Nov. 28, 1944. W. RICHTER 2,363,994

ELECTRIC INDUCTION FURNACE

Filed Nov. 30, 1942

FIG. 1.

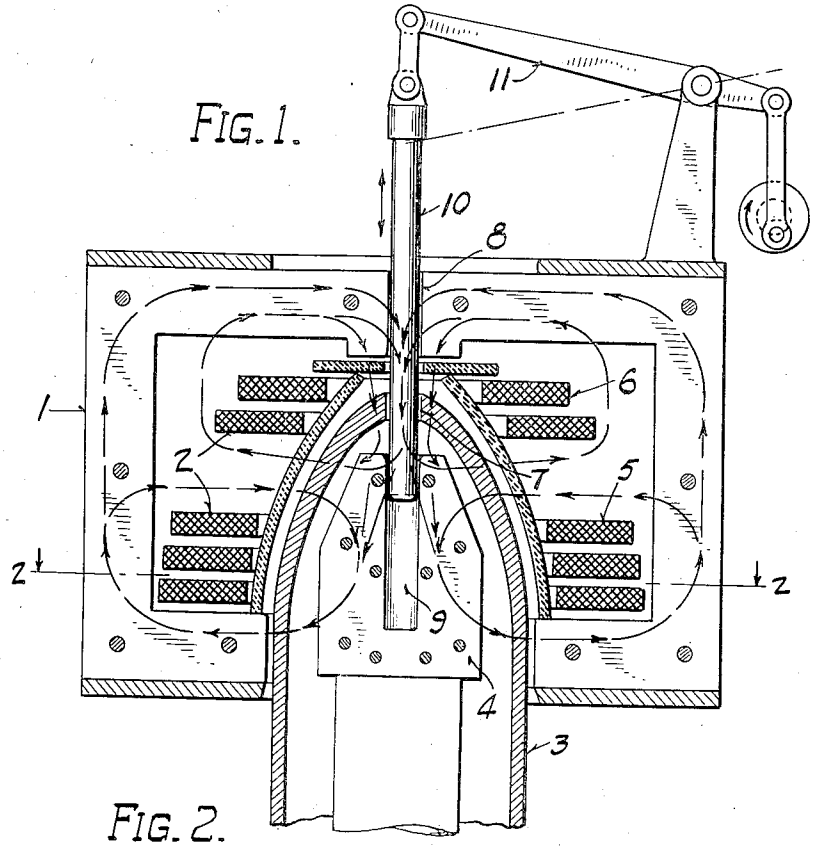
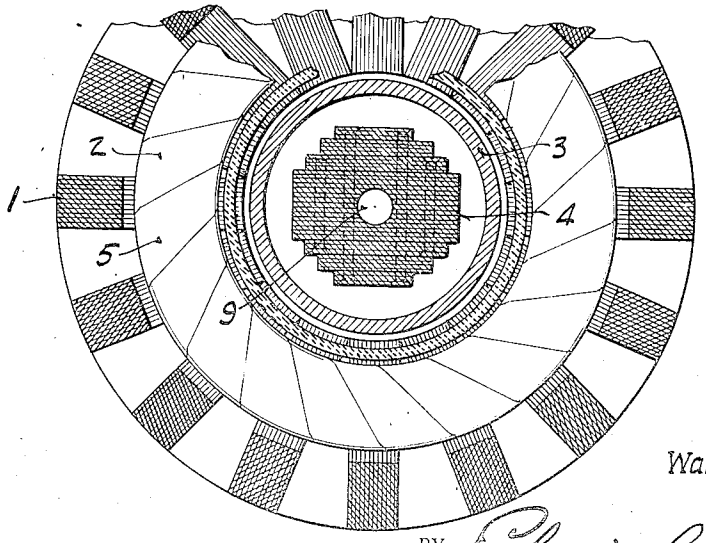


FIG. 2.



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ELECTRIC INDUCTION FURNACE

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5 Claims. (Cl. 219—13)

This invention relates to electric induction furnaces and constitutes an improvement upon the invention set forth and claimed in the copending application of Eugene J. Limpel, Serial No. 453,004, filed July 31, 1942, for Induction heating, and assigned to a common assignee with the present invention, which application issued to Patent No. 2,352,332 on June 27, 1944.

In the Limpel invention the heating of the tip of a partially closed nose of a bomb casing was made practical by employing a temporary core plug extending through the relatively small aperture in the nose and bridging the gap between larger members of the furnace core structure. The temporary core plugs were applied individually to each bomb casing as it entered the furnace and were removed from the respective bomb casings as the latter were withdrawn from the furnace. The plugs were then cooled and made ready for use in subsequent similar heating operations.

The present invention accomplishes the purpose of the plugs by the use of a long core member made a part of the furnace and disposed for reciprocation during heating, the member passing through the aperture in the bomb casing and through similar openings in the larger core elements of the furnace. The reciprocation of the core member during heating prevents overheating of the same and provides a sustained flux path which more effectively induces the desired heating currents in the metal immediately adjacent the aperture at the tip of the bomb casing.

The general object of the invention is to provide for the heating of the metal adjacent an aperture in a partially closed end of a tube by the use of a core member which is a part of the furnace structure and which thereby eliminates the labor and inconvenience attendant the use of individual core plugs for each heating operation.

