

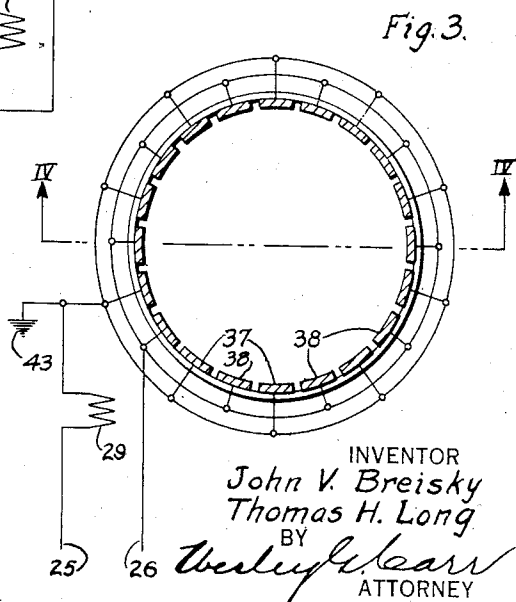
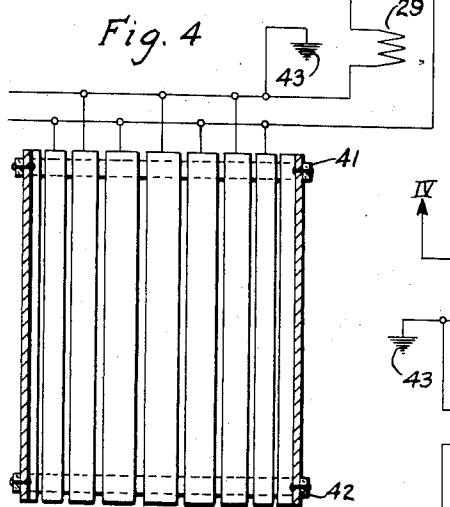
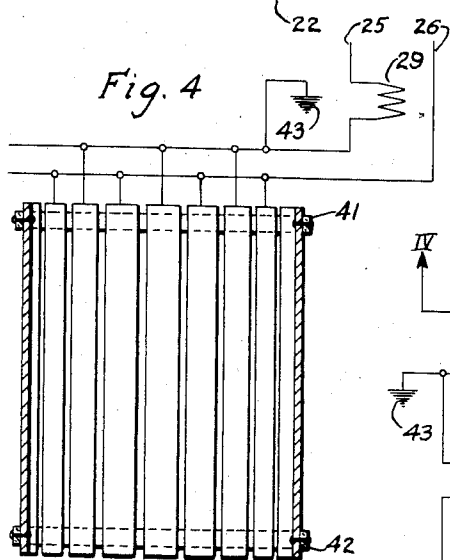
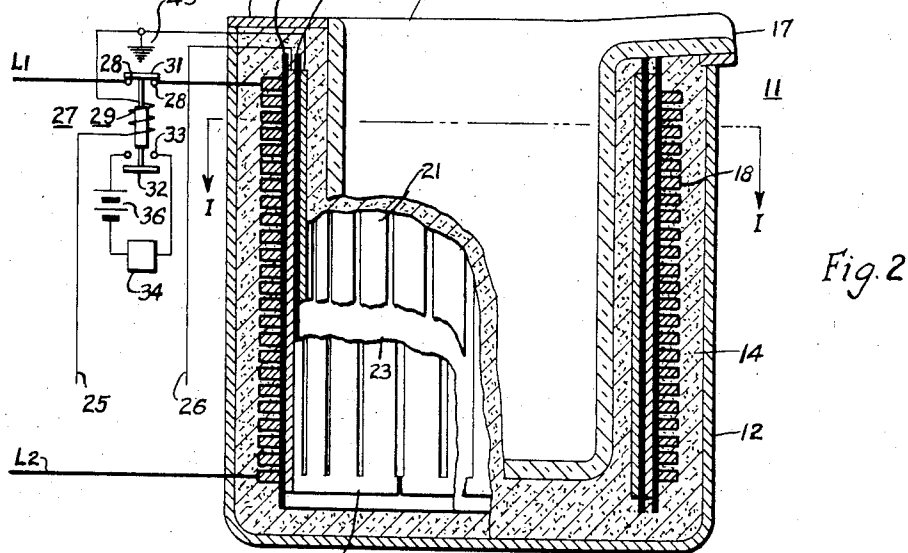
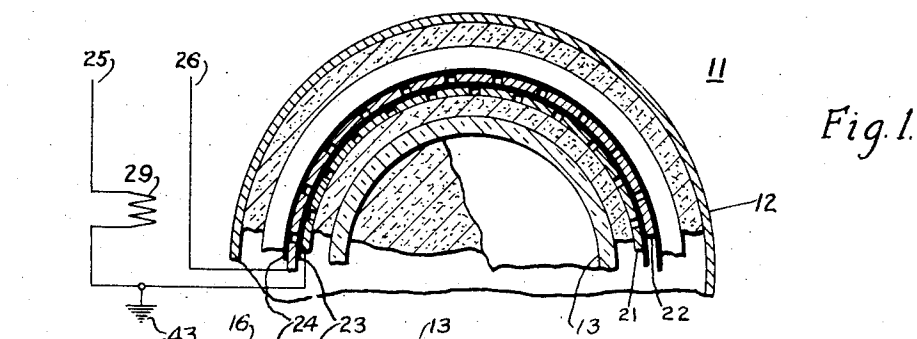
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INDUCTION FURNACE PROTECTIVE CIRCUITS

