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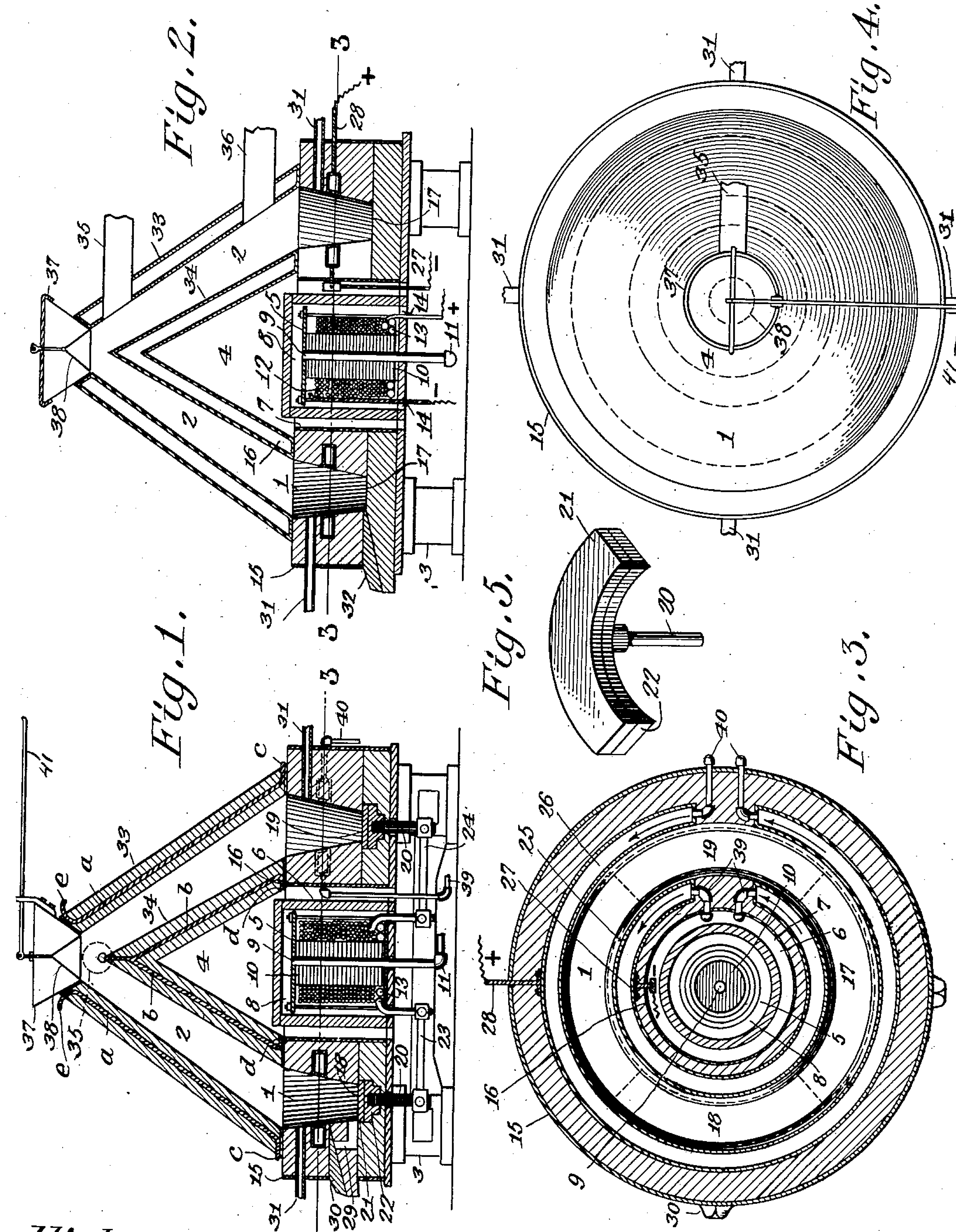
ELECTRIC FURNACE FOR METALLURGICAL PURPOSES.

APPLICATION FILED MAR. 24, 1909.

962,532. Patented June 28, 1910.



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ELECTRIC FURNACE FOR METALLURGICAL PURPOSES.

962,532. Specification of Letters Patent. Patented June 28, 1910.

Application filed March 24, 1909. Serial No. 485,503.

To all whom it may concern:

Be it known that I, HEINRICH F. D. SCHWAHN, a citizen of the United States, and resident of the city of Belleville, in the county of St. Clair and State of Illinois, have invented certain new and useful Improvements in Electric Furnaces for Metallurgical Purposes, of which the following is an exact description.

