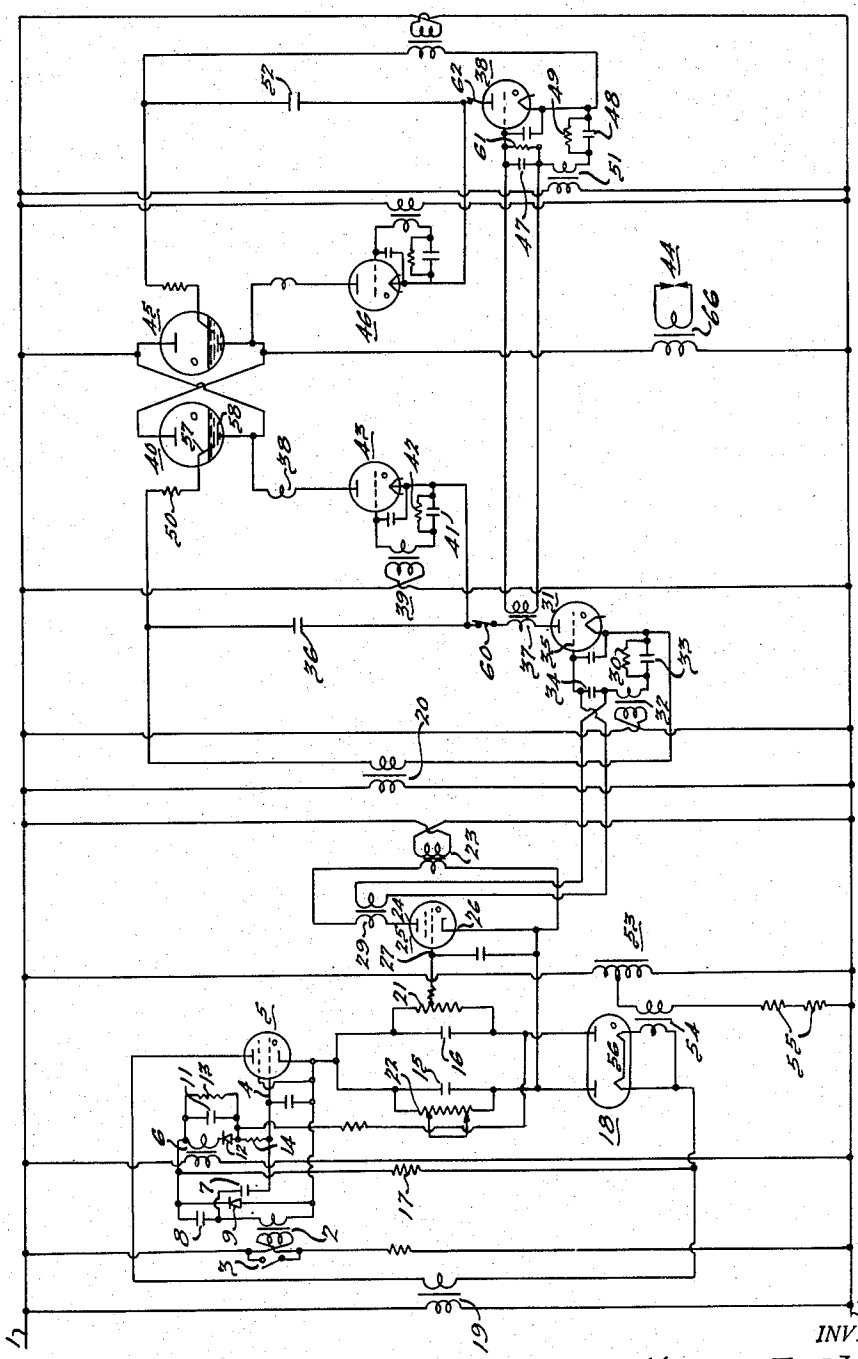
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OVERHEATING SAFETY SYSTEM FOR ELECTRIC DISCHARGE TUBES

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OVERHEATING SAFETY SYSTEM FOR ELECTRIC DISCHARGE TUBES

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This invention relates to safety systems preventing overheating of electric discharge tubes.

