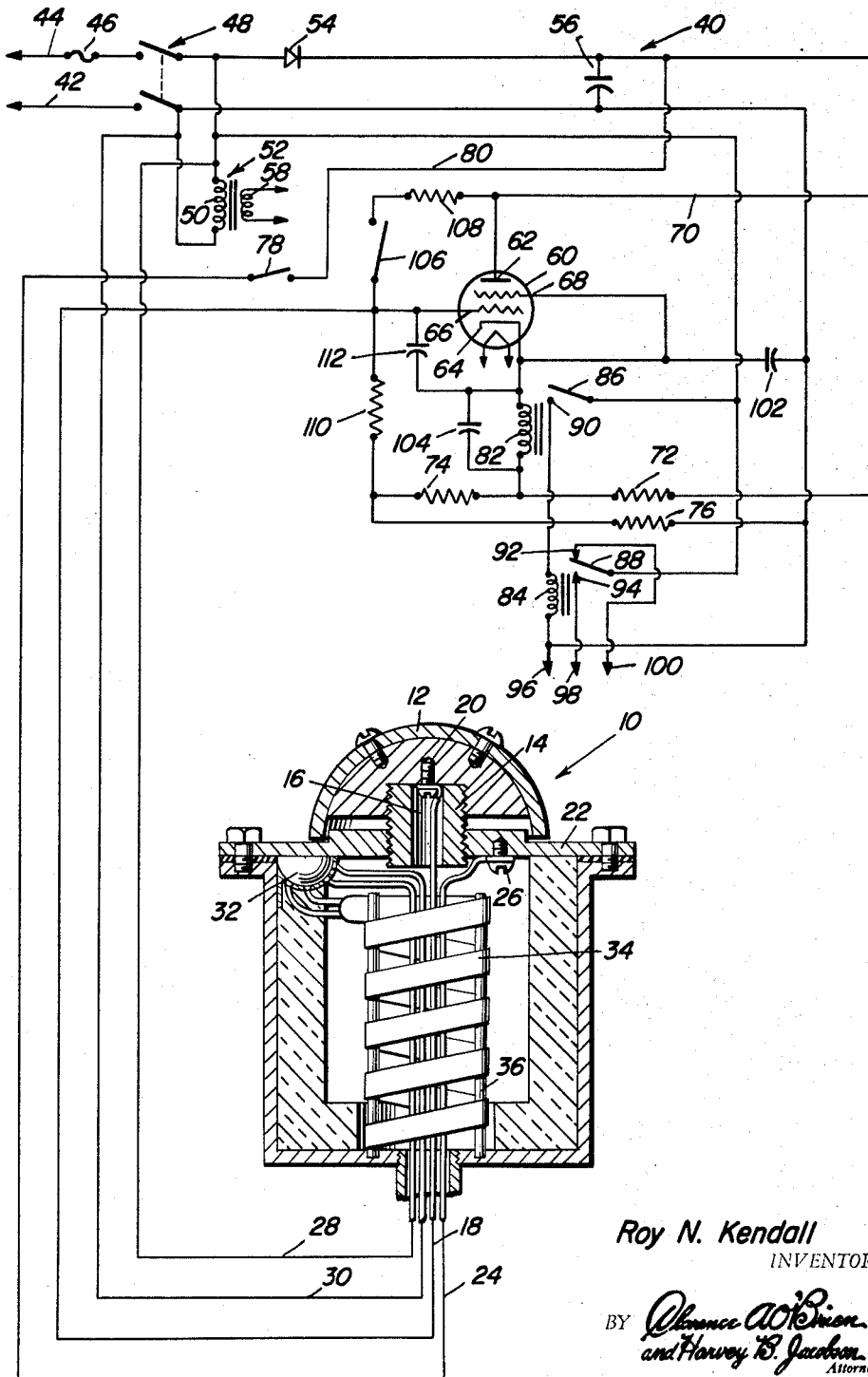


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R. N. KENDALL  
MOISTURE AND HEAT SENSITIVE ELECTRONIC  
SWITCHING CIRCUIT  
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Roy N. Kendall  
INVENTOR.

BY *Alfonse A. O'Brien*  
and *Harvey B. Jackson*  
Attorneys

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## MOISTURE AND HEAT SENSITIVE ELECTRONIC SWITCHING CIRCUIT

Roy N. Kendall, 3707 Patterson Drive, Amarillo, Tex.,  
assignor of fifty percent to Elton M. Kendall, Amarillo,  
Tex.

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This invention relates generally to electronic circuits and more particularly to a moisture and heat sensitive electronic switching circuit for automatically controlling heater means in response to environmental conditions.

Many control circuits are known in the prior art which utilize mechanical or non-automatic means for removing the plate voltage from a control circuit thyatron tube. Although these prior art systems have proved to be highly satisfactory in most instances, they are frequently unreliable. It is the intention of this invention to disclose a novel and improved environmental responsive electronic switching circuit for controlling heating means.

