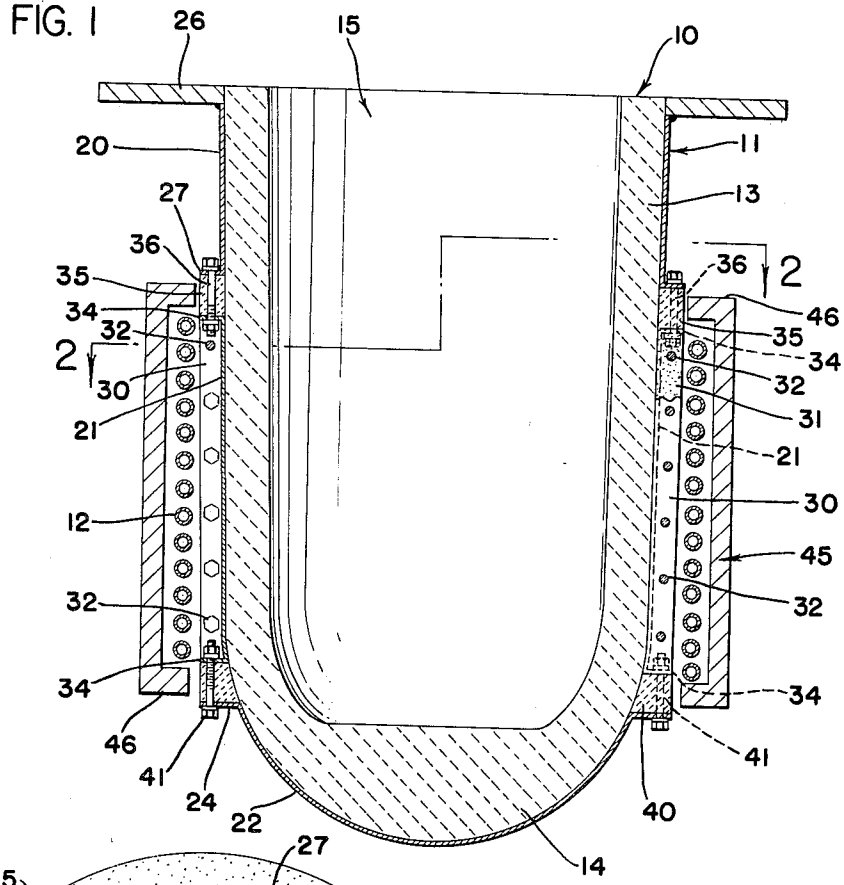
April 6, 1965 R. J. KASPER ETAL 3,177,282

HIGH FREQUENCY INDUCTION MELTING FURNACE

Filed April 21, 1961

FIG. 1



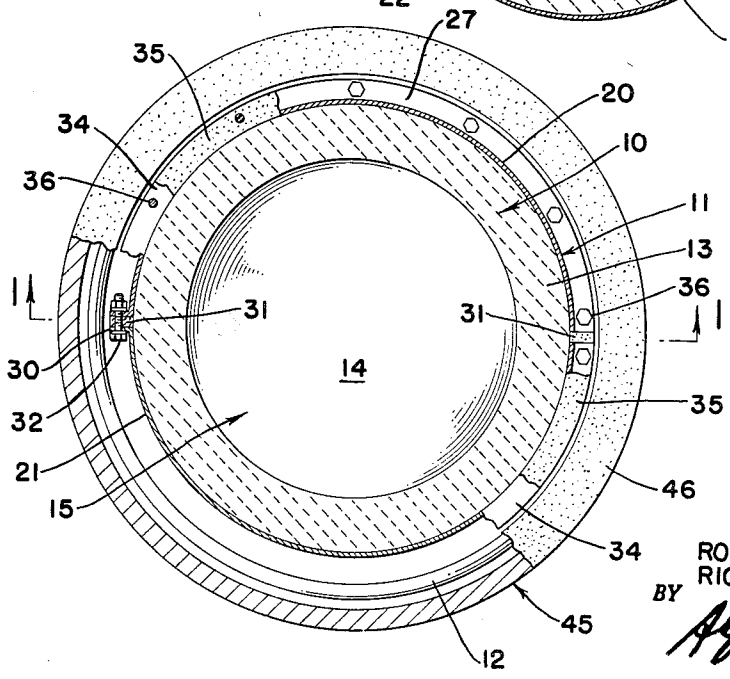


FIG. 2

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HIGH FREQUENCY INDUCTION MELTING FURNACE

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8 Claims. (Cl. 13—27)

This invention relates to the art of induction heating and more particularly to an induction heating type of melting furnace.

The invention is particularly applicable to induction heating type melting furnaces to be employed in the field of vacuum melting and will be described with particular reference thereto, although it will be appreciated that the invention has broader applications.

In the art of vacuum melting, it has heretofore been the practice to surround a crucible with an induction heating coil and then surround the coil and crucible with a sealed container from which all air is evacuated.

