No. 640,283. Patented Jan. 2, 1900.

F. E. HATCH.

ELECTRIC FURNACE.

(Application filed Mar. 4, 1899.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 1

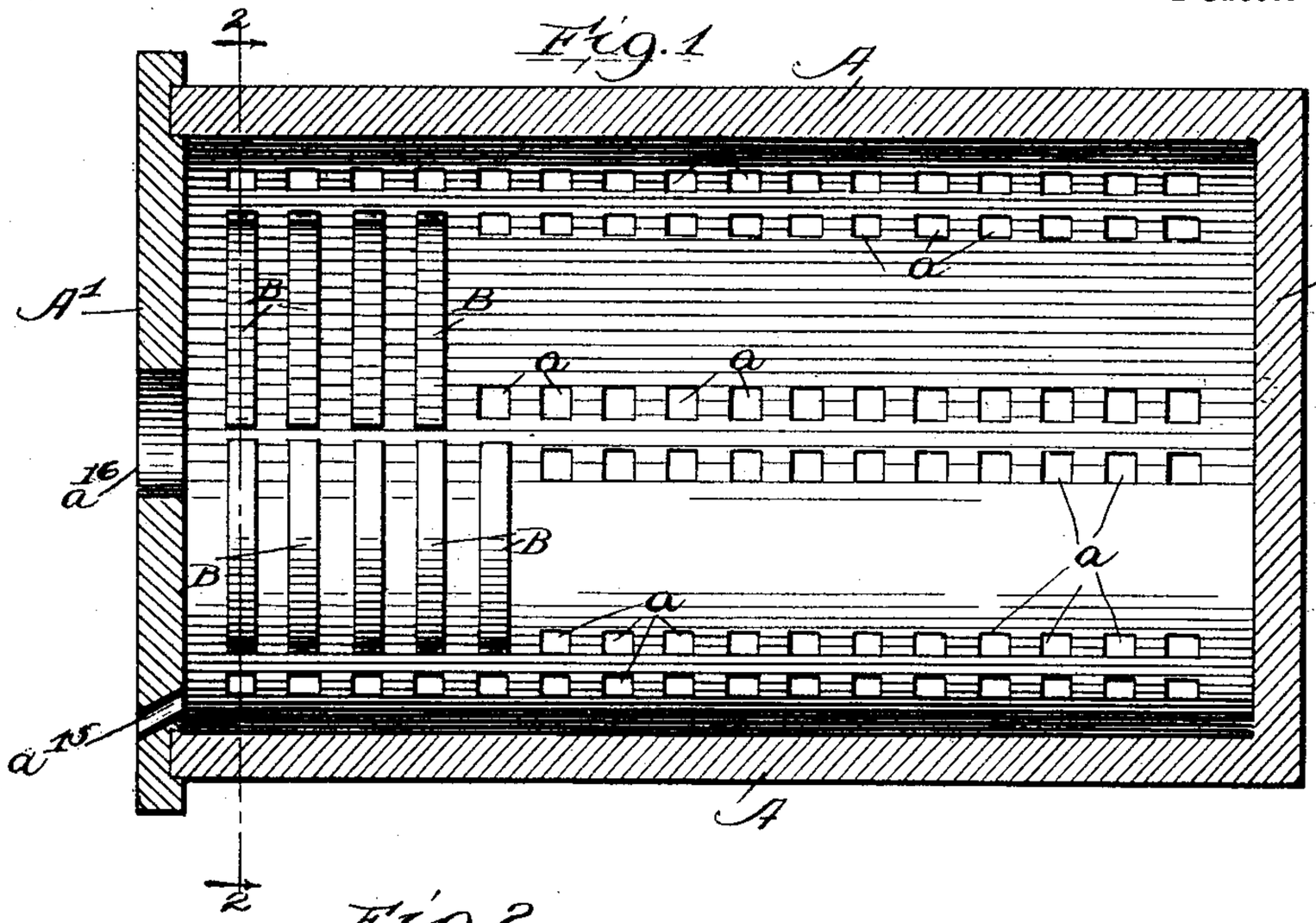

Fig. 2.

