April 7, 1931. M. UNGER 1,800,034

FURNACE

Original Filed June 1, 1928

Fig. 1.

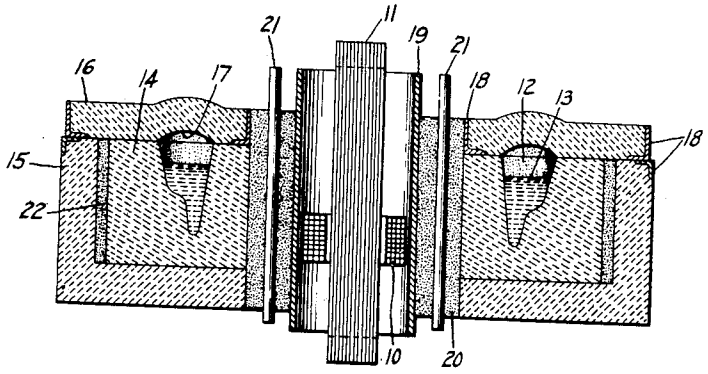
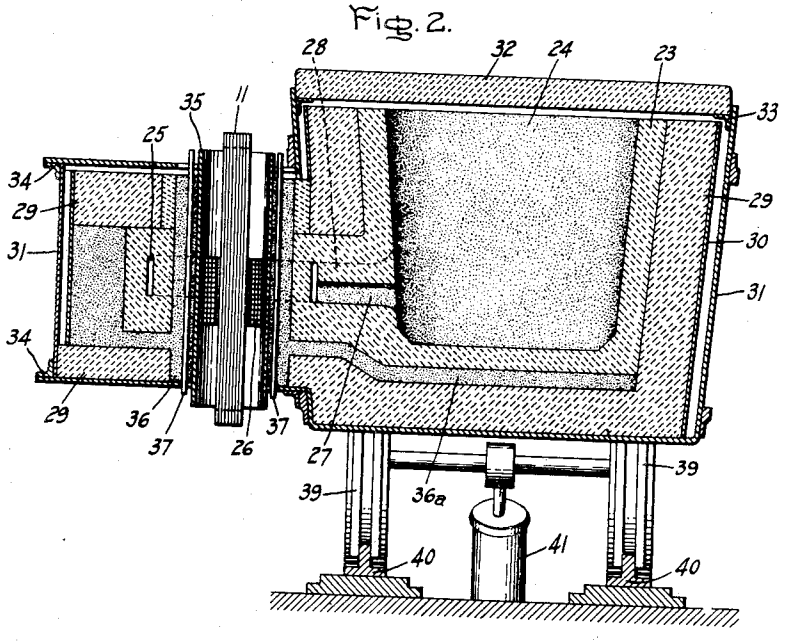


Fig. 2.



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His Attorney.

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UNITED STATES PATENT OFFICE

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FURNACE

Original application filed June 1, 1928, Serial No. 282,154. Divided and this application filed April 18, 1930. Serial No. 445,477.

My invention relates to furnaces, more particularly to electric metal melting furnaces, and has for its object an improved method for making a rugged and efficient furnace construction whereby leakage of the molten metal is prevented.

More specifically my invention has particular reference to electric metal melting furnaces in which all or part of the metal being heated forms a closed secondary in which heating currents are induced from a primary winding arranged within the secondary. In this type of furnace the metal is contained in a crucible which is ordinarily formed by ramming a suitable refractory material in plastic form in a suitably shaped mold, after which the crucible is suitably fired.

It has been found heretofore that refractory crucibles, especially those formed by ramming the refractory material in a mold, sometimes develop cracks due to unequal expansion from changes in temperature or due to local heating and cooling. Oftentimes these cracks resulted in leakage of molten metal from the crucible. In induction furnaces there is the danger that the molten metal escaping through such cracks may form secondary loops and thus become heated by induced current. The escaping metal is thus kept liquid and tends to run further until eventually a serious run-out may take place. Furthermore, in ring type furnaces in which the crucible containing the molten metal surrounds a refractory tube which in turn surrounds a primary heating coil, the crucible tends to expand on heating and thus a space is often formed between the crucible and the tube which surrounds the primary winding. Metal leaking into this space may form a secondary circuit and cause trouble.

In accordance with my invention I pack a layer of powdered or granular refractory material about the crucible so that in case a metal leak occurs through a crack in the lining, the metal will be stopped when it reaches the layer of granular material. The powdered or granular material also allows relative expansion and contraction of the crucible and the heat insulating walls surrounding it. Preferably, the granular or powdered material will be agitated as it is applied so that it will be compacted tightly against the crucible. It is also preferable to heat the crucible so that the material will be packed about the walls of the crucible while they are heated.

