E. WEINTRAUB.

ELECTRIC FURNACE.

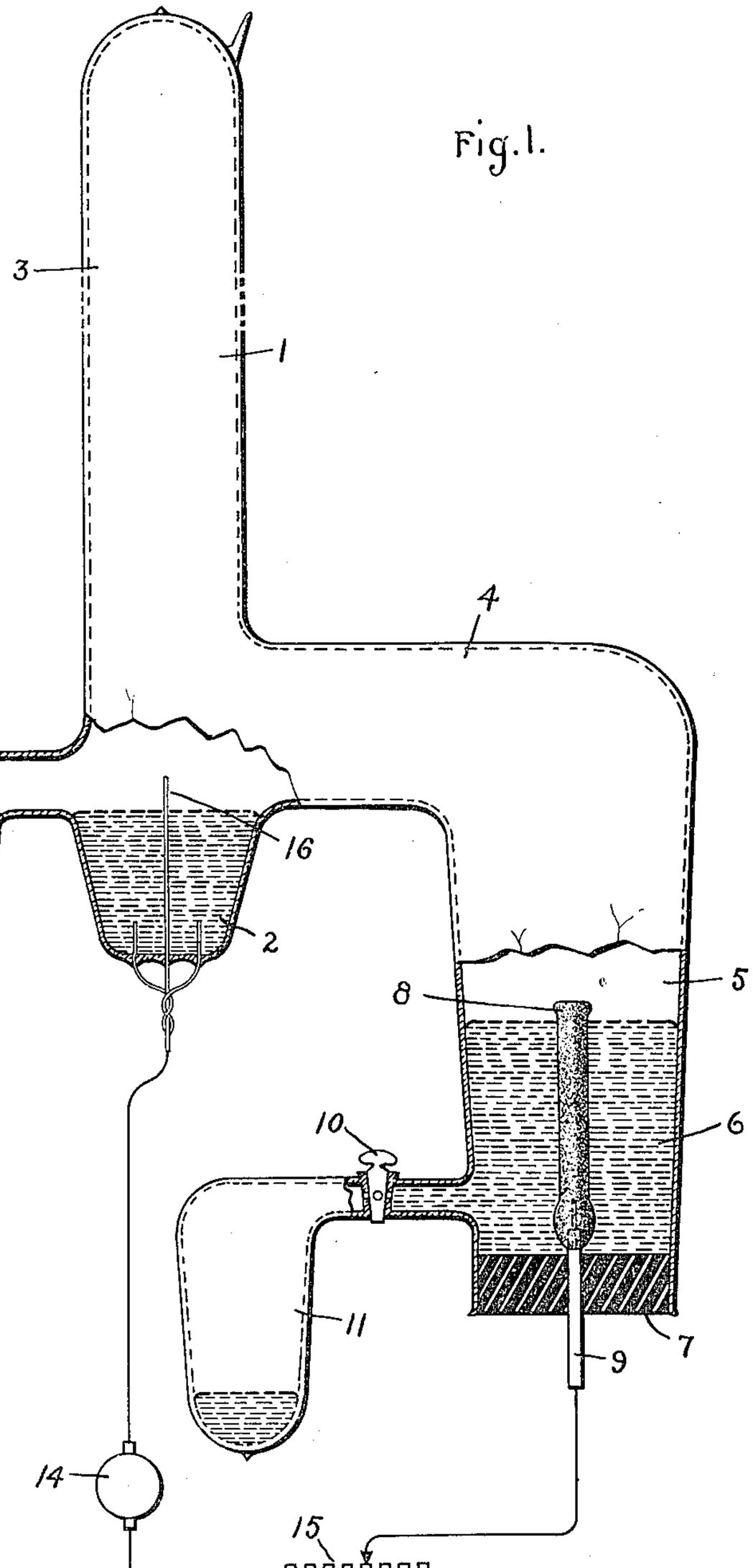
APPLICATION FILED MAY 13, 1908. RENEWED FEB. 23, 1911.

997,882.

Patented July 11, 1911.

2 SHEETS—SHEET 1.

Fig. 1.



