April 26, 1927. 1,626,437

M. UNGER

INDUCTION FURNACE

Filed Dec. 31, 1925

Fig. 1.

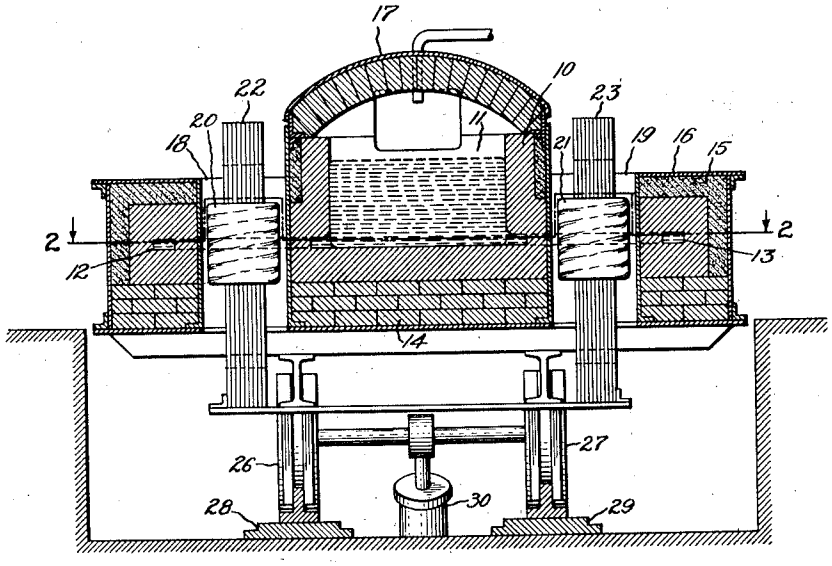
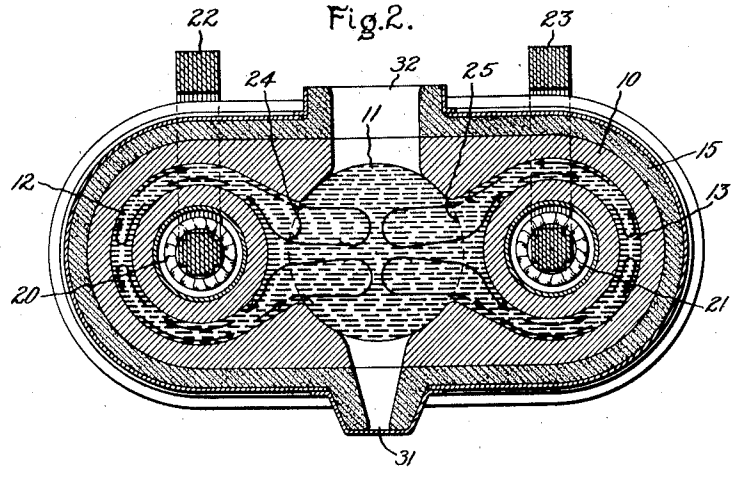


Fig. 2.



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UNITED STATES PATENT OFFICE.

MAGNUS UNGER, OF PITTSFIELD, MASSACHUSETTS, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

INDUCTION FURNACE.

Application filed December 31, 1925. Serial No. 78,668.

My invention relates to electric induction furnaces and has for its object the provision of a simple and reliable furnace and an organization whereby a more pronounced circulation of the charge may be produced.

More specifically my invention relates to furnaces for melting metals and the like, of the type having a looped channel in which a portion of the charge is heated by induced currents. Such a furnace is described and claimed in my copending application, Serial No. 445,514, filed February 16, 1921, of which this application is a continuation in part. In such furnaces it is desirable to set up a circulation of charge between the heated portion of the charge in the channel and the cooler portion in the reservoir.

In carrying out my invention I provide a secondary channel in which the cross sectional dimension of the channel at right angles to its axis is elongated whereby I utilize to advantage the electromagnetic repulsive forces between the primary winding and the liquid secondary to produce a circulation of charge. I also provide a plurality of secondary channels whereby both increased heating effect and circulation are obtained.