This application is a division of my copending application, Serial No. 282,154, filed June 1, 1928.

For a more complete understanding of my invention, reference may be had to the accompanying drawing in which Fig. 1 is a sectional elevation of a ring type furnace embodying my invention; and Fig. 2 is a sectional elevation showing my invention applied to a furnace of another type.

Referring to the drawing I have shown my invention in Fig. 1 as applied to a horizontal ring type induction furnace comprising a primary winding 10 surrounding a core 11, and a crucible providing a channel 12 for holding the molten metal 13 which acts as a closed secondary in which currents are induced by the primary winding 10. The channel 12 is formed in an annular crucible 14 which may be made from a suitable refractory material, such as a mixture of fused magnesia, calcined magnesia and a binder such as magnesium sulphate, as described in Patent No. 1,444,527 to Scharschu, dated February 7, 1925. These materials are mixed in granulated or powdered form, sufficient water being added to make a plastic mixture and the mass thus formed is rammed in place in a suitable mold which defines the crucible 14 with its channel 12. Surrounding and also immediately underneath the crucible 14 is a layer of suitable refractory heat insulating material 15 such as fire brick. A refractory member 16 is provided, forming a cover for the upper surfaces of the crucible 14 and the refractory layer 15, and this cover member 16 may contain a groove 17 in registering relation with the channel 12. For strengthening purposes the cover member 16 and the upper and outer edge of the layer 15 may be bound with metallic strips 18, L-shaped in cross section.

A metallic tubular member 19 surrounds the primary winding 10 wound on one leg

of the core 11 and between this tubular member 19 and the crucible 14 is a layer 20 of refractory, granular material, such as fused magnesia grains. The granular material 20 is rammed and packed to form a very dense mass, and to provide means for packing this material tightly between the tubular member 19 and the crucible 14, I provide a series of tubes 21, preferably made from a suitable non-magnetic material, arranged vertically, approximately midway between the tubular member 19 and the crucible 14. The packing of the granular material 20 is accomplished while the metal 13 and crucible 14 are being heated, by vibrating the tubes 21 continuously by any suitable vibrator (not shown), such as used in foundries. Preferably, the vibration will be applied intermittently, and only so long as the lining expands due to rising temperature. This assures the compacting of the material tightly against the crucible after it has been heated to operating temperatures, and subsequently during operation, whereby leakage of molten metal through any cracks which may be formed in the crucible will be stopped. While the furnace is in operation the tubes 21 also serve the purpose of cooling any metal leaks occurring in the crucible by the passing of a cooling medium, such as air, water or air with atomized water, through the tubes. It will be understood, of course, that the members 21 may have any suitable construction and that it is not necessary for the vibrating operation that they be of tubular form.

Between the outer periphery of the crucible 14 and the refractory layer 15 I provide another layer 22 of the granular material such as used in the layer 20. The space between the crucible 14 and the layer 15 is filled with the granular material 22 while the crucible 14 is cold and this material 22 serves to take up the difference in expansion between the crucible 14 and the layer 15 when the crucible is heated. The crucible 14 has high heat conductivity and hence it is general practice to use an outer layer 15 of a material having low heat conductivity. Consequently, when the furnace is heated the crucible will expand more than the refractory layer 15, and one purpose of the layer 22 of granular material is to serve as a buffer to take up the difference of expansion so that the danger of breaking the refractory layer 15 will be avoided. It is to be understood that the material 22 is not packed as densely as the material forming layer 20. When the furnace is in operation, if a crack should develop in the crucible 14, causing the metal 13 to leak therethrough, the flow of the metal will stop when the metal comes to the junction of the crucible and the granular material forming the layers 20 or 22.