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Inventor:
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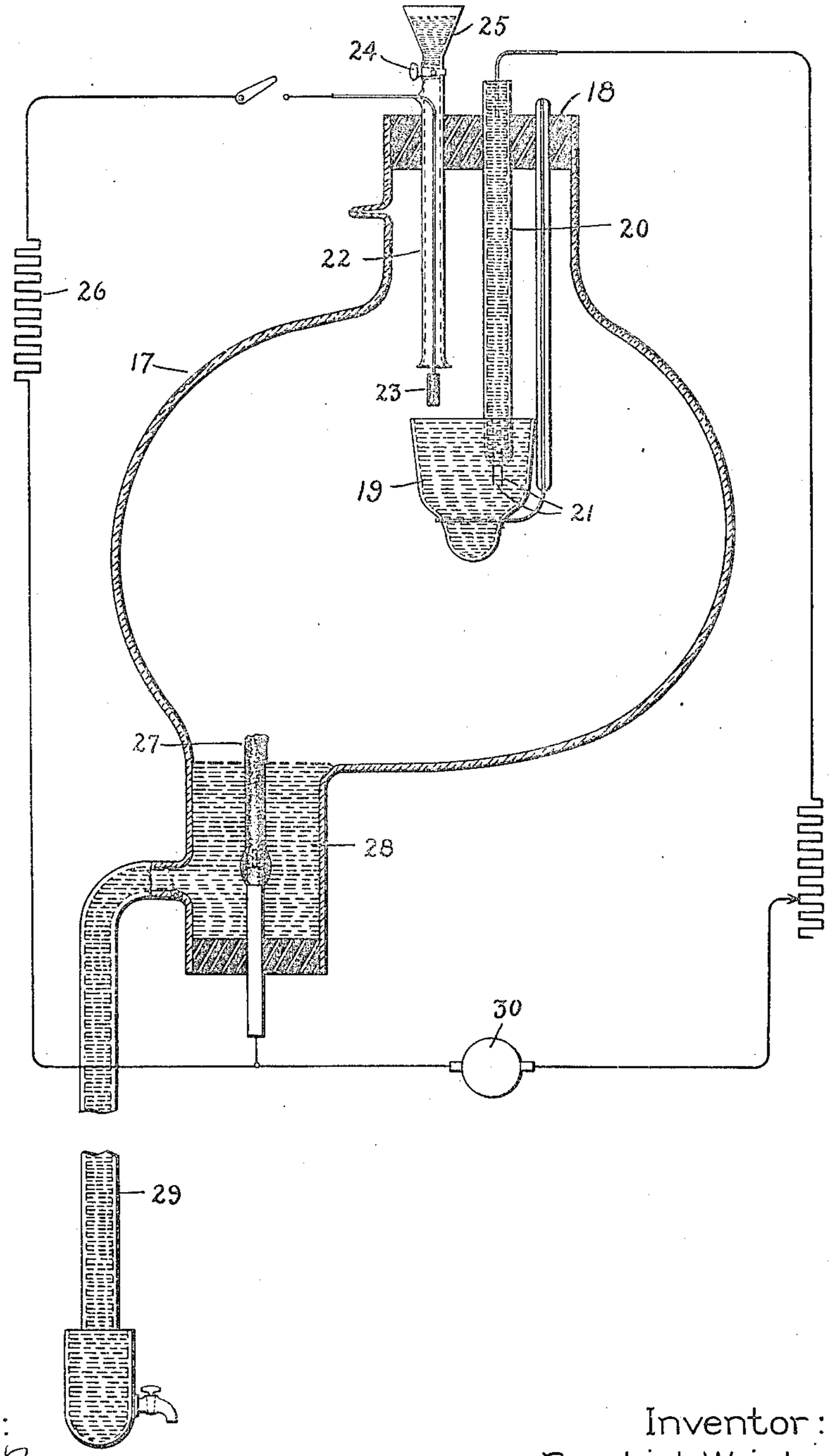
2 SHEETS—SHEET 2.

Fig. 2.



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UNITED STATES PATENT OFFICE.

EZECHIEL WEINTRAUB, OF LYNN, MASSACHUSETTS, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

ELECTRIC FURNACE.

