

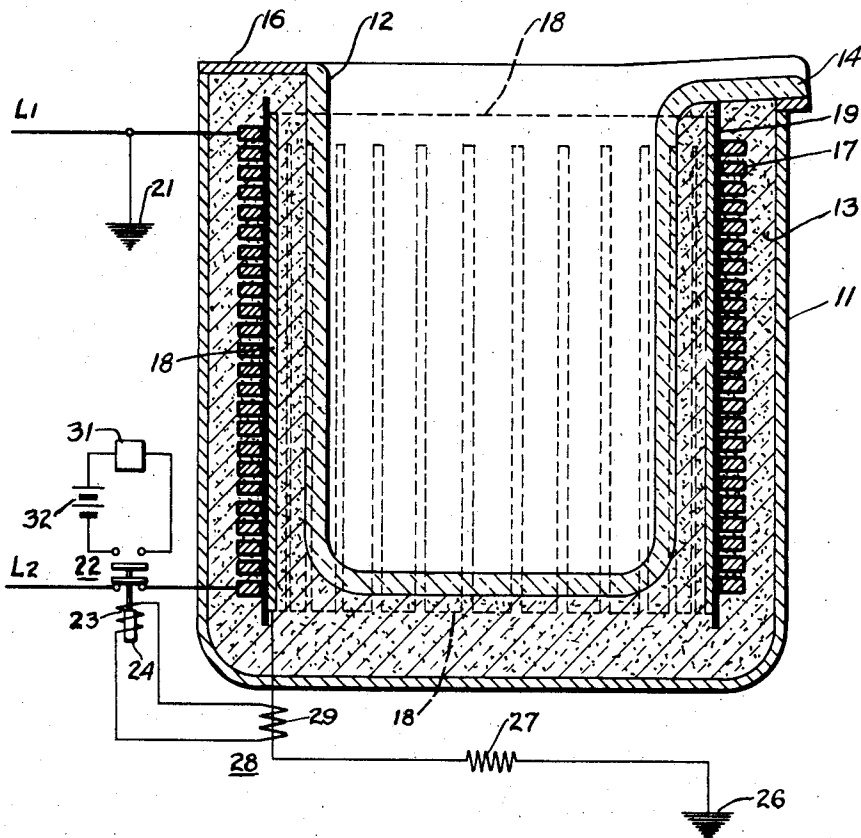
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## INDUCTION FURNACE

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## UNITED STATES PATENT OFFICE

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## INDUCTION FURNACE

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

6 An object of our invention is to provide means operatively associated with an induction furnace that shall effect deenergization of the inductor coil in case of the occurrence of certain conditions in the furnace structure and actuate an alarm device.

10 Another object of our invention is to provide a furnace construction and a control system associated therewith that will prevent molten metal, in escaping from the crucible and engaging the inductor coil, from destroying the coil by short circuiting one or more turns thereof.

15 Another object of our invention is to provide a furnace construction and a control system associated therewith that will prevent molten metal, escaping from the crucible and engaging the inductor coil, from destroying the same by simultaneously engaging a plurality of adjacent turns of the coil to short circuit the same.

20 Another object of our invention is to provide a ground shield in an induction-furnace structure and means cooperating therewith and with the inductor coil for deenergizing the latter in case molten metal escapes through the wall of the crucible and engages the inductor coil.

25 In practicing our invention, we provide an induction-furnace structure including a crucible or lining, an inductor coil surrounding it and electric-insulating material between the coil and the crucible. We provide also a grounded shield of electric-conducting laminated or sub-divided material located in the insulation between the coil and the crucible, a current-limiting reactor or resistor in the ground circuit, as well as a current transformer in this circuit that shall be effective to cause interruption of the supply of energy to the inductor coil and to actuate an alarm in case of breakdown of the insulation between the crucible and the coil and the escape of molten metal through the crucible.

30 The single figure of the drawing is a sectional view of an induction furnace includ-

ing the device and system embodying our invention.

