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AND BISWITCH OPERATION

3,320,437

Filed Nov. 12, 1964

2 Sheets-Sheet 1

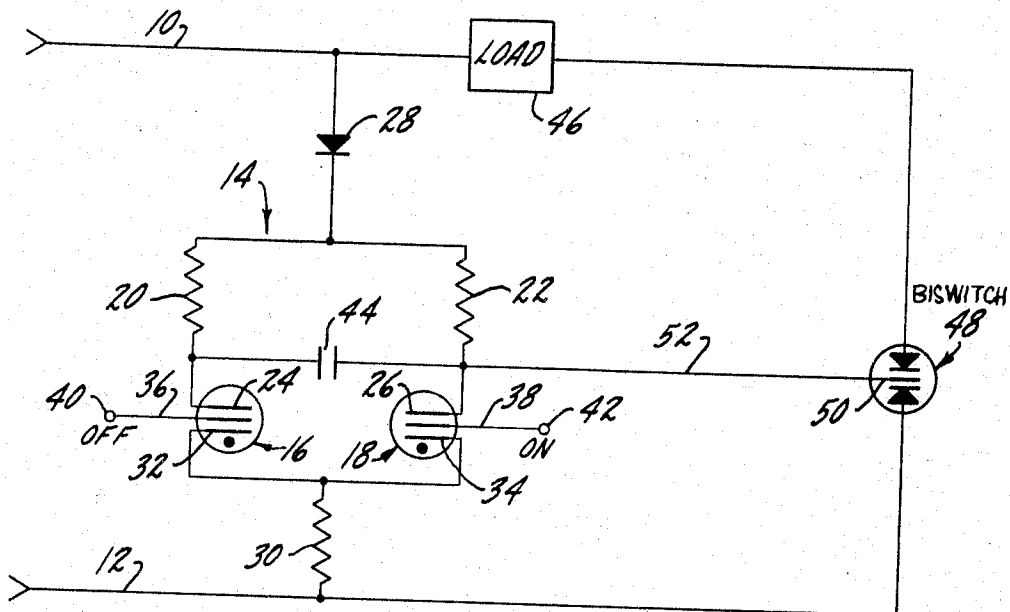


Fig. 1.

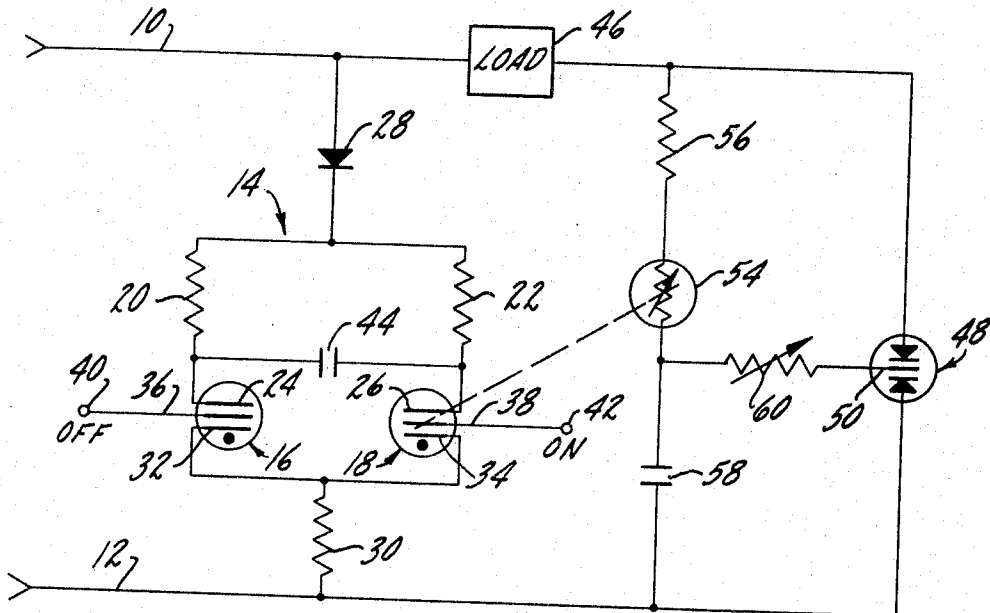


Fig. 2.

