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ELECTRIC HEATING APPARATUS

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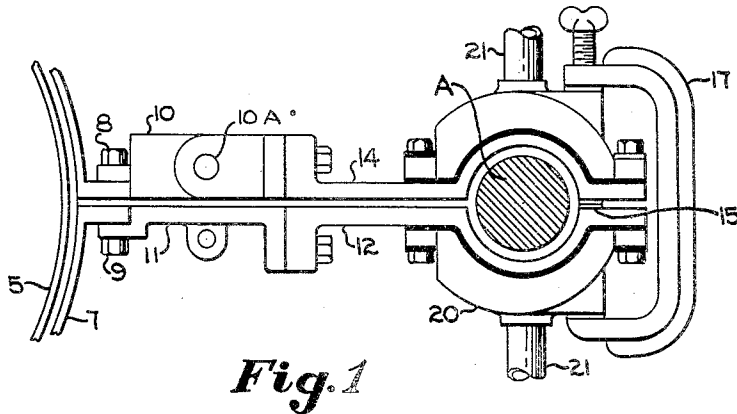


Fig. 1

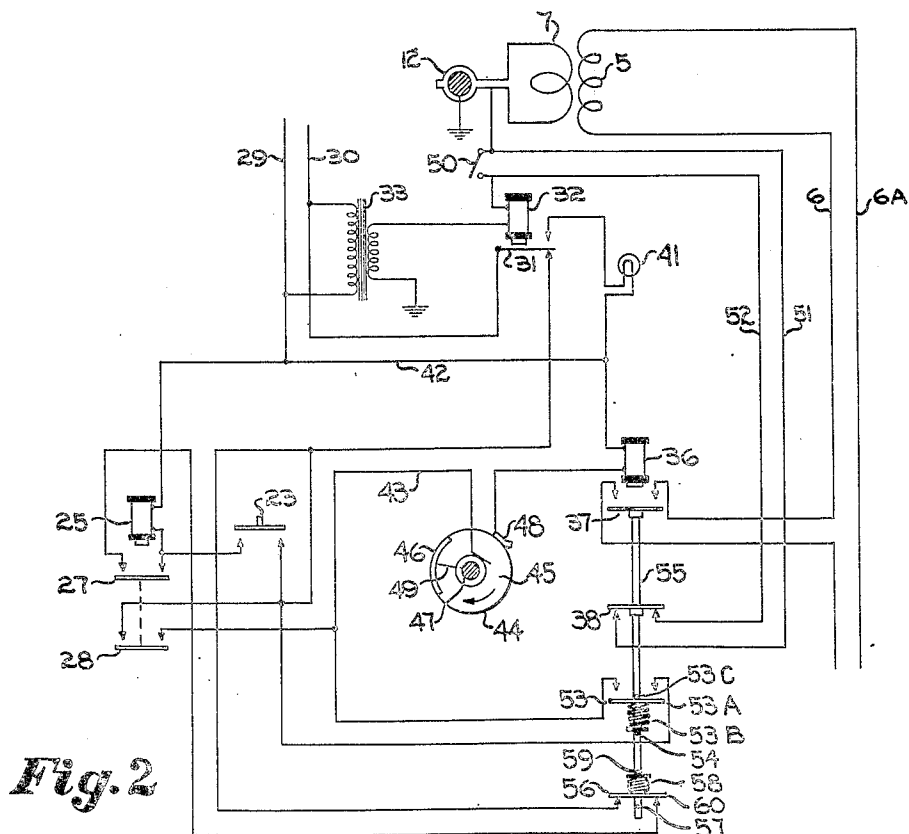


Fig. 2

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ELECTRIC HEATING APPARATUS

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2 Claims. (Cl. 219-13)

This invention relates to apparatus for electric heating and is particularly directed to electric heating apparatus in which the heating member and the article to be heated are maintained out of contact with each other and in which the heating is accomplished inductively.