For a more complete understanding of my invention reference should be had to the accompanying drawing in which Fig. 1 is a vertical sectional view of an electric induction furnace embodying my invention, while Fig. 2 is a sectional view along the line 2—2 of Fig. 1 looking in the direction of the arrows.

Referring to the drawing, my invention in one form embodies a crucible 10, made of a suitable electrically insulating refractory material, which crucible provides a reservoir 11 for the charge and two horizontally disposed looped channels 12 and 13. The crucible may be formed by ramming a suitable plastic refractory clay around a core member which is shaped to define the channels and the reservoir, the core member being subsequently removed after the clay has been dried or fired. The core can be made of a suitable material, such as a metal, which can be melted out. As shown, the crucible rests on heat refractory bricks 14 and its upper portions are enclosed by powdered heat refractory material 15, the whole being enclosed in a metallic casing 16. A suitable cover 17 is provided for the reservoir.

Substantially vertical apertures 18 and 19 are provided in the crucible in concentric relation with the channels in which primary windings 20 and 21 are inserted in inductive relation with the molten charge in the channels. These primary windings are provided with cores of laminated magnet iron 22 and 23.

One of the important features of my present invention is the arrangement of the secondary channels 12 and 13. As previously stated these channels are horizontally disposed and they are arranged at opposite sides of the reservoir at or near the bottom thereof. Preferably each channel constitutes a complete loop so that the molten metal therein forms a closed secondary conductor independently of the reservoir. These secondary channels are connected with the reservoir at points of their outer peripheries, and, as shown, the secondary channels are connected respectively with the reservoir through openings 24 and 25 leading from opposite sides of the reservoir at the bottom thereof to the outer peripheries of the channels.

For the purpose of increasing the circulation of charge the cross section of each secondary channel is elongated horizontally so that the secondary channel is somewhat disk like in shape. In other words, the cross section of the channel is elongated in a direction at right angles to the axis of the channel, i. e., in the plane of the channel. As shown, this horizontal cross sectional dimension is several times greater than the vertical cross sectional dimension. The primary windings 20 and 21 are suitably supported in concentric relation with the channels, for example, by securing them to the cores 22 and 23 by means of wedges (not shown).

In the operation of the furnace a sufficient amount of molten charge is introduced in the reservoir to fill the channels, whereupon the heating operation proceeds by virtue of the electric currents induced in the molten metal in the channels. Additional charge may then be introduced into the reservoir in solid form and melted. By reason of the electromagnetic repulsion between the primary winding and the liquid secondary, forces acting in a radial direction are applied to the molten metal in the channels. These forces are directed from the center radially outward and thus tend

to force the molten metal toward the outer periphery of each channel. It will be observed that these forces are cumulative outwardly. This may be understood by considering each secondary as consisting of a plurality of imaginary concentric conducting elements. With this in mind it will be seen that the outwardly directed forces acting upon each inner molten secondary element of a particular secondary are transmitted to the adjacent outer secondary element and so on, so that as a result a considerable fluid pressure is created in the molten metal at the outer periphery of the channel. Since the walls of the channel are broken at the points of communication with the reservoir defined by the openings 24 and 25, a condition of lower fluid pressure necessarily exists at these regions and, therefore, the metal is forced out of the channels along their outer peripheries, it returning along the inner peripheries, these being regions of low pressure. This circulation is indicated in a general way in Fig. 2 of the drawing by the arrows.