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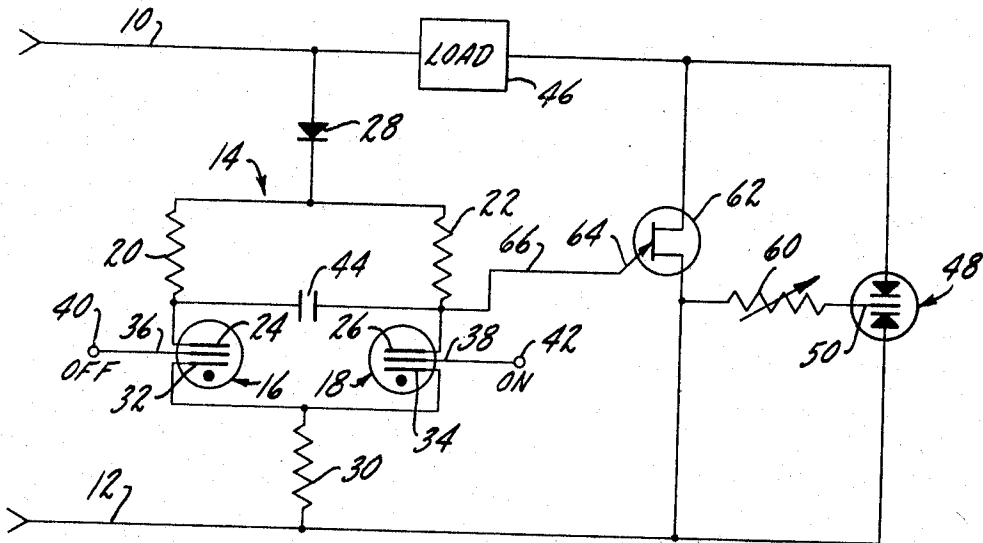


Fig. 3.

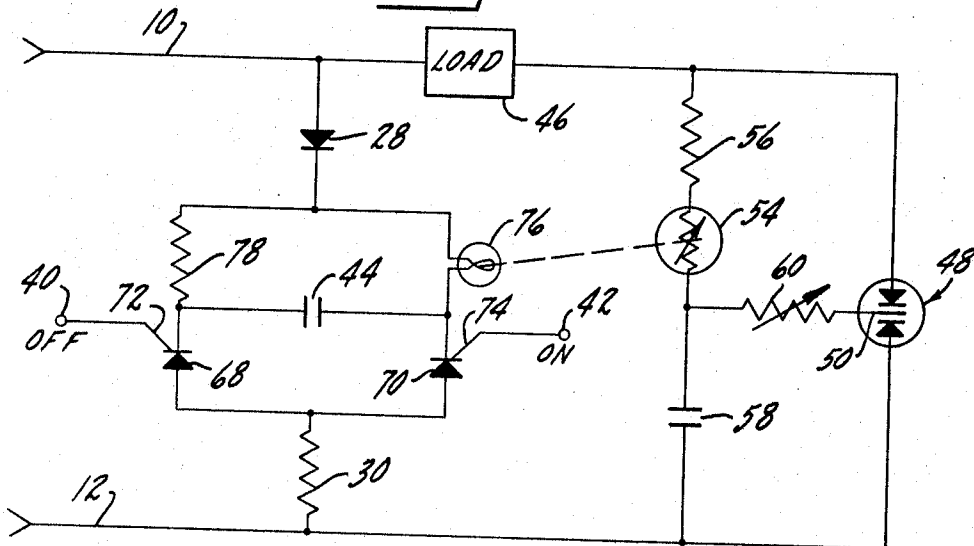


Fig. 4.

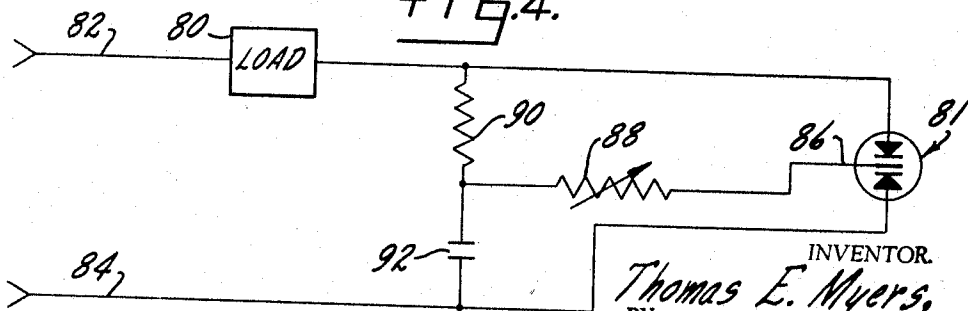


Fig. 5.

