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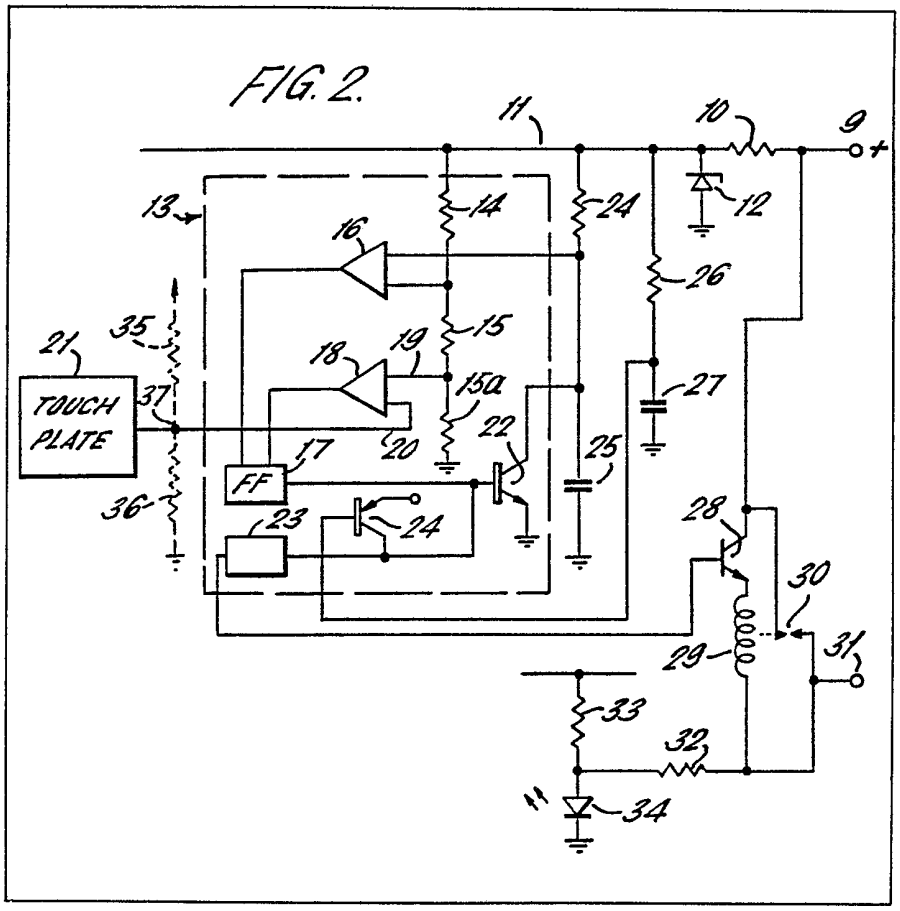
(54) **Touch responsive switching arrangement**

(57) A touch responsive switching arrangement includes a comparator 18 having one input 19 precisely set by a voltage divider 14, 15, 15*a* energised from a stabilised supply and another input which is either directly connected to a touch plate 21 or is stabilised at a potential close to that of the first input as well as being connected to the touch plate. The comparator is capable of switching in response to a very low discharge current through the touch plate. In an alternative arrangement a rectifier voltage from an oscillator is also fed to the second input of the comparator, the voltage excursions at the input being insufficient to cause triggering of the comparator when there is no discharge path through the touch plate.



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The drawing originally filed was informal and the print here reproduced is taken from a later filed formal copy.

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FIG. 1.

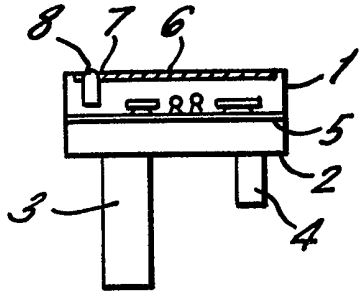


FIG. 2.

