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[45] Patented **Nov. 16, 1971**
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[54] **TOUCH RESPONSIVE CONTROL CIRCUIT**
11 Claims, 8 Drawing Figs.
[52] U.S. Cl. **307/308,**
317/123 D, 328/6, 331/65, 340/258 C
[51] Int. Cl. **H03k 23/22**
[50] Field of Search **317/146,**
123 D; 328/6, 5, 150; 340/258, 258 C; 331/65;
307/308
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ABSTRACT: A miniaturized solid state, touch responsive circuit wherein a touchplate connected to a regenerative feed-back network of a transistor amplifier is operative when touched to supply sufficient capacitive impedance in the feed-back network to dispose the circuit in an oscillatory condition. In a preferred form of the invention, an electrical detection circuit is connected to the amplifier and feedback network to respond to the touch induced signal oscillations and provide a rectified control signal for actuating a load switch or the like. Also a hold circuit is provided for sustaining the oscillatory condition of the amplifier circuit automatically after being momentarily actuated by touch, and wherein a second touch plate is provided for terminating this sustained condition again in response to touch.

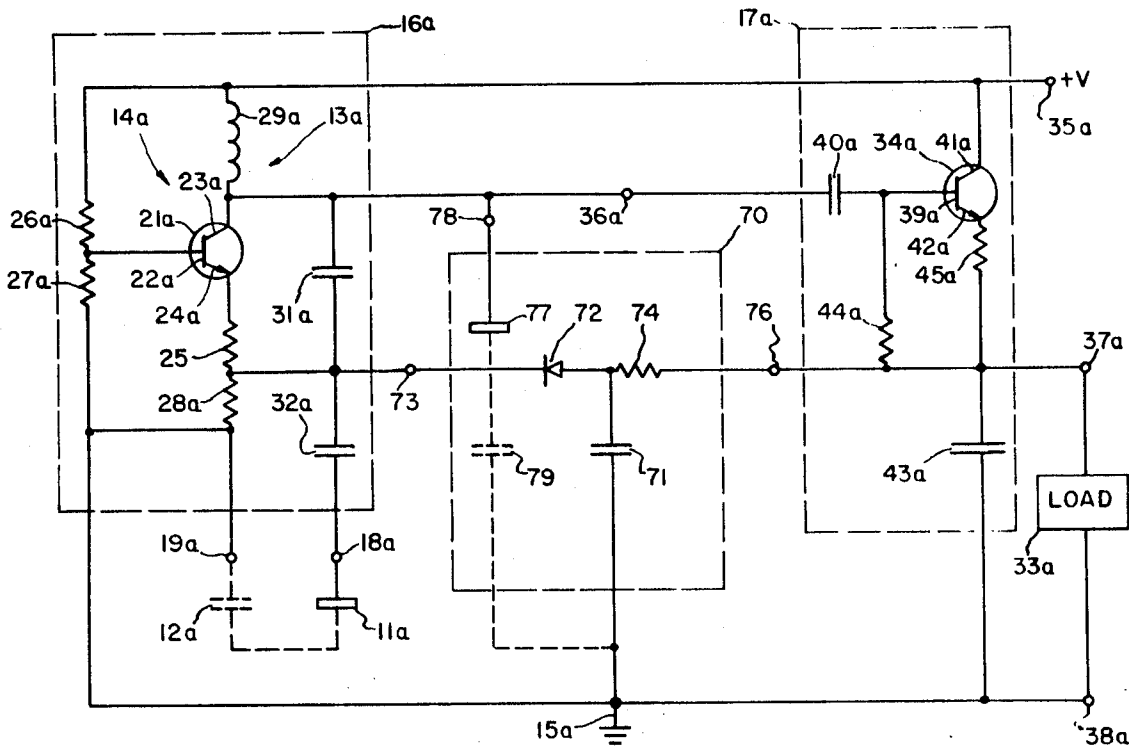


FIG. 1

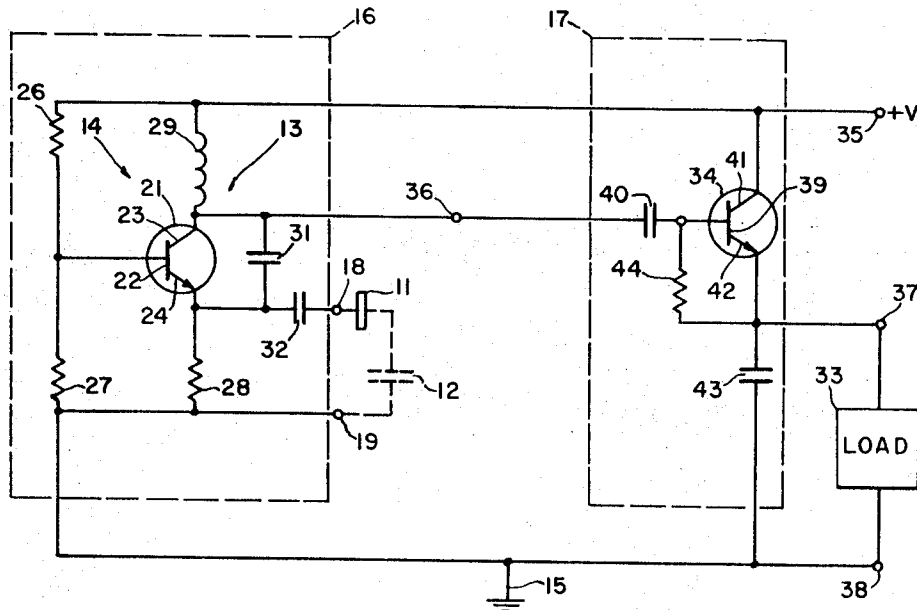


FIG. 2

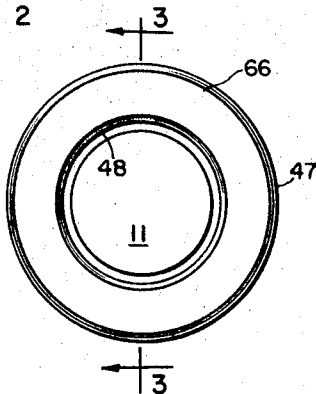


FIG. 3

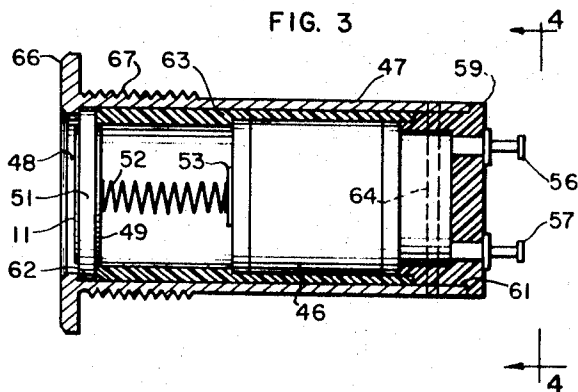
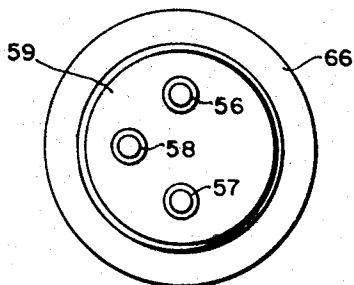
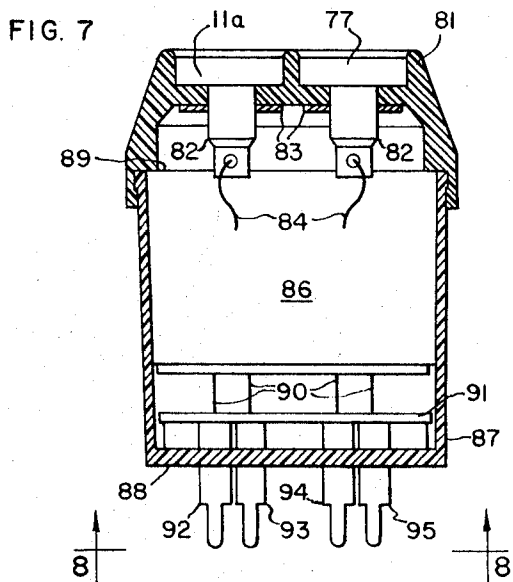
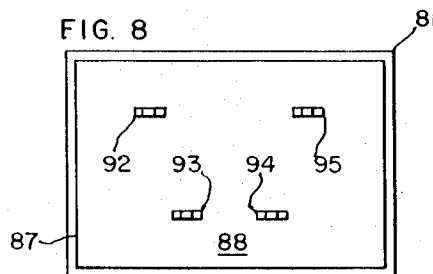
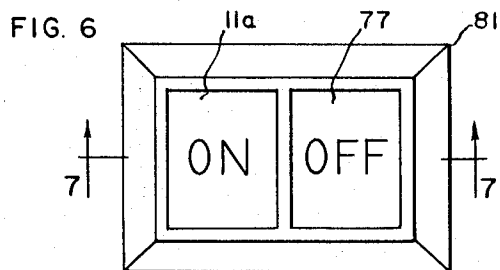
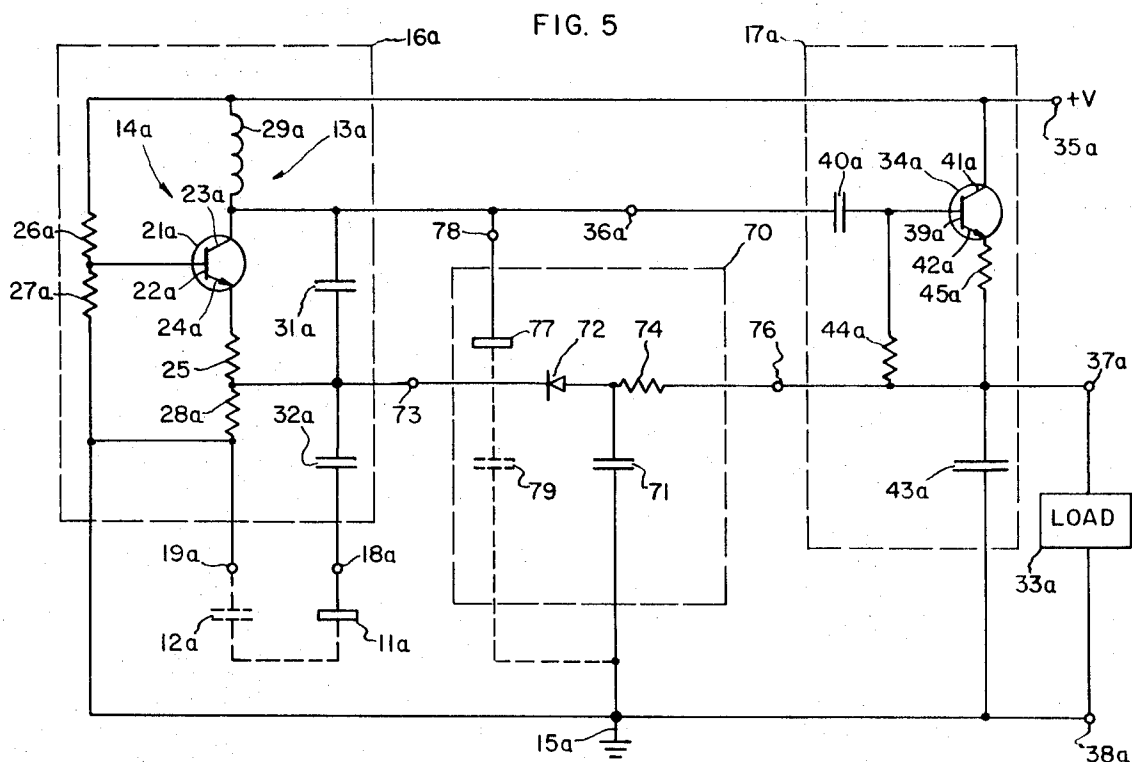