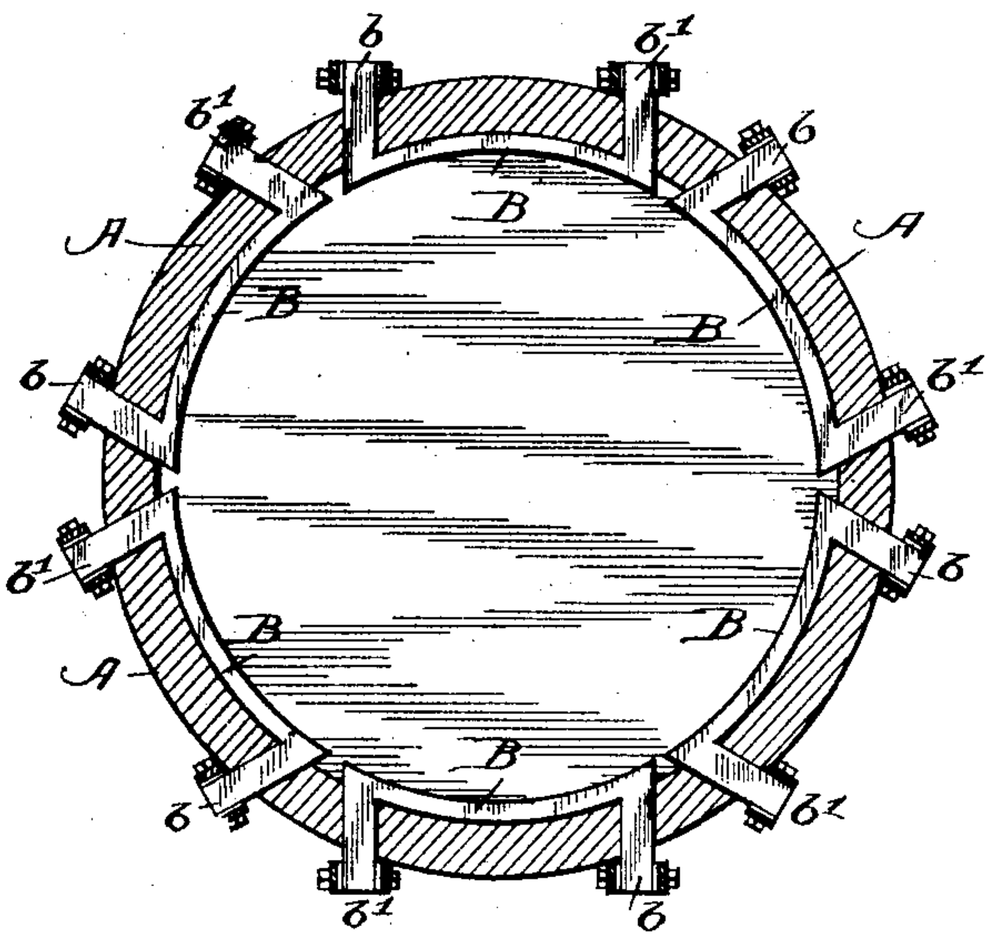

Fig. 3.

Fig. 4.

Fig. 5.

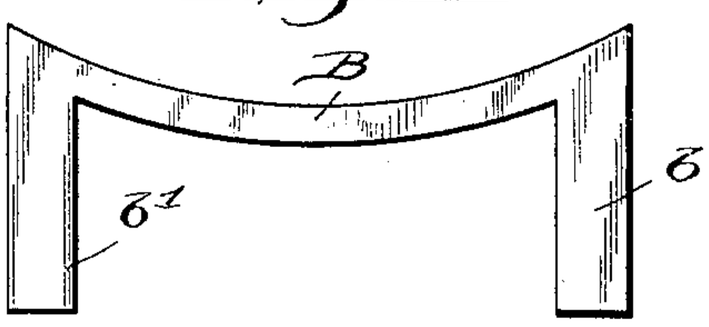

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Fig. 6.