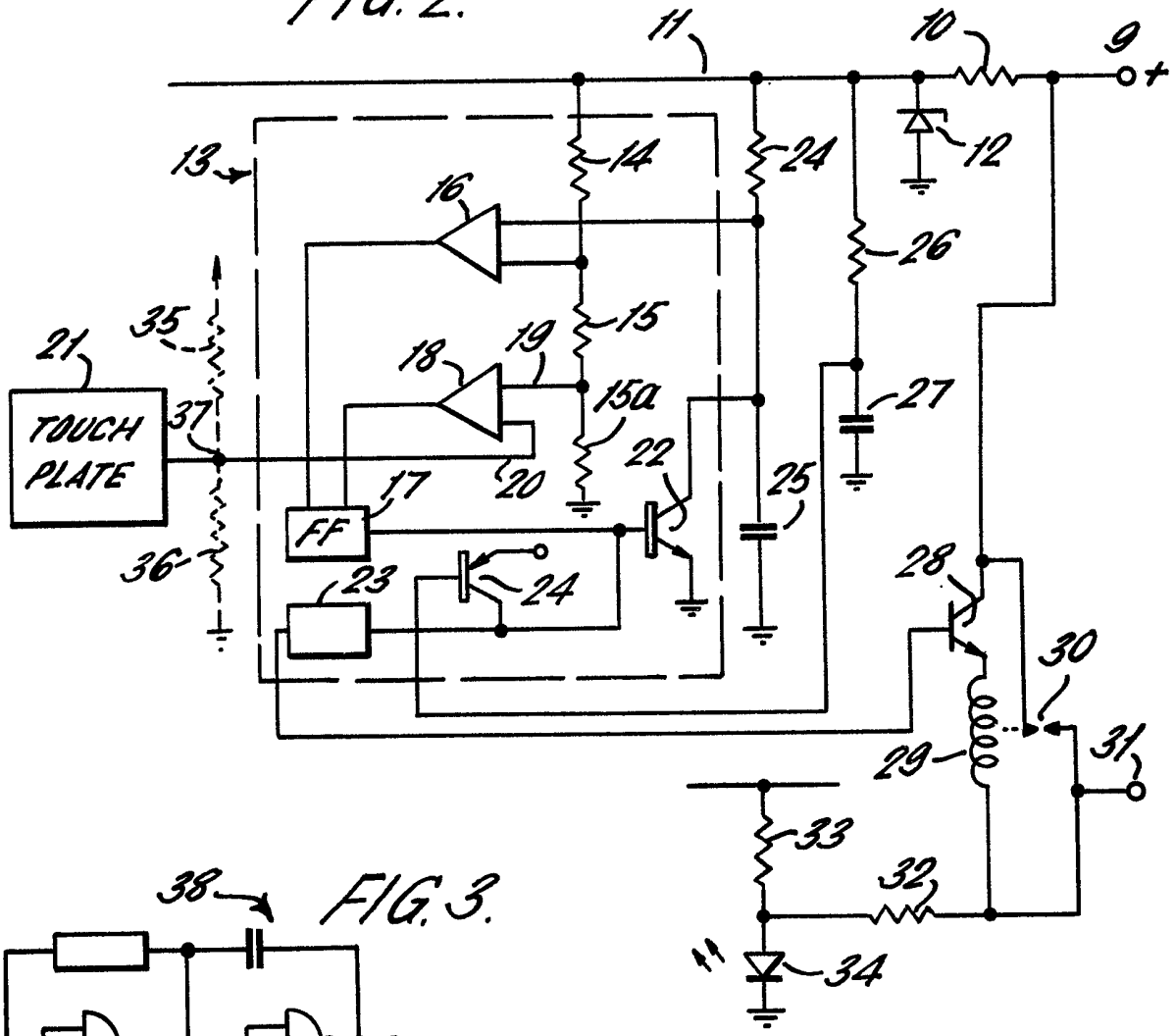
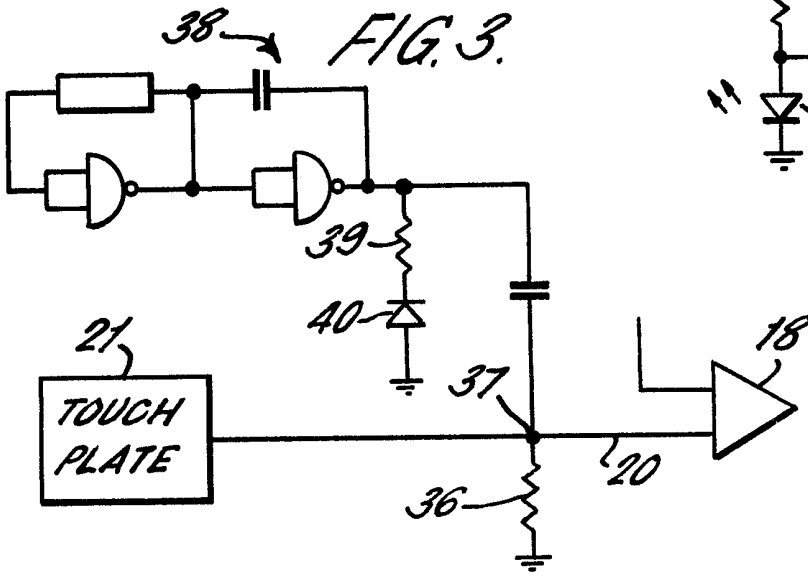


