No. 775,031. PATENTED NOV. 15, 1904.

W. S. FRANKLIN.

METHOD OF ELECTRICALLY TREATING MATERIALS.

APPLICATION FILED DEC. 3, 1900.

NO MODEL. 2 SHEETS—SHEET 1.

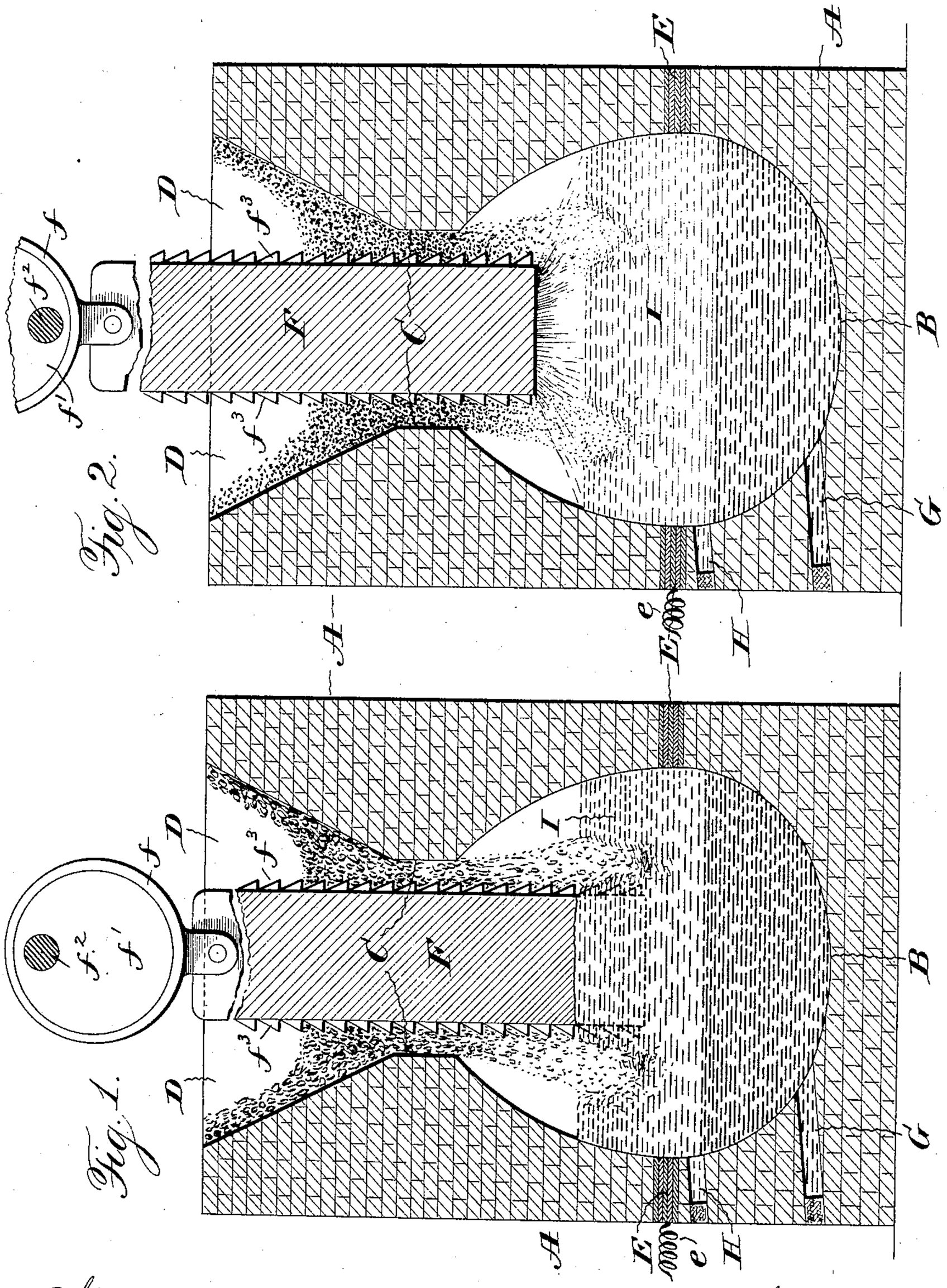

Fig. 2.

Fig. 1.

Witnesses:
Jas. E. Hutchinson
Henry C. Hazard.

Inventor.
William S. Franklin by
Prindle and Russell, his Attys

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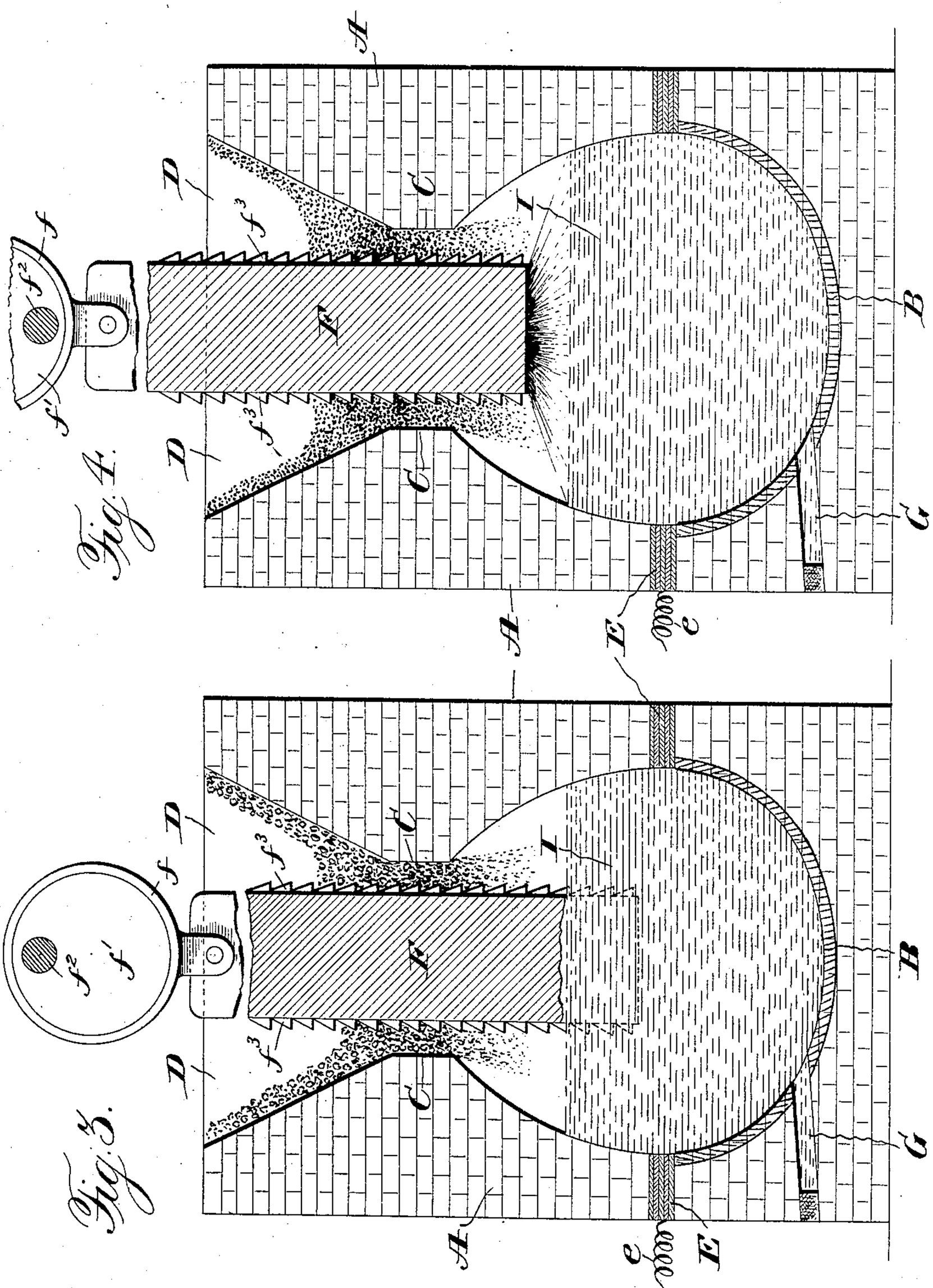

Fig. 4.

Fig. 5.

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UNITED STATES PATENT OFFICE.

WILLIAM S. FRANKLIN, OF SOUTH BETHLEHEM, PENNSYLVANIA, ASSIGNOR OF ONE-HALF TO FREDERICK CONLIN, OF BETHLEHEM, PENNSYLVANIA.

METHOD OF ELECTRICALLY TREATING MATERIALS.

SPECIFICATION forming part of Letters Patent No. 775,031, dated November 15, 1904.

Application filed December 3, 1900. Serial No. 38,489. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM S. FRANKLIN, of South Bethlehem, in the county of Northampton, and in the State of Pennsylvania, have invented certain new and useful Improvements in Methods of Electrically Treating Materials; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, in which—

Figure 1 is a vertical sectional view of a furnace which is adapted to the use of my method, the upper electrode being partly immersed in the molten high-resistance conductor and the method being illustrated as applied to the reduction of iron ore. Fig. 2 is a similar view, the upper electrode being positioned above the upper surface of the molten high-resistance conductor; and Figs. 3 and 4 are respectively views similar to Figs. 1 and 2, illustrating the application of my method to glass-making.

Letters of like name and kind refer to like parts in each of the figures.

The objects of my invention have been to provide an improved method of electrically treating materials by which they can be heated and also, if desired, refined; and to such ends my invention consists in the method of electrically treating materials hereinafter specified.

As an example of apparatus by which my method can be carried into practice, although such method is capable of practice with many other forms of apparatus, I have illustrated an electric furnace consisting of a structure A, in the lower portion of which is formed a preferably pear-shape chamber B, that communicates at its upper end with a short cylindrical passage C. The upper end of the passage opens into a flaring mouth D, by which materials are introduced into the furnace. At a level well above the bottom of the chamber B a layer of carbon, metal, or other suitable material which is a conductor of electricity, preferably in the form of plates E and E, is built into the structure A, and such layer preferably extends entirely around the circumference of the said chamber. It is not, however, essential that the layer of carbon should occupy more than a portion or point of such circumference. If desired, the entire walls of the chamber B may be covered with carbon. The portions of the chamber B which are not covered with carbon and also the passage C and mouth D are preferably covered with refractory material, such as fire-brick.

The layer of carbon is connected, as by a terminal *e*, with a source of electricity and forms one of the electrodes of the furnace. The second electrode is preferably in the form of a rod or bar F of carbon, metal, or other suitable material which is a conductor of electricity, such rod being supported in any suitable manner. I have shown the bar as hung from the strap *f* of an eccentric *f'*, which is fixed on a shaft f^2. The bar F is provided with downwardly-inclined teeth f^3 and f^3 on its sides. Near the bottom of the chamber B a vent G passes through the walls of the structure A and communicates with such chamber. At a higher level than the vent G a second vent, H, affords communication with the chamber B through the wall of the structure A. The vents G and H are normally closed. Any convenient form of closure can be used—such, for instance, as a plug of clay.

In the practice of my method with the above-described electric furnace a portion of the chamber B is filled with a molten electrical conductor I which has a high electrical resistance. Such materials as slag or glass are suitable for the molten conductor. The current of electricity is made to pass from one electrode to the other through the molten conductor I. The passage of the current through the molten conductor develops a large quantity of heat, owing to the resistance to such passage, and the said conductor is raised to and maintained at a very high temperature. If the upper electrode F be partly immersed in the molten conductor I, as shown in Fig. 1, the heat developed will be almost entirely due to the resistance of such conductor. If, however, the upper electrode be raised above the upper surface of the molten conductor, an arc

will be formed between such electrode and the said surface, and the heat of such arc will be added to the heat developed by the resistance of the molten conductor.

The furnace can be constructed with the carbon rod partly immersed in the molten conductor, in which case the heat will be generated almost entirely in such conductor, or it can be constructed with the carbon rod above the upper surface of the molten conductor, in which case heat will be generated both by the arc formed between the carbon rod and the molten conductor and by the passage of the current through such conductor, or, as I prefer, it can be constructed so that the carbon rod is vertically adjustable to permit of the use of the furnace either with or without the arc.

The material to be acted upon by the furnace is introduced into the mouth D and is fed slowly downward by any suitable means. In the example I have chosen for illustration the feeding is caused by the reciprocation of the carbon rod. As the latter descends the horizontal under surfaces of the teeth f^3 and f^3 engage the material and carry it downward. When the carbon rod rises, both the action of gravity and the inclined upper surfaces of the teeth f^3 and f^3 facilitate the passage of the teeth upward through the material without raising the latter, so that on the next downward stroke a fresh quantity of material shall be fed downward. In its downward passage such material is first subjected to the action of the heat ascending from the molten conductor and afterward comes into contact with the highly-heated molten conductor itself. If the upper electrode is raised above the molten conductor, the descending material is also directly acted upon by the arc formed between said electrode and such conductor. If the product resulting from the action of the heat or electricity, or both, on the descending material is of greater specific gravity than the molten conductor, such product will pass through said conductor and collect in the bottom of the receptacle B. During the passage of the said product through the molten conductor the product will be separated from impurities of lighter specific gravity than itself, as such impurities will either float on the surface of the molten conductor or will remain in the body thereof. The product can then be drawn from the lower vent, while the molten conductor can be kept at the proper level by means of the upper vent. If such product is of less specific gravity than the molten conductor, said conductor will occupy the bottom portion of the receptacle B, while the product will accumulate at the level of the upper vent and can be withdrawn therethrough. In such case if the product be of greater conductivity than the molten conductor it is desirable not to have the lower electrode extend above the level of the molten conductor.

In practicing my method in the above-described furnace for the reduction of iron ore the molten conductor I prefer to use is slag. The usual charge containing the ore is fed slowly through the mouth D and passage C into the chamber B. Such feeding can either be in a continuous stream or at intervals, as desired. The latter form of feeding facilitates the adjustment of the quantity of material to be treated to the capacity of the furnace and also enables the charge of ore, coal, limestone, &c., to be fed separately and to be accurately regulated in quantity. As the charge passes downward the ore is reduced during its descent by the heat ascending from the molten conductor or from such conductor and the arc, according as the carbon rod is immersed or not in the molten conductor. When the ore reaches the intensely hot slag, it melts and filters through the slag to the bottom of the receptacle B, where it collects. The iron is drawn off as desired through the lower vent, and the slag is kept at the proper level through the upper vent.

In using the hereinbefore-described furnace to carry out my method for the making of glass only one vent is necessary. For such purpose I use glass itself as the molten conductor, the chamber B being filled to the proper level with such material, The raw materials from which the glass is to be formed are fed through the mouth D and passage C into the chamber B. Such materials become heated as they descend until when they reach the surface of the intensely hot molten glass they are fused and form glass, which is added to the mass of the molten conductor. In constructing the furnace for glass-making it is desirable to line the lower portion of the chamber B with carbon or other conducting material.

In the practice of my method in the before-described furnace the heat being generated in and on the mass of molten conductor easily reaches a large mass of the material to be acted upon, which is not true of a process in which an electric arc alone is used. In the latter case the heat is concentrated in a small zone and is not readily distributed to the mass to be acted upon. When the said furnace is used according to my method with the carbon rod immersed, the heating electric current passes wholly through the circuit formed only by the electrodes and the molten conductor and the resistance to such current is substantially uniform. It is therefore necessary in such case to provide automatic means for adjusting the qualities of the current to the resistance of the circuit.

My method is applicable to the treatment of other materials than iron ore and glass, and changes which are within the scope of my invention can be made.

My method of electrically treating materials is adapted for use with the ores ordinarily

used in the blast-furnace, and the proportions of flux and reducing agent will be approximately the same as in blast-furnace practice.

Having thus described my invention, what I claim is—

1. As an improvement in the art of electrically treating materials, the method which consists in passing a current between electrodes and through a molten vitreous conductor that only partially fills the space between said electrodes, and causing such materials to pass through the arc formed between one of such electrodes and said conductor and also to pass through such conductor, substantially as and for the purpose described.

2. As an improvement in the art of electrically treating materials, the method which consists in passing a current through molten slag that forms part only of the normal electric circuit, and causing such materials to pass through the slag, substantially as described.

3. As an improvement in the art of electrically treating materials, the method which consists in passing a current between electrodes within a chamber and through molten slag, that only partially fills the space between the electrodes, causing the materials to pass first through the arc formed between one of the electrodes and the slag, and then to pass through the slag, substantially as described.

4. As an improvement in the art of electrically treating materials, the method which consists in passing a current between the electrodes within a chamber and through molten slag that only partly fills the space between the electrodes, constantly varying the distance between said electrodes, and causing the materials to pass first through the arc formed between one of the electrodes and the slag, and then to pass through the slag.

In testimony that I claim the foregoing I have hereunto set my hand this 30th day of October, 1900.

WM. S. FRANKLIN.

Witnesses:
H. W. BROWN,
HOWARD L. BRONSON.