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HUMAN CONTACT CONTROLLED DIMMER CIRCUIT WITH MULTIVIBRATOR AND BISWITCH OPERATION

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11 Claims. (Cl. 307—88.5)

This invention relates to a control circuit using a gated semiconductor biswitch, and particularly to the means for applying an operating or control voltage to the biswitch gate.

A primary purpose of the invention is a circuit of the type described using a bistable circuit for controlling operation of the biswitch.

Another purpose is a control circuit of the type described utilizing a phototube to provide the operating voltage for the biswitch.

Another purpose is a control circuit of the type described using a bistable circuit, one side of which is connected to the biswitch gate through a control transistor.

Another purpose is a simply constructed reliably operating control circuit utilizing a gated biswitch.

Other purposes will appear in the ensuing specification, drawings and claims.

The invention is illustrated diagrammatically in the following drawings wherein:

FIGURE 1 is one form of control circuit of the type described,

FIGURE 2 is a second form of control circuit of the type described,

FIGURE 3 is a third form of control circuit of the type described,

FIGURE 4 is another form of control circuit of the type described, and

FIGURE 5 is still a further form of control circuit utilizing a gated semiconductor biswitch.

The invention may be described generally as a control circuit suitable for connecting a load to a source of power. In the alternative, the circuit may activate a relay coil whose contacts perform a control function. The signal for actuating the circuit may come from an antenna. The antenna may have a surface positioned for and adapted for human contact so that the potential of the body applied to the antenna is sufficient to operate the circuit. In the alternative, there may be two adjacent antennas positioned such that human contact bridges or shorts the antennas together to thereby connect a previously established voltage, from one side of the source, to operate the circuit.

In still another form of operation, human contact at the touch surface may be effective through a momentary contact shorting arrangement to apply a predetermined voltage or antenna to operate the circuit. Such a circuit would be particularly useful when the person contacting the touch surface is wearing gloves. In another form of operation, there may be a number of separate antennas positioned at different points, with the application of a potential to any one of these antennas being sufficient to operate the circuit. In still another application of this circuit, the potential for operating the circuit may be applied to the antenna from a completely separate source of voltage.

The invention has application in the field of home wiring, for example turning on lights, dimming lights, or actuating small motors which control appliances. The invention also has application in many other control fields.

This invention is particularly concerned with such a control circuit which utilizes a gated semiconductor biswitch of the type manufactured by the Transistron Elec-

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tronics Corporation of Wakefield, Mass. Such a biswitch will conduct in either direction once a sufficient voltage has been applied to overcome the inherent resistance of the material forming the biswitch. In most such biswitches, this voltage is applied between opposite terminals. However, in the biswitches shown herein, the control voltage or the breakdown voltage is applied to the biswitch gate. By utilizing a gated biswitch, the control voltage can be substantially smaller than is necessary when the control voltage is applied between the opposite terminals of the biswitch. The necessary voltage between opposite terminals of the biswitch to effect a breakdown will be smaller when a gate voltage is present.

In FIGURE 1, a conventional A.C. source, for example 110 or 117 volts A.C., may be connected to lines 10 and 12. A bistable circuit or multivibrator circuit of a conventional design is indicated generally at 14. The circuit 14 may include a pair of gas tubes, for example NE-77S or the like, indicated at 16 and 18. Resistances 20 and 22 are connected to elements 24 and 26 of tubes 16 and 18, with the opposite end of each of these resistances being connected through a diode 28 to line 10. A resistance 30 connects elements 32 and 34 respectively of the tubes 16 and 18 to line 12. The gates of tubes 16 and 18, which are indicated at 36 and 38, may be connected to touch control surfaces or antennas 40 and 42 respectively. The antennas 40 and 42, as described above, are used to change circuit 14 from one stable condition to another. Antenna 40, which may be designated the "off" antenna, may be utilized to cause the left-hand side of the circuit to conduct, with antenna 42 being utilized to cause the right-hand side or the "on" side of the circuit to conduct. When the antennas 40 and 42 are arranged for human contact, there may be a high resistance element between the contact surface and the tube. The multivibrator circuit 14 may be completed by a capacitor 44 connected between the tube sides of resistors 20 and 22.