FIG. 4



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TOUCH RESPONSIVE CONTROL CIRCUIT

The present invention relates in general to control circuitry and more particularly to the type of circuit in which a change in the operating condition thereof is induced by an operator's touch as described in applicants's prior copending application, Ser. No. 747,324 filed July 24, 1968, in respect to which application the present application is a continuation-in-part now abandoned.

Touch responsive circuits as known in the art are characterized by their ability to produce a control signal such as the closing of a switch, by merely bringing an operator's finger or other part of the body close to or upon a portion of the circuit. In general, the principle of operation of these devices is based upon one form or another of the electrical characteristics of the human body which are employed to induce an electrical change in the circuit's mode of operation.

Touch responsive circuits or switches have a number of advantages over the conventional manually operated switches among which is the absence of mechanically reciprocating or moving parts thereby providing longer and more reliable operative service without replacement.

While such touch responsive circuits or switches have the potential of replacing mechanical switches in a substantial number of applications due to their advantageous features, it has been found that these devices are by and large limited to relatively few commercially significant uses. It is believed that the inability of these existing circuits to find wider acceptance in industry relates to their expense, instability and/or large size. Additionally, many of the available touch responsive circuits or switches are impractical in a large number of applications due to their substantial power consumption.

Accordingly, it is an object of the present invention to provide a touch responsive circuit having high characteristic stability together with proper touch sensitivity for providing exceedingly positive and reliable switching operation.

It is a further object of the present invention to provide such a circuit having only a few inexpensive and low tolerance component parts for heretofore unobtainable miniaturization, low power consumption and low cost, wherein all of the components may be arranged in a package of a size comparable with conventional manually actuated mechanical switches.

Another object of the present invention is to provide such a circuit having stable "on" and "off" modes of operation, in which the circuit may be switched between these modes by momentary touch actuation.

The invention possesses other objects and features of advantage, some of which of the foregoing will be set forth in the following description of the preferred form of the invention which is illustrated in the drawings accompanying and forming part of this specification. It is to be understood, however, that variations in the showing made by the drawings and description may be adopted within the scope of the invention as set forth in claims.

In the drawings:

FIG. 1 is a detailed schematic diagram of a touch responsive circuit constructed in accordance with the present invention;

FIG. 2 is a front elevation of an assembled touch responsive switch containing the circuit of FIG. 1;

FIG. 3 is a side elevation view of the assembled switch shown in FIG. 2 having a partial cross section taken generally along lines 3—3 of FIG. 2;

FIG. 4 is a rear elevation of the switch assembly taken along lines 4—4 of FIG. 3;

FIG. 5 is a schematic diagram of the circuit of FIG. 1 having additional circuit components for providing stable "on" — "off" operation in response to separate touch elements;

FIG. 6 is a front elevation of an assembled "on" — "off" touch switch for the circuit shown in FIG. 5

FIG. 7 is a side elevation view of the assembly shown in FIG. 6 having a partial cross section taken generally along lines 7—7 thereof; and

FIG. 8 is a rear elevation of such switch assembly taken along lines 8—8 of FIG. 7.