This invention is an electric furnace capable of general use and especially suitable for the reduction, fusion and treating of metals, and the manufacture of aluminum and its alloys.

The construction of the furnace is shown in the accompanying drawings in which;

Figure 1 is a vertical axial section, taken through the angular groove of the retort, showing the furnace provided with a mantle and a conical core made of refractory material; Fig. 2 is a vertical axial section in a plane at right angles to that of Fig. 1, taken through the tap-hole of the retort, showing the furnace provided with a water cooled mantle and cone; Fig. 3 is a horizontal section on lines III—III Figs. 1 and 2; Fig. 4 is a plan view; Fig. 5 is a detail perspective view of a carbon electrode for the conducting of an alternating electric current, showing the two parts or layers of different composition.

The furnace consists of an annular chamber comprising two distinct working parts, the retort 1 as the lower section and the gas-chamber 2 as the upper section, and the entire apparatus is mounted on a suitable base 3. In the space 4 surrounded by the retort 1 is centrally located an alternating electric step-down transformer 5. Said transformer is surrounded by a mantle 6 consisting of a cylinder suitably made of fire clay and closed on its upper end, this mantle leaving a dead-air space 7 between itself and the inner wall of the retort 1, and an open space 8 around the transformer 5 for the circulating of air passing through conduit 9 of the transformer core 10 from pipe 11 connected with said conduit 9. Said air after passing over the transformer 5 with its primary coil 12 and secondary coil 13 will find its way out from said space 8 through the apertures 14 of base 3. Said air is used for the cooling of the transformer and may be supplied to pipe 11 by any suitable means.

The lower section of the furnace containing the retort 1 may be suitably built of suitably prepared magnesite within the inclosing shells 15 and 16, said shells are preferably made of copper. The lower part of the retort 1 or its hearth 17 is partially formed of the electrodes 18 and 19 being in part resistance conductors, which have terminal connections 20 of highly conductive material. These electrodes are shown here as made of one block of carbon, and each of these carbon blocks made of two parts or layers 21 and 22, the part 21 being the resistance conductor and terminal, while the part 22 is of the highest conductivity suitably connected with the carbon rod 20, which extend through the bottom of the furnace to make terminal connection by means of the copper bars 23 and 24 respectively with the secondary coil 13 of the transformer 5. These electrodes, shown in Figs. 1, 3 and 5, are most suitably made of an electric carbon composition as usually made of oil coke and tar, and from two different mixtures suitably molded together or otherwise suitably attached to each other to make a perfect contact of their parts or layers. The composition of the upper part 21 is suitably made from said electric carbon mixture to which is added a refractory and for electricity non-conductive material, for instance, magnesite in a powdered form, and to such an extent as required to produce the desired resistance to the electric current to be conducted through the same when brought into an electric circuit suitably established by carbon and bring it into an incandescent condition for the heating of the furnace and its starting for operation, while the lower part 22 is made for obvious reason as usual of a mass of the highest conductivity, and said carbon electrodes are then finished as usual by superheating. These electrodes 18 and 19 are embedded in the hearth of the retort 1 as usually practiced in the operation of electric furnaces and are protected by the refractory and nonconductive material of the furnace leaving only one side or the part flush with the hearth 17 exposed. The connection of these electrodes with the copper bars 23 and 24 may be made in any suitable way, here shown as made by split collars and clamps.

In the upper part of the retort 1 flush with its sides are embedded another set of electrodes or terminals 25 and 26 made of metal, suitably copper or aluminum, said terminals are cored for the circulating of water and cooling of said electrodes. These electrodes have terminal connections 27 and 28 respectively with a direct current generator, not shown. However said electrodes may be also connected with the transformer 5 if desired, and used in conjunction with the carbon electrodes 18 and 19 by clamping the said electrodes 25 and 26 by their terminals 27 and 28 to the copper bars 23 and 24 respectively. In the lower part of the retort as shown in Fig. 1 is a right angular groove 29, the vertical inner portion of which communicates with a passage or outlet 30 extending through the side of the retort near its base. A plurality of pipes 31, preferably of graphite crucible composition extend through the outer wall of the furnace and open into the retort at a point slightly above the electrodes 25 and 26 as herein shown. These pipes serve for the introduction of reducing or fluxing gases. A tap-hole 32 is also provided at the base of the retort as shown in Fig. 2 for the emptying of the retort of its entire contents if desired.

