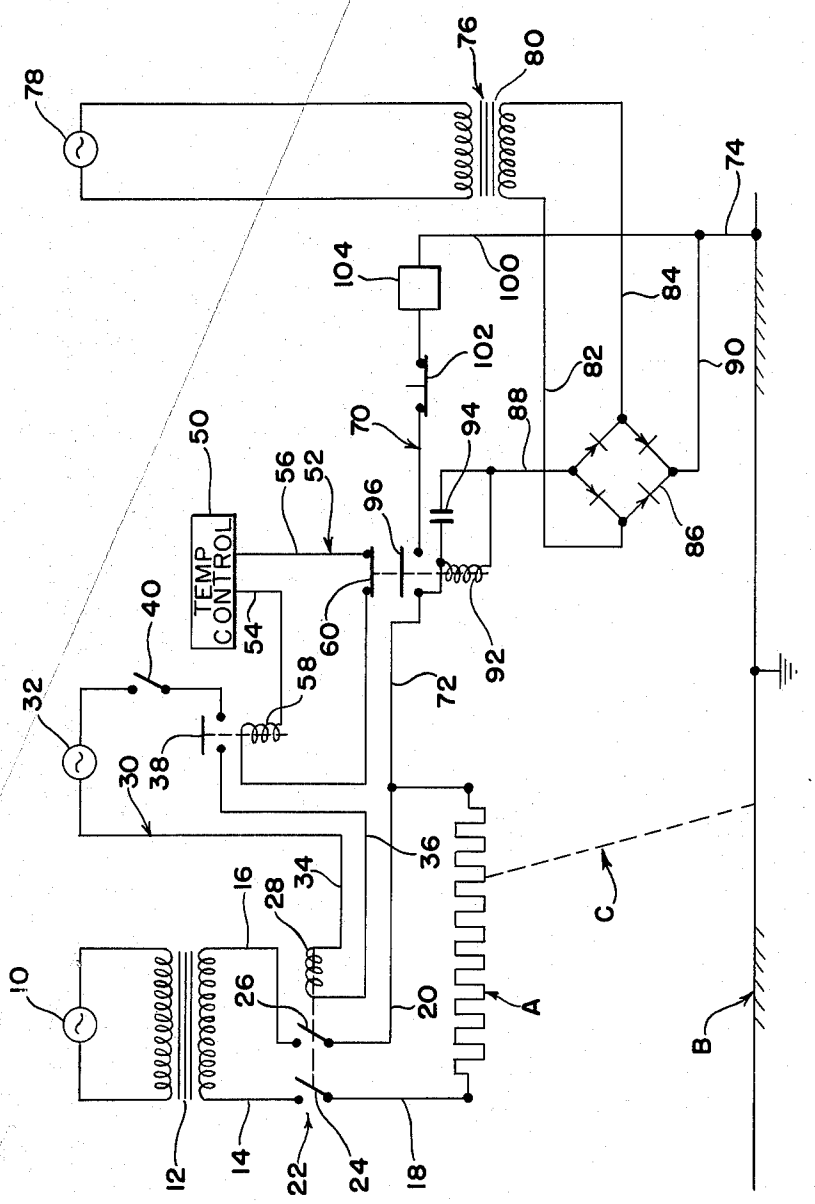
Feb. 8, 1966 F. R. MATHEWS 3,234,316

DEVICE FOR DETECTING GROUNDS IN ELECTRIC FURNACES

Filed March 20, 1963



INVENTOR.
FRANK ROBERT MATHEWS

BY

Tilbury & Body

ATTORNEYS

United States Patent Office 3,234,316 Patented Feb. 8, 1966

3,234,316

DEVICE FOR DETECTING GROUNDS IN ELECTRIC FURNACES

Frank Robert Mathews, Salem, Ohio, assignor to The Electric Furnace Company, Salem, Ohio, a corporation of Ohio

Filed Mar. 20, 1963, Ser. No. 266,694
13 Claims. (Cl. 13—24)

The present invention is directed toward the art of electrical furnaces and more particularly to a device for detecting a grounded heating element in an electrical resistance furnace.

An electrical resistance furnace of the type having a metal frame and one or more electrical heating elements, has become common equipment in industry for various heating tasks. Such furnaces are well adapted for batch heat treating metal articles, for heating articles carried on a metal conveyor traveling through the furnace and for heating an elongated workpiece, such as longitudinally moving metal tubing, as it passes through the furnace. The heating element in such a furnace is usually exposed within the interior of the furnace because any protective structure surrounding the element would form a heat barrier which would decrease the heating efficiency of the furnace.