In general, the invention provides a touch responsive circuit shown in FIG. 1, comprising a touch plate 11 adapted to receive a capacitive impedance 12 with respect to a common 15 provided by contact of the human body with touch plate 11. Touch plate 11 is in turn connected to a feedback network 13 of a transistor amplifier 14, wherein feedback network 13 is adapted to receive capacitive impedance 12 and thereupon assume a zero phase shift regenerative feedback path about amplifier 14. This zero phase shift feedback path causes regenerative signal oscillations to appear within the circuit. By virtue of this construction, amplifier 14 together with feedback network 13 provide a circuit means 16 having a normally inactive or nonoscillatory condition and being adapted to receive a capacitive impedance 12 in the range provided by the human body and in response thereto assume an oscillatory condition. The signal oscillations within circuit means 16 may thereupon be converted into a direct current control signal by detection means 17 as hereinafter discussed.

As an important feature of the present invention, it has been found that amplifier 14 may be provided by a single transistor 21 having a base electrode 22, a collector electrode 23 and an emitter electrode 24 connected to biasing means for maintaining transistor 21 in a normally active or amplifying region. The biasing means is provided in this instance by resistors 26; 27 and 28, wherein resistors 26 and 27 connected between a source of potential +V and common 15 form a voltage divider network connected to base electrode 22. These resistors are selected to bias transistor 21 in its active conduction region in which the collector-base junction is reverse biased while the emitter-base junction is forward biased. This disposition provides that transistor 21 will operate as an amplifier to provide a source of energy for sustaining oscillations of circuit means 16 when touch plate 11 is contacted by the body preferably the finger of the operator. As only a single transistor is required for producing a signal in response to touch, the advantages of extremely low power consumption, miniaturization and low cost production are realized.

In the preferred embodiment of the invention, feedback network 13 is selected to form in combination with amplifier 14 a portion of a Colpitts oscillator. The complete oscillator of this type comprises a feedback network including an inductor and a pair of capacitors connected to provide a zero phase shift between the output and input of a power gain amplifier. In the present invention, (assuming the absence of an isolation capacitor 32, the function of which will be discussed herein) inductor 29 and capacitor 31 form two branches of such a network while circuit means 16 is adapted to receive the remaining capacitive branch across junctions 18 and 19. Accordingly, upon touching of touch plate 11 capacitive impedance 12 is inserted into feedback network 13 providing together with inductor 29 and capacitor 31 a zero phase shift or regenerative feedback path about transistor amplifier 14 thereby causing circuit means 16 to oscillate as a Colpitts oscillator. In the absence of body capacitance, impedance 12, the regenerative feedback path is incomplete, therefore, disabling the oscillatory condition of the circuit. This provides for rapid cut off of the oscillator signal output immediately upon removal of the operator's finger from touch plate 11 as such rapid operation is desired in a number of applications.

Transistor amplifier 14 is connected to provide power gain amplification between an input and an output thereof which are connected across feedback network 13. For this purpose, emitter electrode 24 of transistor 21 is connected as an input for receiving a signal with respect to common 15 while collector electrode 23 is connected as an output issuing a power gain signal also with respect to common 15. Base electrode 22 is biased at a constant potential relative to common 15.

In order for circuit means 16 to enter a sustained oscillatory condition, two electrical characteristic conditions must exist. First, transistor amplifier 14 must provide sufficient power gain to overcome circuit losses and establish a gain slightly greater than unity around feedback network 13. The second condition resides in the selection of feedback components, in-

ductor 29 and capacitor 31 in conjunction with the typical value of body capacitance, impedance 12, to provide a zero phase shift around the closed loop formed by amplifier 14 and network 13. That is, in order to regenerate the amplifier input from the output thereof to provide a regenerative oscillatory condition, network 13 must provide a phase shifted signal at the amplifier input aiding the instantaneous signal appearing at the amplifier output.

The frequency at which this zero phase shift or regenerative effect may occur, defines the frequency of oscillation of circuit means 16. It has been found that the capacitance provided by touching conductor 11 ranges from approximately 50 to 300 pico-farad (pico = 10^{-12}) depending upon the pressure exerted by the operator's finger on touch plate conductor 11. Accordingly, feedback components inductor 29 and capacitor 31, are selected to provide a zero phase shift for a value of capacitive impedance 12 approaching or within this above defined range. The circuit of the present invention performs most satisfactorily when the value of capacitive impedance 12 required for oscillation is somewhat less than the minimum touch capacitance (50 pico-farad) of the above defined range. This insures positive and dependable actuation of the circuit for even the lightest touch on plate 11. In one embodiment of the invention, a capacitance of about 14 pico-farad was selected as a threshold value for impedance 12 from which the values for inductor 29 and capacitor 31 and 32 were calculated. A value of 120 micro-henries for inductor 29, a value of 27 pico-farads for capacitor 31, and a value of 47 pico-farads for isolation capacitor 32 were found satisfactory in this example for use with a typical transistor 21. A circuit constructed using components having these particular design values will oscillate when actuated at a frequency centering around 2 megacycles.

While the circuit shown in FIG. 1 is provided with a ground connection to common 15, it will be apparent that the +V line connected to terminal 35 is at the same signal or reference level for AC signals as common 15 and thus in an alternative arrangement terminal 35 may be grounded and a -V DC potential applied to terminal 38. Moreover it has been unexpectedly found that the circuit of the present invention will work effectively without a conventional ground. For example, operation has been obtained where the battery source is connected across terminals 35 and 38 and both these terminals are isolated from any ground and likewise the person touching plate 11 is similarly isolated from ground. While the capacitive effect of the body touching plate 11 in such instances is not fully understood the operational result, i.e., production of oscillation, is the same as the placing of a capacitance across junctions 18 and 19 as above explained.

