state of pasty consistence incapable of being run off as in the ordinary smelting-furnace, and much better adapted to the purpose of being converted into bar-iron; and this construction and arrangement I claim under the various modifications of which they are susceptible, while the same result is attained by means substantially the same.

CHARLES SANDERSON.

Witnesses:
JAMES SANDERSON,
WILLIAM SMITH.