One of the principal problems with this arrangement has been with the corona discharge and the arcing between terminals in the vacuum and in bringing the power leads through sealed openings into the vacuum, all of which have been very serious impediments to vacuum melting using induced currents.

Another problem has been the weight and bulkiness of the installation making it difficult to move the furnace from the point of melting to the point of pouring which sometimes were considerably spaced one from the other. Also, flexible power leads to the coil had to be provided so the furnace could be tilted for pouring or disconnect terminals had to be provided if the furnace had to be moved.

On the other hand, because of the difficulties of forcing a magnetic field through the outer steel shell, it has been considered very impractical to place the induction heating coil on the outside of such shell.

The present invention contemplates induction heating type melting furnaces which overcome all of the above referred to difficulties and others, and enables the induction heating coil to be placed outside of the shell closing in the crucible.

In accordance with the present invention, an induction type melting furnace is provided comprised of a refractory crucible, a metal supporting shell and an induction heating coil surrounding the supporting shell, the shell being in the form of an upper section, a lower section and an intermediate section all formed of a material having a low magnetic permeability with the intermediate section being in the shape of two semi-circular sections insulated from each other and the upper and lower sections being separated from the intermediate section by electrically non-conductive rings, the induction heating coil being concentric about the intermediate section and having a magnetically permeable outer shell with the upper and lower ends adjacent to the electrically non-conductive material.

The principal object of the invention is the provision of a new and improved induction melting furnace of the type including an outer metal supporting shell which enables the induction heating coil to be placed on the outside thereof and which facilitates the threading of the flux into the inside of the shell.

Another object of the invention is the provision of a new and improved induction melting furnace of the vacuum type wherein the inducing coil may be located on the outside thereof.

Another object of the invention is the provision of a new and improved induction melting furnace of the vacuum type wherein the problems of electrical discharge

of the power leads into the vacuum and electrical insulation between the turns of the induction heating coil are avoided.

Another object of the invention is the provision of a new and improved furnace of the type described wherein the furnace and the inducing coil are independent units readily separable one from the other.

The invention may take physical form in certain parts and arrangements of parts, a preferred embodiment of which will be described in detail in this specification and illustrated in the accompanying drawings which form a part hereof and wherein:

FIGURE 1 is a side cross-sectional view of an induction melting furnace illustrating a preferred embodiment of the invention, the section being taken approximately in the line 1—1 of FIGURE 2; and

FIGURE 2 is a cross-sectional view of FIGURE 1 taken approximately in the line 2—2 thereof.

Referring now to the drawings wherein the showings are for the purpose of illustrating a preferred embodiment of the invention only, and not for the purpose of limiting same, the figures show an induction melting furnace comprised of an inner crucible 10, an outer supporting shell 11, and an inducing coil 12 disposed around the shell 11.

The crucible 10 per se forms no part of the present invention, but includes generally cylindrical side walls 13 and a base 14 defining a cavity 15 open at the top into which the metal or other materials to be melted are placed. The liner may be made in any known conventional way, but preferably by placing a form in the shape of the cavity 15 on the inside of the shell 11 and then pouring in powdered refractory material between the form and the shell 11 and ramming it to a high density as is conventional.

The shell 11 in the embodiment shown is generally comprised of three sections, namely, an upper section 20, an intermediate section 21, and a lower or bottom section 22.

The bottom section is generally in the shape of a spherical dish terminating at its upper edge in an outwardly and horizontally extending flange 24. This bottom section 22 may be of any desired material having the necessary strength, but is preferably of a material having a low magnetic permeability such as stainless steel.

The upper section 20 is generally in the form of a circumferentially continuous sleeve having a large horizontal flange 26 fastened to its upper edge and a small horizontally extending flange 27 at its lower edge. The flange 26 is conventional, forms no part of the present invention, and is provided generally to enable a cap or cover to be placed over the furnace to seal the inside of the furnace to enable the inside to be evacuated.

The center section 21 is also generally in the shape of an elongated sleeve, but is so arranged in accordance with the invention that the metal of the sleeve is not circumferentially continuous. Thus in the embodiment of the invention shown, the center section 21 is made up of two semi-cylindrical members each terminating in an outwardly and vertically extending flange 30 which flanges have a layer of electrical insulation 31 therebetween, and which flanges are bolted against the insulating material 31 by a plurality of bolts 32, the head, shank and nut of which are preferably insulated from the flanges 30.

The semi-cylindrical members making up the section 21 also have outwardly and circumferentially extending flanges 34 at their upper and lower edges.

The material of the upper and intermediate section 20, 21 is preferably the same as the material of the lower section 22.

Intermediate the upper section 20 and the intermediate

section 21 is a ring of electrically non-conductive material 35 which has a radial thickness generally equal to the radial thickness of the flanges 27 and 34 and is tightly bolted to these flanges by means of a plurality of bolts 36 extending through the flanges 27 and 34 and through vertical passages in the ring 35. The heads, shanks and nuts of these bolts are preferably electrically insulated from the flanges 27 and 34. These rings 35 form an important part of the present invention and will be referred to hereinafter.

