No. 750,093. PATENTED JAN. 19, 1904.

A. H. COWLES.

ELECTRIC RESISTANCE FURNACE.

APPLICATION FILED APR. 21, 1903.

NO MODEL. 2 SHEETS—SHEET 1.

Fig. 1.

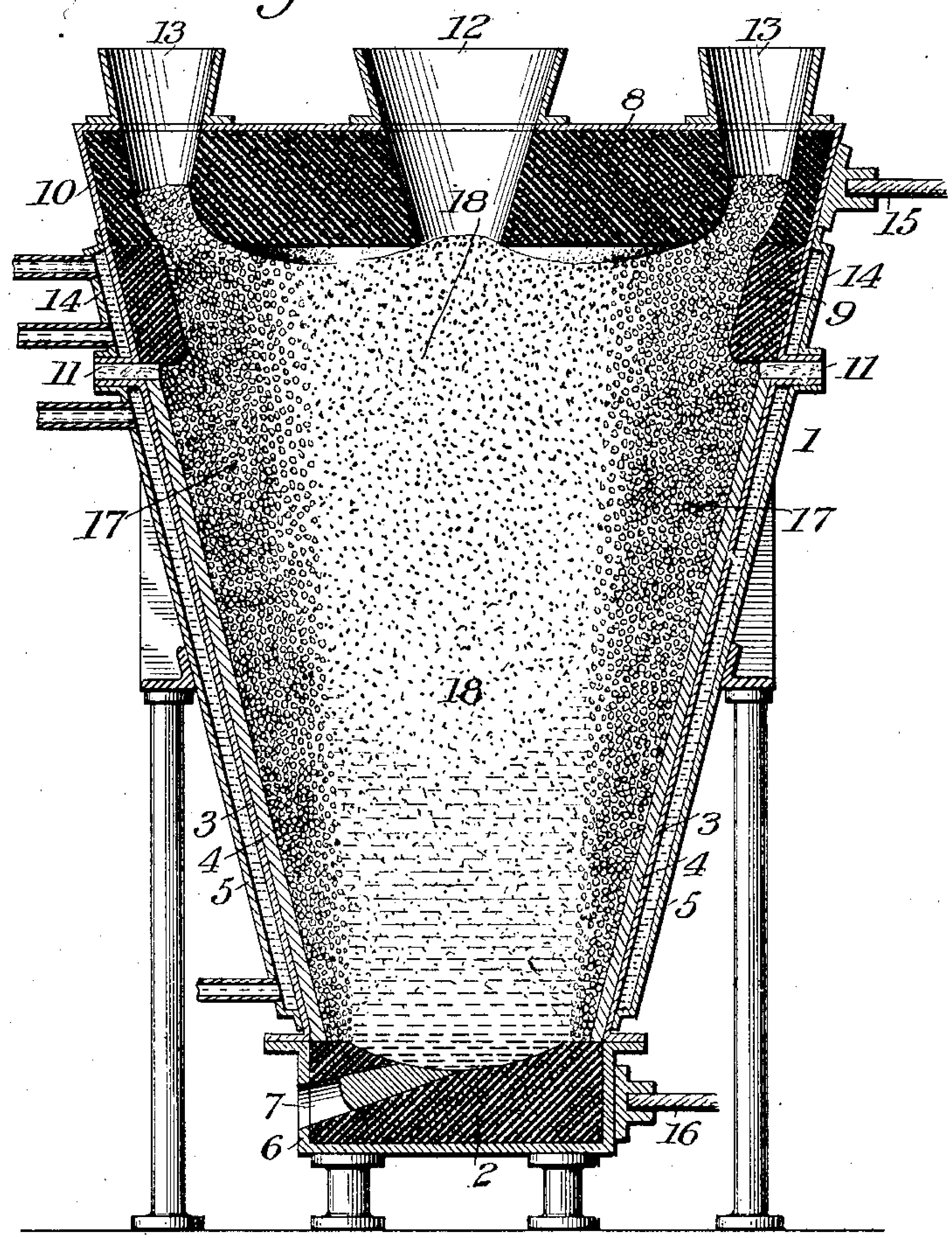
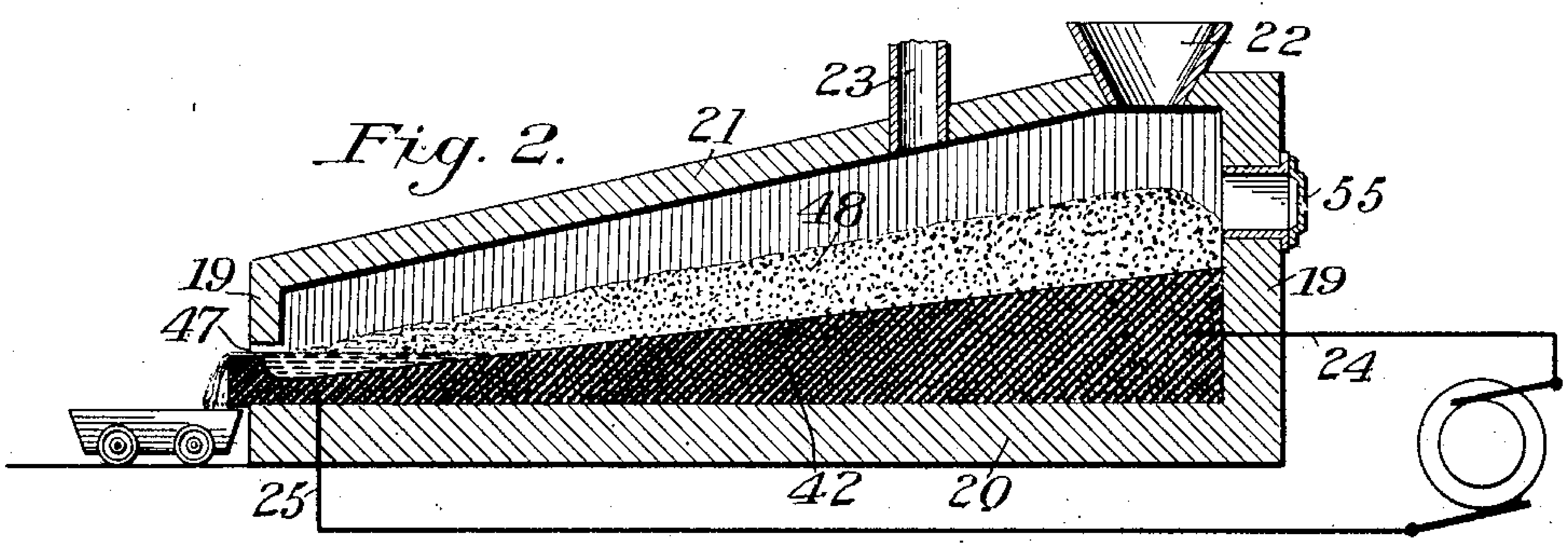


