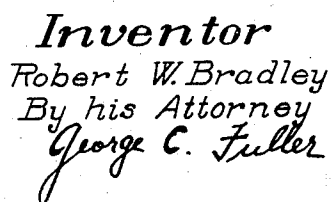


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Robert W. Bradley
By his Attorney
George C. Fuller

George C. Fuller

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BODY CONDUCTIVITY OPERATED CONTROLS FOR ELECTRIC DEVICES

Robert W. Bradley, Marblehead, Mass., assignor to
United Shoe Machinery Corporation, Boston, Mass.,
a corporation of New Jersey

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1 Claim. (Cl. 328—1)

This invention relates to controls for electrically operated devices and more particularly to apparatus for controlling through body conductivity the application of electric power to such devices. The invention is illustrated as applied to a control for energizing an electromechanical relay to initiate the operation of a machine for applying pressure to level the soles of shoes for which purpose the relay is connected to operate contacts in the energizing circuit of a solenoid valve controlling hydraulic pressure to the elements for applying pressure to the shoe sole.

In recent years there have appeared a number of controls adapted to control the energization of an electric device in response to the formation of a conductive path between a pair of conducting surfaces by engagement of the body of an operator simultaneously with both said surfaces, hereinafter referred to for convenience as electrodes.

The growing acceptance of such controls because of their convenience and safety has drawn attention to the need for improving such controls to enhance their economy, safety, comfort and reliability of operation.

Accordingly, the chief object of the present invention is to provide a body conductivity operated control which is inexpensive, reliable, and safe to operate in all anticipated conditions of use, misuse and breakdown.

To this end and in accordance with a feature of the invention, a control is provided comprising a cold-cathode glow-discharge thyatron, normally nonconductive at zero bias, connected in series with the device to be controlled across a D.C. power supply. Since direct current has a lower shock perception level than A.C., a direct current firing circuit is employed. To this end two electrodes are provided, one connected to the positive side of the D.C. supply, the "positive touch electrode," while the other, the "grid touch electrode," is connected to the tube grid so that when the electrodes are bridged by the operator, a positive bias is applied to the grid to fire the tube and energize the device. The connecting means for each electrode comprises a resistance means to limit body current as discussed more fully hereinafter.

A grid resistor is connected between the grid and the cathode of the tube which normally maintains the bias on the grid at zero. To protect the control from being fired by voltage transients on the grid touch electrode such as might be produced by lightning stroke, the electrode is connected to the grid through a series resistor, and a capacitor is connected between the tube grid and cathode. This circuit may also be employed, as will be discussed more fully below, to provide delayed firing of the thyatron.

Means are provided to ground the cathode against drifting with respect to the machine frame to avoid the possibility of the control being accidentally operated by voltages operating between the machine frame and the grid touch electrode. In accordance with the safety feature of the invention, the grounding is accomplished by the provision of a resistor connected between the tube cathode and machine ground. Thus body current through an operator simultaneously engaging the positive touch electrode and the machine frame is limited by the cathode resistor in addition to the resistance means

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connected between the positive touch electrode and the power supply and hence the operator is protected against excessive body current in the unlikely event of partial or complete failure of the resistance means connected between the positive touch electrode and the power supply.

To protect against voltage transients transmitted to the control by the power supply lines, a capacitor is connected between the tube cathode and machine ground.

The provision of a grid to cathode resistor reduces to a certain extent the sensitivity of the control to being fired by minute charges applied to the touch electrode connected to the grid, thus preventing, with the assistance of the RC filter, accidental one-hand operation of the control. However, upon engagement of the operator with the touch electrodes, ample charge is provided to operate the device without body current reaching the perceptible level.