An outer casing 11 is shown as being of pot type and is illustrative of any casing structure for containing the other elements 55 of the furnace proper.

A crucible 12, which may be of the usual kind employed in induction furnaces or may be in the form of a built-up lining, especially in the case of larger furnaces, is located 60 within the casing 11, and granular electric-insulating material 13 is located between the crucible and the casing.

The crucible 12 is provided with a pouring spout 14, and the casing 11 may be provided 65 with an annular cover 16 and with trunnions (not shown) to permit of tilting the furnace structure to empty the crucible 12 of the material which has been melted or heated therein. 70

An inductor coil 17 of helical shape is located between the crucible and the casing and may include a plurality of turns of a suitable electric-conducting element, here shown 75 as being rectangular in cross section. It may be here noted that the casing, the crucible and the coil are illustrated in specific forms in order to show an operative combination of such elements but we desire it to be understood that modifications may be made in 80 these elements, as they do not specifically constitute parts of our present invention.

We provide a ground shield 18 of any suitable electric-conducting material which is inherently of relatively high electrical resistance, and preferably non-magnetic at its normal operating temperature, which is subdivided or of cage form in order that the heat generated therein by eddy currents shall not be great enough to damage the adjacent 85 insulating material. 90

A member 19 of electric-insulating material, such as mica, may be located between the coil 17 and the shield 18 in order to obtain a higher inherent resistance between the shield and the coil than might be obtained by the use of the granular material 13, which may be a material like zirconium sand. 95

Supply conductors  $L_1$  and  $L_2$  are electrically connected to the terminals of the coil 17. 100

A ground 21 is provided for supply-circuit conductor  $L_1$  or, more strictly speaking, the uppermost terminal of the coil 17 is grounded.

A circuit breaker 22 is connected in the circuit of the inductor coil 17 and is shown schematically as connected to supply-circuit conductor  $L_2$ . As illustrated, the circuit breaker comprises an actuating coil 23, a core 24 and cooperating stationary and movable contact members. While we have shown a specific form of circuit-interrupting device, we do not desire to be limited thereto, as it may be necessary to provide a relatively larger circuit breaker to be, in turn, controlled by a circuit breaker of the kind shown in the drawing.

The shield 18 is grounded at 26, a current-limiting reactor or resistor 27 and the primary of a current transformer 28 being connected in series-circuit in the ground circuit of the shield. The terminals of the secondary winding 29 of the current transformer are connected to the terminals of the actuating coil 23.

The circuit breaker 22 may include a second contact-bridging member and contact members cooperating therewith to control an alarm 31, a source of electric energy 32 being provided to energize the alarm device 31, which may be a visual or an audible alarm and be energized simultaneously with the interruption of the circuit of the inductor coil.

We have found that, in the melting of certain materials and alloys, there is a possibility of the molten material escaping through minute cracks of fissures in the crucible to cause caking of the electric-insulating material 13. If there were no provision for protecting the coil 17 against the infiltration of molten metal escaping through the wall of the crucible, it might be possible for such metal to engage the coil and cause a possibly fatal accident to an operator stirring the molten metal with a metal rod, or otherwise coming into engagement with the crucible or the molten metal.

By grounding the coil and the provision of a grounded shield located between the coil and the crucible, we obtain an indication of dangerous conditions in the furnace structure by reason of the deenergization of the inductor coil and by actuation of the alarm device if and when the molten metal escaping from the crucible comes into contact with the ground shield and the coil. The current-limiting reactor or resistor operates, in the usual manner, to reduce or to limit the maximum value of current flowing through the primary winding of current transformer 28.

It may be noted also that it is impossible to energize the inductor coil 17 except momentarily if a dangerous condition as to breakdown of insulation between the crucible and the coil exists, or there is a me-

chanical breakdown or damage to the crucible itself, which damage is large enough to permit of the escape of molten or other material through the wall of the crucible to engage one or more of the turns of the coil.