In Fig. 2 I have shown my invention as applied to a furnace of the type disclosed in a patent in my name, No. 1,628,375, dated May 10, 1927. This furnace comprises an inner heat insulated crucible 23 which is shaped to provide a reservoir 24 for the metal and an annular chamber 25 in which a portion of the molten metal forms a closed secondary for a primary winding 26 associated therewith. The annular channel 25 is horizontally arranged, i. e., with its axis substantially vertical at one side of the reservoir 24, a slight distance above the bottom of the reservoir. It is connected with the reservoir through ducts 27 and 28 provided in the refractory material of the crucible. The crucible 23, similar to crucible 14 of Fig. 1, is made from a suitable refractory material, such as a mixture of fused magnesia, calcined magnesia and a binder such as magnesium sulphate. This material is rammed in place around a suitable core which defines the reservoir 24, the channel 25 and the ducts 27 and 28. Preferably a hollow metallic core is used which can subsequently be filled with molten steel and melted out as described in my aforementioned Patent No. 1,628,375. Surrounding the crucible 23 is a layer of suitable refractory, heat insulating material 29, such as fire brick or diatomaceous earth, the whole being enclosed by a metallic casing 30. A metallic shell 31 surrounds the furnace and a member 32 of refractory material forms a cover for the reservoir 24. The cover member 32 may be supported in any suitable manner and is shown as resting on angle irons 33 attached to the outer shell 31. Angular rings 34 serve to strengthen the outer shell 31.

A metallic, tubular member 35 surrounds the primary winding 26 and between this tubular member 35 and that part of the crucible 23 containing the channel 25 is a layer of compacted granular material 36 similar to the material forming layers 20 and 22 shown in Fig. 1. A layer of granular material 36*a* also is provided between the bottom of the crucible 23 and the refractory material 29 and also surrounds the outer portion of that part of the crucible containing the channel 25. Non-magnetic cooling tubes 37 are provided, as in Fig. 1, and these tubes serve the dual purpose of aiding in packing the granular material and in cooling this material when the furnace is in operation in a manner similar to that used in the furnace shown in Fig. 1.

The furnace is preferably mounted on suitable rockers 39 which rest on tracks 40, and it may be tilted by means of a suitable hydraulic motor 41 in order to pour metal from the furnace. This is described and explained more clearly in my Patent No 1,628,375 hereinbefore referred to.

Should metal leaks occur in the bottom of the crucible 23 or in that part of the crucible containing the channel 25, the flowing metal will be stopped when it reaches the junction of the crucible 23 and the packed, granular

material 35, 36*a*. It will be observed that the granular material 20 and 22 of the furnace shown in Fig. 1 and the granular material 36, 36*a* of the furnace shown in Fig. 2 perform two functions, that is, the granular material assists in absorbing expansion between the crucibles and the outer refractory layer and, secondly, the granular material serves to stop metal leaks occurring in the crucibles.

While I have described my invention as embodied in concrete form and 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. The method of packing a furnace crucible so as to prevent metal leakage therefrom which consists in surrounding said crucible with a layer of granulated, refractory, heat insulating material and agitating said material while applying it to said crucible so as to compact the material tightly against the crucible.

2. The method of packing a furnace crucible so as to prevent metal leakage therefrom which consists in surrounding said crucible with a layer of granulated, refractory, heat insulating material and heating said crucible while applying said material.

3. The method of packing a furnace crucible so as to prevent metal leakage therefrom which consists in surrounding said crucible while heated with a layer of granular heat refractory material.

4. The method of packing a furnace crucible so as to prevent metal leakage therefrom which consists in surrounding said crucible with a layer of granular heat refractory material, the material being agitated as it is applied to the crucible.

5. The method of packing a furnace crucible so as to prevent metal leakage therefrom which consists in surrounding said crucible with a layer of fused magnesia grains, heating said crucible while applying said magnesia, and agitating said magnesia while applying it to said crucible so as to compact the grains into a dense mass against the crucible.

6. The method of packing a furnace crucible so as to prevent metal leakage therefrom which consists in spacing a plurality of rod-like members at intervals around said crucible, and then surrounding said crucible while heated with a layer of heat refractory material, said rod-like members being vibrated as said material is being applied to said crucible whereby said material is packed tightly against said crucible.

7. The method of packing a furnace crucible so as to prevent metal leakage therefrom which consists in surrounding said crucible with a plurality of non-magnetic tubes, heating said crucible, surrounding said crucible while heated with a layer of granulated, refractory, heat insulating material and vibrating said tubes while applying said material to said crucible whereby said material is packed tightly against said crucible.

8. The method of packing a furnace crucible so as to prevent metal leakage therefrom which consists in surrounding said crucible with a layer of granular heat refractory material, heating said crucible while applying said material, and intermittently agitating said material while applying it to said crucible.

9. The method of packing a furnace crucible so as to prevent metal leakage therefrom which consists in surrounding said crucible with a layer of granular heat refractory material, heating said crucible while applying said material, and intermittently agitating said material while applying it to said crucible during the interval in which said crucible is expanding due to rising temperature.

In witness whereof, I have hereunto set my hand this 15th day of April, 1930.

MAGNUS UNGER.