With the heating elements being unprotected, it is common knowledge that the elements are often accidentally grounded to the frame of the furnace. For instance, in heat treating continuously moving tubing, the tubing often strays from its intended path a sufficient amount to allow contact between the grounded workpiece and the exposed heating element. Further, when an operator is loading or unloading a workpiece from a batch heating furnace, the tool with which he grips the workpiece, such as a pair of tongs, often contacts the electrical element. In some cases, from abuse of the furnace or careless charging of a workpiece into a furnace, a portion of the furnace may actually be bent into contact with the heating element. Also, accumulation of conductive scrap particles in the furnace or the accumulation of deposits from various atmospheres that may be used in the furnace can cause a conductive path between the heating element and the frame of the furnace.

Such accidental grounds or connections between the heating element and the frame of the furnace, may cause arcing which can seriously damage the heating element, this is especially true if the heating element is grounded at two widely spaced points. In addition, if the ground connection is through a workpiece within the furnace, and the ground is allowed to continue for a substantial time, the workpiece may actually be welded onto the heating element so that removal of the workpiece from the furnace will cause substantial damage to the heating element.

The present invention is directed toward a device for detecting an accidental ground or other connection between the heating element and the frame of an electric furnace which device is responsive to grounding of the element at only one point and before any damage to the heating element or injury to an operator can occur.

In accordance with the present invention there is provided an improvement in the combination of a furnace having a metal frame, an electrically powered heating element adjacent the frame, and switch means for deenergizing the heating element. This improvement comprises, connecting the power supply in a series circuit extending from the frame to the element, a signal device, and actuator means in the series circuit and responsive to the flow of current through the circuit for energizing the signal device.

In accordance with a more limited aspect of the present invention there is provided the improvement as defined above wherein the signal device includes a normally closed switch and means responsive to opening of the switch for actuating the switching means to deenergize the heating element, and the actuator means as defined above includes a means for opening this switch when current is flowing in the series circuit.

The primary object of the present invention is the provision of a device for detecting accidental grounds in the heating element of a resistance heating furnace.

Another object of the present invention is the provision of a device for detecting an accidental ground in the heating element of an electric furnace which device is responsive to a one-point ground on the element, which usually is not in itself dangerous, instead of a two-point ground which will usually cause an immediate, harmful reaction, such as arcing at the element or shock to an operator.

Another object of the present invention is the provision of such a ground detecting device which is durable in operation, inexpensive to apply to existing equipment and easy to repair.

Still another object of the present invention is the provision of a device for detecting accidental grounds in the heating element in a resistance heating furnace which device includes a power supply connected in a series circuit between the heating element and the grounded frame of the furnace and means responsive to the current in this circuit for indicating an accidental ground.

These and other objects and advantages will become apparent from the following description used to illustrate the preferred embodiment of the invention as read in connection with the accompanying drawing in which the preferred embodiment of the present invention is illustrated.

Referring now to the drawing, wherein the showing is for the purpose of illustrating a preferred embodiment of the invention only and not for the purpose of limiting same, there is shown, somewhat schematically, a resistance heating element A which is secured by insulated hangers onto frame B of an electrically heated furnace and which is spaced only slightly from the frame B. The heating element and frame are graphically illustrated as being somewhat separated; however, it is appreciated that the frame B may be quite close to the resistance heating element in the actual construction of a heating furnace.

To energize the heating element A so that the element can create sufficient heat within the furnace to accomplish a given heating operation, there is provided an A.C. power supply **10** which, in accordance with the preferred embodiment of the present invention, is a 440 volt, 60 cycle line source that feeds a power transformer **12** having secondary leads **14**, **16** adapted to be connected onto heating element leads **18**, **20** by a double pole, single throw solenoid operated switch **22**. Although a variety of switches could be provided for connecting leads **14**, **16** with element leads **18**, **20**, in accordance with the illustrated embodiment of the present invention, switch **22** comprises normally open contacts **24**, **26** controlled by an appropriate solenoid coil **28**. In operation, energization of coil **28** closes contact members **24**, **26** which connects resistance heating element A across secondary leads **14**, **16**.

