H. HELBERGER.

ELECTRICAL RESISTANCE FURNACE.

APPLICATION FILED AUG. 11, 1911.

1,023,309.

Patented Apr. 16, 1912.

2 SHEETS—SHEET 1.

Fig. 1.

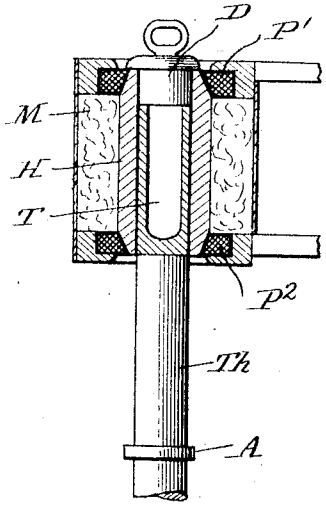


Fig. 2.

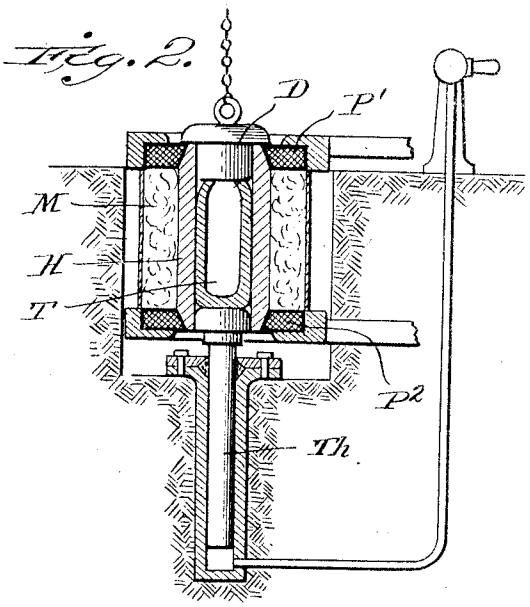
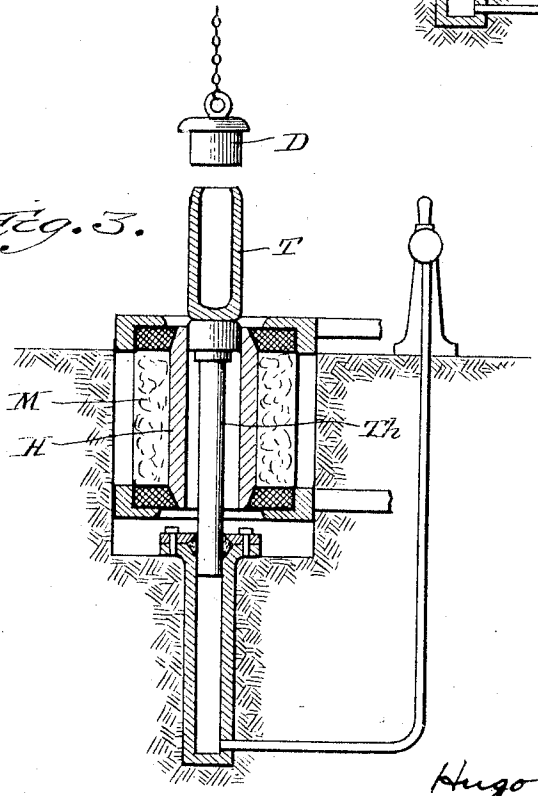


Fig. 3.



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2 SHEETS—SHEET 2.

Fig. 4.

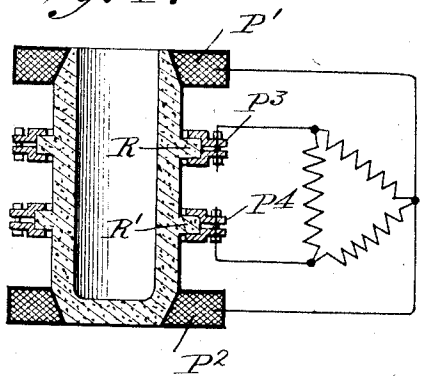


Fig. 6.