FIG. 3.



SPECIFICATION

Touch responsive switching arrangements

This invention relates to touch responsive switching arrangements and is particularly although not exclusively intended to provide an improved switching arrangement which can be incorporated in a motor vehicle and used for the control of various functions in the vehicle, such as the control of lights or other auxiliary operations of the vehicle.

It will be understood that the phrase "touch-responsive" includes a response to a close approach of the human body to the "touch-responsive" member of the switching circuit. Indeed the principal problems of an affective touch responsive switching circuit have been to ensure that the circuit is sensitive enough to produce effective triggering not merely when the touch plate is actually touched by a human finger but also when the plate is separated from the human finger not merely by the thickness of an insulating transparent film which may cover the touch plate but also by the thickness of the material of a glove worn on the hand of the operator. It is a further problem to provide that degree of sensitivity and yet avoid spurious triggering by, for example, pieces of paper, insects or the like.

Many touch responsive circuits have been proposed in the past. Where these circuits can provide triggering without physical contact, they have usually relied on the capacitance of the human body to affect the operation of an oscillatory circuit in some way. For example, British Patent Specifications Nos. 1111735, 1283543 and 1459235 all rely on the capacitance introduced by close approach to a touch plate to change the frequency of oscillation of an oscillator. British Patent Specification No. 1350912 relies on the effect of a capacitance associated with the touch plate to stop and start an oscillation. British Patent Specification No. 1351868 relies on the closing of a feedback loop by the capacitance associated with a touch plate. British Patent Specifications Nos. 1477252 and 1529862 disclose multi-electrode touch plates which rely on a disturbance of a radio frequency coupling between the electrodes when a human finger approaches the multi-electrode touch plate.

The present invention is based upon an appreciation that a discharge current through the human body can be sent by a comparator which is arranged to compare a potential at a point to which a touch plate is connected and another point which is at a stabilised potential.

According to the invention a touch sensitive switching arrangement comprises a supply terminal, a potential divider arranged to be energised with direct current from the supply terminal, means for stabilising the volage across the potential divider, a comparator having one input connected to a point on the potential divider and a second input which is at a potential slightly different from that of the first input, the comparator being capable of detecting a discharge current, through the second input, of the order of 20 microamperes, and a touch plate connected to the said second input.

There follows a description with reference to the accompanying drawings, of several embodiments of the invention.

In the accompanying drawings:

Figure 1 illustrates the physical arrangement of a touch switch;

Figure 2 illustrates one embodiment of the touch sensitive switching arrangement; and

Figure 3 illustrates a modification of the circuit shown in Figure 2.

Figure 1 illustrates by way of example a suitable physical arrangement for the elements of the switching arrangement. A casing 1, which may be made of a suitable synthetic plastics material, is open at two broad faces, of which the lower is closed by a plate like member 2 having two tubular extensions 3 and 4. The tubular extension 3 may accommodate a relay coil (to be described) whereas the extension 4 constitutes a conduit for connections to and from the electrical circuit accommodated mainly on a plate 5 arranged within the housing 1. The top face of the housing 1 is constituted by a plate 6 which may be a simple conductive metal plate that is accommodated in a shallow marginal recess in the plate 1. The plate 6 has near one end an aperture 7 through which a light emitting diode 8 protrudes. This light emitting diode constitutes an indicator for indicating the operation of the switching circuit and its arrangement in the circuit will be described with reference to Figure 2.