The upper part or gas-chamber 2 is formed by the mantle 33 and cone 34 and both are suitably removably constructed either of refractory material as shown in Fig. 1, or of water cooled copper shells as shown in Fig. 2. This mantle 33 serves to exclude the outer air, to carry off the spent gases by means of pipe 35, said pipe 35 may be used in plurality if desired for the carrying off and depositing of heavy metallic vapors as shown by pipe 36 in Fig. 2, said pipes may enter into any suitable appliance for the recovery of said metallic vapors as usually used for this purpose. This mantle 33 is further provided with a hopper 37 suitably controlled by the usual bell 38 for the charging of the green material upon the cone 34 centrally located below said hopper 37 and above the transformer 5 as shown in Figs. 1 and 2. By this arrangement it will be noticed that the charges are evenly distributed over said cone 34 into the gas-chamber 2 and retort 1. Said chamber 2 is not intended to be used only for the excluding of the outer air, feeding of the retort 1 and the carrying off of the noxious spent gases and metallic vapors but also for a repository of the charge to be acted upon by said reducing and fluxing gases, above referred to, chemically and in conjunction with the radiant heat from the retort below, as required for the preparation of some ores or metallic compounds previous to their reduction. 39 and 40 indicate the water pipes of the electrodes 25 and 26 respectively.

The mantle 33 and cone 34 if made of refractory material may be suitably strengthened each separately by a metallic skeleton indicated by *a* and *b* suitably made of bronze or copper, suitably extending from circular plates *c* and *d* as their bases, and suitably ending in hooks *e* and *f* respectively at their upper ends, for their temporary removal to get access to the retort and transformer if desired, or if the furnace shall be used only for the remelting, treating and alloying of metals.

In the operation of the furnace a pool of metal and slag, or bath of fluorids etc. is maintained in the base or hearth of the retort, and to such height as to fill the outlet 30 thereby excluding the outer air from the retort and incandescent electrodes 18 and 19, and establishing the electric circuit between these alternating current terminals, and if filled with more conductive material up to the electrodes 25 and 26 a circuit of the direct electric current is established and both currents may flow then side by side and act upon the charged material by heat and electrolysis in conjunction with the introduced reducing and fluxing gases if desired. The excess of metal or other molten product resulting from the operation of the furnace continuously overflows and discharges through the groove 29. This tap-device may be, if desired, more or less closed suitably by a plug to enable the production of a higher or lower level of the molten product within the retort, or the tapping may be carried out from the tap-hole 32. Any spent gases are allowed to escape through pipe 35, the hopper 37 being normally closed during the operation of the furnace, as by the bell 38 operated by the lever 41.

This furnace is more especially intended for the production of aluminum by the processes, described in my Letters Patent of Febr. 3, 1903, No. 719,698;—an application Serial No. 466,255, filed Dec. 7, 1908, and in an application Serial No. 514,628, filed Aug. 25, 1909—in which is set forth the possible production of alumina from sulfate of aluminum and its reduction in one operation by means of this furnace and reducing gases upon or above and in the usual bath of fluorids. Reduction is principally effected in these processes by the use of a gas and moderate heat acting first upon the aluminous compound but the electric current may be employed to furnish this, and then finish the reduction in heating the charge to the temperature of reaction or action by electrolysis, or both together, which is the more desirable and cheapest. The furnace may also be used without the direct electric current or only with the latter, the improvement may be also used for the reduction, treatment or alloying of any other metal than aluminum, especially volatile metals such as zinc.

The underlying principles of this furnace may be said to consist, (1) in the shortening of the distance of conducting the converted current to its place of action, (2) in the employment of resistance conductors as terminals for the alternating current from a transformer with a winding in proportion of about 100 turns of the primary coil to about 2 turns of the secondary coil, whereby a double action or flow of the alternating current is established, namely that of heating by resistance C_2R in the terminals and by which the furnace and the charged material is heated and fused thereby producing incidentally a bath, and thereby completing the secondary winding of the transformer, with similar results as obtained in furnaces of the induction type which has been found to be correct; and I preferably use for my purposes a transformer of the open circuit type, suitably proportioned in weight of iron and copper and in the windings to get the best results. However, it is immaterial whether the carbon electrodes 18 and 19 are located in the hearth of the furnace or in its side-walls, or are introduced in any other suitable way and manner.