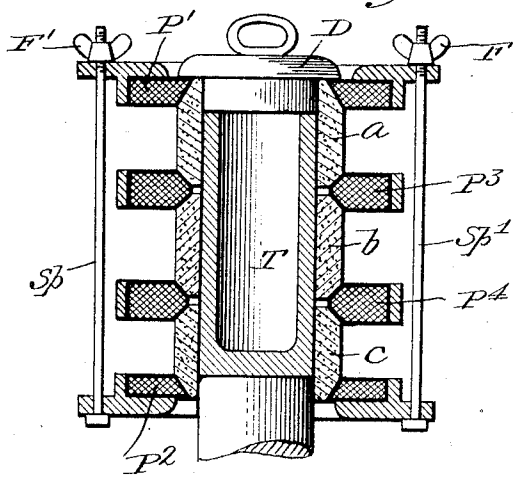
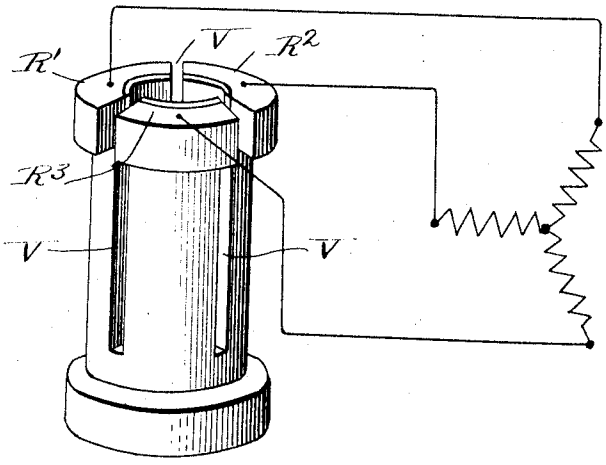


Fig. 5.



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ELECTRICAL RESISTANCE FURNACE.

1,023,309. Specification of Letters Patent. Patented Apr. 16, 1912.

Application filed August 11, 1911. Serial No. 643,564.

To all whom it may concern:

Be it known that I, HUGO HELBERGER, a subject of the Emperor of Germany, residing at Munich, Germany, have invented certain new and useful Improvements in Electrical Resistance Furnaces; and I do hereby declare the following to be a full, clear, and exact description of the same, reference being had to the accompanying drawings, forming a part of this specification, and to the figures and letters of reference marked thereon.

The present invention relates to improvements in that type of electrical furnaces in which the heat is produced by the passage of an electric current through a portion of the wall of the furnace.

The invention relates more especially to furnaces of said type in which the current is caused to flow in the wall of the furnace in a direction parallel with the axis of the furnace, the objects of the invention being to provide a furnace particularly adapted for melting purposes in which the heat generated will be conserved and utilized to the best possible advantage, and with which the charging and discharging may be effected in the most convenient manner.

A further object of the invention is to provide a furnace of the type mentioned, in which the surfaces of the heating wall will be protected against oxidation during the operation of the furnace, whereby the life of said wall will be greatly prolonged.

Referring to the accompanying drawings,—Figure 1 is a sectional elevation, more or less diagrammatic in character, illustrating a simple embodiment of a furnace constructed in accordance with the present invention; Figs. 2 and 3 are similar views, showing a furnace assembled with the mechanism for lifting or discharging the molten material therefrom, and means for controlling such discharging mechanism; Fig. 4 is a detail view showing the heating wall of the furnace provided with intermediate contacts, whereby the structure is adapted for use in connection with a three-wire source of current; Fig. 5 is a perspective view of another arrangement or construction of the heating wall of the furnace adapted for a system of conductors having more than two poles; and Fig. 6 is a view corresponding closely to Fig. 1, but with the heating wall formed in sections and arranged for application thereto of current from a number of terminals whereby the heater may be divided into zones, each heated by its own branch of the current so as to afford an opportunity for regulating the heat at different points.

Like letters of reference in the several figures indicate the same parts.

The furnace of the present invention consists primarily of a heating cylinder or tube H in Figs. 1, 2 and 3, formed of carbon, graphite clay, graphite or like material, which, as well known, may be heated to a high temperature by the passage therethrough of an electric current of proper amperage. This heating cylinder is adapted to have the current supplied thereto in a number of different ways which will be hereinafter referred to, but in all instances it is preferred that the current should flow in the heating wall in a direction parallel with the axis of the cylinder and the cylinder is usually arranged in a vertical position, as shown in the drawings.

Within the cylinder there is removably located a lining or melting crucible T which is of highly refractory material, and made to fit as accurately as possible within the heating cylinder, so as to thoroughly protect the inner face of the cylinder against oxidation. Since, however, it is not possible to make them fit absolutely tight, and thus completely prevent any oxidation of the heating cylinder, and since it is desirable to have intimate contact between the walls in order to secure the best possible conditions for the transmission of heat by conduction, it is preferred to make the lining or crucible, of material which becomes somewhat soft when heated to a very high temperature. Practically all clay has this property and when the crucible is made of clay it is only necessary to raise the heat of a filled crucible to a point where the wall becomes slightly plastic in order that the contents of the crucible may force its wall outwardly and firmly against the heating cylinder. This will result in a tight fit being obtained and may be successfully used for temperatures up to 1800°. The critical temperature at which the clay becomes slightly plastic may be recognized when white silicic acid vapors are given off.

