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3,492,541

TACTILE RESPONSIVE SWITCHING CIRCUIT

Original Filed Nov. 21, 1963

2 Sheets-Sheet 1

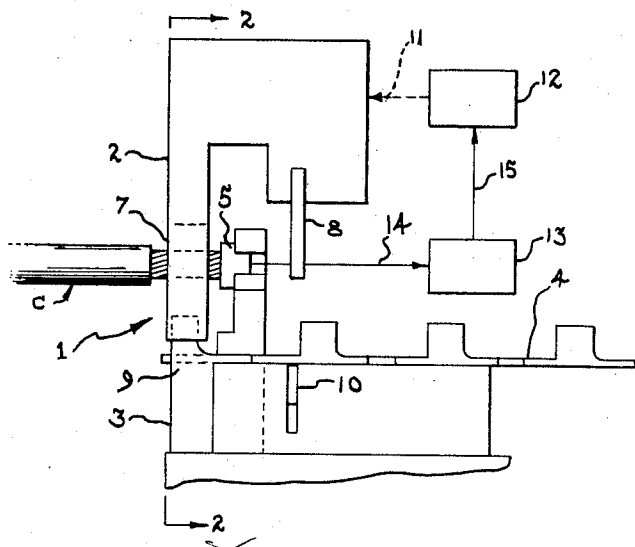


Fig. 1

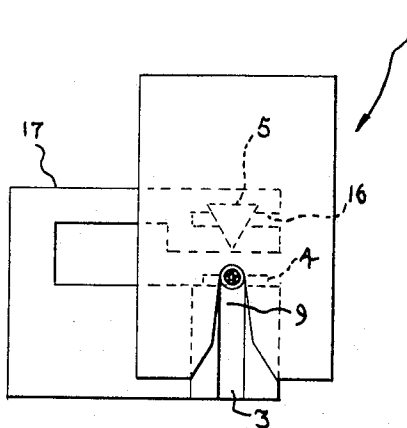


Fig. 2

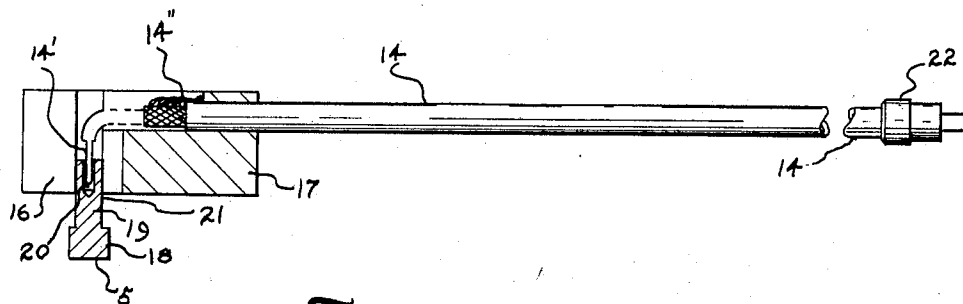


Fig. 3

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Fig. 4

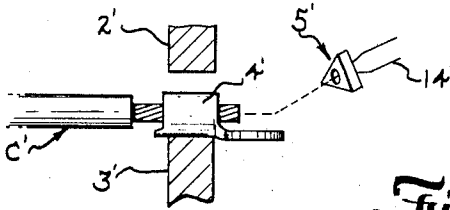
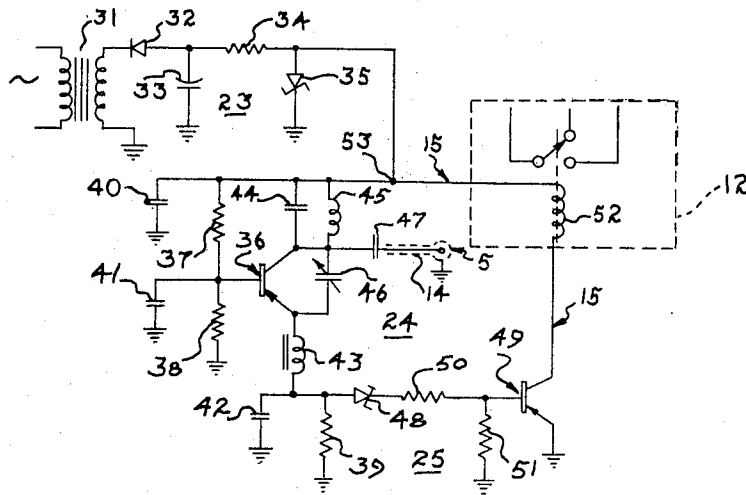