By reason of the elongation of the cross section of the channel in a direction at right angles to its axis it will be observed that increased fluid pressures are obtained at the periphery and consequently a more pronounced circulation. By suitably regulating the length of this dimension, a furnace having a circulation of charge of the desired violence can be constructed. Metals having low electrical resistivity, such as copper and brass, require a higher current density because of their low resistance in order to produce the required rate of heat generation. On the other hand with metals of relatively high resistivity, such as iron and steel, a much smaller current is required. These higher current densities for low resistance metals produce correspondingly high repulsive forces and conversely the lower current densities for high resistance metals produce correspondingly low repulsive forces. Therefore, for high resistance metals a much greater elongation of the secondary channel in a direction at right angles to its axis is required. I have found that for copper a ratio of transverse to axial dimension of the secondary of approximately 2:1 is desirable, while for iron this ratio may be approximately 4:1.

As shown the furnace is mounted on rockers 26 and 27 resting on suitable tracks 28 and 29 whereby the furnace may be tilted by a suitable hydraulic motor 30 to pour the charge out through the spout 31. A suitable charging opening 32 is provided.

While I have described my invention as embodied in concrete form and as operating in a specific manner in accordance with the provisions of the patent statutes, it should be understood that I do not limit my invention thereto, since various modifications thereof will suggest themselves to those skilled in the art without departing from the spirit of my invention, the scope of which is set forth in the annexed claims.

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

1. An induction furnace comprising a crucible forming a reservoir for the charge and a looped channel communicating therewith at its periphery, and a primary winding for inducing heating currents in a liquid charge in said channel, said channel having a greater cross-sectional dimension in a direction at right angles to its axis to provide for increased circulation of the charge by electromagnetic repulsion.

2. An induction furnace comprising a crucible forming a reservoir for the charge and a looped secondary channel having a point of communication between its outer periphery and said reservoir, and a primary winding associated with said channel for inducing heating currents in a liquid charge in said channel, said channel having a greater cross sectional dimension in its own plane to provide for increased circulation of the charge by electromagnetic repulsion.

3. An induction furnace comprising a crucible forming a reservoir for the charge and a looped channel communicating therewith extending horizontally from said reservoir, and a primary winding associated with said channel for inducing heating currents in the molten charge in said channel, said channel having its horizontal cross sectional dimension elongated to provide for increased circulation of the molten metal by electromagnetic repulsion.

4. An induction furnace comprising a crucible forming a reservoir for the charge and a horizontal annular secondary channel extending from the side of said reservoir and having a point of communication between its outer periphery and said reservoir, and a primary winding associated with said channel for inducing heating currents in the molten charge in said channel, said channel having its horizontal cross sectional dimension elongated to provide for increased circulation of the molten charge by electromagnetic repulsion.

5. An induction furnace comprising a crucible forming a reservoir for the charge and a plurality of horizontally disposed looped secondary channels extending from the sides of said reservoir and connected with said reservoir at their peripheries, and primary windings inserted in said channels for inducing heating currents in the molten charge in said channels, said channels having greater cross sectional dimensions in a horizontal direction to provide for increased circulation by radial electromagnetic repulsion.

6. An induction furnace for melting

metals comprising a crucible forming a reservoir for the charge and an annular secondary channel communicating with said reservoir through an opening at one side, and a primary winding inserted in said channel for inducing heating currents in a molten charge in said channel, said channel having a greater cross sectional dimension in a direction at right angles to its axis to provide for regions of high and low fluid pressure at the outer and inner peripheries of said channel respectively whereby a circulation of charge is produced from said region of high pressure through the outer regions of said opening into said reservoir, the charge returning to said region of low pressure through the center of said opening.

7. An induction furnace comprising a crucible forming a reservoir for the charge and an annular secondary channel horizontally disposed at one side of said reservoir adjacent the bottom thereof and communicating with said reservoir through an opening at one side, a primary winding inserted in said channel for inducing heating currents in the molten charge in said channel, said channel having a greater cross sectional dimension in a horizontal direction to provide for regions of high and low fluid pressure at the outer and inner peripheries of said channel respectively, whereby a circulation of charge is produced from said region of high pressure through the outer regions of said opening into said reservoir, the charge returning to said region of low pressure through the center of said opening.

In witness whereof, I have hereunto set my hand this 28th day of December, 1925.

MAGNUS UNGER.