For higher temperatures than 1800°, linings of metal oxids, such as magnesia, zirconium oxid or the like are used, and are either pressed within the heating cylinder with a binding material, such as boracic

acid, tar or the like, or, as preferred, are formed without binding material in the following manner:—Crucible-like vessels of thin sheet metal are placed in the heating cylinder, leaving a space between them and the cylinder. In this space the finely pulverized metal oxids are tamped without binding material of any kind. The sheet metal vessel supports this lining as long as the heating cylinder is cool, but melts when a white heat is reached, but at this heat the metal oxids sinter and form a completely solid melting crucible. The crucible, so formed, is, however, not united to the heating cylinder, but can be easily pushed up out of the same by the lifting apparatus to be presently described.

The crucible and lining are designed to protect the interior wall of the heating cylinder from oxidation and to further conserve the heat, a removable cover D is provided at the top, and at the bottom there is provided the upper end of a lifting mechanism, upon which the lining or crucible may rest, and in some instances said lifting mechanism may constitute a support for the heating cylinder itself. As illustrated the lifting mechanism is in the form of a plunger indicated by the reference letters T*h*, which is supported in line with the lining or crucible T and is adapted to be forced upwardly by hydraulic or other power illustrated in Figs. 2 and 3 of the accompanying drawings, although other known means may be employed. The upper end of the lifting mechanism is of such character that when it forces or lifts the lining or crucible up out of the heating cylinder it will itself close the cylinder against the admission of air, thereby protecting the inner face of the heating cylinder against oxidation, when the lining or crucible is not present. As shown in Fig. 1, the lifting mechanism may be provided with a flange A which by engagement with the lower end of the heating cylinder may be made to lift the cylinder itself out of its surrounding casing.

The entire heating tube or cylinder is surrounded by refractory non-heat conducting material M, preferably of metal oxids or similar materials, so that there can be no contact of the heating cylinder with the atmospheric air, whereby oxidation on the exterior surface is prevented.

Where the heating cylinder is adapted to be lifted it should be embedded in a substance, such, for example, as magnesia, which sinters and hardens under heat, thereby forming a solid, but thin, casing around the heating cylinder, which casing will stand when the cylinder is removed, and be ready for the reception of a new cylinder, thus avoiding the laborious building up and filling in of the insulating material whenever a new cylinder is to be supplied.

The heating cylinder itself, as before stated, preferably consists of carbon, graphite clay, graphite or similar materials, such as are generally used, and it is differently shaped according to the kind of current employed, but the direction of the current is always parallel to the axis of the cylinder.

In Fig. 1 the simplest form of heating cylinder is illustrated, and is adapted for the connection of a two-pole source of current; P′ and P² indicating the contact terminals for the heating tube, said contact terminals conveniently being of annular form.

In the construction shown in Fig. 4, the heating cylinder is adapted for connection with a three-wire source of current, for example, a rectified current. In this instance, the heating cylinder is made in a single piece, but is provided with two projecting ribs R and R′ adapted to carry the contact terminals P³ and P⁴, said contact terminals being in addition to the end terminals P′ and P², which correspond to those hereinbefore referred to.

The construction illustrated in Fig. 4 is primarily adapted for a heating cylinder, made of one piece and of relatively small size, but when the cylinder is of large dimension, it becomes desirable to form it in sections, for instance, as illustrated in Fig. 6. In this case the heating cylinder consists of three separate parts *a*, *b*, *c*, which are held by means of the pole pieces P′, P³ and P⁴, and together with said pole pieces are firmly clamped by the rods S*p* and S*p*′ having thumb nuts or adjustable fastenings F, F′, at the ends. The whole structure is rigid and the three sections *a*, *b*, *c*, form three zones which may be heated to different degrees by regulation of the current fed to each section. This is an important advantage in electric crucible heating, since it is often desirable to be able to maintain the greatest heat at a certain zone, either at the top, the bottom or at the middle.