Fig. 5

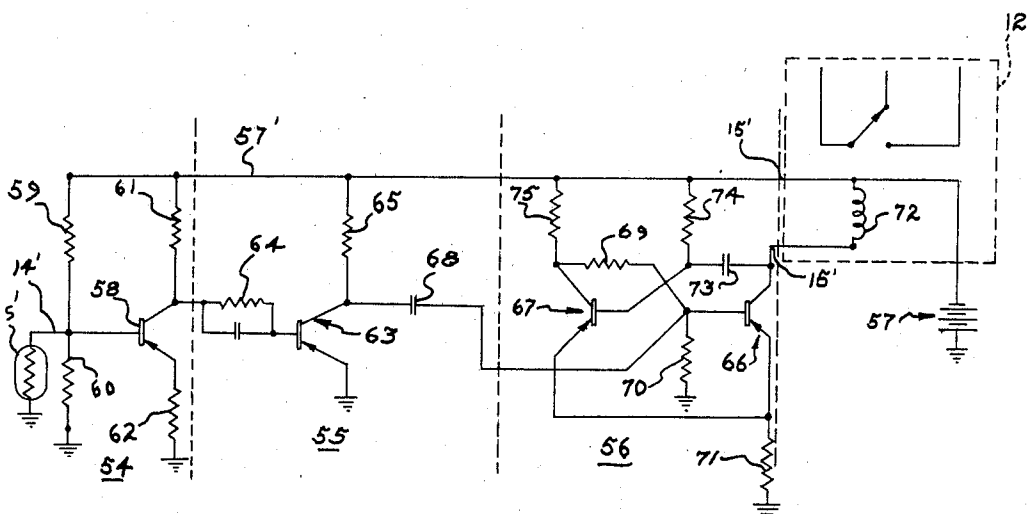


Fig. 6

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3,492,541

TACTILE RESPONSIVE SWITCHING CIRCUIT
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Original application Nov. 21, 1963, Ser. No. 325,321, now Patent No. 3,289,445, dated Dec. 6, 1966. Divided and this application Sept. 19, 1966, Ser. No. 580,372
Int. Cl. H01h 47/12

U.S. Cl. 317-146

9 Claims

ABSTRACT OF THE DISCLOSURE

A tactile responsive circuit comprises an oscillator circuit which is stopped from oscillating when a sensing means connected thereto is engaged by an object and the quiescent state of the oscillator effects operation of a voltage level detection circuit which controls the on or off state of a switch means.

This application is a division of application Ser. No. 325,321, filed Nov. 21, 1963, now U.S. Patent No. 3,289,445.

This invention relates to a device for operating an electric circuit which controls the movement of a member relative to another member such as dies in a press.

In the field of crimping electrical connectors onto electrical conductors, the connectors are successively fed into crimping dies of a crimping machine, and upon each connector being placed in position between the dies, an electrical conductor is fed into the ferrule portion of the connector, then the machine is operated and the movable crimping die moves toward the stationary die to effect the crimping of the ferrule portion of the connector onto the conductor.

In order to effect the operation of the crimping machine in a minimum amount of time, because large quantities of the connectors are used, and to insure that the conductor has been inserted within the ferrule portion of the connector the proper amount to provide excellent electrical and mechanical engagement therebetween, there have been provided various arrangements to operate the crimping machine.

One arrangement of operating the dies employs a foot switch which requires the operator to step on the switch to trip the press as soon as he has inserted the conductor into the connector. In speeding production with this arrangement, even skilled operators frequently close the switch before a conductor is fully inserted into the connectors, thereby making a faulty connection which is difficult to detect.

A second arrangement employs a pressure plate at the rear of the connector which is attached to a micro switch. When the operator inserts the conductor into the connector and presses the plate, the switch is closed, tripping the press. This arrangement avoids the limitations of the foot switch but has one of its own, namely that in view of small diameters, insufficient strength exists to permit the firm pressure against the plate required to operate the switch.

The third arrangement requires an electric circuit between the connector, the inserted conductor and a contact plate placed at the rear of the connector. When the conductor is inserted into the connector, it closes the circuit between the connector and the contact plate. Closing the circuit activates a relay which in turn closes the switch controlling the movement of the dies. This arrangement is unsuited for some types of connectors.