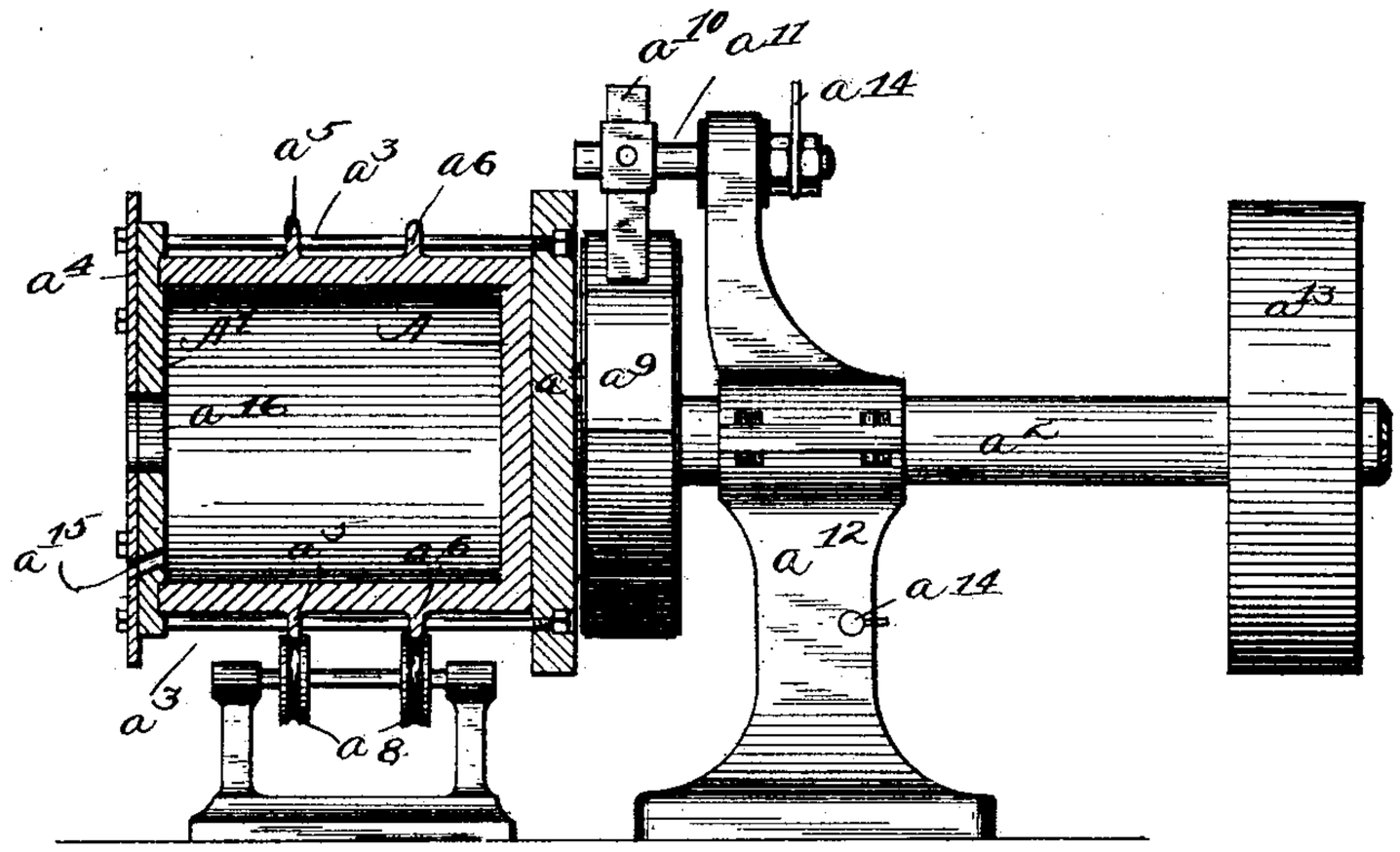


Fig. 7.