The cylindrical form of the heating tube or cylinder may be maintained, and the current caused to flow in the walls of the same, parallel with the axis of the cylinder, by making the walls discontinuous transversely of the axis, for instance, as illustrated in Fig. 5. In this construction, the cylinder is provided with three or more slots V which divide the tube into practically equal parts, the slots extending in from one end of the cylinder but leaving the opposite end integral for the passage of current from one section to the other. The number of parts or sections determines the number of terminals which must be provided for supplying current, and as illustrated, three sections and terminals R′, R², R³, are provided, but it will be understood that the cylinder may be similarly sub-divided into any desired number of sections or segments which at one

end are electrically connected and held together by a common union. The spaces or slots between the sections are filled with highly refractory insulating material, and in this, as well as in the other forms of heater illustrated it will be understood that in use the exterior of the cylinder is inclosed by highly refractory heat insulating material, impervious to air, such as lime, magnesia, infusorial earth or like material, and that the lining or crucible within the cylinder, together with the cover and lifting mechanism completely protect the inner face of the cylinder against oxidation.

By providing a lifting mechanism in connection with the furnace, it will be understood that difficulties and expense incident to the repacking of the insulating material around the furnace when a new heating cylinder has to be substituted, are to a large extent avoided, for with the lifting mechanism, not only may the crucible be removed from the cylinder, and the cylinder guarded against the entry of atmospheric air, but the cylinder itself may be lifted, leaving the insulating material standing in place ready for the reception of a new cylinder.

It is further to be understood that while I have above described and illustrated certain arrangements embodying my invention that it is not limited to these specifically but may be carried out in many ways that will occur to those skilled in the art.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent of the United States, is:

1. In an electric furnace, the combination with the cylindrical heating chamber adapted to be heated by the passage of an electric current through it, of a removable lining mounted in said cylinder with its exterior face in contact with the interior face of the cylinder, whereby oxidation of the latter is prevented, and a refractory heat insulating inclosure surrounding the outer wall of said cylinder, whereby oxidation of its outer face and radiation of heat therefrom are prevented.

2. In an electrical resistance furnace, the combination with the heating cylinder having circuit terminals connected therewith and heat insulating material inclosing said cylinder, of a removable lining for the cylinder formed of material having the property of becoming soft at high temperature, and means associated with said heating cylinder for removing said lining and protecting the inner face of the cylinder against oxidation when the lining is removed.

3. In an electrical resistance furnace, the combination with the heating cylinder open at top and bottom, of a removable crucible mounted within said cylinder with its outer face in contact with the inner face of the cylinder, whereby oxidation of the latter is prevented, a lifting mechanism for supporting said crucible within the cylinder, and a cover of refractory material for closing the upper end of the cylinder.

4. In an electrical resistance furnace, the combination with the heater formed by a cylindrical body open at top and bottom adapted to be heated by the passage of an electric current therethrough, and circuit terminals engaging said cylindrical body, of an inclosure of heat insulating refractory material surrounding said cylindrical body, a crucible mounted within the heater and with its outer face in position to protect the inner face of the cylinder against oxidation, a crucible lifting mechanism movable into and out of the lower end of the heater for supporting the crucible within the cylinder and lifting it up out of the cylinder, and means for closing the upper end of the heater.

5. In an electrical resistance furnace, the combination with the heater formed by a cylindrical body having annular circuit terminals coöperating therewith at different points longitudinally of the axis of the cylinder for supplying heating current to the cylinder, of a removable crucible mounted within and in intimate contact with the inner face of the heater, whereby oxidation of said face is prevented, and means for lifting said crucible, movable into and out of the lower end of the heater.

6. In an electrical resistance furnace, the combination with a heater formed of material adapted to be heated by the passage therethrough of an electric current, of circuit terminals coöperating with the ends of said heater, and an annular circuit terminal surrounding said heater intermediate the ends whereby the heater may be divided into zones transversely of its axis, each of which zones may be heated to a different degree from the other.

7. In an electrical resistance furnace, the combination with a cylindrical heater formed of material adapted to be heated by the passage therethrough of an electric current, of circuit terminals coöperating with the ends of said cylindrical heater, and a plurality of circuit terminals surrounding and coöperating with said heater, intermediate the ends, whereby current may be supplied for heating the heater in zones transversely of its axis.

8. In an electrical resistance furnace, the combination with a cylindrical heater formed in sections longitudinally of its axis, and annular circuit terminals coöperating with the ends of each of said sections, whereby the heater is sub-divided into zones each of which may be heated differently from the other.

9. In an electrical resistance furnace, the combination with the heater formed by a

cylindrical body open at top and bottom adapted to be heated by the passage of an electric current therethrough, and circuit terminals engaging said cylindrical body, of an inclosure of heat insulating refractory material surrounding said cylindrical body, a crucible mounted within the heater and with its outer face in intimate contact with the inner face of the cylinder, and a plunger movable into and out of the lower end of the heater for supporting the crucible within the heater and lifting it up out of the cylinder, said plunger adapted to close the cylinder at the upper end when the crucible is forced out against the admission of air.

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Witnesses:
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