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INDUCTION-FURNACE PROTECTIVE CIRCUITS

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Our invention relates to electric furnaces and more particularly to electric induction furnaces.

5 An object of our invention is to provide a means for and a method of protecting the inductor coil against engagement by material escaping from a crucible located within it.

10 Another object of our invention is to provide a control system cooperating with the inductor coil that shall preclude energization thereof in case a dangerous breakdown occurs in the insulation in the furnace structure.

15 In practicing our invention, we provide a two-part shield, preferably made of non-magnetic but electric-conducting material, located in the space between a crucible and a surrounding inductor coil, the two parts of the shield being electrically insulated from each other as well as from the coil and the 20 crucible. We provide, also, a source of electric energy for the two-part shield and means operatively associated with the inductor coil and the circuit connected to the two-part shield for interrupting the supply of electric 25 energy to the coil in case of the existence of an electric circuit between the two parts of the shield.

In the single sheet of drawings:

30 Figure 1 is a view, in horizontal section, of a part of an induction-furnace structure embodying our invention, taken on the line I—I of Fig. 2.

35 Fig. 2 is a view, in vertical section, through a furnace structure embodying our invention, certain portions being broken away to show the internal assembly thereof.

Fig. 3 is a schematic top plan view of a modified form of two-part shield, and;

40 Fig. 4 is a view, in vertical section, taken on the line IV—IV of Fig. 3.

45 We have found, in the operation of induction furnaces, particularly when melting certain metals or alloys that there is a possibility of the crucible cracking in places. The cracks or openings are so small as to be more

properly called hair cracks but are of sufficient size to permit the escape of molten material through them. If the escaping molten material should come into operative engagement with the inductor coil, it might 50 cause a serious accident in case an operator were to attempt to stir the molten material with a metal stirrer, and damage to the inductor coil might also result by reason of a short-circuit if two or more turns of the coil 55 were engaged by the molten metal.

Referring to Figs. 1 and 2 of the drawings, a furnace structure 11 includes an outer casing 12 which may be of metal and is shown as of substantially pot shape, the 60 particular furnace which we illustrate being one of the smaller sizes of such furnaces.

65 A crucible 13 of any suitable refractory material is located within the outer casing 12 and is spaced therefrom and supported therein by granular electric-insulating material 14, such as some form of zirconium sand or its equivalent, as usually employed in this art.

70 An annular plate 16 may be provided to cover the granular material 14 at the top of the casing 12 where it is not covered by a pouring spout 17 constituting a part of the crucible 13.

75 It is to be understood that any suitable or desired means may be supplied to permit of tilting the furnace to pour the molten metal and that a cover for the furnace may be provided, but, as these details form no part of our present invention, we have not illus- 80 trated them.

85 An inductor coil 18 is located between the crucible 13 and the casing 12. The conductor constituting the plurality of turns of electric conducting material may be of any suitable or desired shape and is here shown as being substantially rectangular in lateral section, this being shown for purposes of illustration but it is to be understood that any suitable or desired shape of conductor, 90

method of support and insulation between adjacent turns, may be employed.