A fourth arrangement utilizes a switch in the form of an electrified contact pad such as a printed circuit or

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laminae which is disposed adjacent the crimping dies. When the conductor is inserted into the connector, the conductor makes contact with the printed circuits or laminae of the contact pad thereby closing the circuit thereof which actuates a solenoid which in turn actuates the dies. This arrangement has been found to be unsatisfactory due to the fact that the structure is thin causing it to wear too easily, and since the conductive elements are so close together they can be easily shorted by dirt and other foreign matter.

It is, therefore, a primary object of the present invention to provide a simple and instantaneously operated automatic tripping device for operating a high speed press, especially in the crimping of electrical connectors onto conductors.

Another object of the present invention is to provide a tripping device which is rugged in construction and which retains high quality throughout the life expectancy of the equipment associated therewith.

A further object of the present invention is the provision of a novel control circuit.

An additional object of the present invention is to provide an actuating device that is foolproof, does not require firm pressure and will not operate before the conductor is fully inserted in the connector.

A still further object of the present invention is the provision of a sensing device which senses the engagement of an element thereon in order to actuate an operating member to operate thereon.

Other objects and attainments of the present invention will become apparent to those skilled in the art upon a reading of the following detailed description when taken in conjunction with the drawings in which there are shown and described illustrative embodiments of the invention; it is to be understood, however, that these embodiments are not intended to be exhaustive nor limiting of the invention but are given for purposes of illustration in order that others skilled in the art may fully understand the invention and the principles thereof and the manner of applying it in practical use so that they may modify it in various forms, each as may be best suited to the conditions of a particular use.

In the drawings:

FIGURE 1 is a diagrammatical side-elevation view of a conventional die arrangement incorporating the present invention with the die parts opened to receive a conductor for crimping onto a connector;

FIGURE 2 is a view taken along lines 2-2 of FIGURE 1 with the press in an operated position and the connector crimped onto the conductor;

FIGURE 3 is a cross-sectional view of the preferred sensing means of the present invention;

FIGURE 4 is a schematic electrical diagram of the control circuit of the present invention using the sensing means of FIGURE 3;

FIGURE 5 is a schematic diagram of an alternative embodiment of the sensing means, connector and conductor; and

FIGURE 6 is a schematic electrical diagram of the control circuit using the sensing means of FIGURE 5.

FIGURE 1 shows a typical press 1 provided with crimping dies used to install open or closed barrel strip connectors. The die consists of the top half 2 which performs the crimping and the bottom half 3 which supports the strip connectors 4 during crimping. A sensing means 5 is located just behind the crimping portion 7 and in front of the shear blade 8. The specific connector being crimped is located over the anvil 9. Slot 10 receives the shear knife when the dies are closed.

Normally used and schematically shown by broken line 11 is a clutch which activates the press operated by an

electric solenoid or control relay whose circuit 12 is closed by control circuit 13. Wire means 14, 15 carry the potential from the sensing means 5 and control circuit 13 to the relay. A slot 16 in support bracket 17 holds the sensing means in proper position. Slot 16 allows sensing means 5 to be adjustable.

In the normal, open position of the die, the wire of conductor C is inserted inside the die through the large opening provided above the connector and underneath the connector crimping portion 7. The operator places the wire against sensing means 5. A smooth surface on the sensing means is desirable so as to provide the least resistance against the end of the conductor when it is carried by the crimping die down into the connector.

As soon as the wire of conductor C touches sensing means 5, it actuates control circuit 13 thereby closing the circuit to the relay in 12 and tripping the press. Therefore, the operator needs only to touch the wire to any portion of the sensing means in order to activate the press.

The position of the dies during the closed, or crimping, portion of the cycle, is shown in FIGURE 2. Here the crimping portion 7 has moved down toward anvil 9 carrying the wire of conductor C with it and forcing it into the open barrel of the connector 4. The crimping die portion 7 has folded the U-shaped barrel around the wire of conductor C forming the final, crimped connection. Simultaneous with the crimping stroke of the die the shear blade 8 has severed the first connector and has entered groove 10 in the base which received it and the portion of the connector strip which has been sheared free. The control circuit becomes open again. When the die returns to its original position, as shown in FIGURE 1, the connector which has been crimped around the wire is now free from the original strip and is removed with the conductor from the die. The strip is then automatically advanced by a mechanism, not shown, so that the next connector is in position over anvil 9 and is ready for another conductor.

In another variation of this type of strip-connector crimping die, the connectors may be positioned side-by-side as shown and described in Ser. No. 834,488 filed August 18, 1959, now U.S. Patent No. 3,115,695, under the name of Glendon H. Schwalm instead of extending end-to-end in line as shown in FIGURE 1. The same sensing means can be applied with equal effectiveness with this type of arrangement.