Electric discharge tubes of the mercury pool cathode type controlling translating circuits carry large currents and means must be provided for carrying away the heat caused by these currents or the tubes will be destroyed. It is the practice to circulate cooling water around the tubes to cool them to safe temperatures, and to provide a water-flow switch sensitive to the temperature of the water leaving the tubes and capable of interrupting the electric control circuit in case the temperature of that water becomes too high, the high temperature indicating improper cooling of the power tube. One form of such switch comprises a metal block or pipe through which the cooling water flows, the pipe or block being heated by electricity, and this heat also being carried away by the cooling water. If the water flow stops or if flow is so impeded that the power tubes are not properly cooled, the pipe or block becomes overheated and a bimetallic strip subject to pipe temperature flexes to open the control circuit and thus acts to stop all current flow through the discharge tube by preventing its becoming conducting. The metal block or pipe through which the cooling water flows is heated by means of a resistance winding connected to the power source. When this winding burned out, or heating current otherwise failed to flow therethrough in the past, the pipe or block which it normally heated would be cool and the bimetallic member would not be heated sufficiently to interrupt the tube control circuit even though the temperature of the cooling water indicated dangerous operating temperature within the discharge tube. In such cases, the expensive discharge tubes were frequently destroyed.

Therefore, one object of this invention is to protect the electric discharge tubes in the event of burn-out of the heater of a flow switch, the switch being responsive to the temperature of the water which serves to cool the discharge tubes.

Another object of the present invention is to provide a safety system protecting electric discharge tubes against overheating, in which power flow through the tubes is interrupted upon the occurrence of burn-out of, short circuit through, or local power failure to, the heating coil of a flow switch responsive to cooling water temperature.

Another object is to provide a safety system in accordance with the preceding objects in which burnout of, or local power failure to, the heater coil prevents conduction of an electric valve in the

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control circuit for the discharge tube and in which a short circuit through the heater coil burns out the heaters or filaments on the electric valve to prevent its functioning.

Other objects and features of the invention will be readily apparent to those skilled in the art from the specification and appended drawing illustrating certain preferred embodiments in which the figure is a diagrammatical representation of a circuit including the safety system of this invention.

The invention as illustrated in the single figure of the drawing employs a source of alternating voltage connected to conductors 1 serving to supply power to control and load circuits. Transformer 2 has its primary energized by the source and has an initiating switch 3 controlling a circuit bypassing the transformer 2 primary. The secondary voltage of transformer 2, modified as hereinafter explained, is applied to the grid 4 of electric valve 5. The secondary of transformer 2 charges capacitor 7 by grid rectification of valve 5. This action produces a hold-off bias at grid 4 of valve 5 equal to the output of transformer 2 displaced from the cathode potential of valve 5 by the amount of the D. C. voltage across capacitor 7. The secondary of transformer 2 also charges capacitor 8 through rectifier 9 to produce thereon a D. C. voltage. This voltage opposes a sawtooth voltage across capacitor 11 produced by the output of transformer 6 through rectifier 12 and by the rapid discharge of capacitor 11 through resistor 13 during periods of non-conduction of rectifier 12. The resultant of the opposing voltages of capacitor 8 and capacitor 11 is applied to the grid 4 of valve 5 through a resistor 14 which also serves as a bleeder for capacitor 7.

There is provided a transformer 19 having its primary connected to the supply across the lines 1 and its secondary connected to the anode and cathode of valve 5 through the rectifier tube 18 and the parallel circuit formed by the timing capacitors 15 and 16. Bypassing the capacitor 15 is an adjustable resistor 22 and bypassing the capacitor 16 is a resistor 21 having an intermediate tap-off point initially adjustable and normally set in the operation of the system.

A transformer 23 has its primary connected to the supply across lines 1 and its secondary output fed to the anode 24 and cathode 26 of the electric valve 25 through the primary of transformer 29. The control grid 27 of valve 25 is connected to the tap-off point of resistor 21 and the cathode 26 is connected between the capacitor 15 and the rectifier tube 18. The secondary of the trans-

former 29 is connected across the capacitor 34 connected in the circuit of the grid 35 of electric valve 31 which controls the charging of the firing capacitor 36.