A two-part protecting shield is located between the coil and the crucible and, in the modification shown in Figs. 1 and 2, this shield includes a divided or laminated inner cage 21 and a substantially similar laminated outer cage 22, each of substantially cylindrical shape and so divided or slotted as to provide no closed electric circuit or circuits therein which might be of such area or section as to cause the generation of excessive amounts of heat therein by inductive effects.

The two parts of the shield are insulated from each other by a tubular member 23 which may be of mica, and the outer part 22 is located closely adjacent to and within the inductor coil 18 and is spaced and insulated therefrom by a tubular member 24 which may also be of mica.

The inductor coil is energized from a suitable source of electric energy indicated by inductors L_1 and L_2 . A source of electric energy, including supply-circuit conductors 25 and 26, is connected to the two parts of the shield hereinbefore described, and a circuit controlling device 27, such as an electromagnetic circuit breaker is provided in the circuit of inductor coil 18 and controlled by the flow of current from the supply-circuit conductors 25 and 26 and between the two parts of the shield. For this purpose, stationary cooperating contact members 28, of the usual kind, may be connected in circuit with conductor L_1 , and an actuating coil 29 may be connected in circuit with supply-circuit conductor 25 to actuate a contact-bridging member 31 so that, in case a current of a predetermined value traverses supply-circuit conductors 25 and 26 and coil 29, the supply of energy to inductor coil 18 is interrupted.

The circuit breaker may be provided with means for controlling an alarm, including an auxiliary contact-bridging member 32 cooperating with stationary contact members 33 to control the energization of an alarm device 34, which may be visual or audible, from a source of electric energy 36.

Referring more particularly to Figs. 3 and 4 of the drawings, we have there illustrated a modified form of shield. The main difference is that, instead of the two parts of the shield being located in coaxial but radially displaced relation relatively to each other, as shown in Figs. 1 and 2, the two parts are in the same circular plane, but alternate so that strips or bars 37 of one part of the shield will alternate in peripheral position with strips or bars 38 of the other part of the shield.

Suitable electrical connections are provided between the bars of one part and the bars of the other part of the shield, and any suitable mechanical means for holding the

two sets of bars in proper operative positions relative to each other may be employed, and we have illustrated suitable rings 41 and 42 mounted at the top and at the bottom of the sets of bars.

It is to be understood that connections are provided between the two parts of the shield and a suitable source of electric energy, as was hereinbefore set forth in connection with Figs. 1 and 2, and that a circuit-breaker-actuating coil 29 is connected in this circuit to be effective for the same purpose as that hereinbefore described.

In Figs. 1 and 2, we have shown a ground connection 43 as being provided for the inner part of the shield and it may be desirable to use this ground although this is not absolutely necessary when using a two-part shield energized from a separate source of electric energy.

As was hereinbefore stated, hair cracks may occur in the wall of a crucible, and molten material may escape through them and into the granular electric insulating material 14 and thus cause caking of the same, and it is obvious that it is not always possible to visually observe such leakage of material in case of a completely enclosed furnace structure. Hence, it may happen, if no protective device is provided, that either the full potential of the circuit connected to the inductor coil may be effective at the molten material or at the crucible of electric-conductive material to cause a severe shock to an operator coming into contact with such part of the furnace, either accidentally or during the handling of the furnace.

If molten material does escape through the wall of the furnace and engages only a portion of the inner part of the shield, it will eventually destroy the insulation between the two parts of the shield and electrically connect them. This permits a current to flow between the two parts 21 and 22 of the shield and, if the effective current value is large enough, it will effect deenergization of the inductor coil 18, thereby not only calling attention, in an unmistakable manner, to the dangerous condition of certain parts of the furnace, but also removing the danger to an operator.

The device embodying our invention thus provides relatively simple means for effecting interruption of the supply of energy to the inductor coil in case of breakdown of the insulation between the two-parts of the shields, as well as means for preventing energization of the coil in case of the breakdown of the insulation between the two-parts of the shield or electrical connection of the two parts. The device embodying our invention thus provides also means for indicating the electrical condition of the furnace structure and, more specifically, of a predetermined part thereof, as well as simultaneously indi-

cating the mechanical condition of the crucible.