Turning now to FIGURE 3, there is shown sensing means 5 disposed in slot 16 of support bracket 17. Sensing means 5 is a metallic body having a preferably triangularly-shaped engaging or tactile section 18 and a shank portion 19 provided with a hole 20 therein. A sleeve 21 of insulating material is disposed on shank portion 19 to insulate sensing means 5 from the support bracket.

Wire means 14 may be a coaxial cable which has the center conductor 14' connected to sensing means 5 via hole 20 and the outer braided conductor 14'' connected to bracket 17 to provide a ground connection. As can be seen, cable 14 is disposed in an aperture in bracket 17 and can be secured therein in any suitable manner to provide strain relief therefor. A conventional coaxial connector 22 is connected to the other end of cable 14 which mates with a complementary connector in the housing in which the control circuit is disposed.

Referring now to FIGURE 4, the complete control circuit embodying the present invention is schematically illustrated and may be disposed in a housing designated as 13 in FIGURE 1. The circuit comprises three parts which are a power supply 23, a detector circuit 24 and relay circuit 25.

Power supply 23 is a half-wave rectifier. Transformer 31 has its primary winding supplied from a source of A.C. voltage. The secondary winding of transformer 31 has one side connected to the negative side of diode 32 while the other side of the secondary winding is connected to

ground. The positive side of diode 32 is connected in series with one side of resistor 34 which in turn has its other side connected at point 53. A capacitor 33 is connected between diode 32 and resistor 34 and ground while Zener diode 35 is connected between point 53 and ground.

The voltage which appears in the secondary winding is rectified by diode 32, and the rectified voltage is then filtered by capacitor 33 and resistor 34 serially connected thereto. The filtered voltage is simultaneously applied to point 53 for the detector and relay circuits.

Prior to the filtered voltage being applied to the detector and relay circuits, Zener diode 35 provides in the power supply circuit a standard regulated A.C. to D.C. power supply for the detector circuit. The regulated supply makes the detector circuit immune to line voltage transients and allows the unit to operate over a wide range of line voltage.

Detector circuit 24 is, in a broad sense, an oscillator and sensing means 5 is a primary component of this circuit which is directly responsive to the engagement thereon of a conducting substance. Detector circuit 24 comprises transistor 36 which is used as a sensitive high frequency oscillator operating in the common base mode. Resistors 37 and 38 provide a resistance network with one end of resistor 37 connected to point 53 and one end of resistor 38 connected to ground and the junction thereof is connected to the base. Resistor 39 has one side connected to ground while the other side is connected to the emitter of transistor 36 through a radio frequency choke 43. These resistors are bias resistors which set the steady-state operating point of transistor 36.

Capacitor 40 is connected between ground and point 53. Capacitor 41 is connected between ground and the junction of resistors 37 and 38. Capacitor 42 is connected between ground and between choke 43 and resistor 39. Capacitors 40, 41 and 42 are by-pass capacitors with capacitor 41 providing the necessary A.C. short circuit to ground to form the common base relationship. Radio frequency choke 43 provides a high impedance to A.C. in the emitter circuit of transistor 36.

Capacitor 44 and inductance 45 are connected in parallel relationship between the collector of transistor 36 and point 53, and provide a resonant circuit which determines the frequency of the oscillator. Variable capacitor 46 is connected between the emitter and collector of transistor 36 to provide feedback to sustain oscillation and to control circuit sensitivity. Capacitor 47 has one side connected to the connection between capacitor 46 and the collector of transistor 36 and the other side connected to the center conductor of coaxial cable means 14 of sensing means 5. The outer conductor of coaxial cable means 14 is connected to ground.

Relay circuit 25 comprises a relay-driving transistor 49 whose base is connected to the junction of bias resistors 50 and 51. The other side of resistor 50 is connected to one side of a Zener breakdown diode 48 whose other side is connected between the junction of resistor 39 and choke 43. The other side of resistor 51 and the emitter of transistor 49 are connected to ground. The collector of transistor 49 is connected to one side of relay 52 while the other side thereof is connected to point 53 through wire means 15. Relay 52 and associated circuitry is disposed in housing 12. Zener diode 48 provides an accurate voltage level at which the detector circuit will switch the state of the output of the relay circuit.

