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HEAT-TREATING APPARATUS

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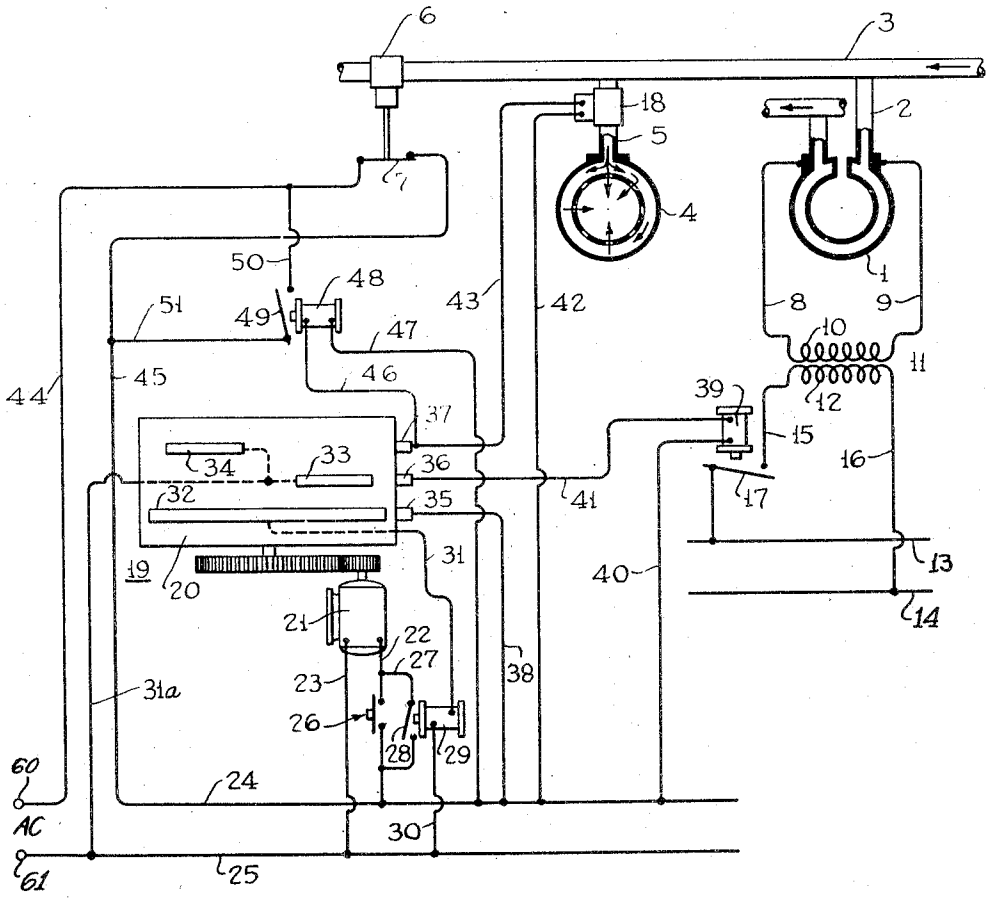

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HEAT-TREATING APPARATUS

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5 Claims. (Cl. 266—4)

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This invention relates to heat treating apparatus, more particularly to apparatus of the type wherein heating currents are first induced in the article to be heat treated and then quenched.

In an apparatus of the induction heating type, it desirable to cool parts of the electrical apparatus such as for example, the inductor and the transformer coils, and in many installations the cooling fluid, such as water, is supplied from the same conduit which supplies the electrical apparatus. It is also the practice to provide a control circuit for the switch means which effects energization and deenergization of the electrical apparatus and movement of the valve which controls the supply of quenching fluid, which control circuit includes pairs of contacts openable and closable in sequence by a suitable timing device to provide sequential heating and quenching cycles. In order tc provide for adequate cooling of the electrical apparatus the cooling fluid is supplied at a predetermined minimum value and a pressure switch is provided which will disconnect the control circuit and said switch and valve from the power source should the fluid pressure drop below that predetermined minimum value during the heating cycle.

In the case where the quenching fluid is obtained from the same source as the cooling fluid, the volume of quenching fluid in many cases is so great as to cause a reduction of pressure below the aforementioned predetermined value with the result that the pressure switch will disconnect the control circuit from the source of power before the quenching operation is completed. This premature termination of the quenching cycle invariably produces a defective or inadequately hardened article.

One of the objects of the present invention is to insure in installations of the above character, the completion of the quenching operation in the event the pressure of the quenching fluid shou'd drop below the predetermined value for which the pressure switch is set to open the control circuit.

Another object is to provide a switch device in the control circuit of the heat treating apparatus of the character described, which switch device is so connected in the circuit as to render the pressure responsive switch ineffective to shut off the control circuit in the event of a drop in fluid pressure below that for which the pressure responsive switch is set for operation.

With the above and other objects in view which will be apparent from the following description to those skilled in the art to which the invention appertains, the present invention consists in certain combinations of parts to be hereinafter described with reference to the accompanying drawing, and then claimed.

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In the drawing the single view is a diagrammatic illustration of an induction heating element and a quenching element together with an automatic control circuit therefor in which the safety control feature of the present invention is incorporated.

Referring to the accompanying drawing, the heat treating apparatus selected for illustration includes a hollow inductor 1 connected through pipe 2 with a water supply conduit 3, and a quenching element 4 connected through pipe 5 to receive quenching liquid from the water supply conduit 3. Also associated with the water supply conduit 3 is a pressure responsive device 6 of any well known type adapted to actuate a switch 7 upon a predetermined drop in pressure of the water flowing through the conduit 3 for a purpose to be later described.

The inductor 1 derives its current through leads 8 and 9 from the secondary 10 of a transformer 11. The primary 12 of the transformer 11 receives its current from the high frequency line 13—14 through leads 15 and 16, a switch 17 being provided for making and breaking the circuit for the transformer primary 12.

A solenoid valve 18 is provided in the pipe 5 for controlling the supply of quenching fluid to the quenching element 4.

The supply of current and quenching fluid for a single heat treating operation is controlled by a control circuit which includes a timer 19 of any suitable construction. The timer 19 shown for illustration is of the type having a drum 20 driven by an electric motor 21 which is connected by leads 22 and 23 with the current supply lines 24 and 25, the lead 22 having a manually operable starting switch 26 therein. Bridging the starting switch 26 is a conductor 27 having a holding switch 28 therein which is operated by a solenoid 29. One terminal of the solenoid is connected by lead 30 with supply line 25 and the other terminal is connected by lead 31 to a segmental contact band 32, carried by the face of the drum 20 which also carries contact bands 33 and 34, contact bands 33 and 34 being connected by lead line 31a with the current supply line 25. The contact bands 32, 33 and 34 are arranged to contact in a manner to be hereinafter described with contacts 35, 36 and 37 respectively. Contact 35 is connected through lead 38 with the current supply line 24. The switch 17 for controlling the supply of current to the transformer primary 12 is

actuated by a solenoid 39 which is connected by leads 40 and 41 with the current supply line 24 and the contact 36 respectively. The quench control valve 18 is of the solenoid type and is connected by leads 42 and 43 with the current supply line 24 and the contact 37 respectively.

The switch 7 which is actuated by the pressure responsive device 6 is connected in series with the current supply lines 24 and 25 by leads 44 and 45 to the source terminals 60 and 61.

The contact band 32 is of such a length as to maintain contact with the contact 35 throughout substantially one full rotation of the timer drum 20 whereas the contact band 33 which effects the closing and opening of switch 17 through solenoid 39 for the heating operation, and the contact band 34 which controls the supply of quenching fluid to the quenching element 4 to the solenoid valve 18 during the quenching operation, are of such length as to contact their respective contacts 36 and 37 for only a small portion of one revolution of the drum 20. Preferably the contact bands 33 and 34 are so related as to provide a desired dwell between the heating and quenching cycles.

Assuming the control circuit to be open, the operator of the heat treating apparatus closes the starting switch 26 which supplies current through leads 22 and 23 to cause the motor 21 to rotate the drum 20. The operator maintains the switch 26 closed until such time as contact is made between contact band 32 and contact 35 whereupon switch 26 is opened. Switch 26 may be of the type which will automatically open upon release of the closing pressure. Engagement of the contacts 32 and 35 establishes a circuit through leads 30, 31 and 38 to energize the solenoid 29 which energization closes the switch 28 to establish a closed circuit through lead 27 around the switch 26.

At a predetermined point in the rotation of the drum 20, contact band 33 engages contact 36 to establish a circuit through leads 31a, 41 and 40 to energize solenoid 39 which energization closes the switch 17. Closure of switch 17 thus establishes a circuit through leads 15 and 16 between the high frequency lines 13—14 and the primary 12 of the transformer, thus energizing the secondary 10 to supply current to the inductor 1.

The contact band 33 is of such length as to maintain the supply of current to the inductor 1 for such time as is necessary to bring the article being heat treated to a desired hardening temperature. Accordingly when this temperature is reached the contact band 33 disengages contact 36 to effect deenergization of the inductor 1 through the opening of the switch 17 by deenergization of the solenoid 39.

In the event that during this heating operation the pressure of the water flowing in conduit 3 and thence through pipe 2 for cooling the inductor 1 drops below that which is necessary to maintain the inductor 1 sufficiently cooled, the pressure responsive device 6 opens switch 7, thus breaking the control circuit which in turn deenergizes solenoid 29 and causes switch 28 to open the motor circuit. This operation of the device prevents the supply of current to the inductor in the event of subnormal cooling fluid pressures and safeguards the inductor 1 against overheating.

After a predetermined time following the disengagement of the contact band 33 and contact 36 which predetermined time provides the desired soaking period between the heating and quenching operations, contact band 34 engages with contact 37 and thus closes two parallel circuits, the

one through leads 31a, 43 and 42 to energize the solenoid of valve 18 to cause the valve 18 to open and supply quenching water from conduit 3 to the quenching element 4, and the other through leads 31a, 46 and 47 to energize solenoid 48. Energization of the solenoid 48 closes a switch 49 connected by leads 50 and 51 which connect with leads 44 and 45 to bridge the switch 7. The closure of the bridging circuit, thus renders the pressure responsive device 6 and associated switch 7 ineffective to open the control circuit and stop the supply of quenching fluid in the event the pressure of the water in the conduit 3 drops during the normal quenching period below that for which the device 6 is set. Insurance is thus had that the supply of quenching fluid will not be interrupted during the entire quenching period by the operation of the device 6.

After the supply of quenching fluid is terminated by the disengagement of contact band 34 and contact 37, which disengagement deenergizes the solenoid of valve 18 and solenoid 48 to close valve 18 and open switch 49, the drum 20 continues to rotate until the contact band 32 disengages contact 35. This disengagement opens the holding circuit by deenergizing the solenoid 29 and causing switch 28 to stop the motor 21 of the timer 19 and condition the apparatus for the next heat treating operation.

The heat treating apparatus and specific control circuits shown and described have been selected for the purpose of illustration only and it is to be understood that the invention is applicable to apparatus of any type wherein the quenching fluid is obtained from the same source as that which supplies the inductor, the transformer or any other part of the electrical apparatus with cooling fluid.

The terms "electrical element" and "electrical apparatus" as used in the claims are to be construed as including the heating inductor, the transformer coils or any other part requiring cooling or all of such parts. It will be understood by those skilled in the art that formal changes may be made in the arrangement of the parts described without departing from the spirit and substance of the present invention, the scope of which is defined by the appended claims.

What is claimed is:

1. In a heat treating apparatus having an energizable fluid cooled electrical element and a normally closed quenching fluid valve both arranged to receive cooling fluid and quenching fluid respectively from a common fluid supply conduit, timing means for sequentially effecting energization of said element, deenergization of said element, opening of said valve and closing of said valve, means responsive to the pressure of the fluid flowing from said conduit to said element and valve to render said timing means inoperative and to effect deenergization of said element at fluid pressures less than a predetermined value, the improvement which comprises circuit means for rendering said pressure responsive means ineffective, and actuating means operated by said timer means for actuating said circuit means during the time period said valve remains open whereby normal functioning of said timing means and the supply of fluid to said valve is continued in the event of a drop in pressure of the fluid below said predetermined value during the period said valve is open.

2. In a heat treating apparatus having electrical apparatus for performing a heating operation, a normally closed electrically operable quenching

fluid supply valve and conduit connections between the electrical apparatus and valve in which fluid flows from a common source to cool portions of said electrical apparatus and to said supply valve, a first circuit including a source of current, said electrical apparatus and an electrically operable switch for making and breaking the same, a second source of current having a pair of current supply lines, a second circuit including said supply lines, said electrically operable switch and a first pair of contacts, a third circuit including said supply lines, said electrically operable valve and a second pair of contacts, timer means for sequentially closing and opening said first pair of contacts and closing and opening said second pair of contacts to first effect a heating cycle and after termination of the heating cycle to effect a quenching cycle, a normally closed switch in one of said supply lines, means for opening said normally closed switch in response to a drop in pressure of said fluid below a predetermined value, a normally open electrically operable switch bridging said normally closed switch, and a fourth circuit including said supply lines, actuating means for moving said normally open switch and said second pair of contacts whereby closure of said second pair of contacts closes said normally open switch and renders said normally closed switch ineffective during the quenching cycle irrespective of the pressure of said fluid.

3. In a heat treating apparatus having a fluid supply source, a fluid cooled electrical element connected with said supply source, a source of current, circuit connections including an electrically operable switch between said current source and electrical element, a quench and coolant supply conduit connected with said fluid supply source and electrical element, a normally closed electrically operable valve in said quench supply conduit, a second current source, a timer having circuit connections with said second current source and with said electrically operable switch and said electrically operable valve for effecting closure of said switch, opening of said switch, opening of said valve and closing of said valve in sequence, a normally closed switch device connected to said second current source in series therewith, means for opening said switch device in response to a predetermined drop in pressure of the fluid supplied by said fluid supply source, circuit connections including a normally open switch for bridging said switch device, switch operating means, and circuit connections between said second current source, said timer and said switch means, said switch means being energizable by said timer simultaneously with the opening of said valve whereby a bridging circuit is established across said switch device.

4. In a heat treating apparatus having an energizable fluid cooled electrical element and a normally closed quenching fluid valve, both arranged to receive cooling fluid and quenching fluid from a common fluid supply conduit, pressure means responsive to the pressure of the fluid flowing from said conduit to said element and valve to effect the deenergization of said element at fluid pressures less than a predetermined value, circuit means for rendering said pressure means ineffective, actuating means for actuating said circuit means, and timing means for sequentially effecting energization of said element, deenergization of said element, opening of said valve, closure of said valve, and for operating said actuating means to actuate said circuit means during the open period of said valve whereby should the pressure drop to less than said predetermined value during the open period of said valve, said electrical element will remain energized notwithstanding.

5. In a heat treating apparatus having an energizable fluid cooled electrical element and a normally closed quenching fluid valve, both arranged to receive cooling fluid and quenching fluid from a common fluid supply conduit, pressure means responsive to the pressure of the fluid flowing from said conduit to said element and valve to effect the deenergization of said element at fluid pressures less than a predetermined value, circuit means for rendering said pressure means ineffective, actuating means for actuating said circuit means, and timing means for sequentially effecting energization of said element, deenergization of said element, simultaneous opening of said valve and operation of said actuating means, and simultaneous closure of said valve and deenergization of said actuating means.

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