Various modifications may be made in the device and system embodying our invention without departing from the spirit and scope thereof, and we 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.

We claim as our invention:

1. In an induction furnace having a crucible and an inductor coil surrounding it, a two-part shield located between the coil and the crucible, electric-insulating material between the two parts of the shield, a source of electric energy connected to the two parts of the shield, and electric means actuated by the breakdown of the electric-insulating material between the two parts of the shield for effecting interruption of the energizing circuit of the coil.

2. In an induction furnace having a crucible, an inductor coil surrounding it, a two-part shield located between the coil and the crucible, electric-insulating material between the crucible, the parts of the shield and the coil, and electric means for preventing energization of the coil in case of electrical connection of the two parts of the shield.

3. In an induction furnace having a crucible, an inductor coil surrounding it, a source of electric energy connected to said coil, a circuit breaker in the circuit of said coil, a two-part grounded shield between the coil and the crucible and electric-insulating material between the coil and the crucible and between the two parts of the shield, electric means operatively associated with the grounded shield for controlling the energization of the coil through said circuit breaker in accordance with the electrical condition of the insulating material between the two parts of the shield.

4. In an induction furnace having a crucible, an inductor coil surrounding it, a two-part shield between the coil and the crucible and electric-insulating material between the coil, the crucible and the two parts of the shield, electric means operatively associated with the shield and the coil to control the energization of the coil in accordance with the condition of the electric-insulating material between the two parts of the shield.

5. In an induction furnace having a crucible, an inductor coil surrounding it, a two-part shield between the coil and the crucible, and electric-insulating material between the coil, the crucible and the two parts of the shield, electric means operatively associated with the shield and the coil to control the energization of the coil in accordance with the condition of the electric-insulating material between the two parts of the shield, and the mechanical condition of the crucible when containing material being heated.

6. In an induction furnace having a crucible, an energizing coil surrounding it, two-part shield between the coil and the crucible, electric-insulating material between the coil, the crucible and the two parts of the shield, a source of electric energy connected to the two parts of the shield, and electric means in the circuit of the two-part shield for controlling the energization of the energizing coil in accordance with the amount of current flowing between the two parts of the shield.

7. In an induction furnace having a crucible, an energizing coil surrounding it, a two-part shield between the coil and the crucible and electric-insulating material between the coil, the crucible and the two parts of the shield, electric means operatively associated with the shield and the coil to control the energization of the coil in accordance with the condition of the electric-insulating material between the two parts of the shield, the condition of the electric-insulating material between one part of the shield and the crucible and the mechanical condition of the crucible when containing material being heated.

8. In an induction furnace having a crucible, an energized inductor coil surrounding it, a two-part shield between the coil and the crucible, and a source of electric energy connected to the two parts of the shield, means operatively associated with the two-part shield and the inductor coil for effecting deenergization of the inductor coil upon engagement of the two parts of the shield by molten metal from the crucible.

9. In an induction furnace having a crucible, an energized inductor coil surrounding it, a two-part electric-conducting shield between the coil and the crucible and a source of electric energy connected to the two parts of the shield, means electrically connected to the two-part shield and the inductor coil to effect deenergization of the coil when an electric current of a predetermined value flows from one part of the shield to the other part thereof.

10. In an electric heating device having a heating coil in operative relation to material to be heated, a multi-part shield between the heating coil and the material being heated and sources of electric energy connected to the heating coil and to the parts of the shield to energize the same, means electrically connected to the heating coil and to the shield to effect deenergization of the heating coil upon flow of an electric current of predetermined value between the parts of the shield.

11. In an electric heating device having a heating coil in operative relation to material to be heated thereby, a multi-part shield of electric-conducting material between the heating coil and the material to be heated, means for electrically energizing the heating coil and the multi-part shield and electric-

insulating material normally insulating the heating coil, the material being heated and the parts of the shield from one another, electric means connected in circuit with the multi-part shield and the heating coil for controlling the energization of the heating coil in accordance with the condition of the insulating material between parts of the shield.

In testimony whereof, we have hereunto subscribed our names this 26th day of February, 1930.

JOHN V. BREISKY.
THOMAS H. LONG