Sept. 22, 1931. T. H. LONG 1,823,908

INDUCTION FURNACE

Filed Sept. 20, 1930

Fig. 1.

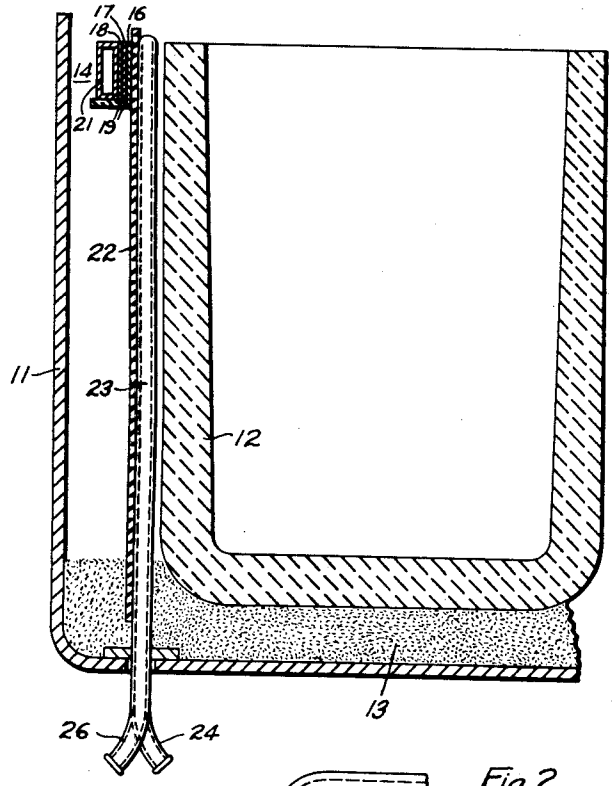


Fig. 2.

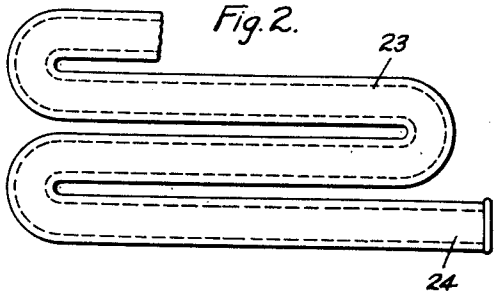


Fig. 3.

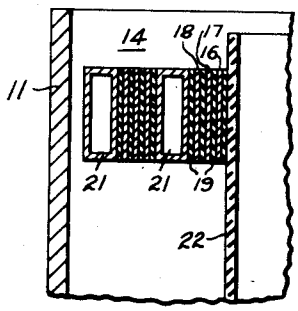
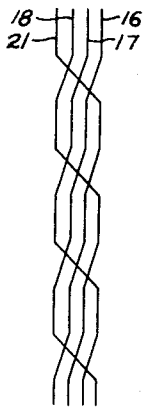


Fig. 4.



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UNITED STATES PATENT OFFICE

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INDUCTION FURNACE

Application filed September 20, 1930. Serial No. 483,242.

My invention relates to electric furnaces and particularly to induction furnaces.

An object of my invention is to provide a relatively simple form of energizing coil for an induction furnace which shall have minimum electrical losses therein.

Another object of my invention is to provide an energizing coil embodying a plurality of laminated parallel-connected conductors to reduce the energy loss therein, and means for preventing excessive flow of heat from material being heated to the coil.

In practicing my invention, I provide an energizing coil of substantially helical shape, embodying a plurality of relatively thin conductors and a tubular conductor adapted to be traversed by a cooling fluid, as well as a fluid-traversed heat shield between the coil and the material being heated.

In the single sheet of drawings,

Figure 1 is a view, in vertical section, through an induction furnace embodying my invention, shown in part only;

Fig. 2 is a view, in developed front elevation, of a portion of a heat shield constituting a part of the device embodying my invention.

Fig. 3 is a fragmentary sectional view of a modified form of a portion of the device embodying my invention.

Fig. 4 is a schematic diagram illustrating the connections between adjacent turns or groups of turns of my multi-layer coil.

It is obvious that it is highly desirable, if not actually necessary, to maintain the temperature of the energizing coil of an induction furnace at as low a value as may be possible, in order to prolong the life of the coil and that of the insulating material, as well as to maintain the electric-current losses therein at a reasonably low value.

To this end, I laminate the conductor and shield it by a fluid-traversed heat screen from the material being heated.

A sheet-metal casing 11 is shown in Fig. 1 of the drawings that may be of any suitable or desired construction and may be made of a metal which is non-magnetic, in order to reduce the eddy-current losses therein. A crucible 12, of refractory material, is located in the casing that may also be made of any suitable or desired material usually employed for such purposes and of any suitable shape. A quantity of electric and heat-insulating granular material 13 is located within the casing 11 to enclose and suport the crucible 12, all in a manner known in the art.