OPERATION

Transistor 36 oscillates at a frequency determined by capacitor 44 and inductor 45 as long as nothing is touching sensing means 5. When transistor 36 is oscillating strongly, a large D.C. current is drawn through resistor 39, and the voltage developed across resistor 39, as measured from the junction of resistor 39 and R.F. choke 43 to ground, is larger than the voltage necessary to cause Zener diode 48 to fall below the break-down point there-

of, thereby causing transistor 49 to conduct which actuates relay 52. This is the quiescent state of the circuit.

If a conducting substance is now touched to sensing means 5, the added capacity to ground of the substance loads the oscillator heavily through capacitor 47 causing a compensating drop in current through resistor 39. This drop in current causes a drop in the voltage developed at the junction of resistor 39 and R.F. choke 43. When the voltage drops below the breakdown point of Zener diode 48, the diode becomes nonconducting and base current is removed from the relay-driving transistor 49, which in turn causes relay 62 to be nonactuated. When the conducting substance is removed from sensing means 5, the oscillator returns to normal and relay 52 is again activated as described.

The sensitivity of the oscillator is controlled by capacitor 46, which controls the amount of circuit feedback. This control may be set so that the amount of voltage developed across resistor 39 just exceeds the break-down point of Zener diode 48, at which point the circuit will be extremely sensitive, due to the sharp cut-off point of the Zener diode and the large size of resistor 39. The circuit as presented here is fail-safe in that if the oscillator fails for any reason, the relay will operate the external circuit it controls and keep it operated until the deficiency is corrected.

The foregoing embodiment provides instantaneous relay actuation upon contact of any size wire with the sensing means to thereby effect faultless press operation. The circuit is not affected by nonconductors, heat light, or line transients. The unit in which the control circuit is disposed may be a sealed unit. The use of a change in the D.C. operating point of the oscillator transistor controls the output thereof, which has the advantage of greater stability and better isolation from external influence. The use of a Zener diode provides an accurate and stable reference point to establish the trip level or sensitivity of the control circuit. The use of a variable feed-back capacity controls the sensitivity and provides a greater range of sensitivity adjustment. The use of a Zener break-down diode directly coupled to the oscillator D.C. bias circuit is unique in the field of oscillator-type capacity relays.

FIGURES 5 and 6 illustrate an alternative embodiment of the present invention. FIGURE 5 schematically shows a connector 4' placed between crimping dies 2' and 3', and the wire of conductor C' is disposed within the ferrule portion of the connector. Disposed at an appropriate position in the manner illustrated in FIGURE 1 is a sensing means 5' which is a thermistor of the Veco #34A1 or equivalent type. The thermistor is embedded in a material that exhibits a rapid thermal inertia, such as aluminum, copper, brass, etc., which in turn is disposed in a mounting means and wire means 14' such as a coaxial cable is connected thereto.

FIGURE 6 shows a schematic diagram of the control circuit incorporating the thermistor as a sensing means in order to control the press of FIGURE 1 or the type of press disclosed in the above-mentioned patent application and includes a detector circuit 54, amplification circuit 55, relay circuit 56 and power supply 57.

Detector circuit 54 comprises a transistor 58 whose base is connected to the junction of resistors 59 and 60. The other side of resistor 59 is connected to a power supply lead 57' while the other side of resistor 60 is connected to ground. Sensing means 5' has one side connected to the junction of resistors 59 and 60 while the other side is connected to ground. The collector and emitter of transistor 58 are connected respectively to the power supply lead by resistor 61 and to ground by resistor 62.

The amplification circuit 55 includes transistor 63 whose base is connected to the collector of transistor 58 by an R-C network 64. The collector of transistor 63 is connected to lead 57' by resistor 65 and the emitter is connected directly to ground.

The relay circuit 56 comprises transistors 66 and 67. The base of transistor 66 is connected to the collector of transistor 63 through a capacitor 68 as well as being connected to the junction of resistors 69 and 70. The other side of resistor 69 is connected to the collector of transistor 67 while the other side of resistor 70 is connected to ground. The emitters of transistors 66 and 67 are connected to ground through resistor 71. The collector of transistor 66 is connected to one side of relay 72 as well as to the base of transistor 67 by capacitor 73. Resistor 74 is connected between lead 57' and the junction of the base of transistor 67 and capacitor 73. The collector of transistor 67 is connected to lead 57' by resistor 75. The other side of relay 72 is connected to lead 57' and relay 72 and associated circuitry are disposed in housing 12' and interconnected with the control circuit via wire means 15'.

