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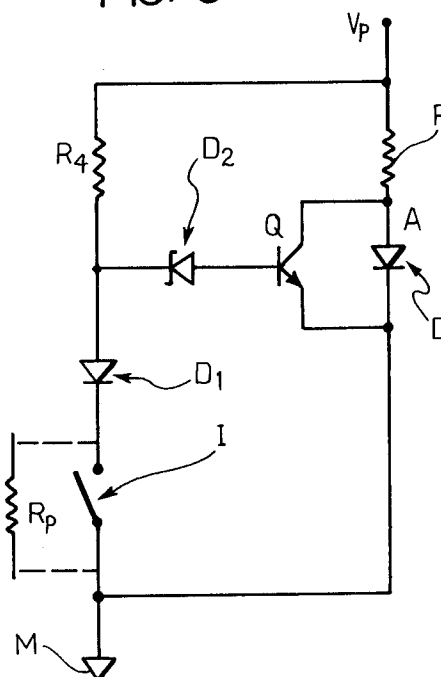
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I-10121 Torino (IT)(54) **A circuit for signalling the state of an electric switch for example, to signal the failure of a vehicle door to close.**

(57) A circuit for indicating the state of an electrical switch (I), usable for example as a signalling interface for a door open check. The circuit includes a transistor (Q) which works in current subtraction relationship with respect to the indicator element (D).

FIG. 3**EP 0 567 877 A1**

Field of the Invention

The present invention relates in general to devices for signalling the state of an electric switch, for example, for optical signalling of the functioning state (open/closed) of the switch. The invention can be used, for example, for signalling by indicator lights, on board a vehicle of the open or closure state of electrical switches disposed at various points around the vehicle for the purpose of providing information useful to the driver.

In the instrumentation equipment of a motor vehicle, wide use is made of indicators (visible and audible) which can provide signals useful to the driver. Generally, said signals are provided by small incandescent lamps which provide back lighting to specific areas of the instrument on which specific symbols are reproduced (for example by printing). Some times such indicators are also fitted to control panels and other controls.

For several years some of the said lights have been made not with incandescent lamps but with light emitting diodes (LED), primarily for miniaturization reasons.

Some light signalling functions are implemented directly by switches which operate in series with the associated indicator lamps. This is the case with the indication of some liquid level indicators, and also with indicators for the state of opening of the doors, boot lid or the like.

Many motor cars, for example, are provided with a device (some times called "door check") which signals if, and which, door remains open in such a way that the driver is alerted to close it.

The necessary signals are provided by electrical switches mounted on the door jambs or within the locks and are actuated mechanically upon opening or closure of the door. Similar applications arise for indicating if a liquid level is low, for example, to indicate the level of the engine coolant liquid. In this case the switch is constituted by a reed relay which detects the position of a float carrying a magnet, by means of which the relay contact is actuated when the level falls below a predetermined value.

Technical Problem Underlying the Invention

A technical problem has arisen in connection with what has been explained above, above all with the use of LEDs in place of incandescent lamps, due to the fact that the control switches mounted on the vehicle are generally exposed to moisture, dirt and other atmospheric agents typical of the motor vehicle environment.

This results in the switches, rather than having a theoretically infinite or in any case very high resistance when in the open state, instead having a

very low resistance (for example, 1KOhm) because of current leakage between the two contacts.

This occurs even with intrinsically sealed contacts because the leakage can occur at other locations, for example, on the cable connectors of the motor car, for example when this is not in a position well protected against the above-mentioned agents.

From tests which have been conducted it is possible to measure resistances sometimes equivalent to less than 1KOhm.

Description of the Prior Art

Usually, if a switch directly controls an indicator lamp, the normalized power of which is in the region of 1Watt, this does not involve operating ambiguity. Such ambiguity can on the other hand exist, for example, when the switch controls an LED in a system such as shown in Figure 1. In this arrangement, the LED indicated D is connected between the battery voltage Vb and earth M with the interposition of a resistor R and under the control of the switch I.

The switch I when in the closure state, closes the circuit between the battery voltage Vb and the earth M thereby activating the LED D.

When, on the other hand, the switch I is in the open state, the passage of current between the battery voltage Vb and earth M is prevented so that the LED is deactivated.

It can happen, however, whenever the equivalent resistance Rp exhibited by the switch I in the open state is very low (for example, less than 1KOhm), the LED D is in any event activated giving rise to an erroneous signal.