Fig. 2.



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NO MODEL. 2 SHEETS—SHEET 2.

Fig. 3.

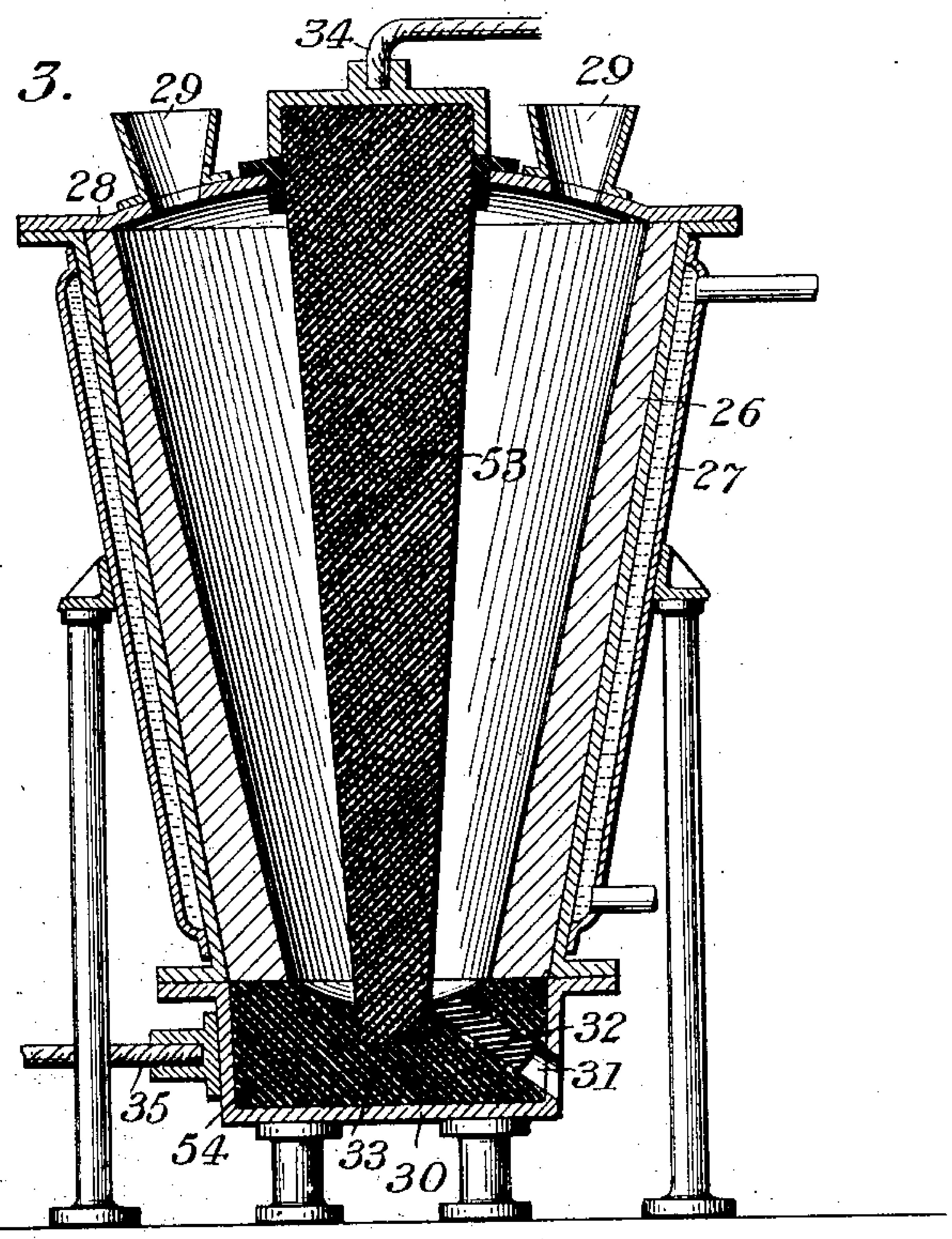


Fig. 4.