To control the operation of solenoid coil **28**, there is provided a switching circuit **30** comprising a line power supply **32**, leads **34**, **36** and normally open switch **38**. When switch **38** is closed, current is supplied to coil **28** which closes switch **22**, that connects element A across leads **14**, **16** as is common in the art of electric furnaces.

To interrupt switching circuit **30**, there is provided, in lead **36**, a disconnecting switch **40** which may be alternately actuated between an open and closed position. Of course, switch **40** must be closed before the power supply **32** can operate coil **28**.

To control switch **38**, in accordance with the illustrated embodiment of the present invention, there is provided a temperature control **50** which may be operated by a thermostat or other temperature responsive means within the heating furnace so that a signal is generated by this control **50** when further heating of the furnace is required. Temperature control **50** is of a well known type to those skilled in the art and closes a contact to apply a control signal to coil **58** when there is need for heat to be supplied by heating element A. Power to operate coil **58** is taken from an internal alternating voltage supply source. After the furnace reaches a desired temperature, the control **50** ceases to create a control signal. To direct the control signal from temperature control **50**, there is provided a temperature control circuit **52** having leads **54**, **56** connected across a solenoid coil **58**. Further, in circuit **52** there is provided a normally closed contact **60**. As long as a signal is being generated by control **50**, i.e. the furnace requires further heating, coil **58** is actuated to hold switch **38** in its closed position. In this position, coil **28** closes contacts **24**, **26** when switch **40** is closed.

In accordance with the illustrated embodiment of the present invention, circuit **52** is controlled by the switch **60** which operates in response to a device **70** for detecting an accidental ground of the resistance heating element A onto the frame B. For purposes of illustration, the accidental ground is represented by dotted line C and is defined as a low resistance electrical connection between the element A and frame B. Such a connection can result from deforming the element A or frame B into contact with each other or by bridging between element A and frame B with an electrically conductive material.

In accordance with the preferred embodiment of the present invention, device **70** includes a series circuit from element A to frame B which circuit includes leads **72**, **74**. Within the series circuit there is provided a power supply **76** which may take a variety of structural embodiments; however, in accordance with the preferred embodiment of the present invention, the power supply includes a line source **78** coupled to transformer **80** which introduces an A.C. signal to leads **82**, **84** for powering rectifier **86**. The output leads **88**, **90** are connected to leads **72**, **74** to complete the series circuit between the element and the grounded frame. Accordingly, a D.C. potential exists between leads **72**, **74**.

Within the output leads **88**, there is provided a coil **92** and a holding capacitor **94** in parallel with the coil to prevent chatter of the coil with fluctuations in the output of this rectifier so that the coil **92** can control normally open switch **96**.

In operation of device **70** as so far explained, the accidental ground C electrically connects leads **72** to lead **74**, irrespective of the position on element A at which the ground occurs. When these leads are connected, a current flows through the series circuit which energizes coil **92** and closes switch **96**. When the switch **96** is closed, switch **60** is simultaneously opened. Consequently, coil **58** is de-energized, switch **38** is accordingly opened, and coil **28** is de-energized. In this manner, switches **24**, **26** are opened in response to an accidental ground between the heating element and the furnace frame. It is noted that the ground C is at only one point on element A; therefore, the ground does not cause an A.C. current leakage from the element to the frame unless the element or its power supply circuit is grounded to the frame in another location. Thus, with only one-point ground no damage is caused and the device **70** can operate before a further ground causes a dangerous condition.

To prevent coil **92** from dropping out with fluctuations in the current flowing through the series circuit, i.e., between leads **72** and **74**, there is provided a holding circuit or by-pass circuit **100** which circuit is closed by switch **96** so that current flows through the holding circuit **100** between leads **88**, **90** irrespective of variations in the accidental ground C. In this manner, as soon as the detrimental ground occurs the holding circuit maintains the coil **92** energized so that the power cannot be re-applied to the resistance heating element A.

Following correction of the accidental ground C, a reset switch **102** is provided for interrupting the holding circuit **100**. This allows dropout of coil **92** so that the heating element A can again be re-energized by source **10**.

To notify an operator that the furnace has been shut down by the device **70**, there is included within the holding circuit **100** a device **104** which, in the preferred embodiment of the present invention, comprises a bell or lamp actuated by various arrangements in response to the flow of current in the holding circuit. It is appreciated that another warning device different from a bell or lamp could be used in device **104**. The device **104** may be the only indicator of the ground C and the operator in such an instance could manually open switch **22** when the device **104** is actuated to signal a ground.