In particular, if the LED forms part of an on-board instrument and must be illuminated only when the switch I is closed, it can happen that the LED is illuminated more or less weakly because of moisture, dust or whatever else causing a current leakage through the switch I (resistance Rp very low).

In certain conditions, such as for example during night driving, activation of a warning light or just an indicator light even if weakly illuminated, disturbs the driver. In approximate terms given the variability in the types of LED diodes used, several tenths of a microamp of current can give rise to a perceptible luminous effect in a dark environment.

Known solutions for providing a functional improvement with respect to the problem described consist in interposing a transistor as in the circuit illustrated in the example of Figure 2. In this case, with respect to the Figure 1 circuit, the passage of current through the LED D is controlled not directly by the switch I, but by a transistor T in turn selectively controlled to adopt a switched-off state

or a saturation state by the switch I.

In particular, the switch I acts via a decoupling diode D1 the presence of which has no relevance on what is discussed here, on a network of three resistors R1, R2 and R3 which set the biasing of the base of the transistor T.

When the switch I is open the transistor T is turned off and the LED D is deactivated. On the other hand, when the switch I is closed, the transistor T is saturated and the LED D is activated.

In the Figure 2 circuit, the transistor T acts specifically as a current amplifier which allows a transition between light and dark of the LED for a very much narrower range of leakage resistance R_p than the circuit of Figure 1.

In particular, in the Figure 1 circuit, the curve which represents the current through the diode D as a function of the leakage resistance R_p has a hyperbolic shape. For a fixed value of the minimum threshold for the current in the LED, below which the LED can be considered to be securely extinguished, it is noted that the curve of the current intercepts this value at rather higher values of R_p , in the region of several KOHms.

In the case of the improved circuit of Figure 2, the curve of the current as a function of resistance R_p has a pronounced commutation knee; the current curve intercepts the threshold value for resistance values R_p very much lower than in the case of the circuit of Figure 1.

It has been established, however, that in practical embodiments the circuit of Figure 2, whilst improved, does not ensure that in extreme cases, in which there is such a leakage with the switch open as to bring the value R_p to about 800-1000 OHms, the current is below the above indicated minimum value.

It is in fact inevitable that if the circuit is dimensioned so that the knee in the characteristic is about 500-700 OHms as required for a correct operation even in the above-mentioned extreme cases, the minimum current value is intercepted for values of R_p equal to three or four times the previous value, that is to say, 1500-3000 OHms, which is still too high.

A further improvement could be obtained by inserting in the Figure 2 circuit a zener diode (for example, with a threshold voltage of 4.7 volts) in series with a resistor R2, without however, achieving the desired objective.

Objects and summary of the invention

The present invention, therefore, sets out to provide an entirely satisfactory solution to the previously explained problems, avoiding the disadvantages of the prior art. According to the present invention, this object is achieved by a circuit having

the characteristics set out in the following claims.

In summary, the present invention is based on the principle of associating with the electrical warning element D sensing means D_z, Q, R_4 for detecting the state of the electrical switch I connected to the indicator element D in current subtraction relationship so that when the switch I is in a first operating state the sensing means D_z, Q, R_4 drain current from the indicator D which is therefore deactivated, and when the switch I is in a second operating state, the sensing means D_z, Q, R_4 allow a certain passage of current through the indicator element D which is thus activated.

Detailed Description of the Invention

The invention will now be described purely by way of non-limitative example, with reference to the attached drawings in which:

Figures 1 and 2 relate to the prior art and have already been described hereinabove;

Figure 3 illustrates, in the form of an electric diagram, a possible embodiment of the invention; and

Figure 4 is a diagram which illustrates the operation of the circuit of Figure 3.

In Figure 3 elements or components identical or having an equivalent function to those illustrated in Figures 1 or 2 have been indicated with the same reference numerals used in the description of these preceding figures.

This, in particular, includes the switch I which exhibits a resistance R_p when open, the LED diode D, the resistor R and the diode D1.

In the Figure 3 circuit the LED diode D has the cathode connected to the emitter of an NPN transistor Q and the anode connected to the collector of the transistor Q. The emitter of the transistor Q is in turn connected to earth M whilst the collector is connected via the resistor R to the battery voltage V_b , which is understood to be positive.

The base of the transistor Q is connected to the anode of a Zener diode D_z . The cathode of the zener diode D_z is connected, via resistor R_4 , to the battery voltage V_b and is further connected to the anode of the diode D1. The cathode of the diode D1 is connected to one of the terminals of the switch I, the other terminal of the switch I being connected to earth.