The preferred embodiment of the invention incorporates an isolation capacitor 32 connected in series between touch plate 11 and the junction of emitter electrode 24 and capacitor 31. Capacitor 32 provides direct current isolation between circuit means 16 and touch plate 11, which generally exposes a conductive surface to touch, for protecting the circuit in the case of an inadvertent direct current short between touch plate conductor 11 and common 15 when grounded. It will be noted that in calculating the appropriate values for inductor 29 and capacitor 31 as above discussed, that the added capacitance of capacitor 32, when included, should be taken into consideration. Accordingly, if it is desired to provide a threshold body capacitance of around 14 pico-farad to actuate the circuit, this value should be combined with the value of capacitor 32 to arrive at a total value of capacitance between emitter 24 and terminal 19 for use in selecting inductor 29 and capacitor 31 for proper feedback oscillation.

It is anticipated that the touch responsive signal oscillation provided by circuit means 16 may be employed to signal or control a variety of receptive electrical devices. However, the preferred embodiment of the invention provides a detector means 17 operative to convert the selective signal oscillations appearing at output terminal 36 of circuit means 16 into a rectified or direct current output control signal at terminals 37

and 38 for controlling a load 33. For example, load 33 may take the form of a solid state multivibrator switch operative in response to the output signal appearing at terminals 37 and 38 to control an external system.

In its preferred form, detection means 17 comprises a transistor 34 biased at the threshold of its cut-off region and coupled to terminal 36 for rectifying the oscillating signal appearing thereat. More particularly, a base electrode 39 of transistor 34 is coupled through a DC blocking capacitor 40 to the output terminal 36 of circuit means 16 while collector and emitter electrodes 41 and 42 are serially connected with a load capacitor 43 between a source of +V common 15. Resistor 44 connected between emitter electrode 42 and base electrode 39 maintain transistor 34 at the threshold of its cut off region where the collector-base junction and the emitter-base junction are both reversed biased. Transistor 34 accordingly responds to the alternating current oscillations passed by capacitor 40 to base electrode 39 and periodically enters its active conduction region. That is, in the presently illustrated embodiment, positive excursions of the oscillation signal appearing at base electrode 39 cause transistor 34 to turn "on" and thereby assume a low impedance condition between collector and emitter electrodes 41 and 42 during each positive half period of the oscillating signal. This periodically assumed low impedance between these electrodes provides a pulsating charging current for capacitor 43 which stores each pulse charge and rapidly assumes a voltage thereacross approximately equal to the supply voltage +V applied to terminal 35. Thus, the direct current or rectified control signal issued across terminals 37 and 38 is provided by the voltage charge assumed by capacitor 43 pursuant to oscillations of circuit means 16.

Of particular advantage, the above-described detection circuit provides an output signal of substantial power in response to a low-voltage and low-power output signal from circuit means 16. Specifically, the input to transistor 34 requires only a nominal amount of current flow for actuation and thereby reduces the loading of circuit means 16 at terminal 36 insuring its proper functioning when placed in an oscillatory condition. Moreover, as resistor 44 is connected to the junction of emitter electrode 42 and capacitor 43, transistor 34 is maintained near the threshold of its cut off region independently of the instantaneous voltage across capacitor 43. This permits an extremely low level amplitude excursion of the oscillating signal at base electrode 39 in order to drive transistor 34 into its active or conductive region. For example, a voltage amplitude of less than one positive volt of the oscillating signal has been found sufficient to turn transistor 34 on and thereby charge capacitor 43. This low-voltage operation permits circuit means 16 to operate over a wider range of output characteristics giving a wider latitude in its design criteria and component tolerances. In selecting capacitor 43, consideration should be taken of the impedance of a particular load 33 with which the circuit is utilized. It is preferred that the combined impedance of capacitor 43 and that of load 33 be selected to provide a time constant greater than the period of the signal oscillation provided by circuit means 16. This insures that capacitor 43 will properly charge to a maximum value approximating the source potential, +V, in response to actuation of touch plate 11.

Due to the few number of component parts of the circuit of FIG. 1 and the use of only two solid state devices for the active components, the entire touch responsive circuit may be packaged into a compact miniaturized switch as shown in FIG. 3. Particularly, the circuit of FIG. 1 is preferably preassembled into a package 46 and thereupon encapsulated by a cylindrical metallic shield 47 to protect the circuit from spurious external electrical and magnetic fields. To provide for exposing and thereby presenting touch plate 11 for contact by the body and particularly the finger of an operator, shield 47 is formed with a cylindrical aperture 48 in which conductor 11 is disposed insulated from shield 47.

This arrangement provides a convenient mount for the formation of isolating capacitor 32 which is provided by the disposition of plate conductor 49 internally of shield 47 in parallel registration with plate conductor 11 and separated therefrom by discoidal insulator 51. The connection of isolation capacitor 32 to the junction of feedback capacitor 31 and emitter electrode 24 of circuit means 16 is provided by spring 52 formed of a conductive material and placed in compression between plate conductor 49 and electrical contact 53 of circuit package 46. As noted above, isolation capacitor 32 in this instance provided by the proximity of touch plate 11 and plate conductor 49 provides direct current isolation protection of circuit package 46 and furthermore by this isolation eliminates the possibility of the operator receiving a shock from the circuit.