The power supply 57 is illustrated as a battery which can effectively provide suitable voltage to operate the control circuit; however, the power supply of FIGURE 4 can be utilized if desired. Likewise, a battery power supply can be used in FIGURE 4 in place of the power supply described therein. The type of power supply will be determined in accordance with the conditions.

The operation of FIGURE 6 is as follows. When the wire of conductor C' touches the thermistor assembly 5', the wire will act as a mild heat sink and conduct a small portion of the thermal energy away from this assembly. This effect is enhanced due to the fact that the thermistor is operating at a temperature well in excess of the normal ambient range. The temperature of the thermistor is maintained by the flow of current through resistors 59, 60 and the thermistor.

Due to a rapid loss of thermal energy, the ratio of current developed by 59, 60 and the thermistor will be transmitted via the base of transistor 58. The change in the base current of transistor 58 will be amplified and appear at the collector thereof. The R-C network 64 connected between the collector of transistor 58 and the base of transistor 63 is used to insure that the reduced thermal energy is rapid in nature and minimizes the possibility that the device will be actuated falsely by changes in ambient temperature.

The current change at the base of transistor 63 is amplified thereby and reappears on the collector thereof. This change is supplied via coupling capacitor 68 to the base of transistor 66. Transistors 66 and 67 are so connected as to form a triggering circuit, i.e., a mono-stable multi-vibrator. This circuit actuates relay 72 for a period of time approximately equal to the product of capacitor 73 and resistor 74.

It is important to note that this device will detect the presence of substances regardless of their electrical properties.

As can be discerned, there has been described control circuit means which is useful to instantaneously actuate a relay to perform a desired operation upon a sensing means being engaged by a member.

It will, therefore, be appreciated that the aforementioned and other desirable objects have been achieved; however, it should be emphasized that the particular embodiments of the invention, which are shown and described herein, are intended as merely illustrative and not as restrictive of the invention.

We claim:

1. A tactile responsive switch comprising a selectively operable oscillator circuit means including a resonant output circuit means to provide a predetermined frequency of operation of said oscillator circuit means and a bias circuit means setting the steady-state operation of said oscillator circuit means at said predetermined frequency to provide a control voltage, sensing means connected to said oscillator circuit means to cause said oscillator circuit means to cease to provide said control voltage when said sensing means is engaged by an object,

Zener diode means connected to said bias circuit means, and switch means connected to said Zener diode means, said switch means being normally actuated by said oscillator circuit means and said Zener diode means but being non-actuated upon the control voltage dropping below the breakdown point of said Zener diode means.

2. A tactile responsive switch according to claim 1 wherein a source of power is connected to said oscillator circuit means which includes means to provide a stable source of supply.

3. A tactile responsive switch according to claim 1 wherein said oscillator circuit means includes a variable capacity feed-back means to control the sensitivity thereof.

4. A tactile responsive switch according to claim 1 wherein said switch means is a relay.

5. A control circuit for controlling the movement of one member relative to another comprising a first transistor having a base electrode, emitter electrode and collector electrode, a resonant circuit connected between said base electrode and said collector electrode, a bias circuit connected between said base electrode and said emitter electrode, a capacitance feed-back connected between said collector and emitter electrodes, sensing means connected to said collector electrode to trigger operation of said first transistor, a second transistor having a base electrode, emitter electrode and collector electrode, a break-down circuit means connected between the base electrode of said second transistor and said bias circuit and including a Zener diode, control means connected between the collector electrode of said second transistor and an output circuit, and direct current supply means for energizing said transistors.

6. A control circuit according to claim 5 wherein said capacitance feed-back is variable.

7. A control circuit according to claim 5 wherein said direct current supply means includes a Zener diode.

8. A control circuit according to claim 5 wherein said control means is a control relay means.

9. A tactile responsive switch comprising a selectively operable oscillator circuit means including a resonant output circuit means to provide a predetermined frequency of operation of said oscillator circuit means and a bias circuit means setting the steady-state operation of said oscillator circuit means at said predetermined frequency to provide a control voltage, sensing means connected to said oscillator circuit means to cause said oscillator circuit means to cease to provide said control voltage when said sensing means is engaged by an object, voltage breakdown circuit means connected to said oscillator circuit means to provide an output voltage while receiving said control voltage from said oscillator circuit means and to provide no output voltage when said control voltage drops below a predetermined voltage level, and switch means connected to said voltage breakdown circuit means and having an on state and an off state, said switch means being responsive to the output voltage from said voltage breakdown circuit means to turn said switch means from one of said states to the other.

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