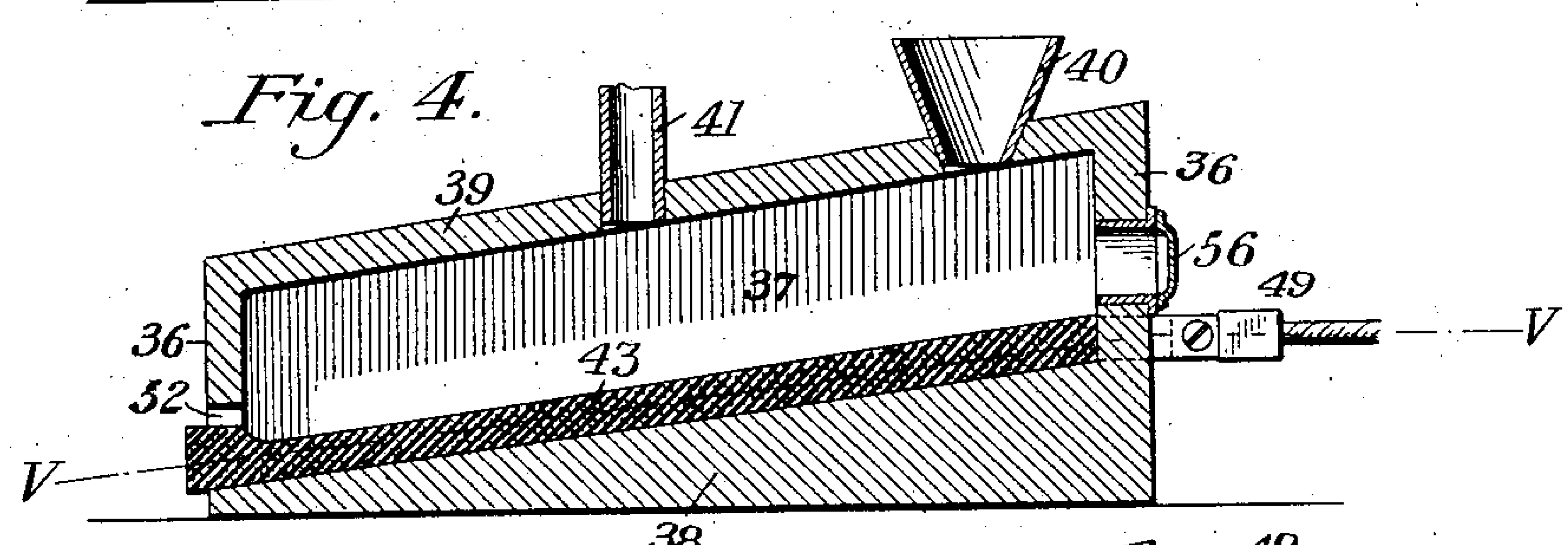
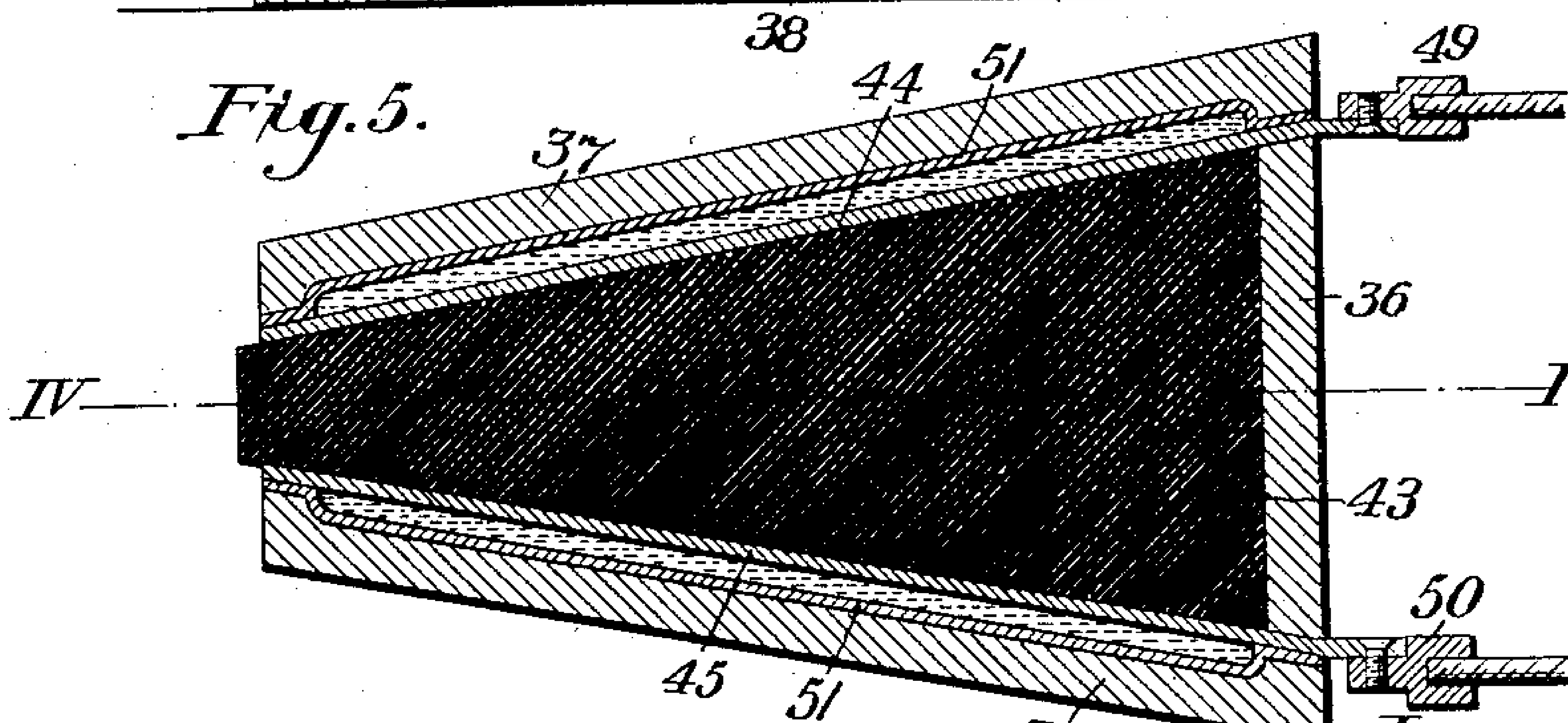