An energizing coil, including a plurality of turns of a plural-element conductor 14, is employed, only one side of one turn being shown, it being understood that the other turns are like that shown. The conductor 14 includes a plurality of relatively thin strips 16, 17 and 18 of copper, which are separated from each other and from a tubular conductor 21 by relatively thin layers of electric-insulating material 19, the conductor 21 being traversed by a cooling fluid, such as water or air. The tubular conductor 21 is preferably located on the outside of the multi-element conductor 14, as is shown in Fig. 1 of the drawings, and I may employ a tubular member 22 of solid electric-insulating material, such as mica, between the strip 16 and the crucible 12.

I provide also a fluid-traversed heat screen 23 between crucible 12, which is, of course, to contain the material being heat treated, and the coil, and locate it between the outer wall of crucible 12 and the member 22. The heat shield 23 includes a flattened tubular member which may be built up in any suitable or desired manner, as by brazing suitably formed sheets of copper to constitute a structure of serpentine shape, substantially as shown in Fig. 2 of the drawings, it being understood that the number of convolutions is such as to extend around the crucible 12. An inlet end 24 is provided to permit of connecting a suitable hose thereto which should preferably be made of electric-insulating material to permit the cooling fluid to enter the heat shield at this point and to discharge it at the exit end 26, closely adjacent to the inlet end 24. It may be desirable to circulate the water through the thermal shield in a plurality of parallel-connected paths.

It is highly desirable to insure that all of the elements 16, 17, 18 and 21 which are to be connected in electric-conducting relation

shall be subjected to a uniform electric loading, as regards the flux generated thereby, and I have illustrated, in Fig. 4 of the drawings, one means of accomplishing this. The respective elements of the conductor are illustrated schematically only, and, after one turn or group of turns of the coil has been completed, the end of element 16 is connected to the second conductor element, as indicated, in a radially outward direction, while element 17 is connected to the third element of the second turn, and element 18 is connected to the fourth element of the second turn, while element 21 is connected to the innermost element of the second turn. This method of connection is repeated for all of the turns and will result in a substantially uniform electric loading of all the elements in all of the turns.

Referring more particularly to Fig. 3 of the drawings, I have there illustrated one turn of an energizing coil embodying eight parallel-connected conductor elements and it may be noted that the innermost member 21 will be operative, not only to dissipate heat from those conductor elements inside thereof, but also from those conductor elements outside thereof. I have illustrated the annulus 22 of mica, but have not illustrated the crucible or heat shield, as all of the other parts are the same as shown in Fig. 1 of the drawings. As was hereinbefore set forth in connection with Fig. 1, only one turn of a helical plural-turn energizing coil has been illustrated, and it is to be understood that the coil extends downwardly to near the bottom of the crucible.

The device embodying my invention thus provides a laminated conductor in which the radial thickness of the conductor elements is made such that the eddy-current losses therein are relatively small and whereby means for maintaining the temperature of the conductor at a relatively low value by the use of the fluid cooling-current-traversed element 21.

As a coil of this type may be used, not only for the melting of metals but also for the heating of solid blocks of metal, the temperature within the coil may be relatively high and, in order to prevent over heating of the coil, I provide the heat screen embodying the fluid-traversed flattened tubular member, hereinbefore described.

While I have illustrated and described a plural layer coil in which the respective layers are connected in parallel-circuit relation, they may be connected in series-circuit relation.

Various modifications may be made in the device embodying my invention without departing from the spirit and scope thereof, and I desire, therefore, that only such limitations shall be placed thereon as are imposed by the prior art or are set forth in the appended claims.

I claim as my invention:

1. In an electric inductive heating device, a plural-turn energizing coil embodying a radially-laminated conductor and a fluid-cooled thermal shield located between the energizing coil and material to be inductively heated thereby.

2. In an electric inductive heating device, an energizing coil embodying a radially-laminated conductor, a fluid cooled subdivided shield between the coil and material to be heated to reduce flow of heat from heated material to the coil, and a fluid-traversed cooling means substantially coextensive with said conductor and operatively engaging the same.

3. In an electric inductive heating device, an energizing coil having a plurality of turns of a radially-laminated conductor, said conductor including an outermost hollow fluid-and-current-traversed lamination and a fluid-cooled subdivided shield between the coil and material to be heated.

4. In an electric inductive heating device, an energizing coil for inductively heating material and embodying a radially-laminated conductor, a fluid-cooled subdivided shield located between the coil and material being heated, a portion of said conductor constituting a fluid-cooling means substantially coextensive, and closely operatively associated therewith to carry away any heat generated therein by the passage of an electric current therethrough.

5. In an electric inductive heating device, an energizing coil embodying a conductor subdivided radially so that the current density in the respective portions is substantially uniform, and a cooling means located between the coil and a material being heated.

6. In an electric inductive heating device, an energizing coil having a plurality of layers of a laminated conductor, an intermediate lamination being hollow and fluid-traversed, and a laminated fluid-cooled thermal screen between the coil and material being heated to reduce heat flow from the heated material to the coil.

In testimony whereof, I have hereunto subscribed my name this 12th day of September, 1930.

THOMAS H. LONG.