In operation of the invention as shown in the drawing, the accidental ground closes switch **96** and opens switch **60** so that the element A is shut down and the holding circuit **100** is energized. Thereafter, the ground may be corrected and reset switch **102** pushed to drop out the holding circuit **100** and prepares the device **70** for detection of future grounds of the heating element A.

In the embodiment described, the furnace heating element is energized by alternating current at a usual frequency such as 60 cycles. The ground-detecting current is superimposed on the main alternating current in some part of the conducting path which includes the element. Using direct current for ground detection, suitable apparatus is provided to respond to the detecting direct current flow only, independent of the main alternating current flow.

It the main power supply were direct current, an alternating current could be superimposed on it fcr detection purposes. Also, for an A.C. power circuit at normal frequency, it is possible to superimpose a high frequency A.C. detecting current upon it and to provide apparatus which responds to the latter, independent of the standard frequency flow in the main circuit. Consequently, the series circuit provides a detection current supply dissimilar for the current in the heating element and a means for detecting the flow of this detection current.

The present invention has been discussed in connection with one preferred embodiment; however, it is appreciated that various structural changes may be made without departing from the intended spirit and scope of the invention as defined by the appended claims.

Having thus described my invention, I claim:

1. In the combination of a furnace having a metal frame, an electrically powered heating element adjacent said frame, and switch means for de-energizing said heating element, the improvement comprising: means for detecting whether said element is grounded to said frame and including a power supply connected in a series circuit extending from said frame to said element, signal means, and actuator means in said series circuit responsive to current flow through the circuit for energizing said signal means.

2. The improvement as defined in claim **1** wherein said signal means comprises a switch and means responsive to actuation of said switch for actuating said switch means to de-energize said element, and said actuator means comprising a means for actuating said switch when current is flowing in said circuit.

3. The improvement as defined in claim **2** wherein said actuator means comprises a solenoid coil connected in said series circuit, and means operable by said coil and operably connected onto said switch.

4. The improvement as defined in claim **3** including a

temperature responsive control circuit, said control circuit having means for de-energizing said element when said control circuit is open, said switch being a normally closed switch in series with said control circuit, and energization of said solenoid coil opening said switch.

5. The improvement as defined in claim 4 including a holding circuit for said coil, said holding circuit being in parallel with said coil and said power supply.

6. The improvement as defined in claim 5 including an electrically energized alarm and a means in said holding circuit for actuating said alarm.

7. The improvement as defined in claim 6 including a manually operated circuit breaker in said holding circuit.

8. The improvement as defined in claim 1 wherein said actuator means comprises a solenoid coil connected in said series circuit, and means operable by said coil and operably connected onto said signal means for energizing said signal means when said coil is energized.

9. The improvement as defined in claim 1 including a temperature responsive control circuit, said control circuit having means for de-energizing said element when said control circuit is open, said signal means including a normally closed switch in series with said control circuit, and said actuator means including means for opening said switch in response to a flow of current through said series circuit.

10. The improvement as defined in claim 9 wherein said actuator means is a solenoid operably connected onto said normally closed switch and including a holding circuit for said coil, said holding circuit being in series with said coil and said power supply.

11. The improvement as defined in claim 1 wherein said signal means is an electrically energized alarm.

12. In the combination of a furnace having a metal frame, an electrically powered heating element adjacent said frame, and switch means for de-energizing said heating element, the improvement comprising: means for detecting whether said element is grounded to said frame and including a first power supply connected across said heating element for energizing said element, a second power supply connected in a series circuit extending from said frame to said element, signal means, said second power supply having a detectably different electric characteristic than said first power supply, and actuator means in said series circuit responsive to flow of said detectably different current for energizing said signal means.

13. The improvement as defined in claim 12 wherein said first power supply takes the form of an alternating current voltage supply and said second power supply takes the form of a direct current voltage supply.

References Cited by the Examiner

UNITED STATES PATENTS

2,196,362	4/1940	Osborn	317—18
2,400,749	5/1946	Foster	317—18
2,542,838	2/1948	Reagan	317—18 X
2,637,843	5/1953	Kammerdiener	317—18 X
3,086,999	4/1963	Kramer	13—24

FOREIGN PATENTS

580,787	9/1946	Great Britain.

RICHARD M. WOOD, *Primary Examiner.*