This application is a continuation in part of our copending application, Serial No. 166,648 filed Sept. 30, 1937.

In electric heating apparatus employing an inductor spaced from the work to be heated, there is provided a predetermined electrical input to the inductor which will result in a corresponding heating effect in the adjacent article. We have found that if the article, which is usually grounded through its support, is in accidental contact with the inductor during any part of the time when current is being supplied to the inductor, serious injury sometimes results to the article or the inductor or to both and injury may even occur to other parts of the apparatus or to persons.

The general object of our invention therefore has been to provide a control system by which it is impossible to carry on the heating operation if the inductor and article come into contact. An additional object has been to devise an inductor which is opened and thereafter closed about a piece to embrace the same, together with means to operate the safety control switch if any part of the inductor is in contact with the article.

To the accomplishment of the foregoing and related ends, said invention, then, consists of the means hereinafter fully described and particularly pointed out in the claims; the annexed drawing and the following description setting forth in detail certain means and one mode of carrying out the invention, such disclosed means and mode illustrating, however, but one of various ways in which the principle of the invention may be used.

In said annexed drawing:

Fig. 1 is a side elevation of an inductor block used with our invention showing in section an article therein; and

Fig. 2 is a wiring diagram showing the control mechanism employed with the safety device.

Referring now to the drawing, and particularly to Fig. 1, we provide a primary winding 5 and a secondary winding 7 of a transformer which supplies current of the proper value to the inductor. The primary coil is connected through leads 6 and 6-A (Fig. 2) to a source of periodically varying current, as for instance a motor

generator set and preferably of much higher frequency than that of ordinary power circuits. The secondary of the transformer is bolted as at 8 and 9 to fixed arms 10 and 11 of the inductor block. The arm 11 has an inductor section 12 rigidly bolted thereto which has its outer end shaped to lie in predetermined spaced relation with an article A to be heated. Pivotally carried at 10-A by the inductor portion 10 is a complementary inductor portion 14 which cooperates with the portion 12 to encircle the article A to be heated. A pair of contact surfaces 15 are carried by respective inductor parts 12 and 14 and are held in contact with each other by a clamp 17.

As the inductor parts 12 and 14 are in contact with each other only at the ends, there is provided an uninterrupted current path around the outer portion of the article A to be heated. Thus, as current is supplied to the inductor, the flux field established thereby will set up eddy currents in the article to heat it to a predetermined temperature. If the article is magnetic, the heating effect is augmented by the hysteretic heat set up in the article.

To cool the inductor, a hollow jacket 20 is provided on the exterior of each inductor portion and cooling fluid is supplied thereto through the tubes 21. At the proper time the heated area is quenched by cooling fluid forcibly projected on to the article from the inductor jacket through holes in the work adjacent face of the inductor, all as more fully set forth in the copending application above referred to.

While we have shown the article being heated as the round outer portion of a shaft or the like, it is to be expressly understood that we contemplate shaping our inductor to conform to many various shapes and to lie in work adjacent relation with either or both the exterior and the interior portions of articles to be heated.

An article is supported in heating relation with the inductor in a properly supported frame which may be of any desired construction. The frame, which is grounded, is in metallic connection with the article, hence the article is grounded. This, to a certain extent, protects persons and the apparatus, and also contributes as hereinafter described, to the operation of the safety control mechanism.

After an article has been mounted in proper heating relation with the inductor, the operator presses a manual controlled normally open switch 23 (Fig. 2) which receives current through the leads 29 and 30 and energizes a solenoid 25

to pull arm 27 into position to establish a holding circuit to continue to energize the solenoid after the switch 23 is released. This solenoid also controls the normally open switch 28 through which current is supplied to solenoid 36 which controls the main power switch 37. The lead 30 connects with switch 23 through a solenoid controlled normally closed switch 31 actuated by a solenoid 32.