In the railroad industry, it is necessary to provide heaters for keeping on the line switches clear of snow and ice during winter months. It is the contemplation of this invention to provide an electronic switching circuit for automatically controlling electric or gas fired switch heaters. Railroad operation under centralized traffic control of trains poses many major problems amongst which is that of maintaining line switches clear of snow and ice. Many types of electric and gas fired switch heaters are employed in an effort to keep remotely located electrically operated switches operative under severe freezing conditions. In most cases operation of switch heating equipment is manually controlled on the spot or is controlled by the terminal dispatcher through use of an expensive manually operated remote control system. The remote control type of operation is not satisfactory for the reason that the dispatcher must make educated guesses of the weather conditions out on the line, a hundred or more miles distant. The invention to be disclosed herein is sensitive to precipitation in any form and can successfully control automatically, at the location, any electric or gas fired de-icing device.

In view of the above, it is the principal object of this invention to provide a novel and improved environmental electronic switching circuit which is characterized by its simplicity, reliability, and low cost.

It is more particularly an object of this invention to provide in combination with environmental temperature and moisture responsive switches, a control circuit for operating heating means automatically for the purpose of de-icing. The control circuit includes a thyatron and provides novel means for extinguishing the thyatron which avoids the use of any mechanical or non-automatic means of removing the plate voltage.

It is a still further object of this invention to provide a novel environmental responsive electronic switching circuit.

These together with other objects and advantages which will become subsequently apparent reside in the details of construction and operation as more fully hereinafter described and claimed, reference being had to the accompanying drawing forming a part hereof, wherein like numerals refer to like parts throughout, and in which:

The figure illustrates the schematic wiring diagram of the environmental responsive electronic switching circuit and shows in detail a moisture responsive switch which may be utilized.

As noted above, it is contemplated that one of the applications of the invention be for the purpose of controlling electric or gas fired railroad switch heaters. In such an application, the moisture sensing electrode unit 10 would be placed in a small concrete slab located within the

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switch area to be de-iced. The moisture responsive switch unit 10 includes a first aluminum electrode 12 mounted on an insulating nipple 14. The nipple 14 defines a bore 16 through which extends conductor 18 which is electrically connected to the electrode 12 by screw 20. The nipple 14 spaces the electrode 12 from a second electrode 22 which is connected to conductor 24 by screw 26. As noted, the remainder of the unit preferably extends beneath a concrete slab. Conductors 28 and 30 are connected through thermostat unit 32 to a cable type heater 34 wound around a steel cylinder radiator 36.

The control circuit 40 is electrically energized through leads 42 and 44 which include a fuse 46 therein. The leads 42 and 44 are to be connected to a 115-volt alternating current source. It is contemplated that the fuse 46, for the values to be indicated, has a 20 amp. rating. A double-pole single-throw line switch 48 is provided for connecting the main portion of the circuit 40 to the lines 42 and 44. When the switch 48 is closed, the line voltage is applied through fuse 46 and switch 48 across primary winding 50 of transformer 52. Also, a 115-volt potential is applied across the leads 28 and 30 to the heater in the moisture sensing electrode unit 10. Moreover, the 115-volt potential is applied to a rectifier circuit including a 215 milliamp. selenium rectifier 54 and a filter condenser 56 preferably having a rating of 8 microfarads and 250-volts. Extending from the rectifier circuit so formed are direct current B-plus and B-minus lines. Secondary coil 58 of transformer 52 derives 6.3 volts A.C. which is applied to the heater of a thyatron tube 60. The thyatron tube 60 includes within its gas-filled envelope a plate 62, cathode 64, control grid 66 and shield grid 68. The plate 62 is connected by conductor 70 to the B-plus line for applying thereto a constant positive potential. The cathode 64 is connected to a capacitor circuit including capacitor 102, the relay coil 82 in parallel with the capacitor 104 and a voltage divider network. The voltage divider network includes resistors 72, 74 and 76, respectively, having values of 500K ohms, 38K ohms, and 10K ohms, connected to the B-plus and B-minus lines. A thermostatic switch 78 is interposed in conductor 80 which extends from the B-plus line to electrode 22 of the moisture sensing unit 10. Electrode 12 extends through conductor 18 to the control grid 66. It will be appreciated that if the temperature is sufficiently low, thermostatic switch 78 will be closed. If the thermostatic switch 78 is closed, the circuit is ready to sense moisture which bridges the gap between the electrodes 12 and 22. If the thermostatic switch 78 is open, no voltage may be applied to the control grid 66 of the tube 60. As long as no voltage is applied to the control grid 66, the tube 60 does not conduct and relay coils 82 and 84 remain de-energized with their relay switches 86 and 88 in their normal positions as illustrated. Coil 82 has a resistance value of 10K ohms.