Our system thus provides a relatively simple and highly efficient means for safeguarding an induction-furnace structure, including a grounded shield, and one which effectively prevents operation of the furnace in case of certain damage to the furnace structure and, more particularly, to the electric-insulating material therein.

Since various modifications may be made in the device and system embodying our invention without departing from the spirit and scope thereof, we desire 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. An induction furnace including a crucible, an inductor coil therefor and a source of electric energy for said coil, an electric-conducting shield located between the crucible and the inductor coil and means operatively associated with the shield and the coil for deenergizing the coil in case escaping molten metal from said crucible engages said shield and said coil.

2. An induction furnace including a crucible, an inductor coil surrounding it and electric-insulating material between them, electric means, including an electric-conducting shield, located between the coil and the crucible to indicate the escape of molten metal through the crucible and to simultaneously deenergize the inductor coil.

3. An induction furnace including a crucible and an energized inductor coil surrounding it, an extended electric-conducting shield located between the crucible and the inductor coil, a ground connection for said shield, a current transformer in said connection, and electric means operatively associated with the current transformer and the energized inductor coil to indicate the engagement of the shield and the coil by molten metal from the crucible and to effect deenergization of the coil.

4. An induction furnace including a crucible and a surrounding energized inductor coil, of a grounded shield between the coil and the crucible, a current transformer and a reactor connected in the ground circuit of the shield, a ground on the inductor coil, and a circuit-interrupting means in the circuit of said inductor coil electrically connected to, and controlled by, said current transformer to effect deenergization of the inductor coil upon the shield and the coil being engaged by molten metal from the crucible.

5. An induction furnace including an energizing coil and a crucible therein for containing metal to be melted, electric means, in-

cluding a grounded shield located between the coil and the crucible, for precluding the energization of the coil in case the ground shield and the inductor coil are engaged by molten metal escaping from the crucible.

5 6. An induction furnace having a coil, a crucible therein for holding material to be heated, a source of electric energy connected to said coil, and a circuit breaker in the circuit of said coil, a grounded shield located  
10 between the coil and the crucible and a current transformer in said ground circuit having a winding connected to the circuit breaker to preclude energization of the coil by said  
15 source of electric energy upon engagement of the shield and the inductor coil by material escaping from the crucible.

7. An induction furnace having a coil, a crucible therein for holding material to be  
20 heated, a source of electric energy connected to said coil, a circuit breaker in the circuit of said coil, a shield located between the coil and the crucible and electric-insulating material between the coil and the crucible, electric means operatively associated with said  
25 grounded shield for controlling the energization of the coil in accordance with the condition of the crucible and of the electric-insulating material between the crucible and  
30 the coil.

8. An induction furnace including a crucible, an inductor coil surrounding it and a source of electric energy for the inductor coil, an electric-conducting shield located between  
35 the crucible and the inductor coil and means operatively associated with the shield and the inductor coil for indicating the simultaneous engagement of the shield and the inductor coil by metal from the crucible.

9. An induction furnace including a crucible an inductor coil surrounding it and a source of electric energy for the inductor coil, an electric-conducting shield located between  
40 the crucible and the inductor coil and means operatively associated with the shield and the inductor coil for indicating a breakdown of the electric insulation between the shield and  
45 the coil.

10. An induction furnace including a crucible, and an inductor coil therefor, an electric-conducting shield between the crucible and the inductor coil, electric-insulating material between the shield and the coil and means operatively associated with the shield  
50 and the coil to control the energization of the coil in accordance with the condition of the electric-insulating material between the shield and the coil.

11. An induction furnace including a crucible, and an inductor coil therefor, an electric-conducting shield and means operatively associated with the shield to deenergize the coil and actuate an alarm device in case  
60 molten metal escapes from the crucible and before it engages the coil.

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

JOHN V. BREISKY.  
THOMAS H LONG.