In a like manner, a ring 40 of electrically non-conductive material is positioned between the lower section 22 and the intermediate section 21 and is held in assembled relationship therewith by means of bolts 41 extending through the flange 34, a vertical opening in the ring 41 and the flange 24. The heads, shanks and nuts of such bolts are insulated from the metal in a manner similar to the bolts above described.

It will thus be seen that the shell is comprised of upper and lower sections 20, 22 of electrically conductive material which may be circumferentially continuous, an intermediate section 21 of an electrically conductive material which is not electrically continuous in a circumferential direction, and adjacent sections being separated by rings 35, 40 of electrically nonconductive material.

Obviously, all of the joints will be suitably caulked so as to make them water and gas tight.

The induction heating coil 12 is so arranged as to generate a high concentration of magnetic flux just radially outside of the rings 35 and 40. These rings, being of electrically nonconductive material, act like a window to the magnetic flux enabling it to thread on the inside of the furnace and into the metal contained in the cavity 15.

In the embodment of the invention shown, the induction heating coil is comprised of an elongated helix coaxial with the outside of the intermediate section 21 in slightly spaced relationship therewith. Immediately outside of the coil 12, magnetically permeable material 45 is provided which extends the entire axial length of the coil 12 and has radially inwardly extending ends 46 located just opposite the rings 35 and 40. This magnetically permeable material 45 with the ends 46 serves to concentrate and direct the flux from the coil 12 so that the maximum amount will thread through the rings 35 and 40 into the inside of the shell 11.

The vertical height of the portions 46 generally are the same as the radial thickness of the material 45. Preferably the rings 35 and 40 each have a vertical or axial height at least twice the axial height of the ends 46. With this arrangement, the maximum amount of flux can pass through the rings 35 and 40.

The coil 12 may be water cooled as is conventional. It may also be necessary to water cool the permeable material 45. Such constructions are not shown inasmuch as they are conventional.

In a like manner, it may be necessary to water cool the shell 11 to remove any heat generated therein by eddy current or by heat flowing alternately from the molten metal through the crucible 10.

With the construction shown, it will be appreciated that the coil 12 with its magnetically permeable material may be fixedly mounted on a support, while the crucible 10 and its surrounding shell 11 may be readily removed therefrom without disturbing the coil 12 and without the need for flexible connections being made to the coil 12 as would be necessary if the coil 12 were located on the inside of the shell 11.

The invention has been described with reference to preferred embodiments. Obviously, modifications and alterations will occur to others upon a reading and understanding of this specification, and it is my intention to include all such modifications and alterations insofar as they come within the scope of the appended claims.

Having thus described our invention, we claim:

1. An induction melting furnace comprised of a crucible; an outer metallic shell surrounding said crucible; said shell comprising an upper section, a base section, and an intermediate section being formed of a metallic member which is electrically discontinuous in a circumferential direction; and electrically non-conductive rings having a substantial vertical height separating said intermediate section from said base section and said upper section; said rings forming flux windows through said shell for passage of high frequency magnetic flux lines into the interior of said crucible.

2. A melting furnace as defined in claim 1 wherein a multi-turn induction heating coil is disposed around said intermediate section.

3. A melting furnace as defined in claim 2 wherein magnetically permeable material extends along the outside of said induction heating coil, said material having inwardly facing ends, said said ends being positioned adjacent said nonconductive rings.

4. An induction type of melting furnace comprised of a crucible of electrically non-conductive material and including generally cylindrical side walls and a base closing the lower end thereof, a supporting shell for said crucible comprised of a metallic base extending across the bottom of said crucible and terminating generally in the plane of the bottom of the cavity defined by the crucible, an upper metal section extending around the upper portion of the walls of said crucible and an intermediate section extending generally around the intermediate portion of said crucible, said intermediate section being of electrically conductive material, but being electrically discontinuous in a circumferential direction, rings of electrically non-conductive material spacing said upper section from said intermediate section and said intermediate section from said bottom section, said rings forming flux windows through said supporting shell for passage of high frequency magnetic flux lines into the interior of said crucible.

5. A melting furnace as defined in claim 4 wherein a multi-turn inducing coil surrounds intermediate section.

6. A melting furnace as defined in claim 5 wherein magnetically permeable material extends around the outside of said coil and forms ends which terminate adjacent said non-conductive rings.

7. A melting furnace as defined in claim 6 wherein said magnetically permeable material ends extend radially inwardly of said coil across the axial ends thereof and terminates adjacent said non-conductive rings, the axial width of each of said rings being at least twice the axial width of the ends of said magnetically permeable material.

8. In an induction melting furnace comprising a crucible, a non-magnetic metallic shell around said crucible, and an induction heating coil surrounding said shell, the improvement comprising: axially spaced, circumferentially extending flux windows of electrically non-conductive material in said metallic shell, and a flux focusing member of high magnetic permeability surrounding said coil and having axially spaced, flange-like ends facing inwardly toward said flux windows.

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