In accordance with a further feature of the invention, a portion of the resistance connected between the positive touch electrode and the power supply is shunted by a capacitor of small value. When the operator touches the electrodes, this capacitor provides a momentary reduction of the impedance of the resistance means connected between the positive touch electrode and the power supply without lowering its steady state resistance. Thus, the use of a capacitor shunting a portion of this resistance means permits a higher value of total resistance to be used in the resistance means without impairing the operation of the control with resulting less steady state body current than where less resistance is employed with no shunting capacitor. Preferably, the capacitor should shunt less than all the resistance of the resistance means, the residual resistance being employed for protection against capacitor breakdown as well as reducing the instantaneous body current.

Other features and advantages of the invention will best be understood from the following description taken in connection with the accompanying drawing, which is a schematic of the control of the present invention, the control being illustrated as connected for the control of an electromechanical relay device.

Referring to the figure, the control of the present invention comprises a cold-cathode glow-discharge thyatron 10 comprising a cathode 11, a control grid 12 and a plate 13. The thyatron 10 is connected in series with the operating circuit of an electromechanical relay K1 across the output terminals of a D.C. power supply 15. The connections include a cam operated switch 16 operable to deenergize the tube 10 after it has been fired. Two touch electrodes 18 and 20, which may comprise relatively insulated metallic spheres or plates mounted at convenient locations on a machine so that they may be grasped by the operator with both hands simultaneously, are connected respectively to the positive terminal of the power supply and to the control grid 12 of the thyatron 10. In series between the electrode 18 and the positive terminal of the power supply is connected resistance means 24 which for safety reasons preferably comprises a plurality of resistors 26, 27 and 28, while a second resistance means, which may comprise a single resistor 29, is connected in series between the electrode 20 and the grid 12. Preferably, the resistance means 24 also comprises a resistor 30 shunted by a capacitor 32, the resistor 30 having a relatively high value and the capacitor 32 having a relatively low value so that the resistance means 24 has a high steady state resistance. The effect of shunting the resistor 30 by the capacitor 32 on the behavior of the circuit in being fired by the operator touching the two touch electrodes, is substantially as if the resistor 30 had been omitted, while at the same time the operator is protected by the additional resistance of the resistor 30 during steady state conditions. To put it another way, the firing

sensitivity of the circuit is enhanced without danger of increasing the steady state flow of body current.

A resistor 34 is connected between the grid 12 and the cathode 11 and a resistor 36 is connected between the cathode 11 and the frame 40 of the machine on which the control is being used. The grounding of the cathode 11 to the machine frame is desirable to prevent the voltage on the cathode from drifting, for example because of leakage currents, with respect to that on the machine frame which drifting might result, in the case of the cathode drifting negative to the machine frame, in permitting accidental firing of the tube by the operator touching the machine frame 40 and the grid touch electrode 20 particularly if the operator had picked up a certain static charge.

The resistance provided in the grounding of the cathode by the resistor 36 in accordance with a feature of the present invention safeguards an operator in touching the frame 40. It will be seen that the negative side of the power supply 15 is connected directly to the cathode 11 and consequently if the cathode were grounded directly to the frame 40 the latter would be connected directly to the negative side of the power supply. If through mischance the circumstance arose where the operator engaged both the frame and a surface connected directly to the positive terminal of the power supply 15, the only limitation on body current would be the body resistance offered which might be low enough to pass an undue amount of current. By the introduction of a series resistance means such as the resistance means 24 in series between the positive electrode 18 and the positive terminal of the power supply 15, the body current would be limited to a safe level but, for example, in case of partial failure of the means 24, might rise to the shock perception level which might be disagreeable. The introduction of the resistor 36 ensures the limitation of body current in such a case to a magnitude less than the perception level. Normally, of course, in engaging the two touch electrodes the body current of an operator is limited both by the resistance means 24 and by the series combination of the resistors 29 and 34.

