Sept. 22, 1931. N. R. DAVIS 1,823,970

INDUCTION FURNACE

Filed Sept. 26, 1929

Fig. 1

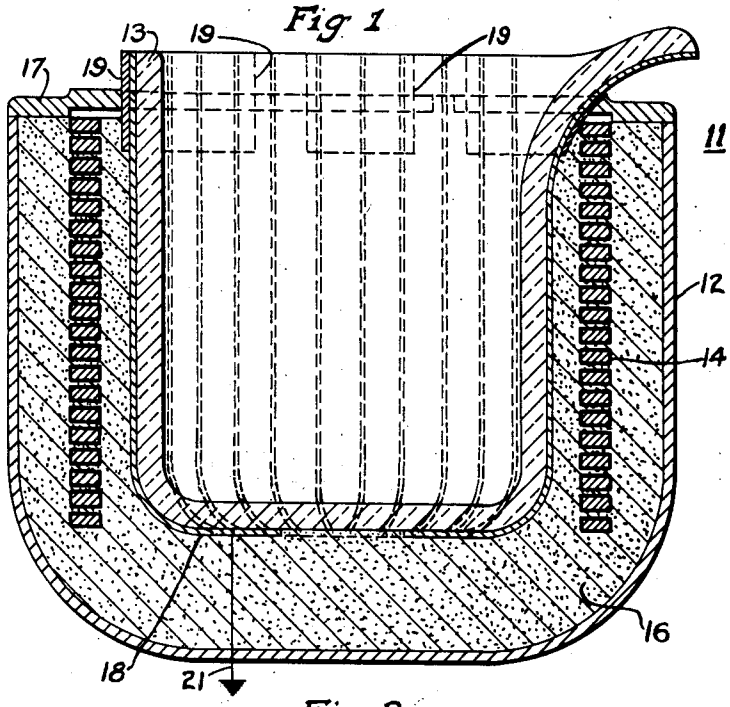


Fig. 2

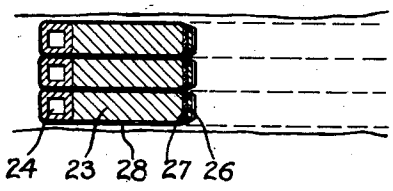
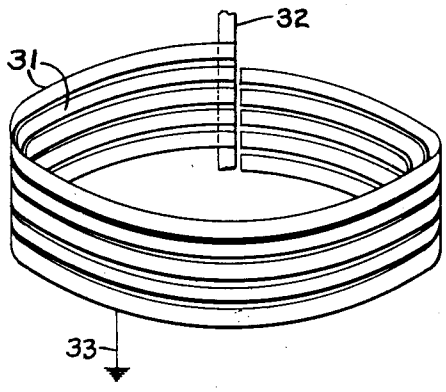


Fig. 3.



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UNITED STATES PATENT OFFICE

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INDUCTION FURNACE

Application filed September 26, 1929, Serial No. 395,229, and in Great Britain October 9, 1928.

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

An object of my invention is to provide a relatively simple and highly efficient protecting means for an electric induction furnace.

Another object of my invention is to provide a relatively simple means for preventing electrical shock to an operator in case of molten metal leaking from the crucible of an induction furnace.

In practicing my invention, I provide a furnace assembly including a crucible, an induction coil located therearound and other suitable elements, such as a casing, and I provide a laminated metallic structure or electric-conducting screen connected to ground and located either between the crucible and the winding or between the winding and the casing.

In the single sheet of drawings,

Figure 1 is a view, in vertical section, of an electric induction furnace embodying my invention.

Fig. 2 is a fragmentary view, in section, on a somewhat enlarged scale, of an induction coil with which is associated the particular device embodying my invention, and

Fig. 3 is a view, in perspective, of a modification of the device particularly embodying my invention.

Referring more particularly to Fig. 1 of the drawings, I have there illustrated an induction furnace of the surrounded-pool type, as embodying an outer metal casing 12 which may have an open top and which may have any other mechanical elements associated therewith to permit of filling and emptying a refractory crucible 13 located within the casing.

An induction coil 14 is shown schematically only as embodying a plurality of turns of a suitably insulated electric conductor surrounding the crucible 13 and coaxial therewith. A quantity of electric and heat-insulating granular material 16, such as zirconium sand, may be used within the casing 12 to support not only the induction coil but also the crucible. The construction and assembly shown in Fig. 1 of the drawings are for illustrative purposes only and it is to be understood that such modifications may be made in these parts as may be desirable, as my particular invention does not embody these elements.

A cover 17 of substantially annular shape is provided to cooperate with the upper rim of the casing 12 and with the crucible 13 to close the casing.

While no terminal members or terminal leads have been shown for the induction coil 14, it is to be understood that any structure suitable for such purposes may be employed.