997,882. Specification of Letters Patent. **Patented July 11, 1911.**

Original application filed July 2, 1906, Serial No. 324,399. Divided and this application filed May 13, 1908, Serial No. 432,565. Renewed February 23, 1911. Serial No. 610,389.

To all whom it may concern:

Be it known that I, EZECHIEL WEINTRAUB, a citizen of the United States, residing at Lynn, county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Electric Furnaces, (division of my application, Serial No. 324,399, filed July 2, 1906,) of which the following is a specification.

This invention relates to the heat treatment of refractory materials by means of an arc in a vacuum. In carrying out my invention, I use the material to be melted or treated as an electrode in a vacuum arc furnace and I pass sufficient current through the arc to sinter or even to melt down the refractory material under treatment. The apparatus whereby I carry out this process is hereinafter described and includes various novel means and arrangements whereby the heating action of the arc may be concentrated on the electrode and whereby the general treatment may be effectively and rapidly carried on.

I may apply my method to the fusion or purification of the more refractory metals such as tungsten, thorium, osmium, etc., by pressing up rods from the powdered metal and using them as anodes in a mercury arc.

In order that the means for carrying out my invention may be better understood, reference should be had to the drawings forming a part of this specification, in which—

Figure 1 is a view of one form of vacuum furnace suitable for the melting of tungsten and other refractory metals, and Fig. 2 is a modified form of furnace particularly adapted for the use of high current.

The vacuum furnace shown in Fig. 1 comprises an evacuated envelop 1 of glass or other suitable material provided with a mercury cathode 2 and a condensing chamber 3 located thereabove and also provided with a lateral extension 4 opening into an anode chamber 5. This anode chamber contains a relatively large body of mercury 6 and is closed at the bottom by a rubber cork 7. A rod 8 of the material to be melted or sintered by the heat of the arc is cemented or otherwise secured to a suitable lead-wire 9 projecting through the rubber cork. Before starting the operation, I prefer to have the level of the mercury in the anode chamber only slightly lower than the upper end of the stick to be treated as I find that with such an arrangement the heating action of the arc is concentrated on the end of the stick, and the latter may be readily fused down. The level of the mercury may be controlled by a stop cock 10 connecting with a waste mercury chamber 11 so that after the end of the refractory stick has been melted I may gradually draw off the mercury and thus cause the heated zone to gradually travel down the stick. The mercury at all times covers up the lead wire and prevents contact of the arc therewith. The product resulting from the high heat treatment above described is a globule of the metal fused or sintered by the heating action of the arc and substantially free from volatile impurities. As the rod 8 may be pressed or molded out of one of the metals ordinarily obtained only in a powdered form, the above treatment serves to consolidate and otherwise change the metal under treatment.

To facilitate the starting of the mercury arc, I provide the apparatus with an auxiliary mercury anode 12 connected to the cathode and receiving direct current through a suitable circuit 13, and by this means I am able, by slightly shaking the tube to establish an arc to the mercury cathode 2 and thereby start the main arc.

The main heating current is preferably a direct current and may be supplied by a suitable dynamo 14 and may be controlled by a rheostat 15 or other regulating mechanism. As the current is likely to be high, I prefer to provide the mercury cathode 2 with a plurality of leading-in wires, to diminish the likelihood of rupturing the glass because of the heating action of the current. I prefer to provide the cathode with a platinum wire 16 projecting slightly above the surface of the mercury as I find that this arrangement diminishes the total quantity of mercury vaporized from the cathode and consequently prevents an abnormal quantity of mercury vapor from cooling the anode by contact therewith.

In the operation of the furnace, I find that the metal stick under treatment carries substantially all the current, or in other

words, that the mercury body surrounding the stick does not become anode with respect to the cathode of the tube. This phenomenon I attribute to the difference in the polarization of a mercury surface and of a solid anode, the polarization of the solid material being less than that of mercury; consequently the stick under treatment acts as anode to the exclusion of the surrounding mercury.

If desired, the apparatus may be cooled, either by an air blast or by water circulation.