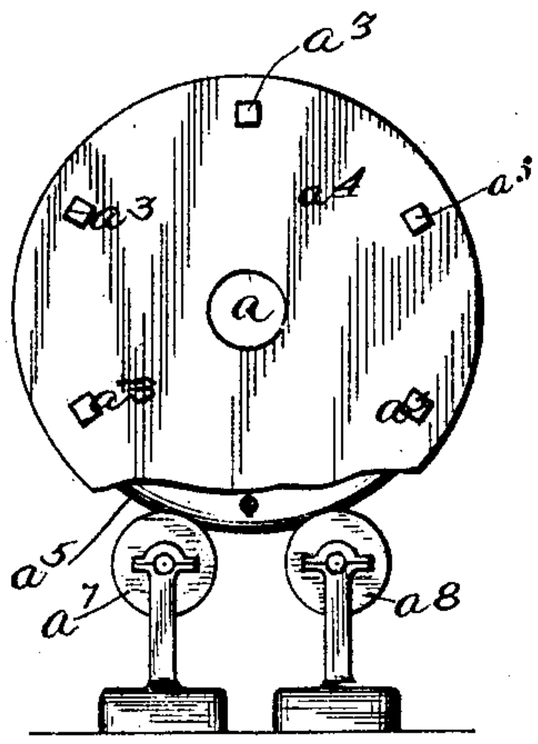
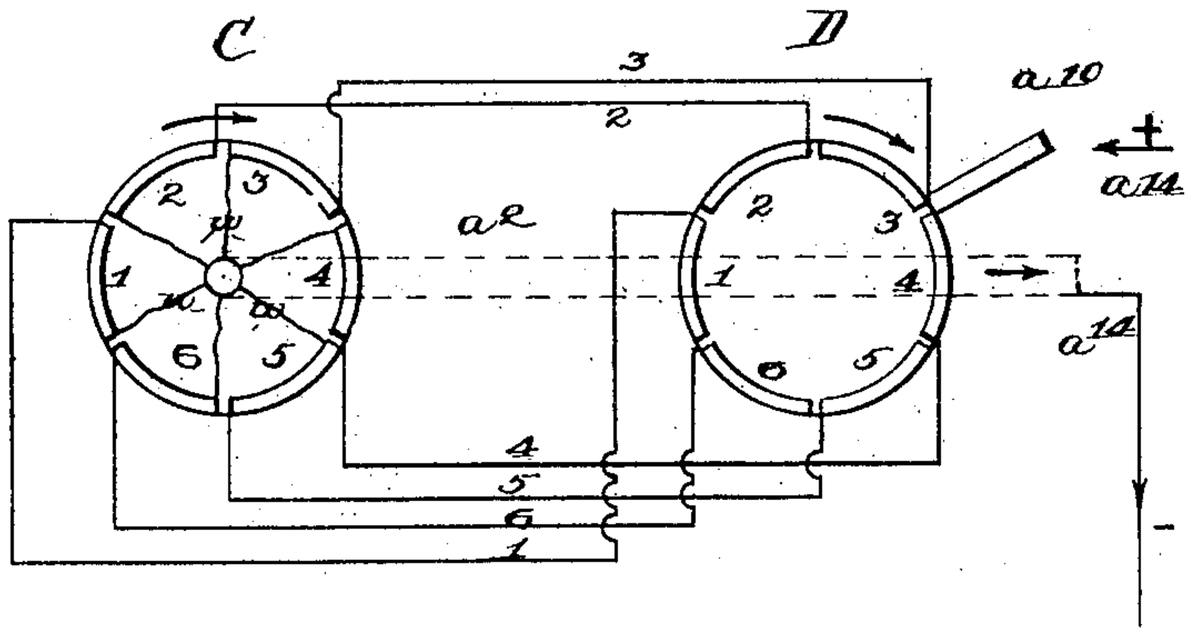


Fig. 8.



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UNITED STATES PATENT OFFICE.

FRANCIS E. HATCH, OF NORWAY, MICHIGAN.

ELECTRIC FURNACE.

SPECIFICATION forming part of Letters Patent No. 640,283, dated January 2, 1900.

Application filed March 4, 1899. Serial No. 707,705. (No model.)

To all whom it may concern:

Be it known that I, FRANCIS E. HATCH, a citizen of the United States, residing at Norway, county of Dickinson, and State of Michigan, have invented a Process of and Certain New and Useful Improvements in Electric Furnaces for Smelting Ore or the Like; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable persons who are skilled in the art to which it appertains to practice, make, and use the same.

My invention relates to a process of smelting ore and to improvements in electric furnaces and especially to that class known as "incandescent" in contradistinction to those wherein the electric arc is employed for smelting ores, metals, or the like.

The object of my invention is to provide a means wherein the entire charge of material to be smelted is uniformly subjected to the heating effect of the current without being traversed by the current, so that the work done in the furnace is more constant than is possible to be maintained when the current is caused to pass directly through the charge. In the latter event the electric resistance of the charge varies with its changing condition, and the path through the charge is in the most direct line of least resistance, the result of which is to overheat or volatilize a portion of the charge, while a larger portion thereof is not influenced by the thermic effect of the current. To overcome these objections, I heat a refractory conductor to a high state of incandescence by the electric current and then pass the conductor while so heated under the charge to be smelted or cause the charge to cover or surround the incandescent conductor until the heat contained therein has been imparted to the charge. By heating a series of like conductors and passing them in succession into the charge I find that the charge can be more uniformly heated and that the resistance through the various conductors is more constant than obtains when the charge itself forms a part of the electric path.

With these and other objects in view my invention consists in a new method of and furnace for smelting metal, ores, and the like by the application of an electric current wherein a refractory electric conductor is heated to a high state of incandescence and then placed in intimate contact with the material to be effected.

In the accompanying drawings, which form a part hereof, I have shown one form of furnace by which my new method may be carried into effect.