It is preferred that conductive touch plate 11 be formed with a discoidal shape as shown in FIGS. 2 and 3 to provide a surface area approximately the size of a finger tip. This will insure a substantial and sufficiently uniform capacitive impedance 12 upon fingertip engagement with touch plate 11 and thereby enhance the positive and reliable operation of circuit means 16.

Electrical access to circuit package 46 is provided by terminal posts 56, 57 and 58 corresponding to terminals 35, 37 and 38 of the circuit of FIG. 1. Insulating plug 59 mounted within an open end 61 of metallic shields 47 provides a mount for terminal posts 56, 57 and 58 and insures insulation therebetween.

In the assembly of the touch responsive switch, discoidal insulator 51 having attached thereto conductive touch plate 11 and plate conductor 49 is inserted through open end 61 of metallic shield 47 to abut against shoulder 62 thereof. Spring 52 and circuit package 46 mounted within cylindrical insulating sleeve 63 are then introduced through open end 61 to force sleeve 63 against discoidal insulator 51. Insulating plug 59 with terminal posts 56, 57 and 58 is thereupon inserted in open end 61 and held firm therein by locking pin 64 inserted within a mated opening formed within shield 47 and plug 59 as shown. The entire touch plate switch assembly as shown in FIGS. 2, 3, and 4 provides a compact device comparing favorably with conventional manually operated electromechanical switches. This miniaturized size and self-contained package offers many advantages in apparatus and instrumentation where a multiplicity of such switches are required in a closely spaced array.

Preferably housing 47 is formed with a mounting flange 66 and external threads 67 to facilitate its mounting in a control panel or the like.

As an alternative arrangement to the circuit shown in FIG. 1, the present invention provides additional circuitry for achieving sustained "on" operation in response to momentarily touching a first touch plate element, whereafter the switch may be returned to its "off" condition either by an externally derived control signal or as in the herein described and preferred embodiment, by momentarily touching a second or "off" touch plate element. With reference to FIG. 5, wherein circuit elements common to those of FIG. 1 are assigned corresponding reference numerals with the postscript "a," a further subcircuit 70 is provided for automatically sustaining the oscillatory condition of circuit means 16a in response to the presence of the rectified control signal provided by detection means 17a. For this purpose, subcircuit 70 comprises a capacitor 71 having one side thereof connected to common 15a and having its other end adapted for connection into feedback network 13a for providing an auxiliary capacitive impedance therefor to sustain the regenerative feedback about amplifier 14a and thus sustain its oscillating condition in place of capacitive impedance 12a, when the latter disappears after an operator releases his finger from touch plate conductor 11a. Furthermore, this connection of capacitor 71 provided by the momentary appearance of capacitive impedance 12a is maintained until released by an external command signal or by actuating a second touch plate element as hereinafter

described. The circuitry controlling the connection of capacitor 71 to feedback network 13a is advantageously provided in this instance by a diode 72 connected between the input of amplifier 14a and the output of detection means 17a whereby diode 72 forms a solid state switching element having a forward biased low impedance state and a reverse biased high impedance state. These states of the diode respectively connect and disconnect capacitor 71 between common 15a and a terminal 73 connected in feedback network 13a at the junction thereof with the input to amplifier 14a. In this instance, the amplifier input is provided by emitter 24a of transistor 21a. In order to drive diode 72 between its forward bias or "on" state and its reverse biased or "off" state, it is arranged with its cathode connected to terminal 73 and its anode connected through an isolating resistor 74 to a terminal 76 which in turn is connected to the junction of resistor 44a and load capacitor 43a receiving thereat the control signal output of detection means 17a. In this manner diode 72 is effectively connected across capacitor 43a through resistors 28a and 74 such that the state of diode 72 is dependent upon the instantaneous voltage appearing across load capacitor 43a. Resistor 74 serves to effectively isolate capacitor 71 from load capacitor 43a. Accordingly, the switching of diode 72 and thus the controlled connection of capacitor 71 to feedback network 13a occurs as follows:

Assuming that circuit means 16a is in a quiescent or nonoscillating condition, the output of detection means 17a at terminal 37a exhibits an essentially zero voltage. At this same time, a certain amount of quiescent current flowing through the collector emitter path of transistor 21a develops a slightly positive voltage across resistor 28a relative to common 15a. This positive voltage is presented at terminal 73 causing a higher voltage to appear at the cathode of diode 72 than is provided at its anode, the latter of which is connected through resistors 74 and terminal 76 to output terminal 37a. Diode 72 thereby presents a relatively high impedance between its cathode and anode effectively disconnecting capacitor 71 from feedback network 13a.