The essential features of this improvement are: (1) the arrangement of the furnace and electrodes or electric terminals for the heating of the furnace and reducing and fusing of the charge by the combined action of alternating and direct electric currents and reducing gases whereby the use of the so expensive carbon rods for electrodes is omitted; (2) the subduing of the extreme revolving motion by the action of the secondary electric current upon the bath of molten metal etc. as experienced in the ordinary induction furnace so injurious to its trough, by means of the currents conducted into the bath through the resistance conductors or terminals directly from the transformer and the terminals of the direct current generator; and (3) high electrical and thermal action and its even distribution over a wide area with the possible confining of the evolved spent gases and volatile metals for their recovery.

By using an alternating electric current in conjunction with a direct electric current the reduction of metals, such as aluminum in the usual fluorid bath, is greatly improved and cheapened as stated above, however, such a bath or any other metallurgical bath of any substance, metal or slag is not herein claimed, neither do I claim resistance conductors for electrodes which under ordinary condition are nonconductive and only convey electric currents when highly heated by a charge of molten metal, as practiced by Rochling in operating his induction furnace, for heating and treating iron to produce steel thereof.

The construction of furnace shown is capable of modification, within the scope of the claims.

I claim:—

1. An annular electric furnace around an electric current transformer said furnace provided with electrodes consisting each of two parts one part of which is made substantially of pure carbon, while the other part being its terminal is made of carbon compounded with a suitable refractory material to give it adequate resistance to an electric current secured from said transformer, substantially as and for the purpose set forth.

2. An annular electric furnace having an alternating electric current transformer located in its center, said furnace provided with a plurality of electrodes, one number of said electrodes comprising each two parts, one of which is highly conductive for electricity while the other part is a resistance conductor being the electric terminal connecting by said highly conductive part with said transformer, while another number of said electrodes are normally good conductors for electricity and connecting with a direct current generator, as set forth.

3. An annular electric furnace around an electric current transformer, said furnace provided with a plurality of electrodes, one number of said electrodes comprising each two parts, one of which is highly conductive for electricity while the other part being its terminal is a resistance conductor and extending over a major part of the hearth of said furnace, while another number of said electrodes are arranged to be conductive throughout, substantially as and for the purpose set forth.

4. An annular electric furnace upon a suitable base, said furnace comprising two working parts registering into each other, the lower part of which consists of an annular retort provided with suitable electric terminals, gas-inlets and metal and slag outlets, said annular retort inclosing an alternating electric current transformer connecting with said electric terminals, while the other and upper working part consists of an annular conical gas-chamber with a conical core in its center, said cone located over and above said transformer, said gas-chamber being provided with a suitable hopper centrally located over and above said cone for the charging of the furnace, and suitable outlets for the spent gases and metallic vapors for their recovery, as set forth.

5. An annular electric furnace comprising an upper chamber for the preparing of the material, and a lower chamber for the reduction of said material, said chambers registering into each other and inclosing an alternating electric current transformer, said lower chamber having suitable gas-inlets, suitable electric terminals, an opening near its base and an angular passage extending upwardly and outwardly from said opening as an outlet for the furnace product, said upper chamber having a suitable hopper and gas-outlets, as set forth.

6. An electric furnace upon a suitable base, said furnace comprising a substantially closed chamber having an interior and exterior wall spaced apart to form said chamber annularly around an alternating electric current transformer, said chamber suitably decreasing upwardly in size slightly from above said transformer to form an annular conical upper chamber removably arranged, said conical chamber provided with suitable means for the charging of the furnace and discharging of the spent gases and metallic vapors, while the lower part being the lower chamber and retort is provided with a plurality of electric terminals connecting with the secondary coil of said transformer, as set forth.

7. An electric furnace having a plurality of electrodes, one number of said electrodes consisting of an electric resistance conductor embedded in the furnace wall substantially flush with its hearth, while another number of electrodes are made of metal, cored and cooled by water and are embedded in the furnace walls, substantially flush with their inner sides above said hearth, as set forth.

8. The herein described electric furnace, which consists in an annular furnace chamber upon a suitable base, said chamber inclosing an alternating electric current transformer, a cone shaped removable mantle over and above said chamber and a conical core within said mantle removably arranged over and above said transformer, and the space between said mantle and core forming a continuation of said chamber, as set forth.

9. The herein described electric furnace which consists of an annular furnace chamber the upper part of which is removably arranged and suitably made of metal, cored and cooled by water, while its lower part is arranged stationary and is substantially made of refractory material and inclosing an alternating current transformer.

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