The arrangement shown in Figure 1 is shown by way of example only. Preferably the plate 1 is covered by a thin film of a suitable insulating transparent synthetic plastics material of any suitable composition.

The circuit arrangement which is shown in Figure 2 is suitable for incorporation in a motor vehicle. It is intended to provide switching of one of the auxiliary functions of a motor vehicle and for this purpose includes the relay aforementioned so as to provide for switching of a current of rather larger magnitude than could be handled by the mere use of a switch controlled by a touch plate.

A positive supply terminal is connected by way of a voltage drop in resistor 10 to a positive supply rail 11 of which the voltage relative to earth, provided preferably by the chassis of the vehicle, is stabilised by a zener diode 12. The supply rail 11 provides voltage for a circuit 13 which for the most part is included within the dashed lines for a reason which we have made apparent hereinafter.

Within the circuit 13 is a voltage divider constituted by resistors 14, 15 and 15*a*, which may typically be 10 megohms, 22 kilohms and 470 ohms respectively. To the junction between the resistors 14 and 15 is connected one input terminal of a comparator 16 which drives one input of a bistable circuit 17. The other input to this bistable (flip-flop) is controlled by a comparator 18 of which a first input 19 is connected to the junction between resistors 15

and 15*a*. The other input 20 to the comparator 18 is connected directly and only to a touch plate 21. The ouput from the flip-flop is connected to the base of a transistor 22 of which the emitter is connected to earth. The aforesaid base is connected to an output stage 23. The base of the transistor 22 is also connected to the connector of a transistor 24 of which the emitter is connected to the junction between the resistors 14 and 15 and of which the base is connected to a circuit yet to be described.

The circuit 13 can be implemented using an integrated circuit type 555 made by Signetics International Corporation. The 555 timer is an eight pin circuit and if it is used to implement the circuit 13 pin 5 should be left disconnected. It should be operated from a supply between 5 volts and 18 volts, the upper limit preferably not exceeding 15 volts so as to permit normal supply voltage variation.

The collector of transistor 22, is connected (by way of pin 7 if an integrated circuit type 555 is used) to the junction between the resistor 24 and a capacitor 25 which is connected to earth. The base of transistor 24 is connected (by way of pin 4 if the integrated circuit type 555 is used) to the junction of a resistor 26, which is connected to the supply rail 11, and a capacitor 27, which is connected to earth.

The output of the output stage 23 is connected (by way of pin 3 if the type 555 integrated circuit is used) to the base of a transistor 28 of which the collector is connected to the positive supply terminal 9 and of which the emitter is connected to a relay coil 29. The other end of the relay coil may be connected to earth. The collector of transistor 28 (and thereby the supply terminal 9) is connected by way of the contacts 30 of the relay to an output terminal 31, which can control the auxiliary function which is switched by means of the switching arrangement constituted by Figure 2. The terminal 31 is connected by way of a resistor 32 to the junction of a resistor 33 and a light emitting diode 34, the resistor 33 and the diode 34 being connected between the positive rail 11 and earth. In the absence of closure of the contacts 30, the current flowing through resistor 33 is insufficient to cause full illumination of the diode 34, but on closure of the contacts 30 sufficient current flows through resistor 32 to cause full illumination of the diode 34.

In the type 555 integrated circuit, the comparator corresponding to comparator 18 is quite sensitive, being capable of triggering if the current flowing through the input 20 is of the order of 0.5 microamps for a time of 0.1 microseconds. Thus the current required is so small that a finger may be used to trigger the device even through the finger is gloved. In the arrangement shown in Figure 2, by virtue of the sensitivity of the comparator 18, the touch plate and only the touch plate need be connected to the input 20 of the comparator 18. The capacitative discharge path which is provided if a human finger, whether gloved or not, approaches the touch plate is sufficient to produce the outflow of triggered current through the input 20 and cause the comparator to operate flip-flop 17. The operation of this flip-flop provides *via* output stage 23 switching at transistor 28 and thereby the energisation and latching of the relay constituted by coil 29 and contacts 30 and consequently the provision of positive switching at the output 31. The switching of flip-flops 17 discharges capacitor 25 through transistor 22. However, the fall in voltage across the capacitor 25 is sensed by comparator 18, which causes the bistable 17 to revert to its original state. Capacitor 25 will then charge back to its normal voltage.