A transformer 32 has its primary energized from the supply across lines 1 and its secondary in the circuit of grid 35 in series with the capacitor 34 and a capacitor 33 bypassed by resistor 30. The anode and cathode of the valve 31 are connected across the secondary output of a transformer 20 in series with a firing capacitor 36. The primary of transformer 20 is energized from the supply across lines 1. Also in series with the anode circuit of the valve 31 are the contacts 60 of a thermal flow switch for the electric discharge tubes 40 and 45 and the primary of a transformer 37. Across the firing capacitor 36, which discharges therethrough, are connected the igniter 57 and mercury pool cathode 58 of electric discharge tube 40 through an electric valve 43. Valve 43 has its grid connected to a hold-off bias circuit comprising the secondary of transformer 39 and capacitor 41 bypassed by resistor 42, the primary of transformer 39 being connected to the supply across lines 1.

Connected back to back with the electric discharge tube 40 is a second tube 45, these discharge tubes serving to pass both half cycles of supply current through the load represented by the welding transformer 66 supplying a welding load at 44. Electric discharge tube 45 is fired by components similar to those set forth with respect to tube 40, these constituting the firing capacitor 52, the discharge valve 46 and charging valve 38.

To secure proper firing of the charging valve 38, the secondary output of transformer 37 is fed across a capacitor 47 in the grid circuit of valve 38, in series with the elements supplying the hold-off bias and constituted by the secondary of transformer 51 and the capacitor 48 bypassed by resistor 49. The capacitor 47 is bypassed by the discharge resistor 61. In series with the firing capacitor 52 and the valve 38 are the contacts 62 of the thermal flow switch.

The heaters for the thermal flow switches, whose contacts are shown at 60 and 62, are shown at 55 connected in series with each other and through the primary of transformer 54 to a tap-off point of an auto transformer 53 connected across lines 1. The secondary output of transformer 54 is fed through the cathode heaters or filaments of the rectifier tube 18.

In the drawing, the surge bypass capacitor for the electric valves have been shown but they have not been described; the grid resistors and cathode heaters which would be used have been neither shown nor described as these are conventional elements not essential to the invention, although they would customarily be used in a working circuit.

The operation of the discharge tube control system is as follows:

When initiating switch 3 is closed, the output voltage of transformer 2 disappears and capacitor 7 discharges rapidly. The voltage at control grid 4 of electric valve 5 quickly changes, therefore, from the near sine wave curve of capacitor 7, consisting of the D. C. voltage due to grid rectification plus the A. C. output of transformer 2, to the sawtooth voltage of capacitor 11 plus the steady D. C. voltage of capacitor 8. Valve 5 fires at the next sawtooth peak grid voltage after closure of the initiating switch 3. Valve 5 ceases to conduct as soon as timing capacitors 15 and 16 are charged, capacitor 8 being rapidly discharged through resistor 17. This leaves at the grid 4 of valve 5 only the capacitor 11 sawtooth voltage which is always sufficiently negative to prevent conduction of valve 5, which will, therefore, conduct for only a portion of a half cycle for each closure of the initiating switch 3.

While valve 5 conducts, capacitors 15 and 16 are charged through rectifier tube 18, said capacitors being charged at the same time from the same voltage source, both charging circuits having the same impedances. Therefore, capacitors 15 and 16 are charged to the same voltage and then effectively disconnected from the supply transformer 19 as valve 5 ceases to conduct. Capacitor 16 discharges very slowly through the voltage dividing resistor 21; capacitor 15 discharges more quickly through the weld time adjustment resistor 22.

Transformer 23 is so disposed as to make the anode 24 of valve 25 negative with respect to cathode 26 during the period of conduction of valve 5 and rectifier tube 18. As soon as anode 24 becomes positive with respect to cathode 26, valve 25 conducts, because its cathode is at the full negative potential of capacitor 15 while its grid 27 is at approximately one-third the negative potential of capacitor 16, being electrically connected to approximately the one-third point of capacitor-bridging resistor 21. Control grid 27 is positive, therefore, with respect to cathode 26 and will remain so until capacitors 15 and 16 discharge to the cross-over point, where the potential of capacitor 15 is equal to that at the tap on the capacitor-bridging resistor 21 and subsequent positive potentials of the anode 24 with respect to cathode 26 will not fire the valve 25. Time measuring valve 25 will conduct, therefore, on the next half cycle after valve 5 and tube 18 conduct and will continue to conduct during each half cycle during which anode 24 is sufficiently positive with respect to cathode 26 until the above mentioned cross-over point is reached. Conduction of valve 25 energizes coupling transformer 29 which delivers to the grid circuit of valve 31 a measured number of pulses equal in number to the number of full cycles of weld time desired.