A transformer 33 has its primary connected across the leads 29 and 30. One lead of the secondary is connected to the ground. The other end of the secondary is connected to the solenoid 32 and from there to one arm of the inductor block, which is normally insulated from the ground. As above stated, the article is so supported that it is grounded. It thus follows, that if the article is in electrical contact with the inductor the secondary of the transformer 33 will complete a circuit to the solenoid 32 through the grounds. As the solenoid 32 is actuated, it opens the switch 31 thereby disconnecting the lead 30 from the manual switch 23. This prevents energizing the solenoid 25 which in turn prevents connecting the inductor to the current source. Thus in case the inductor and the article happen to be in electrical contact it is impossible to start the heating operation until after the short or contact has been broken and hence no damage can occur to the parts by reason of the existing short between the article and the inductor.

If the articles being heated should shift during the heating cycle and short with the inductor due to heat expansion, electro-magnetic action or other causes, in some cases the supply of power should be immediately interrupted to prevent serious arcing between the inductor and the article. This might seriously harm the article and also the apparatus generally.

Serious harm from that cause is guarded against as follows:

When a short occurs between the inductor and the article being heated, solenoid 32 is energized instantly opening the bottom contact and closing the upper contact at switch 31. This disconnects the current supply to solenoid 36, thereby opening switch 37 and completely interrupting the power current supply to the inductor. At the same time solenoid 25 is deenergized opening the holding circuit switch 27 and the switch 28. Opening switch 28 provides a second break in the current supply to solenoid 36. When a short between the inductor and the article causes switch 31 to close at its upper contact, current flows from line 30 to light a warning light 41 so that the operator will know there is a short or contact between the article and the inductor.

The supply of current to the inductor is, as above set out, cut off as soon as a short is set up between the article and the inductor, whether prior to the heating cycle or during the heating cycle.

Under some conditions, such for instance as when momentary grounds between the inductor and the article are caused by moisture or light contacts, it may be found necessary or desirable not to interrupt the heat, once the heating cycle has started and in such cases the switch 50 is previously set in the open position so that the solenoid 32 remains inoperative and the power continues being applied to the inductor until the end of the heating period.

In case switch 50 has been set in the open position as above described, we have provided an auxiliary current path through line 51, switch

38 and line 52 so that solenoid 32 will be energized opening the lower contact at switch 31 in case of a short between the inductor and the article and will thereby prevent applying heating current to the inductor until the short has been cleared. Except when switch 50 is open, switch 38 performs no necessary function. In many cases some form of timer or relay such as 44 shown inserted in line 43 is desirable or necessary, particularly where there is more than one heating station supplied from the same power source. One form of such device is timer 44 which consists of a rotatable disc 45 with a conducting sector 46 on its periphery, the disc being mounted on and driven by a shaft 47. Current is supplied to the sector 46 through a lead 49 connected to the shaft 47, which in turn is connected to line 43 as shown.

After the operator closes the switch 23, in turn causing switch 28 to close, the sector 46 is energized from the line 43 as above explained. At the proper time, shaft 47, driven by suitable mechanism not shown, rotates turning disc 45 in a clockwise direction, and when brush 48 contacts sector 46 the solenoid 36 is energized closing the heating power switch 37 thereby supplying heating current to the inductor and continuing that supply as long as sector 46 and brush 48 remain in contact. The length of the sector 46 and the peripheral speed of the disc 44 are set so as to accurately apply the heating power for exactly the predetermined time which may be of any value as the work may require. When the disc 45 has turned far enough to break the contact between brush 48 and sector 46, the solenoid 36 is deenergized and switch 37 opens disconnecting the power supply from the inductor and cutting off the inductive heating effect in the article.

After contact between brush 48 and sector 46 is broken, disengaging solenoid 36, the switches 37, 38, 53 and 56 are returned to their normal or initial position ready to start the entire operation again. As hereafter explained these four switches are controlled from the single solenoid 36. It will be seen that even if the disc 44 continues to revolve, no heating current will energize the inductor until after the starting switch 23 has been closed again to energize solenoid 25.