Fig. 5.



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THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

ALFRED H. COWLES, OF CLEVELAND, OHIO.

ELECTRIC-RESISTANCE FURNACE.

SPECIFICATION forming part of Letters Patent No. 750,093, dated January 19, 1904.

Original application filed November 20, 1902, Serial No. 132,134. Divided and this application filed April 21, 1903. Serial No. 153,702. (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-Resistance Furnaces, of which the following is a specification.

This invention is an electric-resistance furnace for heating materials, especially mixtures of a metallic compound and a reducing agent, and specifically lime and carbon for the production of calcium carbid.

The furnace is designed to effect reactions at high temperatures, and the construction is such as to facilitate the withdrawal of any molten products through a tap-hole.

The furnace comprises a resistance-conductor in position to heat the charge and means for passing through the conductor an electric current, the density of which increases through a portion of the conductor in proximity to the charge, so that it is heated ununiformly. The outlet for the molten product, if any, is preferably placed adjacent to the region of maximum current density in the resistance-conductor, so that the product may be heated to a high temperature, and thereby brought into a highly-fluid condition. This feature is of especial importance in the production of calcium carbid, which attains a fluidity sufficient to permit it to be tapped from a furnace only at very high temperatures.

The invention will be more readily understood by reference to the accompanying drawings, in which—

Figure 1 is a vertical axial section of a stack-furnace. Fig. 2 is a vertical longitudinal section of a hearth-furnace. Fig. 3 is a vertical section of a furnace employing a central resistance-conductor. Fig. 4 is a vertical longitudinal section of a modified hearth-furnace, taken on line IV IV of Fig. 5; and Fig. 5 is a horizontal section on line V V of Fig. 4.

The furnace shown in Fig. 1 comprises a vertical frusto-conical stack 1 and a crucible or hearth 2. The stack consists of an iron shell 3, having a lining 4 of refractory non-conducting material and a water-jacket 5 surrounding it. The hearth is of refractory conducting material, such as carbon, inclosed in an iron casing 6 and provided with a tap-hole 7. The top of the furnace is closed by a cover comprising a massive plate of carbon 8 and a carbon ring 9, inclosed by an iron casing 10. The cover rests on a ring 11 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 12 and a plurality of hoppers 13 near its edge, the several hoppers communicating with the interior of the furnace through corresponding openings in the cover. A water-jacket 14 surrounds the lower portion of the cover. Secured to the iron casing of the cover is one terminal 15 of a source of electric current, the other terminal 16 being secured to the iron casing of the hearth.

In operation loose, broken, or granular refractory conducting material 17, such as lumps of coke or carbon, is fed into the furnace through the hoppers 13, and the charge of material to be heated, 18, is fed in through the central hopper 12. The material 17 arranges itself in a vertical layer surrounding the central column 18 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 8 and ring 9 and the carbon hearth 2 and through the resistance-conductor 17, 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 18 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 18 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 18 thereupon gradually descends, and fresh material is fed in through the hopper 12. Such portions of the resistance-conductor as are carried down with the charge may also be replenished through the hoppers 13. 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.

The furnace shown in Fig. 2 comprises end walls 19 19, floor 20, and roof 21 of refractory non-conducting material, such as fire-brick. A feed-hopper 22 and waste-gas pipe 23 pass through the roof. The hearth 42 of the furnace is a resistance-conductor, which may either be of loose material, such as used in the stack-furnace previously described, or of solid carbon, as shown. The upper surface of this conductor slopes downwardly from a point beneath the hopper to the discharge end of the furnace. One terminal, 24, of the source of electric current is connected to the resistance-conductor at the charging end of the furnace, and the other terminal, 25, is connected to the resistance-conductor at the discharge end of the furnace. The material to be heated, 48, is fed into the furnace through the hopper 22 and distributed in a layer upon the resistance-conductor by a tool inserted through the door 55 in the end wall. An electric current is then passed through the resistance-conductor, heating it ununiformly, the density of the current in the conductor increasing toward the discharge end of the furnace by reason of its diminishing cross-section. That portion of the charge 48—for example, lime and coke—near the discharge end of the furnace will soon be brought to a temperature sufficient to cause the materials to react to form carbid and the carbid to be brought into a molten condition, whereupon it will flow out from the furnace through tap-hole 47. The charge 48 is then moved downward upon the conductor and fresh material introduced. If desired, the tap-hole may be temporarily closed by a plug of refractory material and the carbid drawn off intermittently.

Fig. 3 shows a vertical or stack furnace having a conical outer wall 26 of refractory non-conducting material, surrounded by a water-jacket 27. The top of the furnace is closed by a cover 28, having charging-openings 29. The hearth 54 is of refractory conducting material, such as carbon, inclosed in an iron casing 30 and provided with a tap-hole 31, which may be closed by a plug 32. The resistance-conductor 53 is arranged within and concentric to the outer walls of the furnace and consists of a conical self-supporting body of refractory conducting material, such as carbon, the lower end of which is seated in a central recess 33 in the upper part of the carbon hearth. One terminal 34 of the source of electric current is connected to the upper end of the resistance-conductor, and the other terminal 35 is connected to the iron casing of the carbon hearth. The material to be heated or smelted is fed into the space around the resistance-conductor, which is ununiformly heated by the current passing through it by reason of the gradually-increasing current density, which varies substantially inversely as the cross-section from the upper to the lower end of the conductor. By the use of sufficient current the lower part of the resistance-conductor and of the charge surrounding it may be brought to any desired temperature, and the molten product may be removed through the tap-hole.

The furnace shown in Figs. 4, 5 comprises end walls 36, side walls 37, floor 38, and roof 39 of refractory non-conducting material. A feed-hopper 40 and waste-gas pipe 41 pass through the roof. The hearth 43, which constitutes the resistance-conductor, is shown as a plate of solid carbon. This hearth-conductor, while of substantially uniform thickness, narrows transversely from the receiving to the discharge end of the furnace. Metal plates 44 45 extend along the sides of the hearth and project out through the furnace-wall 36, their ends being secured to the terminals 49 50 of the source of electric current. These plates are preferably protected by water-jackets 51. The charge is fed in through the hopper and distributed over the hearth by a tool inserted through the door 56 in the end wall. An electric current is then passed transversely through the hearth between the metal plates, heating it ununiformly, the density of the current flowing through the hearth increasing toward the discharge end of the furnace. The charge is thus heated to the desired temperature, and any molten product may be withdrawn through tap-hole 52.

The tap-holes of the various furnaces are specified in the claims as "means for withdrawing a product by gravity." It will be understood, however, that the removal of the product may, if necessary, be facilitated by mechanical means.

This invention as presented in the claims is a division of that claimed in my earlier application, Serial No. 132,134, filed November 20, 1902, being limited to the specific form in which the heating is mainly effected by a resistance-conductor distinct from the charge, although a portion of the current may be carried by the charge or its product, according to their composition and as an incident of the operation in some cases.

I claim—

1. An electric-resistance furnace, comprising a resistance-conductor in position to heat the charge, and means for passing through

said conductor an electric current the density of which increases through a portion of said conductor in proximity to the charge, and thereby heating it ununiformly, as set forth.

2. An electric-resistance furnace, comprising a resistance-conductor in position to heat the charge, means for passing through said conductor an electric current the density of which increases to a maximum through a portion of said conductor in proximity to the charge, and thereby heating it ununiformly, 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 resistance-conductor in position to heat the charge, and means for passing through said conductor an electric current the density of which increases along the path of the current through a portion of said conductor in proximity to the charge, and thereby heating it ununiformly, as set set forth.

4. An electric-resistance furnace, comprising a resistance-conductor in position to heat the charge, means for passing through said conductor an electric current the density of which increases to a maximum along the path of the current through a portion of said conductor in proximity to the charge, and thereby heating it ununiformly, 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 a resistance-conductor of varying cross-section, in position to heat the charge, and means for passing through said conductor an electric current the density of which increases along the path of the current in the conductor and substantially inversely as the cross-section of the conductor, and thereby heating it ununiformly, as set forth.

6. An electric-resistance furnace, comprising a resistance-conductor of varying cross-section, in position to heat the charge, means for passing through said conductor an electric current the density of which increases to a maximum along the path of the current in the conductor and substantially inversely as the cross-section of the conductor, and thereby heating it ununiformly, and means adjacent to the region of maximum current density for withdrawing a product by gravity, as set forth.

7. An electric-resistance furnace for the production of carbids, comprising a resistance-conductor in proximity to the charge of carbid-forming materials, and means for passing through said conductor an electric current the density of which increases through a portion of said conductor in proximity to the materials to a point where the heat generated by the resistance of the conductor will cause the materials to react to form carbid, as set forth.

8. An electric-resistance furnace for the production of carbids, comprising a resistance-conductor in proximity to the charge of carbid-forming materials, means for passing through said conductor an electric current the density of which increases through a portion of said conductor in proximity to the materials to a point where the heat generated by the resistance of the conductor will cause the materials to react to form carbid and the carbid to be brought into a molten condition, and means for withdrawing the molten carbid by gravity, as set forth.

9. An electric-resistance furnace, comprising a resistance-conductor of loose, broken or granular material, in position to heat the charge, and means for passing through said conductor an electric current the density of which increases through a portion of said conductor in proximity to the charge, and thereby heating it ununiformly, as set forth.

10. An electric-resistance furnace, comprising a resistance-conductor of loose, broken or granular material, in position to heat the charge, means for passing through said conductor an electric current the density of which increases to a maximum through a portion of said conductor in proximity to the charge, and thereby heating it ununiformly, 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:
CHAS. H. HOLT,
M. J. LARACY.