To turn the switch on, plate conductor 11a is touched, providing capacitive impedance 12a and causing circuit means 16a to enter an oscillating mode as above described. This in turn causes detection means 17a to rectify the oscillating signal and develop a voltage across load capacitor 43a approaching the V+ source applied at terminal 35a. The rise in voltage across capacitor 43a, which represents the rectified control signal output, is extended through terminal 76 resistor 74 to the anode of diode 72 presenting a higher voltage thereat than is present at its cathode, immediately placing diode 72 in a forward biased or low impedance condition. Thus, capacitor 71 is connected into feedback network 13a and effectively takes the place of capacitive impedance 12a when the operator removes his finger from touch plate conductor 11a and maintains circuit means 16a in a continuing oscillatory condition which in turn sustains the control signal output of detection means 17a at terminal 37. This sustained or latched "on" mode of the touch responsive switch has thereby been accomplished through the use of only three additional components, requiring a negligible amount of additional operating power and occupying very little additional space.

While it will be apparent that a number of circuit arrangements may be utilized for releasing the circuit once placed in its sustained "on" releasing mode of operation such as by momentarily removing +V from collector 41a of transistor 39a, the present invention provides an additional touch plate conductor 77 for accomplishing this operation. Conductor 77 as in the case of touch plate conductor 11a consists of a generally flat plate formed of electrically conductive material and having a lead extended therefrom which is connected to the output of amplifier 14a or in this instance to collector 23a of transistor 21a through a terminal 78. Furthermore, the capacitive impedance provided by contact with conductor 77 by the human body, such as an operator's finger, occurs relative to common 15a and is represented in this instance by a capaci-

tive impedance 79 shown by dotted lines connected between common 15a and conductor 77. In operation, and assuming that the circuit of FIG. 5 has been turned "on" by momentarily engaging touch plate 11a, the switch may be subsequently turned "off" as desired by merely touching plate 77. When this occurs, the signal oscillation emitted by collector 23a of transistor 21a at the output of amplifier 14a, is effectively short circuited common 15a through capacitive impedance 79 thereby suppressing the oscillatory signal otherwise presented to detection means 17a. In other words, touching conductor 77 terminates the oscillating signal output of circuit means 16a, whereupon detection means 17a ceases to provide the rectified control signal at output terminal 37a as will be evidenced by dissipation of the voltage charge across capacitor 43a. Furthermore, the decrease in voltage across capacitor 43a returns diode 72 to its reverse biased condition in which capacitor 71 is disconnected from feedback network 13a and restores the circuit to its nonoscillatory "off" mode.

In addition to the provision for subcircuit 70, the embodiment of the invention shown in FIG. 5 includes low value (e.g., 100 ohm) emitter resistors, resistors 25 and 45, connected respectively to emitters 24a and 42a of transistor 21a and 34a. Resistors 25 and 45 function to stabilize the base-emitter circuit in each case and thereby minimize changes in the switch performance due to variations in the transistor parameters which vary within production tolerance limits from transistor to transistor. Compensation in this manner facilitates production of touch responsive switches having substantially uniform capacitance requirements for initiating the oscillating condition of circuit means 16a and attendant uniform touch pressure.

In a manner similar to the circuit of FIG. 1, the components of FIG. 5 may be arranged in a miniaturized switch assembly as shown in FIGS. 6 through 8. With reference to FIGS. 6 and 7, conductors 11a and 77 are formed with a rectangular shape and nested within separate adjacent recesses of an insulating cap 81. The exposed metallic surfaces of the touch plate conductors may be provided with engraved or etched indications of their separate "on" and "off" functions such as shown in FIG. 6. Each conductor plate is provided with an extended terminal portion 82 extending inwardly of cap 81. A pair of clip springs 83 serve to maintain touch plate conductors 11a and 77 securely seated and leads 84 provide means for connecting the separate touch plate to an electronic circuit package 86 which houses the remaining components of the circuit shown in FIG. 5. Encapsulating electronic package 86 is a hollow rectangular sleeve 87 having an enclosed end 88 and being suitably secured to cap 81 about the periphery of an open end 89 and disposing package 86 in proximity with conductors 11a and 77 for connection of leads 84 therebetween. A terminal header 91 is mounted within sleeve 87 adjacent enclosed end 88, providing a mounting board for connection of leads 90 from package 86 to insulated terminals 92, 93 and 94 which extend through end 88 of sleeve 87 for external access to terminal 35a (+V), terminal 37a (output) terminal 38a (common) respectively, and a spare terminal 95 for optional connection to the circuit in special installations.

At variance with the packaging shown in FIGS. 2 through 4, isolation capacitor 32a for the circuit of FIG. 5 is a conventional lumped impedance circuit element mounted within electronic package 86. In common with the former embodiment, advantageous miniature size of the "on-off" switch assembly shown in FIGS. 6 through 8 is provided, with typical dimensions being on the order of 1 inch in width, ½ inch in thickness and about 1 ½ inches long.

What is claimed is:

1. In a touch responsive circuit having voltage supply, output, and common terminals; a transistor having base, collector and emitter electrodes, said collector electrode being connected to said output terminal; a pair of resistors connected in series to and between said voltage supply and common terminals and providing a mid-voltage terminal therebetween connected to said base electrode; bias impedance connected

to and between said emitter electrode and common terminal; said resistors and impedance cooperating with the supply voltage to bias said transistor in a active amplifying region; and an inductor connected to and between said collector electrode and voltage supply terminal; the improvement comprising:

a capacitor connected to and between said collector and emitter electrodes; and

a touch plate connected to said emitter electrode and mounted for human body contact for providing a capacitive impedance between said emitter electrode and common terminal;

said inductor and capacitor having values providing, when, and only when, said capacitive impedance is present, a regenerative feedback causing said circuit to oscillate.