Fig. 2 shows a modification adapted for the transmission of especially heavy currents. It comprises an evacuated envelop 17 provided at the top with a rubber stopper 18 from which is suspended a cathode cup 19 of silica, alumina or other non-conductive and refractory material. This cup is filled with mercury and is connected with a power circuit by means of a mercury column 20 inclosed in a tube the lower end of which is pierced by a plurality of lead-wires 21. The rubber stopper 18 also carries a glass tube 22 in which is supported an auxiliary anode 23 to serve as a starting means. This starting is effected by opening a stop cock 24 at the upper end of the tube 22 and permitting mercury to run down from a funnel 25 and momentarily establish contact between the auxiliary anode 23 and the mercury cathode and thereby complete the circuit through a resistance 26 to a suitable source of current. The main anode of the furnace is at the lower end of the chamber and consists of a rod 27 of pressed metal or other material to be treated. It is surrounded by a body of mercury 28 which communicates with the open air through a barometric column 29. A suitable source of direct current 30 is connected between the anode and the cathode and the general heating operation is effected in the same manner as with the apparatus shown in Fig. 1. By supporting the cathode in a silica cup well removed from the walls of the vessel, it is impossible for the arc to come in contact with the glass, and I am thereby enabled to run the current density to a very high value without danger of cracking the envelop.

Although I have referred to mercury as a suitable material for establishing a heating arc, I also contemplate the use of amalgams and similar alloys, vaporizable at the operating temperature of the furnace and chemically inert with respect to the material under treatment.

What I claim as new and desire to secure by Letters Patent of the United States, is,—

1. A vacuum furnace comprising a substantially exhausted envelop, a cathode therein, an anode of compressed powder in fixed relation to said cathode, means for rendering conductive the space between said anode and cathode to establish a heating arc therein, and means for concentrating the heating action of said arc on a limited portion of said anode.

2. A vacuum furnace comprising a sealed envelop, a cathode therein of vaporizable metal, means for producing an arc from said cathode, and a furnace charge supported in fixed position relative to said cathode and operative as anode for the heating arc.

3. A vacuum furnace comprising an exhausted envelop, a cathode therein, a body of material to be structurally changed supported in fixed position relative to said cathode but separated therefrom, and means for ionizing the space between said cathode and said material to start an arc therethrough.

4. In a furnace, the combination of an exhausted envelop, a liquid cathode therein, a body of compressed refractory metal powder mounted in fixed relation to said cathode, and means for initiating and maintaining an arc to said powder of a magnitude sufficient to melt it into a homogeneous body.

5. A vacuum furnace comprising an envelop, a removable closure for said envelop carrying the charge to be heated, a mercury cathode, and means for establishing and maintaining a mercury-vapor arc between said cathode and said charge of a magnitude sufficient to fuse said charge.

6. A vacuum furnace comprising an envelop, a removable closure for said envelop carrying a furnace charge in the form of a stick of compressed refractory metal powder, a cathode at a distance from said charge, and means for establishing an arc between said cathode and said charge.

7. In a furnace, the combination of an envelop, a mercury cathode therein, means for starting an arc to said cathode, means for supporting a furnace charge to be treated, and means for concentrating the heating action of said arc on a limited portion of said furnace charge.

8. In a furnace, the combination of an evacuated envelop, a liquid cathode therein, means for starting an arc to said cathode, a furnace charge supported in fixed position with respect to said cathode and constituting an anode therefor, and a liquid protecting a part of said anode from the heating action of the arc between said cathode and anode.

9. In a furnace, the combination of an evacuated envelop, a cathode therein, a furnace charge, means for establishing an arc between said cathode and said charge, means for protecting a part of said charge from the heating action of said arc, and means for withdrawing said protective means to progressively expose said furnace charge to treatment by said arc.

10. In a furnace, the combination of an evacuated envelop, a mercury cathode therein supported remote from the wall of said

envelop, means for supporting a furnace charge as anode for said cathode, means for establishing a mercury arc between said anode and cathode, and protective means for said furnace charge progressively removable to expose said charge to the heating action of said arc.

In witness whereof, I have hereunto set my hand this ninth day of May, 1908.

EZECHIEL WEINTRAUB.

Witnesses:
JOHN A. MCMANUS, Jr.,
CHARLES A. BARNARD.