

PATENT SPECIFICATION

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(54) ELECTRICAL LAMP FAILURE INDICATING CIRCUITS

(71) I, GORDON ALAN KING, a British subject, of ARACUS INDUSTRIAL MARKETING SERVICES, 8, Wroxham Mansions, 36, Canfield Gardens, London, N.W.6., do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:

10 The invention includes electrical circuits for providing an indication of failure of one or more lamps. Although the invention is not so restricted, it will be described with reference to a motor vehicle lamp failure warning system; another example is in the field of lamp failure warning systems in automated process or machinery control panels.

20 According to the invention an electrical circuit which provides an indication of failure of one or more lamps includes one or more resistive elements connected respectively in series with the or each lamp, first normally non-conductive semiconductor switch means arranged to be biased conductive by the potential developed at the junction of any lamp and its associated resistive element following failure of that lamp, and second normally non-conductive semiconductor switch means arranged to be biased conductive and to operate an electrical indicating device whenever the first said switch means conducts.

35 Thus, circuits according to the invention may be used to monitor the continuity of operation of lamps, e.g. brake lights, in a motor car and to provide a visual indication upon failure of one or more of them.

40 Preferred embodiments of electrical circuits in accordance with the invention will now be described by way of example with reference to the accompanying drawings in which:

[Price 25p]

Figure 1 is a circuit diagram illustrating the electrical circuit according to the invention; and

Figures 2 and 3 are circuit diagrams illustrating modified versions of the circuit of Figure 1.

In Figure 1 the positive and negative terminals of a battery 10 are connected to the supply lines 11 and 12 respectively of the circuit. Wiring resistance between the battery 10 and circuit is indicated by a resistor 13 and circuit protection, in the form of a fuse 14, is also provided. The two lamps to be monitored, which may be vehicle brake lamps, are referenced 15A and 15B and are connected in series with resistors 16A and 16B and manually operable lamp switches 17A and 17B, respectively, extending between the lines 11 and 12. The junctions of the lamps 15A and 15B their individually associated resistors 16A and 16B are connected through respective diodes 18A and 18B to the emitter of a p-n-p transistor 19. The collector of transistor 19 is connected to line 12 via a pair of series-connected resistors 20 and 21. The base of transistor 19 is connected to line 12 by a resistor 22 and to line 11 by a pair of series-connected diodes 23 and 24, as shown. The two diodes 23 and 24 are included in the circuit to balance the forward voltage drop across the diodes 18A and 18B and the emitter-base junction of transistor 19.

An n-p-n transistor 25 is provided in the circuit with its base connected to the junction of resistors 20 and 21, its emitter coupled directly to line 12 and its collector connected to line 11 via an indicating lamp 26 and a lamp-protecting resistor 27. When the switches 17A and 17B are both open and the filaments of the lamps 15A and 15B are sound, the potential at each anode of the

diodes 18A and 18B is substantially the potential of line 12. Thus the transistor 19 is biased OFF. If one or both of the switches 17A, 17B is or are closed, the potential at the anodes of the diodes 18A or 18B will rise to a value determined by the potential drop across the resistors 16A, 16B. The values of resistors 16A, 16B are chosen such that transistor 19 is maintained OFF. If one of the lamps, 15A say, should fail, the potential at the anode of the associated diode 18A will rise until this diode is forwardly biased and transistor 19 turns ON. Once transistor 19 is ON, current is drawn from the line 11 via resistors 16A or 16B and diodes 18A or 18B and is passed to the collector of this transistor. The current flowing through the resistors 20 and 21 will raise the potential on the base of transistor 25 from that of the line 12 and the resistance values of resistors 20 and 21 are chosen such that transistor 25 turns ON and illuminates the lamp 26.

It has been found that the potential drop required across the resistors 16A, 16B is, when the circuit is implemented using commercially available components, of the order of 100 to 300 millivolts. This may be a disadvantage when, for example, the supply voltage is low and the potential drop across resistors 16A, 16B may be a substantial proportion of the total available voltage.

An advantage of the modified forms of the circuit shown in Figures 2 and 3 is that each is arranged such that the resistance value of the resistors in series with the monitored lamps may be substantially reduced. Those of the components of the circuit illustrated in Figure 2 which correspond to the components shown in Figure 1 are given the same reference numerals.

The junction of the lamps 15A, 15B and resistors 16A, 16B are in their circuit arrangement coupled directly to respective ones of the emitters of a multiemitter transistor 30, the base of which is biased from a potential divider including a single diode, 31 and the resistor 22. The emitter-base junctions of the transistor 30 perform the blocking function of the diodes 18A, 18B used previously.

The operation of the circuit shown in Figure 2 is essentially the same as that previously described; failure of either lamp 15A, 15B will raise the potential at one of the emitters of transistor 30, turning this transistor ON. The collector current of transistor 30 will generate a potential on the base of the transistor 25 turning this transistor ON and illuminating the lamp 26.