Grid 35 of charging valve 31 receives A. C. hold-off voltage from transformer 32 output plus a D. C. component across capacitor 33 which is charged by valve 31 grid rectification. Each output pulse from coupling transformer 29 charges energy into capacitor 34. This energy is discharged into the circuit of grid 35 at the beginning of the following half cycle, providing a voltage signal which overcomes the hold-off bias on grid 35 and causes valve 31 to conduct.

Conduction of valve 31 charges firing capacitor 36 through current transformer 37. Each time capacitor 36 is charged, valve 31 conduction current energizes transformer 37 and the output from the secondary of transformer 37 delivers a pulse to the valve 38 grid circuit.

The circuit consisting of grid bias transformer 39, capacitor 41 and resistor 42 provides D. C. hold-off voltage for valve 43. After the firing capacitor 36 is charged, the tube 43 fires as its grid voltage becomes less negative and quickly discharges capacitor 36 through resistor 50, inductor 38, the igniter 57 and mercury cathode pool 58 of discharge tube 40. Resistor 50 and inductor 38 serve to shape the discharge pulse of capacitor 36 for best firing performance, the

high current pulse produced by the discharge serving to initiate conduction of tube 40 in conventional manner.

Discharge tubes 40 and 45 accomplish the function of switching the primary current to the welder transformer 66, being connected back to back in series with one power line to the welder transformer and serving in effect as a single pole contactor.

The circuits for valves 38, 46 and tube 45 are substantially the same as the previously described circuits for valves 31, 43 and tube 40 respectively. Valve 38 fires in response to the output pulses of transformer 37 which occur each time valve 31 conducts. Each of these pulses charges energy into capacitor 47, this energy being discharged into the grid circuit of valve 38 at the beginning of the following half cycle, providing a voltage peak which overcomes the hold-off bias due to capacitor 48, resistor 49, and transformer 51. When valve 38 fires, it charges firing capacitor 52, the firing capacitor being discharged by conduction of valve 46, to effect conduction of mercury pool tube 45 in the same manner as previously described for the interaction of capacitor 36, valve 43 and mercury pool tube 40.

Transformer 54 is seen to have its secondary in series with the filament 56 of relatively inexpensive rectifier tube 18 and its primary in series with the thermal flow switch heaters 55. The transformer ratio is so selected that in normal operation the flow switch current through the primary transforms to proper filament current in the secondary. The supply voltage tap on transformer 53 is selected so that both heaters and tube filament receive proper voltage. In the event one or both of the thermal flow switch heaters 55 should burn out, the associated thermal flow switch becomes inoperative to protect the discharge tubes with which it is associated. Upon the occurrence of such burnout, the primary circuit of transformer 54 is interrupted so that current ceases to flow through the filament 56 and the tube 18 becomes non-conducting to prevent further charging of the timing capacitors 15 and 16 and thus interrupt further conduction through the discharge tubes after the completion of any timing cycle in operation at the time of burnout. In the event of local power failure, current again ceases to flow through the filament 56 and the tube 18 is non-conducting to prevent further timing of a conducting cycle for the discharge tubes.

Upon the occurrence of a short circuit through one or both of the thermal flow switch heating resistors 55, the current through the primary of transformer 54 will be greatly increased and the secondary current flowing through filament 56 will be sufficiently high as to burn out the filament to render the tube 18 non-conducting. The rectifier tube 18 is relatively inexpensive compared to the discharge tubes and serves to protect the discharge tube without the necessity of fusing and other complications in the circuit.

It will readily appear, therefore, that the expensive discharge tubes in the circuit are protected from any type of failure of the thermal flow switch heaters and that no harm can be sustained by the electric discharge tubes due to any of the faults to which said thermal flow switch heaters are normally subject.

While certain preferred embodiments of the invention have been specifically disclosed, it is understood that the invention is not limited thereto, as many variations will be readly apparent to those skilled in the art and the invention is to be given its broadest possible interpretation within the terms of the following claims.