An embodiment of the invention is illustrated in the accompanying drawing in which:

Figure 1 is a sectional view, largely diagrammatic, of an induction furnace with a bomb casing therein and showing the reciprocating core member of the present invention; and

Fig. 2 is a transverse section through the furnace taken on line 2—2 of Fig. 1.

The induction furnace illustrated comprises, in general, an outer core structure 1 enclosing energizing coils 2 and having its bottom open for receiving the partially formed nose of a bomb casing 3. The bomb casing is raised into the furnace by an elevator, not shown.

An inner core structure 4 is raised vertically inside the bomb casing to co-operate with the outer core structure in providing a substantially closed circuit for magnetic flux in the furnace. Energizing coils 5 encircle the position of the bomb casing 3 and serve to produce the magnetic flux which induces the heating currents in the bomb casing. An auxiliary energizing coil 6 is disposed adjacent the tip of the bomb casing and encircles the aperture 7 in the nose of the bomb.

In carrying out the invention, a vertical opening 8 is provided centrally of the top of the outer core structure in alignment with the aperture 7. An axial bore 9 of a diameter similar to aperture 7 and opening 8 is provided in the upper end of the inner core structure 4 in alignment with the aperture 7. A reciprocating core member 10 is disposed vertically to extend through the opening 8 and aperture 7 and into the bore 9.

The core member 10 is as large in cross section as the aperture 7 will accommodate and preferably has only sufficient clearance in opening 8 and bore 9 to allow for the vertical reciprocation of the member during operation of the furnace. The member 10 is preferably suspended from above by suitable mechanism 11 adapted to reciprocate it up and down.

When the furnace is in operation, the core member 10 serves to carry a heavy load of flux through aperture 7 from the top of the outer core structure 1 to the top of the inner core structure 4, and vice versa. The flux is more concentrated and dense in the member 10 than it is in the larger core elements, and this fact taken in addition to the proximity of the member 10 to the metal being heated results in a tendency to unduly heat the member 10 were it kept stationary. As it becomes heated in any given position, the member 10 loses its ability to carry as much flux and as a result its effectiveness becomes diminished. However, by reciprocating it up and down during operation of the furnace, the heating effect on the core member 10 is spread over a substantial area and volume of metal, and undue heating is eliminated. The efficiency of the member 10 to carry flux is thereby kept at a maximum.

The invention is particularly applicable where the size of aperture 7 is such as to require a maximum core section through the aperture and thereby substantially prohibits the employment of passages for cooling fluid in the member 10. The core member may be cooled between successive operations of the furnace by applying a cooling medium externally to the member.

The entire core structure of the furnace including member 10 is laminated to avoid eddy current losses as much as possible. This also tends to prevent undue heating of the member 10.

The core member 10 should extend into the inner core structure 6, at all times during operation of the furnace, a distance sufficient to give a substantially large surface area for transfer of flux from one to the other so that saturation of the core member can be obtained.

The flux passing through the core member 10 induces heating current in the metal at the tip of the blank immediately surrounding the aperture 7 and insures that this portion of the bomb casing will become heated as quickly as the remaining part through which the main portion of flux passes.

Various embodiments of the invention may be employed within the scope of the claims.

The invention is claimed as follows:

1. In an induction furnace having an external stationary core member and primary energizing coils therefor, a longitudinally movable central core member disposed to extend through an aperture in the article being heated and to carry flux between the relatively stationary core elements in all operative longitudinal positions of said member, and means to move said central core member longitudinally during the heating cycle of the furnace to prevent undue local heating of the member without substantially altering the reluctance of the flux path.

2. In an induction furnace having an external stationary core member and primary energizing coils therefor, a longitudinally movable central core member disposed to extend through an aperture in the article being heated and to carry flux between the relatively stationary core elements in all operative longitudinal positions of said member, and means to reciprocate said central core member longitudinally during the heating cycle of the furnace to prevent undue heating of the member without substantially altering the reluctance of the flux path.

3. An induction furnace for heating an electrically conductive article having an opening through which magnetic flux must pass for inducing heating current in the conductive material thereof adjacent said opening, said furnace comprising magnetic core structure including a longitudinally reciprocatory core section extending through said opening, coil means for magnetically energizing said core section, and means operative during the heating cycle of the furnace to reciprocate said core section longitudinally without substantially altering the reluctance of the flux path in all of the operative positions of the core section, the length of the reciprocatory stroke imparted to said core section being substantially less than the length of the core section and sufficient to preclude said core section becoming injuriously overheated.

4. An induction furnace comprising magnetic core structure including an elongated longitudinally movable laminated core section designed to extend through an opening of small diameter in an electrically conductive article to be heated, stationary coil means for magnetically energizing said core section, and means operative while the furnace is on heat for imparting substantially continuous longitudinal movement to said core section without substantially altering the reluctance of the flux path in all of the operative positions of the core section for preventing the same from becoming locally overheated.

5. The method of preventing loss in efficiency of a portion of the core structure of an induction furnace where such portion is saturated with flux and disposed to receive substantial radiation of heat from the article being heated, comprising providing a separate core member of dimensions longer than the portion subjected to overheating, and moving such member longitudinally during the heating cycle of the furnace to present successive sections of said core member to the zone of maximum heat while maintaining a substantial area of flux transfer from said moving core member to the remainder of the core structure of the furnace.

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