Figure 1 is a cylinder of refractory material, such as fire-clay or the like. Fig. 2 is a cross-section taken through line 2 of Fig. 1. Figs. 4 and 5 are detailed views of the carbon conductors, which are contained within the cylinder. Fig. 3 is a plan view, showing the manner in which the terminals of the various carbon conductors are connected together. Fig. 6 is a reduced view of the assembled parts constituting a rotary furnace. Fig. 7 is a broken-away end of same, showing the roller-guides upon which the cylinder A is supported. Fig. 8 is a diagram of connections between the carbon sections and the commutator.

Referring to Fig. 1, A is a cylinder of refractory material, provided with openings a in its circumference, through which carbons B, having terminal pieces b and b', pass and which are connected together on the exterior thereof, as shown in Figs. 2 and 3, in this manner forming a terminal for all the carbons in each of the respective sets. The cylinder shows places for six sets with sixteen carbons in each set. The carbons when placed within the cylinder, as shown, form a complete lining, consisting of ninety-six carbons, each presenting a maximum of surface.

Fig. 6 shows my furnace complete and ready for operation, with the exception that for the sake of clearness I have not shown the carbons B in place. A is the cylinder, into which the ore or the like is placed. A' is a cap which covers one end, having a hole a^{16} through the center for escape of gases and admission of air. The cylinder A is held against the face-plate or flange a' of the shaft a^2 by means of bolts a^3, which pass through the face-plate on the shaft and through the plate a^4 on the front end of the cylinder A. They also pass through the rings a^5 and a^6. The rings a^5 and a^6 are designed to surround the cylinder A and are adapted to engage with the rollers a^7 and a^8. By means of this arrangement the cylinder

is supported in a horizontal position while it is being rotated. Attached to the face-plate a' is a six-part commutator a^9, to each section of which one of the terminal carbon sections in the cylinder is connected. A brush a^{10}, which bears upon the commutator a^9, is held in position by the insulated stud a^{11}. The latter forms one electrical terminal of my furnace. The shaft a^2 is journaled in bearing a^{12}. The pulley a^{13} affords a means by which the shaft and cylinder may be rotated. The electric wires may be connected to a stud a^{11} and connection a^{14} on the standard a^{12}.

Fig. 8 is a diagram of the connections between the carbon sections of the cylinder and the commutator. C represents the carbons within the cylinder A, and D represents the commutator. The carbon sections I have numbered from "1" to "16," inclusive, and corresponding commutator-sections are designated in the same manner. Connecting-wires numbered to correspond with the carbon and commutator sections connect the respective sections together. One end of each of the carbon sections is connected to the shaft a^2 by means of wires w. The arrows show the electric circuit and also the direction of rotation of the cylinder and commutator.

The operation of my device is as follows: Iron ore or the like with the necessary flux and reducing agent, such as carbon and lime, when the furnace is to be used for smelting iron ore, is placed within the cylinder A until it is filled about even with the lower edge of the hole a^{16}. The material is then in contact with the three lower sets of carbons, Fig. 2. The circuit is attached to the terminals a^{14}. Now referring to Fig. 8 it will be seen that the current will flow from brush a^{10} through wires 3 and 4, through the respective carbon sections 3 and 4, and thence to the shaft to the opposite wire of the supply-current, completing the circuit through the machine. This condition of parallel circuit only lasts for a very short time while brush a^{10} is in contact with both commutator-sections 3 and 4. Section 4 has been heated by the current and the cylinder is now being rotated, while the hot section 4 is approaching lowest position and the ore, flux, &c., contained within the cylinder are being piled upon it by the effect of the rotation. Section 3 will be heated next, when it in turn will pass under the ore, as above described. They will all be in like manner and in consequence heated and passed into and out from under the ore on the opposite side of the cylinder.

Powdered or granular carbon and lime may be placed in the furnace with the iron ore. The iron is contained in the ore in a state of oxid—that is, in chemical combination with oxygen. This element must be removed in order to obtain the iron in the metallic state. This could be readily done by the carbonic gases and heat of the furnace if the ore consists of oxid of iron only; but the presence of clay in the iron ore introduces a difficulty. Clay consists of alumina and silica and cannot be readily melted alone. In the presence of oxid of iron the clay combines chemically and melts to a liquid black glassy substance, containing most of the iron; but if lime (preferably quicklime) be mixed with the ore the clay will combine with it instead of combining with the oxid of iron. The iron will then be left clear of the silica and alumina.