In the operation of relatively large induction furnaces of this type, it is sometimes desirable, and even necessary, that relatively high-voltage energization of the induction coil be used, and as it is possible, in the operation of the furnace, that the charge within the crucible or electrically-conducting parts of the furnace casing may accidentally become connected to the induction coil and, consequently, may be subjected to a relatively high alternating electric potential which may constitute a danger to workmen who are operating the furnace.

The element particularly embodying my invention includes a laminated or foraminous screen of electrically-conducting material of relatively high inherent electrical resistance which is located either closely adjacent to the crucible and between the crucible and the coil or between the coil and an outer casing.

In the construction shown in Fig. 1 of the drawings, the ground shield comprises a plurality of relatively thin and narrow strips 18 of a suitable metal having a high electrical resistance. The material of the strips may be some form of nickel-steel or nickel-chromium-steel alloy which may be purchased in the open market. The strips 18 are so located that their main or body portions extend longitudinally or axially of the crucible and may be located a relatively small distance apart, the lower ends thereof being made narrower and bent under the crucible, substantially as shown in Fig. 1 of the drawings. The strips also help to support the crucible and strengthen the same.

A plurality of peripherally extending spaced and alined plates 19, which may be of the same material, and are mechanically secured against the upper ends of certain of the strips 18 either by rivets or screws or by welding. It is essential that the construction of the ground shield or basket be such that there is no closed electrical circuit surrounding the charge in order that the energy expended in the generation of eddy currents therein may be relatively small and the temperature rise therefor also be relatively small. A ground wire 21 is shown schematically only in Fig. 1 of the drawings.

If the construction shown in Fig. 1 is employed, it is desirable that the width of the strips, expressed in centimeters, shall be below a certain value, and a careful analysis of this problem has indicated that the desirable relationship expressed in the formula

$$\frac{W}{\sqrt{\frac{R}{4\pi \times 2\pi F}}}$$

shall be less than 2, where W is the width of the strips in centimeters, R is the resistivity of the material employed in the strips in electromagnetic units and F is the frequency at which the coil is energized.

Fig. 2 shows an induction coil, partly in section, having a plurality of turns of a composite conductor including a solid intermediate section 23 and a tubular outer section 24 in heat interchanging relation with each other. Each turn has located adjacent to the inner edge portion thereof a strip or bar 26 of substantially the same type as bar 18 in Fig. 1, but coextensive with the inner periphery of the portion 23 and separated therefrom by narrow strips of electric-insulating material 27, each turn being enclosed by suitable insulating material 28.

Fig. 3 shows a still further modification of the device embodying my invention. A plurality of strips 31 of relatively thin material have one end of each strip connected to an electric-conducting strip 32 extending at right angles to the strips 31, the other ends of the respective strips 31 being left unconnected, so that no closed electric circuit shall be provided thereby. In this case, the strips 31 extend peripherally of the crucible instead of axially thereof, but, in other respects, the action is identical. A suitable ground connection 33 is provided which may be of the usual kind.

It is obvious that a foraminous metal screen may be employed in place of the strips of electric-conducting material to produce substantially the same results.

It may happen that a crucible will crack slightly or that minute fissures may appear in the walls and, when certain metals are to be melted in the crucible, a very minute fissure will permit this metal to leak or seep through the crucible, and the molten metal may, in time, reach the induction coil, in which case, a dangerously high potential will be impressed upon the crucible and its contents which may result in injury to workmen. The use of my grounded screen will overcome this danger and make the device and furnace structure safe to operate under all conditions.

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 induction furnace having a crucible, an induction coil surrounding the crucible, and a casing therearound, an earthed electric-conducting screen located within the casing and between it and the crucible.

2. In an electric induction furnace having a crucible and an induction coil surrounding the crucible, an earthed electric-conducting screen located between the crucible and the coil.

3. In an electric induction furnace including a crucible and an induction coil therearound, an earthed laminated metal shield surrounding the crucible.

4. In an electric induction furnace including a crucible and an induction coil therearound, an earthed discontinuous metal shield surrounding the crucible and including a plurality of relatively narrow strips.

5. In an electric induction furnace including a crucible and an induction coil therearound, an earthed discontinuous metal shield surrounding the crucible and including a plurality of relatively narrow strips, the individual strips being such that the ratio expressed by the formula

$$\frac{W}{\sqrt{\frac{R}{4\pi \times 2\pi F}}}$$

is less than 2, where W is the width in centimeters of the strips, R is the resistivity of the material in the strips expressed in electromagnetic units and F equals 2π times the frequency.

6. In an electric induction furnace having a crucible, an induction coil surrounding the crucible, and a casing therearound, means immediately surrounding the crucible for preventing leakage of material from causing the potentials of the induction coil to be impressed on said casing.

In testimony whereof, I have hereunto subscribed my name this 11th day of September, 1929.

NEVILLE RYLAND DAVIS.