For (non-limitative) reference purposes, the values of the resistors R and R_4 can, for example, be equal to 820 Ohms and 1KOhm respectively.

In operation, described by way of example, when the switch I is open, a current exists which via D_z enters the base of the transistor Q maintaining it in saturation and therefore subtracting current from the diode D, which is therefore extinguished. This is true even when the resistance R_p across

the terminals of the switch reaches very low values, of the order of 700-800 Ohms.

When the switch I is closed the resistance across its terminals is practically zero so that the cathode of the zener diode Dz is at a voltage close to the ground voltage. The diode Dz is therefore switched off preventing the passage of current to the base of the transistor Q, which is therefore switched off permitting all the current to pass to the diode D which in this way is activated.

The diagram of Figure 4 illustrates, with reference to the circuit of Figure 3, the variation of the current through the diode D (along the ordinate) as a function of the resistance Rp of the switch I (along the abscissa).

In this Figure it is seen that when the switch I is closed, that is when there is a resistance of a few Ohms across its terminals, the current in the diode D is at a maximum and provides the maximum illumination; if the switch is open, only leakage current corresponding to resistance less than 700-800 Ohms can cause unwanted illumination in the LED diode. This, however, is a leakage value which is never encountered in practice.

In principle, since the proposed circuit works by subtracting current from the diode D, even with the switch open an unwanted illumination of the diode D could occur for low supply voltages. However, with the indicated values in the circuit proposed in Figure 3, this could occur only for battery voltage Vb of about 4-5 volts, which values are entirely anomalous and would not be encountered in any event during correct operation of the motor vehicle electrical equipment.

It is to be noted that the proposed embodiment of the present invention discussed hereinabove has purely exemplary characteristics and is not limitative of the present invention. A man skilled in the art will easily be able to put the present invention into practice in a different way, which, however, does not depart from the principles explained here and which therefore fall within the scope of the present patent.

This in particular relates to the possibility of replacing the bipolar transistor Q described with reference to Figure 3, with a component (for example, a field effect transistor FET) capable of performing a selective current subtraction operation with respect to the indicator element (LED D in the illustrated example).

Claims

1. A circuit for indicating the state of an electric switch (I) comprising:
 - an electrical indicator element D,
 - means (Dz,Q,R4) sensitive to the state of said electrical switch (I) and capable of activat-

ing said electrical indicator element (D), characterised by the fact that:

said means (Dz,Q,R4) sensitive to the state of said electrical switch are connected to said indicator element (D) in current subtraction relationship such that when said switch (I) is in a first operating state said sensing means (Dz,Q,R4) drain current from said indicator element (D) which is therefore deactivated, and when said switch is in a second operating state said sensing means (Dz,Q,R4) allow certain passage of current through said indicator element (D) which is thus activated.

2. A circuit according to claim 1, characterised by the fact that said sensing means (Dz,Q,R4) comprise a transistor (Q) the emitter and collector of which are connected to the terminals of said electrical indicator (D) in such a way that when said transistor (Q) is in saturation conditions said indicator element (D) is deactivated, and when said transistor (Q) is turned off said indicator element (D) is activated; said transistor (Q) being operatively connected to said electrical switch (I) in such a way that a change of state of said electrical switch causes commutation of said transistor between saturation and switched-off conditions.
3. A circuit according to claim 1 or claim 2, characterised by the fact that said electrical indicator element is a light-emitting diode (D).
4. A circuit according to claim 2 and claim 3, characterised by the fact that the cathode of said diode (D) is connected to the emitter of said transistor (Q) and the anode of said diode (D) is connected to the collector of said transistor (Q).
5. A circuit according to claim 2, characterised by the fact that a biasing resistor (R) is positioned between the collector of said transistor (Q) and the supply voltage (Vb).
6. A circuit according to claim 2, characterised by the fact that the emitter of said transistor (Q) is connected to earth.
7. A circuit according to claim 2, characterised by the fact that said sensing means sensitive to the state of said electrical switch are constituted by an electrical network (R4,Dz,D1) connected to the base of said transistor (Q).
8. A circuit according to claim 7, characterised by the fact that said electrical network includes: a zener diode (Dz) which controls the biasing of

the base of the said transistor (Q).