The introduction of the grid cathode resistor 34 reduces, in comparison to floating the grid, the firing sensitivity of the thyatron 10 in that it prevents the buildup of positive charges on the grid from high impedance sources. Less importantly, it reduces the grid voltage through voltage divider action with the resistor 29 and any other resistors which may be in circuit with an applied voltage. However, the resistor 34 is not by itself effective in materially reducing the firing effect of high frequency voltage transients of the type which might be induced in or coupled to the electrode 20 as from static discharges such as lightning. For this reason, in accordance with another feature of the invention, the capacitor 42 is connected between the grid and the cathode which acts in conjunction with the resistor 29 to act as a low pass filter against such transients.

Similarly, in accordance with yet another feature of the invention, protection is afforded from transients transmitted over the power line by connecting a capacitor 44 between the cathode and the machine frame 40.

In further illustration of the invention, a table of typical values for the aforementioned components is provided:

Component:	Value
R ₂₆ -----	ohms... 120K
R ₂₇ -----	do... 120K
R ₂₈ -----	do... 120K
R ₂₉ -----	do... 150K
R ₃₀ -----	do... 10M
R ₃₄ -----	do... 10M
R ₃₆ -----	do... 470K
C ₃₂ -----	mfd... .01
C ₄₂ -----	mfd... .005
C ₄₄ -----	mfd... .005
C ₅₀ -----	mfd... .005

By employing a sufficient value for condenser 42, e.g. .025 mfd., a momentary delay in firing of the thyatron may be provided if desired.

The control circuit of the invention is illustrated in Fig. 1 as applied to a machine for applying pressure to a workpiece, in particular to a machine for leveling the soles of shoes. The machine, a further description of which may be found in a copending application Serial No. 613,441, filed October 2, 1956 in the names of Hart et al., is provided with shoe supports and rolls for applying pressure to the bottoms of shoes, the pressure being supplied to each roll by a fluid pressure operated motor. The pressure fluid is supplied to the fluid pressure operated motor by a pump operated by an electric motor indicated in the diagram as 60, the supplying of the pressure fluid to an individual fluid pressure operated motor being controlled by a solenoid operated valve of which the solenoid is indicated in the diagram at 62. A microswitch 64 on the shoe support is arranged to be closed by the positioning of a shoe on the shoe support. When there is no shoe on the support the switch 66 is momentarily closed energizing a relay coil K2 through the switch 66 and the normally closed contacts K1A of the relay K1. Energization of K2 closes contacts K2A across the switch 66 to hold K2 energized, closes the contacts K2B in the energizing circuit of the valve 62 and closes the contacts K2C in the energizing circuit of the motor 60 which thereupon operates the pump to furnish fluid pressure.

The touch electrodes 18 and 20 of the control are mounted at spaced locations of the leveling machine and after jacking a shoe on the shoe support thereby closing the switch 64, the operator sends the corresponding pressure roll through its cycle by touching the electrodes 18 and 20 with his two hands thereby energizing the relay K1 to close the contacts K1B energizing the solenoid of the hydraulic valve to apply pressure fluid to the fluid pressure operated motor of the roll. If there is no shoe jacked on the support so that the switch 64 is still open when the touch control is operated, energization of the relay K1 opens contacts K1A and deenergizes K2 to interrupt the energization circuit of the valve solenoid 62 and to shut off the motor 60. Where a shoe has been correctly positioned and the switch 64 closed, the relay K1 will remain energized until its energizing circuit is interrupted by the switch 16. Switch means connected for operation by the pressure roll is connected to perform this switching in the manner diagrammatically indicated by the cam of the switch 16.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent of the United States is:

A control operable by body conductivity comprising, in combination, a source of D.C. voltage, a cold-cathode glow-discharge thyatron having an anode, a cathode and a control grid adapted normally to hold the tube nonconductive at zero bias, resistance means connected between said grid and said cathode, means for connecting said thyatron by its anode and cathode in series with an electrically operated device to be controlled across said source, a pair of touch electrodes adapted to be simultaneously engaged by an operator, means including series resistance means having a portion of its resistance shunted by a capacitor connecting one electrode to the positive side of said source, and means connecting the other electrode to said control grid.

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