The load in the circuit of FIGURE 1 is indicated at 46, and it may be any type of load as described above. Load 46 is in series with a gated semiconductor biswitch 48, with the load and the biswitch 48 being connected across the source or between lines 10 and 12. The biswitch 48 may have a gate element 50 which is directly connected to element 26 of tube 18.

Assuming the circuit of FIGURE 1 is in the "off" condition, or the left-hand side of the bistable circuit is conducting, when a potential is applied to surface 42, tube 18 will ionize and tube 16 will be cut off. The right-hand side of circuit 14 will begin to conduct with the result that a potential will be applied by line 52 to element 50 or the gate of the biswitch 48. This gate will provide a sufficient voltage to the biswitch to overcome its inherent resistance with the result that the biswitch will conduct and current will pass through load 46. The biswitch will conduct on both halves of the A.C. sine wave as tube 16 will remain in a conduction condition even after the potential is removed from surface 42. The period of time in which the biswitch will conduct during each cycle is determined by the voltage applied to the gate which is determined by the voltage on element 26 of tube 18. It is the voltage applied to the gate, as well as the voltage applied between opposite terminals, which determines the breakdown time or the period of conduction of the biswitch. The higher the potential on the gate, the longer the period of conduction of the biswitch.

An alternative arrangement to that shown in FIGURE 1 is to provide a variable resistance in line 52 between the gate 50 and the element 26 of tube 18. Such a variable resistance can be used to control the period of conduction of the biswitch and may be termed a dimmer control when the circuit is used in lighting. For example, the

shorter the period of conduction of biswitch 50, the lower will be the intensity of the light provided by load 46.

FIGURE 2 is a modified circuit with common parts of FIGURES 1 and 2 being given the same designations. A phototube 54 may be in series with a resistance 56 and a capacitor 58 between lines 10 and 12. A variable resistance 60 may be connected between one side of the phototube and the gate 50 of the biswitch 48. Phototube 54 is positioned adjacent tube 18 or in a position to be exposed to the light from tube 18. Whenever circuit 14 is conducting on the right side, phototube 54 will receive light from tube 18 with the result that a voltage will be applied to the gate of the biswitch. The biswitch will conduct for a period during each half cycle determined by the voltage applied to its gate. Resistor 60 is a variable resistor to control the period of conduction. In the alternative, resistor 60 may be fixed, as in some circuits it will not be necessary to control or vary the period of conduction. Capacitor 58 is a phase shifting capacitor which provides further control of the period of conduction of the biswitch. For example, the value of the capacitor may be varied to change the time during a half cycle of the applied sine wave at which a potential is applied to the biswitch.

The operation of the circuit in FIGURE 2 is substantially the same as that of FIGURE 1, with the exception that voltage for operating the biswitch is provided by a phototube which is exposed to one side of the bistable circuit.

FIGURE 3 shows a somewhat similar circuit with the control for the biswitch being provided by a transistor 62. As shown herein, the transistor is a unijunction transistor, although other types of transistors may be equally satisfactory. The transistor 62 has an emitter 64 which is connected by line 66 to element 26 or tube 18. When the right side of circuit 14 is conducting, a voltage will be applied to the emitter 64 with the result that the transistor will conduct. A voltage will then be applied through resistor 60 to the gate 50 of the biswitch. As shown in FIGURE 3, resistor 60 is variable, although it may be fixed in many applications, or in some applications it may be omitted. When the resistance is variable, it is used to provide additional control.

The circuit of FIGURE 3 operates substantially the same as FIGURE 2. When the right side of the bistable circuit conducts, transistor 62 will conduct with the result that an operating potential will be applied to the gate of the biswitch.

Turning now to FIGURE 4, the bistable circuit includes a pair of silicon controlled rectifiers 68 and 70, with each of the rectifiers having gates 72 and 74 respectively, which are connected to the "on" and "off" antennas or contacts 40 and 42. In series with SCR 70 is an incandescent lamp or the like 76 which may have somewhat the same resistance as resistance 78 in series with SCR 68. Whenever a potential is applied to contact or antenna 42, SCR 70 will conduct, in a conventional manner, with the result that current will flow through lamp 76 and the light from this lamp will be used to activate phototube 54. The circuit will then operate in the same manner as FIGURE 2.