2. A circuit as defined in claim 1, the values of said inductor and capacitor being selected to provide a phase shift approaching zero at a threshold value of said capacitive impedance.

3. A circuit as defined in claim 1, and

a capacitor connected to and between said emitter electrode and said touch plate.

4. The circuit as defined in claim 3:

a metallic housing for the aforesaid circuit components and having an aperture;

said touch switch comprising a member of dielectric material mounted in said aperture and having opposed conducting surfaces on opposite sides thereof insulated from said housing and exposed internally and externally of said housing, said internal conducting surface being connected to said emitter electrodes, and said external conducting surface being positioned within said aperture for exposure to human touch.

5. A circuit as defined in claim 1 and an electrical detector comprising:

a second transistor having a base, emitter and a collector;

a capacitor connected to and between said output terminal and said second transistor base;

a biasing resistor connected between said second transistor base and emitter;

said second transistor collector being connected to said voltage supply terminal; and

an output circuit connected to and between said second transistor emitter and common terminal and including a capacitor connected across said output circuit.

6. A touch responsive circuit comprising:

circuit means including an amplifier having an input and a feedback network connected between said input and output and being adapted to receive a capacitive impedance for producing regenerative signal oscillations at said amplifier output;

a touch plate adapted for human body contact connected to said feedback network and providing when touched said capacitive impedance;

an electrical detector connected to said output and providing a rectified control signal in response to said signal oscillations;

a capacitor;

second circuit means connected to said capacitor and said first named circuit means and said detector and having first and second states in which said capacitor is effectively connected and disconnected respectively to said feedback network for sustaining and not sustaining said oscillatory condition;

said second circuit means assuming said first state in response to said control signal and assuming said second state in the absence thereof; and

means for terminating said control signal.

7. The circuit defined in claim 6, wherein said second circuit means comprises, a diode connected between said feedback network and capacitor and being connected to said detector means and responsive to the presence of said control signal to assume a forward biased condition providing said first state and to assume a reverse biased condition in the absence of said control signal providing said second state.

8. The circuit defined in claim 6, said terminating means comprising, a second touch plate adapted for human body contact for providing a second capacitive impedance, said amplifier being connected to said second touch plate and being responsive to the capacitive impedance provided thereby to cease said oscillatory condition.

9. The touch responsive circuit defined in claim 7, wherein said detector means is provided by a transistor biased at the threshold of its cut off region and being connected and responsive to said amplifier to rectify said signal oscillations, a load capacitor connected to said transistor to receive such rectified signal oscillations and assume a voltage charge in response thereto providing said control signal, and an isolating impedance effectively connecting said diode across said load capacitor such that said diode responds to said voltage charge to assume its forward biased condition.

10. The touch responsive circuit defined in claim 7, wherein said amplifier circuit is provided by a second transistor having base, emitter and collector electrodes biased for signal amplification between an input associated with said emitter electrode and an output associated with said collector electrode and an inductor connected between said output and a com-

mon AC reference and a capacitance connected between said input and output, and said touch plate being connected to said input for providing when touched said capacitive impedance relative to said common AC reference which forms together with said inductor and capacitance regenerative oscillatory signal coupling between said output and input, said diode being connected between said input and said detector circuit and responsive to said control signal to assume its forward biased condition, and said capacitor being connected between said common AC reference and the connection of said diode with said detector circuit.

11. The touch responsive circuit defined in claim 10, wherein said terminating means comprises a second touch plate adapted for human body contact for providing a second capacitive impedance, said additional touch plate being connected to said output for providing when touched said second capacitive impedance relative to said common AC reference substantially terminating said signal oscillations at said output, and said detector means being connected to said output and responsive to the termination of said oscillations to terminate said control signal.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,621,307 Dated November 16, 1971

Inventor(s) Richard C. Raven et al.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 6, change "aplicants's" to --applicant's--.

Column 2, line 26, change "ad" to --and--.

Column 2, line 60, change "operatr's" to --operator's--.

Column 3, line 13, change "(pico = 10⁷E¹²)" to ~~10⁷E¹²~~
--(pico = 10⁻¹²)--.

Column 3, line 14, change "operatr's" to --operator's--.

Column 3, line 44, change "ad" to --and--.

Column 4, line 20, change "oscillation" to --oscillating--.

Column 5, line 24, change "ad" to --and--.

Column 6, line 64, after "on", delete --releasing--.

Column 6, line 67, change "as i" to --as in--.

Column 7, line 8, after "short circuited", insert --to--.

Claim 1, column 8, line 3, change "in a" to --in an--; line 12, change "valves" to --values--.

Claim 6, column 8, line 47, after "input", insert --and output--.

Claim 7, column 8, line 71, change "ad" to --and--.

Signed and sealed this 30th day of May 1972.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents