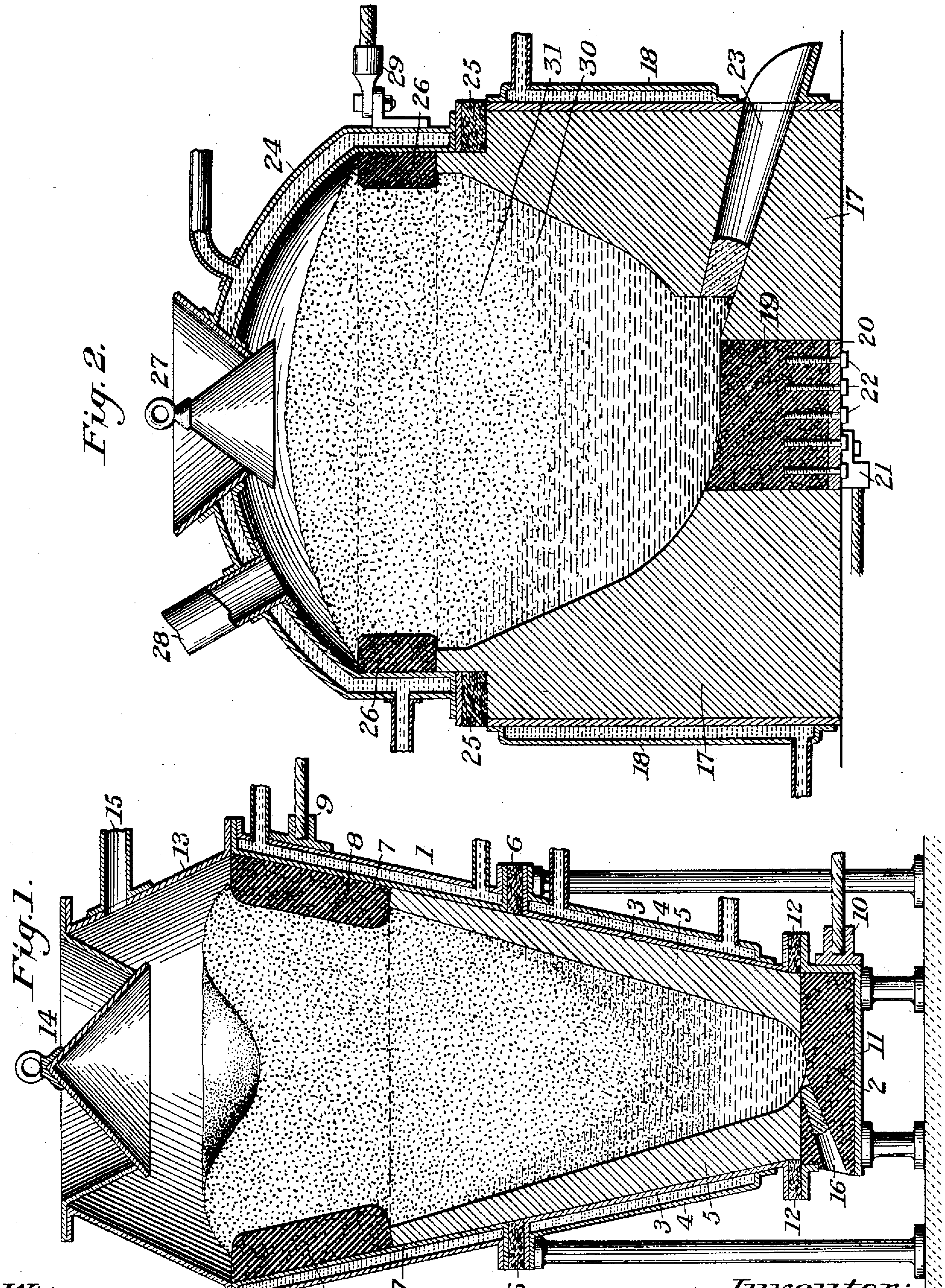
No. 750,171. PATENTED JAN. 19, 1904.

A. H. COWLES.

ELECTRIC FURNACE.

APPLICATION FILED NOV. 20, 1902.

NO MODEL. 2 SHEETS—SHEET 1.



Witnesses:
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W. E. Neff.

Inventor:
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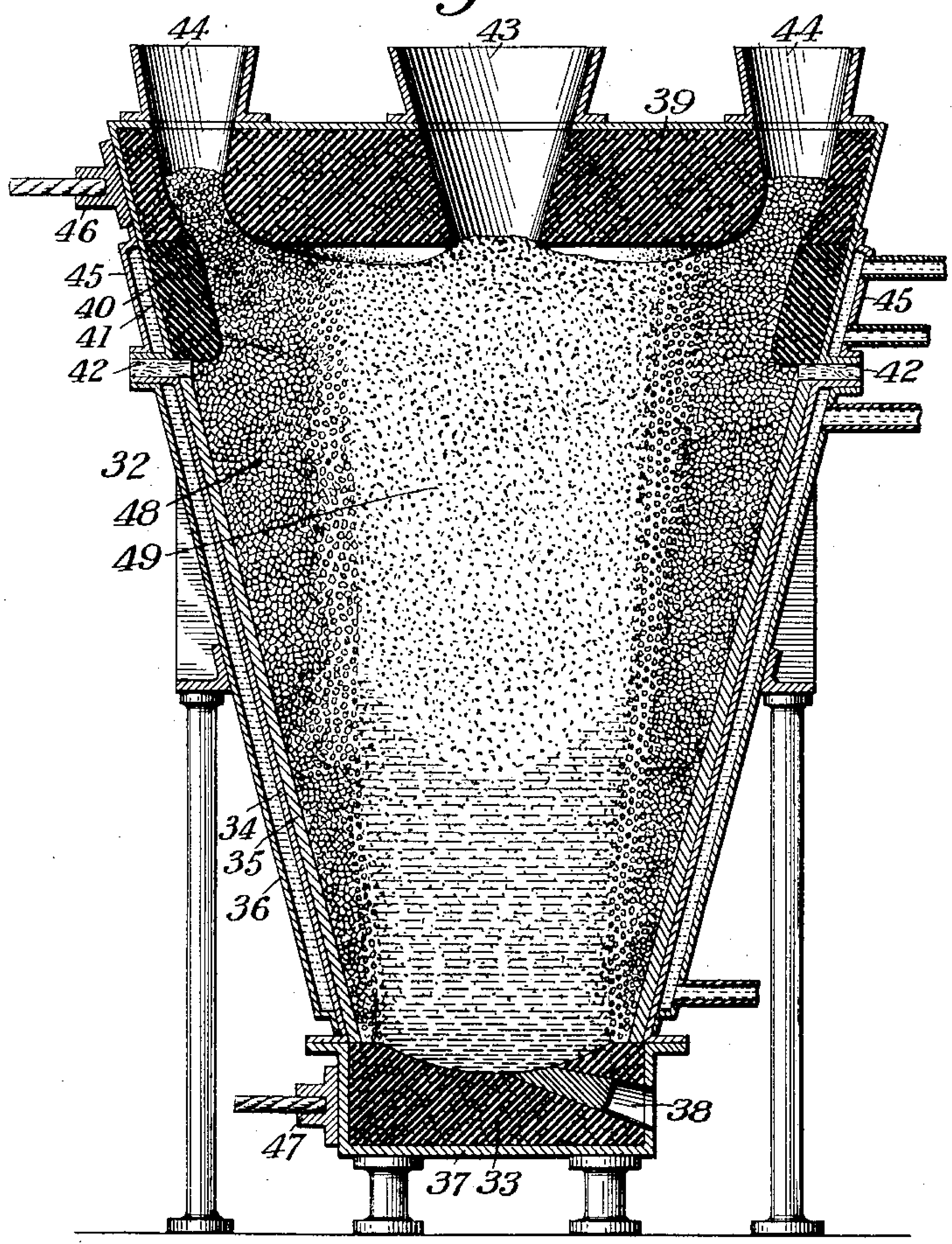
NO MODEL. 2 SHEETS—SHEET 2.

Fig. 3.



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UNITED STATES PATENT OFFICE.

ALFRED H. COWLES, OF CLEVELAND, OHIO.

ELECTRIC FURNACE.

SPECIFICATION forming part of Letters Patent No. 750,171, dated January 19, 1904.

Application filed November 20, 1902. Serial No. 132,134. (No model.)

To all whom it may concern:

Be it known that I, ALFRED H. COWLES, a citizen of the United States, residing at Cleveland, in the county of Cuyahoga and State of Ohio, have invented certain new and useful Improvements in Electric Furnaces, of which the following is a specification.

This invention is an electric furnace designed for effecting reactions at high temperatures, and more particularly for producing calcium carbid, the construction of the furnace and the arrangement of its parts being such as to facilitate the tapping of the molten product of the reaction.

Calcium carbid attains a fluidity sufficient to permit of tapping from the furnace only at very high temperatures, and constructions whereby such necessary high temperature may be maintained in the vicinity of the tap-hole of the furnace are illustrated in the accompanying drawings, in which the several figures, numbered 1, 2, and 3, are vertical axial sections of three different furnaces.

The furnace shown in Figure 1 is an annular stack having a body or shell 1, of iron, such as boiler-plate, and a hearth 2, of carbon. The iron shell comprises a lower downwardly-converging ring or bosh 3, which is surrounded by a water-jacket 4 and has a continuous lining 5, of refractory non-conducting material, which preferably is of the same composition as the material being reduced, extending down to the carbon hearth. Supported upon the bosh-ring 3, but separated therefrom by a layer 6 of refractory insulation, such as asbestos, is a downwardly-converging water-jacketed iron ring 7. The refractory lining 5 extends upwardly within the lower portion of ring 7, while a carbon lining 8, acting as one electrode, is arranged in contact with the upper portion of ring 7. To ring 7 is secured one terminal, 9, of the source of electric current. The other terminal, 10, is secured to an iron casing 11, which surrounds the carbon hearth. This hearth-casing 11 is separated from the bosh-ring 3 by a layer of refractory insulation 12. Supported upon body-ring 7 is an iron ring 13, which carries a bell-and-hopper charging mechanism 14. A flue 15 for waste gases opens from the upper part of ring 13. A tap-hole 16 for the molten product extends through the carbon hearth. Instead of the carbon lining 8 a number of separated stationary or movable electrodes may be used. In employing this furnace to produce calcium carbid an initial charge, consisting of lime or limestone and carbon, is fed into the furnace. In some instances and to provide for good conductivity I may employ the well-known charge containing pieces of coke or hard carbon, which lie in contact with each other at various points, and thereby afford direct paths for the flow of current, the lime being distributed in the interstices between the pieces of carbon. An electric current of sufficient amperage is passed through the charge and the portion where the current density is sufficient is brought to a temperature which causes the materilas to react to form carbid and the carbid to be brought into a molten condition. The molten carbid is tapped out from time to time as it accumulates and fresh material fed into the furnace as required. The process is thus a continuous one. The waste gases passing up from the zone of reduction through the charge serve to preheat it, as well understood, and may be removed for heating or other purposes. The lines of current-flow converge from the upper electrode to the lower one, giving a gradually-increasing current density through the charge toward the lower electrode. The corresponding heat generated by the passage of the current through the charge thus gradually increases downward to a region where a zone of reduction and fusion is maintained. The charge is thus gradually preheated before reduction, not only by the waste gases, but also by the heat engendered by the passage of the current through the mass.

It is not essential that the charge should consist of a mixture which is a conductor at atmospheric temperatures. The process may be equally employed for the production of calcium carbid from a mixture of ground coke and lime. In this case, however, it is necessary to provide an initial conducting-path or to employ high voltage to start the operation. The charge will be preheated during the normal operation of the furnace by the waste gases and by conduction and radiation to a temperature which will enable it to act as a resistance-conductor before it descends into the path of current-flow.

The furnace shown in Fig. 2 comprises a circular body and hearth 17, of refractory non-conducting material, which preferably is of the same composition as the material being reduced, though it may be different, as would be the case if made of fire-brick. The sides of the hearth are incased by an iron water-jacket 18. An electrode 19, consisting of a carbon block, extends centrally up through the base of the furnace. Current is supplied to this electrode through a metal plate 20, covering the lower face of the electrode and having a terminal connection 21. Metal screw-bolts 22 extend from plate 20 up into the electrode to increase the surface of contact. A tap-hole 23 extends out through the hearth from a point at or near the bottom of the furnace. Resting upon the upper edge of the body is an iron cover 24 with double walls or their equivalent, between which water is circulated. A ring of insulation 25 is interposed between the hearth 17, with its water-jacket 18, and the cover 24. The sides of the cover have a carbon lining 26. The furnace has a bell-and-hopper charging mechanism 27 and an outlet-flue 28 for waste gases. The cover 24 has a terminal 29, which is also connected to the source of electric current, and thus constitutes the other electrode of the furnace, the electric current flowing between the carbon lining 26 of cover 24 and the carbon block 19. In employing this furnace to produce calcium carbid an initial charge, consisting of lime or limestone and carbon, is fed in through the hopper. An electric current is passed through the charge, and the portion where the current density is sufficient is brought to a temperature which causes the materials to react to form carbid and the carbid to be brought into a molten condition. The current employed is of sufficient volume to maintain within the furnace a body 30 of molten or partially-molten carbid and partly-reduced material sufficient to nearly or quite fill the hearth 17. The partially-molten material may even extend up into contact with the carbon lining 26. The lines of current-flow converge from the upper to the lower electrode 19, giving a gradually-increasing current and energy density downward through the pool of molten or partially-molten material. The heat evolved by the passage of the current through the pool thus gradually increases downward to the electrode 19, at which point it is a maximum. The molten carbid is tapped out from time to time and fresh material is fed into the furnace as required, the process thus being a continuous one. The waste gases serve to preheat the unreduced portion 31 of the charge and being combustible may be removed and used for generating steam or for other purposes.

The furnace shown in Fig. 3 comprises a vertical frusto-conical stack 32 and a crucible or hearth 33. The stack consists of an iron shell 34, having a lining 35, of refractory non-conducting material, and a water-jacket 36 surrounding it. The hearth is of refractory conducting material, such as carbon, inclosed in an iron casing 37 and provided with a tap-hole 38. The top of the furnace is closed by a cover comprising a massive plate of carbon 39 and a carbon ring 40, inclosed by an iron casing 41. The cover rests on a ring 42, of refractory insulating material, such as asbestos, which in turn rests upon the upper end of the stack. The cover is provided with a central hopper 43 and a plurality of hoppers 44 near its edge, the several hoppers communicating with the interior of the furnace through corresponding openings in the cover. A water-jacket 45 surrounds the lower portion of the cover. Secured to the iron casing of the cover is one terminal, 46, of a source of electric current, the other terminal, 47, being secured to the iron casing of the hearth. In operation loose, broken, or granular refractory conducting material 48, such as lumps of coke or carbon, is fed into the furnace through the hoppers 44, and the charge of material to be heated, 49, is fed in through the central hopper 43. The material 48 arranges itself in a vertical layer surrounding the central column 49 of the material to be heated and constitutes a resistance-conductor. It will be seen that this tubular conductor by reason of the conical shape of the stack decreases in cross-sectional area toward the hearth, and its resistance thereby increases downwardly. When either a direct or alternating current is caused to pass between the carbon plate 39 and ring 40 and the carbon hearth 33 and through the resistance-conductor 48, this conductor is non-uniformly heated by reason of the gradually-increasing current density toward the hearth. The heat generated by the passage of the current and conducted to the central column of material 49 thus increases downwardly. By the use of sufficient current the lower part of the resistance-conductor and of the charge within it may be brought to any desired temperature. When the charge 49 consists of a mixture of lime and carbon in proper proportions to form calcium carbid, the temperature in the charge will be gradually raised as it descends within the furnace until the materials reach a zone where they react to form calcium carbid. This carbid may be allowed to accumulate as a pool in the hearth and drawn off from time to time through the tap-hole or may be allowed to run out continuously as produced. The column 49 thereupon gradually descends and fresh material is fed in through the hopper 43. Such portions of the resistance-conductor as are carried down with the charge may also be replenished through the hoppers 44. The central column of material is heated not only by radiation and conduction from the surrounding resistance-conductor, but also by the waste gases passing up from the zones of reduction and fusion below.