What is claimed is:

1. In a safety system for thermal flow switch overheating protection for electric discharge tubes, an electric discharge tube for controlling the passage of current to a load, means including an electronic tube controlling the conduction of said electric discharge tube, a thermal flow switch including cooperating contacts and a heater, a transformer, means connecting the primary of said transformer in series with said heater, and means connecting the secondary of said transformer to the cathode heater of said electronic tube, said electronic tube being of the type requiring a hot cathode for conduction and preventing conduction of the electric discharge tube upon failure of current flow through the thermal flow switch heater.

2. In a safety system for thermal flow switch overheating protection for electric discharge tubes, an electric discharge tube for controlling the passage of current to a load, means including an electronic tube controlling the conduction of said electric discharge tube, a thermal flow switch including cooperating contacts and a heater and means supplying energy to the cathode heater of said electronic tube, said last mentioned means being responsive to current flow through said thermal flow switch heaters, said electric valve being of the type requiring a hot cathode for conduction and preventing conduction of the electric discharge tube upon failure of current flow through, or short circuit of, said thermal flow switch heaters.

3. In a safety system for thermal flow switch overheating protection for electric discharge tubes, an electric discharge tube for controlling the passage of current to a load, means including an electronic tube controlling the conduction of said electric discharge tube, a thermal flow switch including cooperating contacts and a heater, a transformer, means connecting the primary of said transformer in series with said heater, means connecting the secondary of said transformer to the cathode heater of said electronic tube, said electronic tube being of the type requiring a hot cathode for conduction, said cathode heater burning out and preventing conduction of the electric discharge tube upon the occurrence of a short circuit of said thermal flow switch heater.

4. In a safety system for thermal flow switch overheating protection for electric discharge tubes, an electric discharge tube for controlling the passage of current to a load, means including an electronic tube controlling the conduction of said electric discharge tube, a thermal flow switch including cooperating contacts and a heater, a transformer, means connecting the primary of said transformer in series with said heater, means connecting the secondary of said transformer to the cathode heater of said electronic tube, said electronic tube being of the type requiring a hot cathode for conduction and preventing conduction of the electric discharge tube in the event said thermal flow switch heater should be deenergized or short circuited.

5. In a safety system for thermal flow switch overheating protection for electric discharge tubes, an electric discharge tube for controlling the passage of current to a load, means controlling the timing of conduction of said discharge tube, other means including an electronic tube

controlling the initiation of operation of said timing means, a thermal flow switch including cooperating contacts and a heater, a transformer, means connecting the primary of said transformer in series with said heaters, means connecting the secondary of said transformer to the cathode heater of said electronic tube, said electronic tube being of the type requiring a hot cathode for conduction and preventing initiation of operation of said timing means upon failure of current flow through the thermal flow switch heater.

6. In a safety system for thermal flow switch overheating protection for electric discharge tubes, an electric discharge tube for controlling the passage of current to a load, timing means controlling the period during which said discharge tube conducts, other means including an electronic tube controlling the initiation of operation of said timing means, a thermal flow switch including cooperating contacts and a heater, a transformer, means connecting the primary of said transformer in series with said heater, means connecting the secondary of said transformer to the cathode heater of said electronic tube, said electronic tube being of the type requiring a hot cathode for conduction and preventing the initiation of a period in which said electric discharge tube could conduct should said thermal flow switch heater be deenergized or short circuited.

7. In a safety system for thermal flow switch overheating protection for electric discharge tubes, an electric discharge tube for controlling the passage of current to a load, timing means

controlling the period during which said discharge tube conducts comprising resistors and capacitors of different decaying rates, means including an electronic tube controlling the admission of charge to said capacitors, a thermal flow switch including cooperating contacts and a heater, a transformer, means connecting the secondary of said transformer to the cathode heater of said electronic tube, said electronic tube being of the type requiring a hot cathode for conduction and preventing the initiation of a period in which said electric discharge tube conducts when said cathode heater is deenergized.

8. In a safety system for thermal flow switch overheating protection for electric discharge tubes, an electric discharge tube for controlling the passage of current to a load, timing means controlling the period during which said discharge tube conducts, means including an electronic tube controlling the initiation of operation of said timing means, a thermal flow switch including cooperating contacts and a heater, means supplying energy to the cathode heater of said electronic tube, said last mentioned means being responsive to current flow through said thermal flow switch heater, said electronic tube being of the type requiring a hot cathode for conduction and preventing the initiation of a period in which said electric discharge tube conducts upon failure of current flow through, or short circuit of, said thermal flow switch heater.

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No references cited.