The air admitted into the furnace consists of one part oxygen and four parts nitrogen, which, coming in contact with the glowing carbon granules, combines quickly, forming a carbonic-acid gas containing eight parts oxygen and three parts of carbon, and it will give up one-half of its oxygen to the heated carbon in turn and becomes carbonic-oxid gas, which consists of four parts of oxygen and three parts carbon. When the carbonic-oxid gas meets the red-hot ore containing oxid of iron, it regains sufficient oxygen to convert it into carbonic acid, thus reducing the iron to a metallic liquid state.

It will be noticed by referring to Figs. 2 and 8 that while the current is heating section 3, for instance, there is no ore in contact with this carbon section and that the entire current is utilized in heating this section and is not directed through the ore. Therefore a more uniform resistance is maintained and a constant regular load on the dynamo will result.

The cylinder may be revolved slowly at a constant speed or in impulses by any suitable mechanism. By this operation the ore is tumbled over and covers the carbon sections that are approaching the lowest position. At the same time these said carbon sections have just been passed out from the pyro-electric effect of the electric current and are in a state of incandescence. The charge absorbs the heat of the incandescing carbons and is again tumbled over and covers the next set of incandescing carbons as they approach the lowest position. This operation is repeated as the cylinder is revolved, each set of carbons being heated and passed in turn into contact with the ore. In the course of time the ore will be smelted, when iron may be drawn out through the hole a^{15}.

It is evident that the carbon section B may be made in one solid piece, but I prefer to make them as shown, as in this form they present more surface and they may be more easily and cheaply replaced in sections than in one piece.

The brush a^{10} may be rotated around the commutator to any point, so as to control the point where the carbon sections B shall leave the electric circuit.

My furnace may be used to greater advantage for smelting iron ore where it is desirable to heat the ore to a degree sufficient to separate the iron, but not to such a high temperature as to volatilize the iron.

The cylinder of my furnace may be made of fire-clay or other refractory materials, such as that contained in fire-brick, crucibles, and the like.

From the above description, taken in connection with the accompanying drawings, it will be seen that I have provided an electric furnace by which ore, metal, or the like may be heated indirectly by the effect of an electric current to a uniform temperature and that the material so heated does not at any time form a part of the electric circuit, and in this particular I believe my furnace differs from all others heretofore known.

I desire it understood that I do not limit myself to any specific details of construction nor to the construction of any particular form of furnace, as my invention consists in the process or method of melting metal ores or the like in the manner hereinbefore shown and described, and I reserve to myself the right to all of the uses of my process that will fairly fall within the spirit and scope of my invention.

Having described my invention, what I claim as new and useful, and desire to secure by Letters Patent, is—

1. A process for treating ore, metal or the like, which consists in heating a refractory electric conductor to a high state of temperature by the direct application of an electric current, withdrawing the current and subjecting the material to be treated to the thermic effect of the said electric conductor, substantially as set forth.

2. A process for smelting ore, metal or the like, which consists in heating a refractory electric conductor to a state of incandescence with an electric current, withdrawing the current, and then placing the incandescing conductor in intimate contact with a material such as ore, or the like, associated with a suitable reducing agent, whereby the said material is smelted, substantially as set forth.

3. A process for smelting ore, metal or the like, which consists in heating a refractory, independent, continuous conductor by including it within an electric circuit, disconnecting it from the said electric circuit, and subjecting the material, associated with a suitable reducing agent, to the thermic effect of the said electric conductor, whereby the said material is smelted, substantially as set forth.

4. A process for smelting ore, metal or the like, which consists in heating a series of refractory electric conductors by the application of an electric current, by subjecting said conductors to the effect of said current in sequence, and placing said conductors, after being so heated, successively in contact with the material to be smelted, associated with a suitable reducing agent whereby said material is smelted, at the same time other conductors of the said series are being heated by the current, substantially as set forth.

5. An electric furnace consisting of a horizontal cylinder, composed of electric insulating, refractory material, electric conductors adapted to be heated to a high degree of temperature, placed on the inner surface of the said cylinder, a means for rotating the cylinder, and an electric circuit including a commutator and the said electric conductors, substantially as set forth.

6. An electric furnace consisting of a horizontal cylinder composed of electric insulating, refractory material, electric conductors, adapted to be heated to a high degree of temperature, divided into groups on the inner surface of the said cylinder, a means for rotating the cylinder, an electric circuit and a commutating device for directing the current through the said groups of conductors in succession, substantially as set forth.

In testimony whereof I have signed this specification, in the presence of two subscribing witnesses, this 27th day of February, 1899.

FRANCIS E. HATCH.

Witnesses:
FORÉE BAIN,
M. F. ALLEN.