9. A circuit according to claim 8, characterised by the fact that the anode of said zener diode is connected to the base of said transistor (Q). 5
10. A circuit according to claim 7, characterised by the fact that said electrical network includes a resistor (R4). 10
11. A circuit according to claims 7,8 and 10, characterised by the fact that said biasing resistor (R4) of said electrical network is connected on one side to the positive supply terminal and on the other is connected to the cathode of said zener diode. 15
12. A circuit according to claim 7, characterised by the fact that said electrical network includes a diode (D1). 20
13. A circuit according to claims from 7 to 12, characterised by the fact that the anode of said diode (D1) of said electrical network is connected to the cathode of said zener diode (Dz) whilst the cathode of said diode (D1) is connected to one of the terminals of said electrical switch (I), the other terminal of said electrical switch being connected to earth (M). 25
14. A circuit according to claims from 7 to 11, characterised by the fact that the resistance of said resistor (R4) and the threshold voltage value of said zener diode (Dz) are chosen in such a way that the commutation of said transistor takes place for a desired resistance value (Rp) between the two terminals of said electrical switch (I). 30
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FIG. 1 PRIOR ART

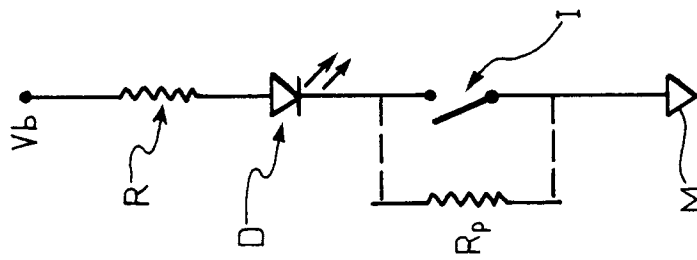


FIG. 2 PRIOR ART

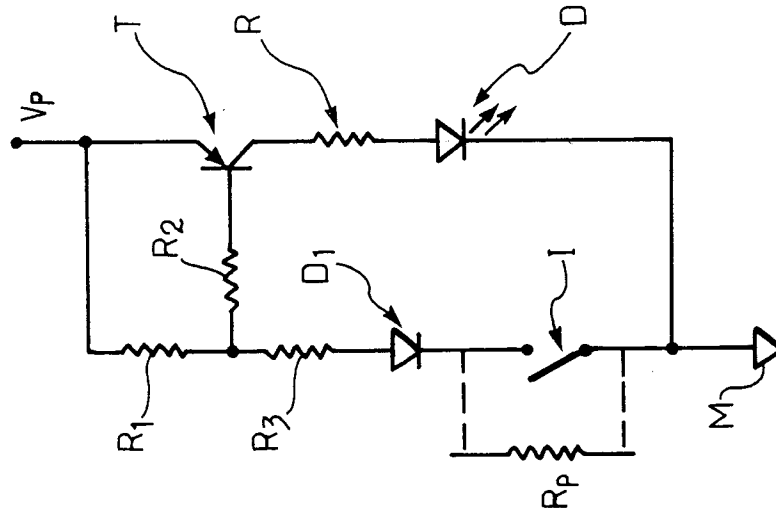


FIG. 3

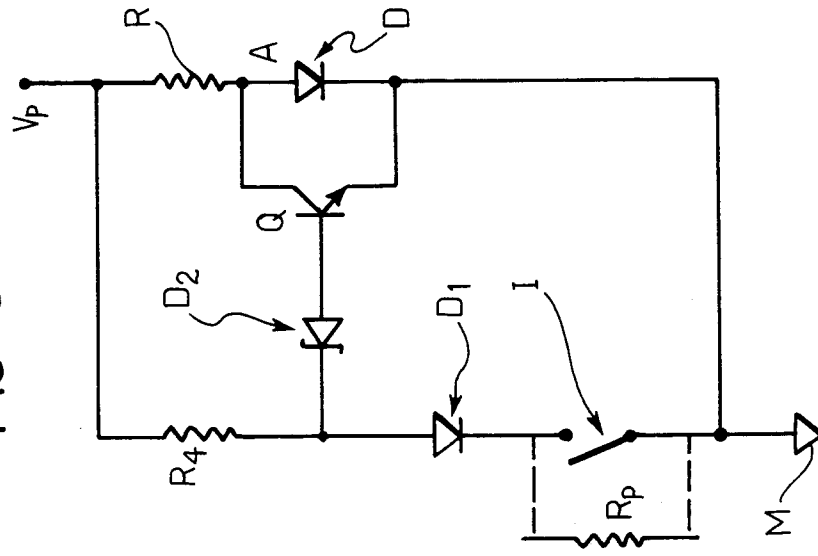
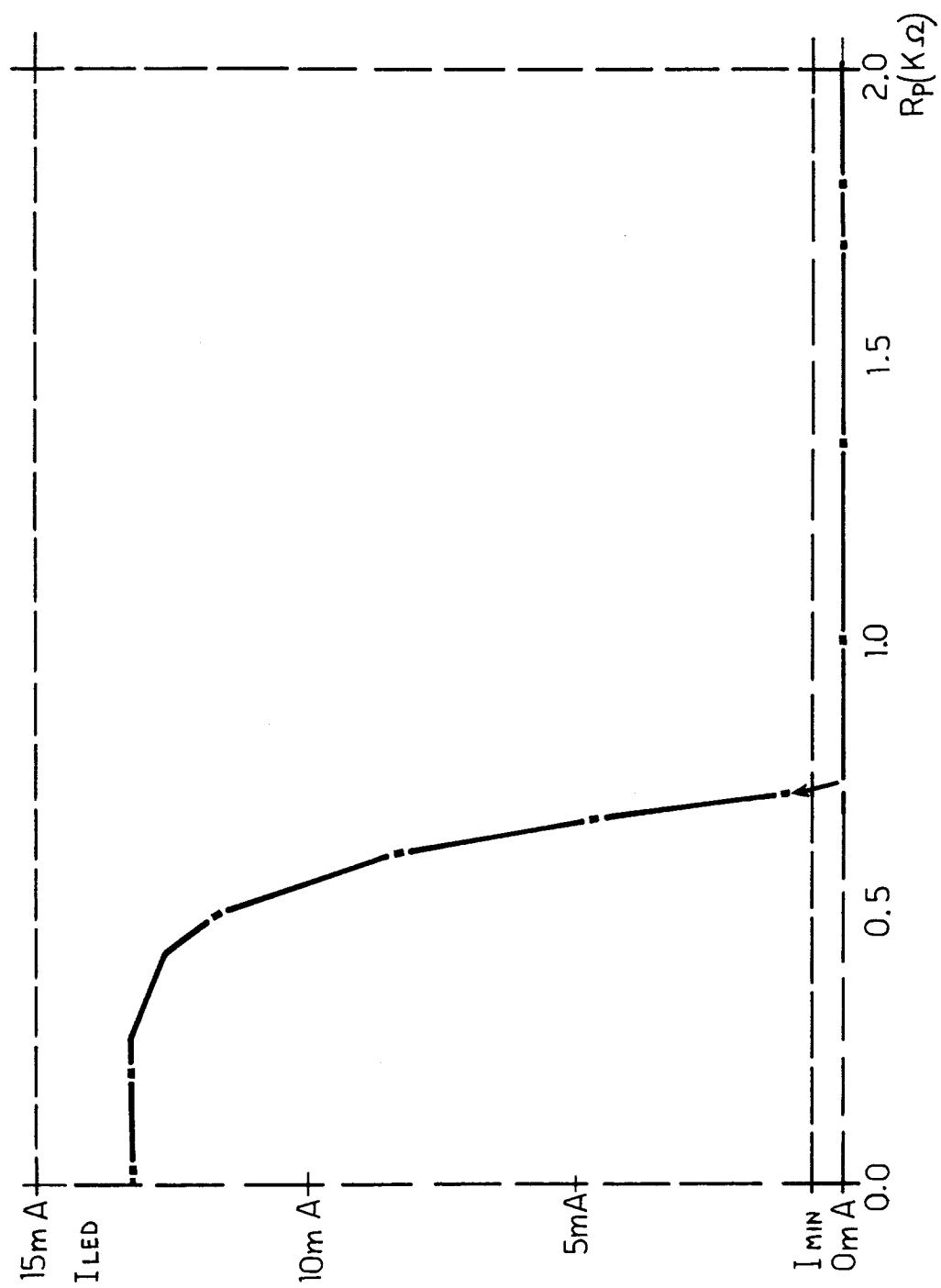


FIG. 4





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EUROPEAN SEARCH REPORT

Application Number

EP 93 10 6288

DOCUMENTS CONSIDERED TO BE RELEVANT

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
Y	US-A-4 017 847 (BURFORD ETZ AL.) * column 3, line 35 - column 5, line 55; figures 3,4 * ---	1-14	G08B23/00
Y	EP-A-0 271 267 (EMHART INDUSTRIES,INC.) * column 2, line 54 - column 3, line 26; figure 2 * -----	1-14	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			G08B
The present search report has been drawn up for all claims			
Place of search THE HAGUE	Date of completion of the search 21 JULY 1993		Examiner REEKMANS M.V.
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