Solenoid 36 closes the two normally open switches 37 and 53 and opens the two normally closed switches 38 and 56, all of which are insulated from each other in a known manner and hence not shown, and mounted to function properly on the vertical shaft 55.

As above explained, the starting switch 23 having been closed and the shaft 47 being in rotation, the instant sector 46 rotates far enough to contact brush 48, solenoid 36 is energized and causes switches 37, 38, 53 and 56 to act. The functions of switches 37 and 38 have already been explained. The function of switch 53 is to provide a holding circuit around switch 28 and the function of switch 56 is to open the holding circuit of solenoid 25. When sector 46 first contacts brush 48 and energizes solenoid 36, it is desirable that solenoid 25 be deenergized so as to set switches 27 and 28 again in their normal open positions in order that the main line switch 37 will not again become operative until the starting switch 23 has again been momentarily closed. At the end of the heating period, when brush 48 breaks contact with sector 46, the circuits should be restored to their starting positions.

The actual connection at switch 53 is made by

a member 53—A slidable on a shaft 55 and cushioned by a light helical spring 53—B. A pin 53—C holds 53—A against the top of spring 53—B and a similar pin 54 holds spring 53—B in compression from the bottom. In a similar manner, referring to bottom switch 56, a member 60 effects the actual connection and is slidable vertically on shaft 55 and, due to the weight of shaft 55, is normally held down against the switch contact points by a light spring 58 held in compression by a pin 59 which passes through shaft 55. When switch 56 is in its normally closed position, pin 57 passing through shaft 55 clears the bottom of member 56 a sufficient amount such that when solenoid 36 is energized lifting shaft 55, member 60 remains closed at switch 56 until after the switch member 53—A has closed the contacts at switch 53. As shaft 55 continues to lift, pin 57 engages the bottom of member 60, breaking the contact and opening switch 56. When switch 53 closes, it establishes a holding circuit around switch 28 before switch 56 opens. Then switch 56 opens breaking the holding circuit previously established around switch 27.

From the foregoing description it will be seen that we have provided a safety control system to prevent accidents and spoilage of the parts to be treated if the piece heated becomes improperly located with respect to the inductor and shorts or if a short is created by foreign matter between the piece and the inductor.

Other modes of applying the principle of our invention may be employed instead of the one explained, change being made as regards the means and the steps herein disclosed, provided those stated by any of the following claims or their equivalent be employed.

We therefore particularly point out and distinctly claim as our invention:

1. In apparatus for electric heating, comprising an inductor adapted to lie in spaced heating relation to an article to be heated below the melt-

ing point thereof, the inductor being connected to terminals of a secondary of a transformer, a first circuit including in seriatim a primary of the transformer and a switch to supply current to the transformer from a power supply source; a second circuit including in seriatim an emergency switch and a solenoid adapted to operate the said power supply switch, the emergency switch being connected to supply current to the solenoid from a current source independent of the aforesaid power supply source; a third circuit including in seriatim the aforesaid transformer secondary, a part of the inductor, the article normally spaced from the inductor and a solenoid which when energized opens said emergency switch whereby electric contact between the inductor and said article causes the solenoid in said third circuit to open the emergency switch to de-energize the first named solenoid which then opens the switch interposed between the primary of the transformer and the power supply source, the said third circuit being supplied with current from a transformer connected to a source independent of the said power supply source.

2. In apparatus for electric heating as claimed in claim 1, a switch in a part of the third circuit, said switch being adapted to be set open to prevent the solenoid in said third circuit from becoming operative in case of a momentary disturbance during heating, an auxiliary current path being connected to supply current to the solenoid in the third circuit when the switch in the part of the third circuit is open, said auxiliary current path bridging said switch to supply current to the solenoid in the said third circuit to energize the solenoid in the second circuit and interrupt current supply to the inductor upon occurrence of a definite short between the inductor and the article being heated.

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