If conditions are such that temperatures have closed the thermostatic switch 78 and moisture has bridged electrodes 12 and 22 of unit 10, a grid biasing potential is applied through the temperature and moisture switches to the control grid 66. It is to be noted that the contemplated D.C. potential of the B-plus line is 150-volts. By applying 150-volts to the control grid 66, the tube 60 (2D21 grid controlled rectifier tube) starts conducting inasmuch as the positive potential is applied to the plate 62 and a negative potential to the cathode 64 through the divider network. Initially therefore, a potential difference exists between the plate 62 and cathode 64 above the tube extinction value so that the control bias of the grid will cause the initial ionization of the plate to cathode current path. This conduction causes relay coil 82 to become energized and accordingly move relay switch 86 into engagement with contact 90 to thereby control a heater switching circuit through relay coil 84. As relay

coil 84 becomes energized, relay switch 88 moves from contact 92 into engagement with contact 94. A.C. input potential is thereby causing an A.C. output voltage to be impressed across output terminals 96 and 98 rather than the normal output terminals 96 and 100.

While this conducting condition continues, the voltage drop across resistors 74 and 76 and relay coil 82 charge capacitor 102. At the same time, voltage drop across the relay coil 82 charges capacitor 104. This raises the potential value of cathode 64 and shield grid 68, which is connected directly to the cathode, toward the potential of the plate 62 because of its connection to the positive potential sides of the capacitors 102 and 104 which store charges when the tube 60 is conductive. Capacitor 102 should have a rating of 4 microfarads and capacitor 104 should have a rating of 2 microfarads. The potential difference between the plate and the cathode reduced by the capacitor 102 below extinction value is however of such value that the tube 60 continues to conduct keeping the relay coil 82 energized only by virtue of the bias on grid 66.

When the moisture bridge between electrodes 12 and 22 is removed or thermostatic switch 78 opens, the potential is removed from grid 66. The charge on capacitors 102 and 104 holds the potential of the cathode 64 and shield grid 68 respectively near enough to the potential of plate 62 so that the tube 60 will stop conducting. When the tube stops conducting, relay coil 82 becomes deenergized which in turn deenergizes relay coil 84 and the circuit again reverts to its original condition until voltage is again applied to grid 66 causing the above cycle to be repeated.

Switch 106 is a test switch which may be closed to feed a positive potential through 1 megohm resistor 108 to grid 66. Resistor 110 constitutes a 1 megohm grid load resistor. .1 microfarad capacitor 112 causes a slight delay in the firing or cutting off of the circuit when the voltage is applied to or removed from grid 66.

The foregoing is considered as illustrative only of the principles of the invention. Further, since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation shown and described, and accordingly all suitable modifications and equivalents may be resorted to, falling within the scope of the invention as claimed. It will therefore be appreciated that the ratings recited for the various circuit components are exemplary in nature only.

What is claimed as new is as follow:

1. Automatic environmental control means comprising:
  - environmental sensing switch means;
  - output control switch means;
  - relay means operatively connected to the output control switch means for control thereof;
  - a source of direct current energy;
  - relay control means including a gas tube having a cathode, a control grid and a plate, means for applying a constant positive potential to the plate and initially a negative potential to the cathode of one value to render the tube conductive in response to a positive potential on the control grid, thereby operating the relay;
  - capacitive means responsive to flow of current between the plate and cathode for increasing the potential on the cathode to a second value for extinguishing conduction in the tube in response to interruption of the positive potential on the control grid;
  - and capacitive circuit means in parallel with the relay, responsive to the flow of current through the relay for maintaining operation of the relay despite intermittent conduction in the tube.

2. A switching circuit comprising:

a thyatron tube having a plate, a cathode, and a control grid;

means for applying a constant positive potential to said plate;

environmental responsive switch means operatively connected to the control grid for applying a positive bias to the control grid while a negative potential is applied to the cathode to render the thyatron tube conductive;

capacitor circuit means connected to said cathode and operative in response to flow of current through the tube to raise the cathode potential and extinguish the thyatron tube in response to interruption of the positive bias on the control grid by the switch means; and an output circuit including a relay having its coil in parallel with a capacitor, the parallel combination being connected in the cathode circuit, the capacitor serving to keep the relay contacts closed despite intermittent conduction of the thyatron tube.

3. The combination of claim 2 wherein said environmental responsive switch means includes a temperature responsive switch;

and a moisture responsive switch;

said switches serially connecting said control grid to said constant positive potential.

4. An environmental responsive switching circuit comprising:

a thyatron tube having a control grid and a cathode; an environmental responsive switch;

a direct current source of electrical energy including a positive and a negative D.C. line, said environmental responsive switch connecting said control grid to said positive D.C. line thereby controlling conduction through said tube;

said thyatron tube further including a plate connected to said positive D.C. line;

a voltage divider connected across said source of electrical energy;

cathode circuit means including a capacitor connected between said cathode and said negative D.C. line;

and an output circuit including a relay having a relay coil in parallel with a capacitor, the parallel combination being connected between the cathode and the voltage divider.

5. The environmental responsive switching circuit of claim 4 wherein:

said environmental responsive switch includes a temperature responsive switch;

and a moisture responsive switch;

said switches serially connecting said control grid to said positive D.C. line.

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