An arrangement which relies on a capacitative path thorugh the human body to cause the triggering of the capacitor should b sensitive enough to detect a current of less than about 15 to 20 microamperes. The circuit may be required to be more sensitive than this though sensitivity of the order of that provided by the arrangement just described is not usually necessary. If the comparator used is not as sensitive as that which has been described, it may normally be made sufficiently sensitive by stabilising the voltage at the input 20, it being presumed that the voltage at the input to the other comparator will be stabilised by means of a voltage divider energised by a stabilised potential or otherwise. Shown in ghost in Figure 2 is a potential divider constituted by a resistor 35 and a resistor 36, of which the junction 37 is connected to the touch plate 21. The resistor 35 would be connected to the supply rail 11 and the resistor 36 to earth and the resistors 35 and 36 would be so chosen that the potential at the input 20 is sufficiently close to the stabilised potential applied to the input 19 of the comparator 18 that the required sensitivity is achieved.

Figure 3 shows an alternative arrangement in which an oscillator is used. However, unlike known switching circuit arrangements, the touching of the touch plate 21 does not alter the operation of the oscillator. The function of the oscillator in the arrangement shown in Figure 3 is only to provide energisation of the point corresponding to the point 37 in Figure 2, that is to say a point on the conductive paths between the touch plate 21 and the input 20 to the comparator 18.

For the sake of simplicity, Figure 3 shows only the comparator 18 and those components which are connected thereto. It will be understood normally that the remainder of the circuit will be similar to that shown in Figure 2.

In the circuit shown in Figure 3, the point 37 is connected to earth by way of a resistor 36, which normally must be of the order of 1 megohm, or greater. An oscillator circuit 38, provides an alternating output of which the negative excursions are eliminated by a shunt circuit consisting of resistor 39 and diode 40. The resultant, clipped, output of the oscillator is fed by way of a 0.1 microfarad capacitor to the junction point 37. Thus the potential of the point 37, which

would vary about a mean just above the potential at the input 19 of the comparator 18, as excursions extending from a potential just above the potential at the input 19 and greater, the extent of these excursions being of no consequence.

When the touch plate 21 is touched, the discharge path which is provided between the junction point 37 and earth is sufficient to lower the potential at the point 37 below the potential at the input 19 to the comparator 18, so that the comparator provides an output which switches the flip-flops 17 as previously described. For this purpose it does not matter whether the discharge path provided between the touch plate 21 and earth is resistive or capacitative.

CLAIMS

1. A touch sensitive switching arrangement comprising a supply input, a potential divider arranged to be energised with direct current from the supply terminal, means for stabilising the voltage across a potential divider, a comparator having one input connected to a point on a potential divider and a second input which is at a potential slightly different from that of the first input, the comparator being capable of detecting a discharge current through the second input of the order of 20 microamperes, and a touch plate connected to said second input.

2. An arrangement according to claim 1 in which only the touch plate is connected to the said second input.

3. An arrangement according to claim 1 in which the second input is connected to another voltage divider which provides a stabilised potential for the second input.

4. An arrangement according to claim 1 in which a junction point between the touch plate is provided with a voltage from an oscillator of which the output is rectified such that the voltage excursions at said junction point are insufficient in the absence of a discharge path through the touch plate to cause triggering of the comparator.

5. An arrangement according to any foregoing claim in which an output circuit triggered by the comparator includes a latched relay of which the energisation effects illumination of an indicator.

6. An arrangement according to claim 5 in which the indicator protrudes through an aperture in the touch plate.

7. A touch sensitive switching arrangement substantially as hereinbefore described with reference to Figure 2 or Figure 3 of the accompanying drawings.

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