While in the operation of the furnaces shown and described the molten product flows out through a tap-hole and is therefore specified in the claims as withdrawn by gravity, it will be understood that in some cases the movement of the molten material may be assisted by mechanical means. For example, the tap-hole must be kept clear from obstructions, and the flow of the carbid under the action of gravity may be suitably facilitated or assisted.

I claim—

1. An electric resistance-furnace, comprising a hearth arranged to support a body of conductive material, means for passing through said body an electric current the density of which increases to a maximum along the path of the current in the body, and means adjacent to the region of maximum current density for withdrawing a product by gravity, as set forth.

2. An electric resistance-furnace, comprising a hearth arranged to support a body of conductive material, a plurality of electrodes in contact with said body and so arranged and connected to the source of electric current as to pass through the body an electric current the density of which increases to a maximum along the path of the current in the body, and means adjacent to the region of maximum current density for withdrawing a product by gravity, as set forth.

3. An electric resistance-furnace, comprising a hearth arranged to support a body of conductive material of varying cross-section, means for passing through said body an electric current the density of which increases to a maximum along the path of the current in the body and inversely as the cross-section of the body, and means adjacent to the region of maximum current density for withdrawing a product by gravity, as set forth.

4. An electric resistance-furnace, comprising an inclined hearth arranged to support a body of conductive material of varying cross-section, means for passing through said body an electric current the density of which increases to a maximum along the path of the current in the body and inversely as the cross-section of the body, and means adjacent to the region of maximum current density for withdrawing a product by gravity, as set forth.

5. An electric resistance-furnace, comprising an annular hearth with converging sides, arranged to support a body of conductive material of varying cross-section, means for passing through said body an electric current the density of which increases to a maximum along the path of the current in the body and inversely as the cross-section of the body, and means adjacent to the region of maximum current density for withdrawing a product by gravity, as set forth.

6. An electric resistance-furnace, comprising an annular hearth with downwardly-converging sides, arranged to support a body of conductive material of varying cross-section, means for passing through said body an electric current the density of which increases to a maximum along the path of the current in the body and inversely as the cross-section of the body, and means adjacent to the region of maximum current density for withdrawing a product by gravity, as set forth.

7. An electric resistance-furnace, comprising an annular hearth with downwardly-converging sides, arranged to support a body of conductive material of varying cross-section, means for passing through said body an electric current the density of which increases to a maximum along the path of the current in the body and inversely as the cross-section of the body, and a tap-hole extending through the hearth at or near the lower end of the furnace, as set forth.

8. An electric resistance-furnace, comprising a hearth supporting a body of a conductive carbid or carbid-forming material, and means for passing through said body an electric current the density of which increases to a maximum in the body, as set forth.

9. An electric resistance-furnace, comprising a hearth supporting a body of a conductive carbid or carbid-forming material, means for passing through said body an electric current the density of which increases to a maximum in the body, and means adjacent to the region of maximum current density for withdrawing a product by gravity, as set forth.

In testimony whereof I affix my signature in presence of two witnesses.

ALFRED H. COWLES.

Witnesses:

F. W. Power,

A. J. Frith.