FIGURE 5 shows a substantially simpler control circuit utilizing a gated semiconductor biswitch. In this case, there is no control for turning the circuit on or off, although such a control may be added in the form of a simple mechanical switch. In the circuit of FIGURE 5, a load 80 is connected in series with a gated semiconductor biswitch 81 between lines 82 and 84. Gate 86 of the biswitch may be connected through a variable resistance 88 to the junction between resistor 90 and a capacitor 92. Resistor 90, resistor 88 and capacitor 92 provide a phase shifting network to control the period of conduction of biswitch 81. This period of conduction may be varied by resistance 88 which will control the voltage applied to the gate 86. The biswitch will conduct during

both halves of the applied A.C. sine wave with the period of conduction during each half cycle being determined by the values of the elements forming the phase shifting network as well as the setting of control resistor 88.

The use, operation and function of the invention are as follows:

All of the circuits shown use a semiconductor biswitch which is gated to provide fine control. The period of conduction of the biswitch, which determines the period of operation of the load, is regulated by the voltage applied to the biswitch gate. This voltage, as well as the voltage between the terminals of the biswitch, will determine the point at which the biswitch will break down and conduct. The voltage applied to the biswitch gate may be controlled in a number of different ways, any one of which provides a satisfactory control circuit.

One method of gate voltage control is to use a phototube which is in series with a resistance and the biswitch gate. Whenever the phototube conducts, current will flow through it to place a voltage on the gate. The phototube may be activated either by one of the tubes in the bistable circuit, or a separate incandescent lamp may be arranged to provide sufficient light to operate the phototube.

In another form of operation a transistor, either a unijunction transistor or otherwise, may be arranged to control the application of a voltage to the biswitch gate.

The invention should not be limited to the particular types of bistable circuits shown. In like manner, the invention should not be limited to phototubes or unijunction transistors for applying an operating voltage to the biswitch gate. Any element which is activated in response to a signal and remains in a conducting state as long as the signal continues is satisfactory. Semiconductor devices of the type shown in U.S. Patent 2,978,618 are acceptable.

The voltage applied to the gate may be fixed, in the sense that it never varies during circuit operation, or it may be variable to provide a further control on the current through the load. Both forms have application in the home wiring field, for example, as a control for the brightness of an electric lamp, or for control of the speed of a motor or other operating means on an appliance.

Whereas the preferred form of the invention has been shown and described herein, it should be realized that there are many modifications, substitutions and alterations thereto within the scope of the following claims.

I claim:

1. In a control circuit for connection to a source of power, a bistable circuit connected across said source, means for causing said bistable circuit to switch from one stable condition to the other a pair of spaced antenna means, each connected to one side of said bistable circuit for switching said bistable circuit upon human contact with one of said antenna means, a load and a gated semiconductor biswitch connected in series across said source, and means cooperating with said bistable circuit and operable when said bistable circuit is in only one stable condition for applying a voltage to the biswitch gate to cause it to conduct and to permit current to pass through said load.

2. The circuit of claim 1 further characterized by and including a connection between one side of said bistable circuit and said biswitch gate.

3. The circuit of claim 2 further characterized by and including a variable resistance in the connection between said one side of said bistable circuit and said biswitch means, said resistance providing control of the period of conduction of said biswitch.

4. The circuit of claim 1 further characterized in that said bistable circuit includes a pair of gated gas tubes, one on each side of said bistable circuit.

5. The circuit of claim 4 further characterized by and including a connection from one of said gas tubes to said biswitch gate.

6. The circuit of claim 4 further characterized in that

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the means cooperating with said bistable circuit includes a phototube, exposed to one of said gas tubes, and a connection between said phototube and said biswitch gate.

7. The circuit of claim 6 further characterized by a variable resistance in the connection between said phototube and said biswitch gate.

8. The circuit of claim 4 further characterized in that the means cooperating with the bistable circuit includes a transistor, one element of which is connected to one side of said bistable circuit, with another element of said transistor being connected to said biswitch gate, and the third element of said transistor being connected to said load.

9. The circuit of claim 1 further characterized by and including variable resistance means connected to said biswitch gate for controlling the period of conduction of said biswitch.

10. The circuit of claim 1 further characterized in that said bistable circuit includes a pair of gated semiconductor rectifiers, one on each side of said bistable circuit.

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11. The circuit of claim 10 further characterized in that the means cooperating with said bistable circuit for applying a voltage to the biswitch gate includes a phototube connected to said biswitch gate, and a light emitting resistance in series with one of said gated semiconductor rectifiers and positioned to expose said phototube.

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