It will be appreciated that the omission of the diodes 18A, 18B and the replacement of the diodes 23 and 24 by a single diode 31 reduces the difficulty in matching the forward potential drops across them. It has been

found that the potential drop required across resistors 16A, 16B when the circuit of Figure 2 is implemented using integrated circuit technology is less than 100 millivolts, and may be as low as 50 millivolts, as a result of the automatic matching of the diode parameters in a "chip".

A feature of the two circuits so far described is that the indication of lamp failure is provided only whilst the corresponding switches 17A, 17B are closed. The modified circuit illustrated in Figure 3 shows one way of "staticising" or rendering permanent the failure indication.

In the circuit of Figure 3 the lamps to be monitored include a first pair of lamps 33A and 33B connected serially, as shown, to respective resistors 34A and 34B. These two lamps are controlled by a single switch 35, which may be for example a road vehicle brake light switch. A second switch 36 passes current through a resistor 37 to one or other of two lamps 38A and 38B in dependence on the setting of a two-way switch 39, for example, a head lamp dipping switch.

The junctions of lamps 33A and 33B with the resistors 34A and 34B respectively are directly coupled to the emitters of two p-n-p transistors 40A and 40B. The junction of resistor 37 and the switch area of switch 39 is similarly directly coupled to the emitter of a p-n-p transistor 40C. The base potentials of the three transistors 40A, 40B and 40C are provided by potential divider circuits formed, respectively, by diodes 41A, 41B, and 41C, and resistors 42A, 42B, and 42C, respectively, as shown. The collectors of the three transistors 40A, 40B and 40C are connected through diodes 43 to a common line 44 which includes a potential divider formed by resistors 45 and 46. The junction of these two resistors is connected to the control electrode of a low current silicon-controlled rectifier (S.C.R.) 47 the anode of which is connected to line 11 via two lamps 48. The cathode of S.C.R. 47 is connected to line 12 via a resistor 49 which is shunted by a series circuit including a resistor 50, a diode 51 and an electrolytic cell 52. A capacitor 53 is coupled across the resistor 49 as shown.

In operation, failure of either lamp 33A, 33B will raise the emitter potential of the respective transistor 40A or 40B turning it ON. The collector of the conducting transistor will pass current to line 44 and generate a potential across resistor 46. This potential is arranged to turn S.C.R. 47 ON. When S.C.R. 47 conducts, it illuminates the lamps 48 and develops a potential across resistor 49. Thus the circuit including the electrolytic cell 52 will draw current and the state of charge of the cell 52 will indicate the period

WHAT WE CLAIM IS:

1. An electrical circuit which provides an indication of failure of one or more lamps including one or more resistive elements connected respectively in series with the or each lamp, first normally non-conductive semiconductor switch means arranged to be biased conductive by the potential developed at the junction of any lamp and its individually associated resistive element when that lamp fails, and second normally non-conductive semiconductor switch means which is arranged to be biased conductive whenever the first said switch means conducts and is arranged to operate an electrical indicating device when the first switch means conducts. 65 70 75 80
2. An electrical circuit as claimed in claim 1 wherein the first semiconductor switch means includes at least one transistor the potential of the base of which is determined by one or more diodes. 85
3. An electrical circuit as claimed in claim 1 or claim 2 wherein the first semiconductor switch means includes a single p-n-p transistor the emitter terminal of which is connected to the or each said junction through a respective diode. 90 95
4. An electrical circuit as claimed in claim 1 or claim 2 wherein the first semiconductor switch means includes a single multi-emitter transistor some or all of the emitters of which are individually and directly connected to one of the said junctions. 100
5. An electrical circuit as claimed in claim 1 or claim 2 wherein the first semiconductor switch means includes a number of p-n-p transistors the emitter terminal of each of which is connected to a respective said junction, and the collectors of which are respectively connected to a common line. 105 110
6. An electrical circuit as claimed in any preceding claim wherein the second semiconductor switch means comprises a n-p-n transistor the collector circuit of which includes said indicating device and the base-emitter junction of which is connected across one or more resistors, the arrangement being such that in use the potential developed across the resistor when the first semiconductor switch means is conductive biases the n-p-n transistor ON. 115 120
7. An electrical circuit as claimed in any of claims 1 to 5 wherein the second semiconductor switch means comprises a switching device operable in either a conductive or a non-conductive state, and wherein the 125

of time during which the warning lamps 48 have been lit.

Similarly, if either of the lamps 38A and 38B fail while switch 39 closes their circuit connection, then transistor 40C will turn ON and initiate operation of the S.C.R. 47.

The capacitor 53 is provided to shunt high frequency pulses across resistor 46 and stop the S.C.R. 47 turning ON due to momentary operation of one of the transistors 40A, 40B or 40C. For example, if the switch 39 is of the break-before-make type, the transistor 40C will be turned ON for a short period whenever this switch is operated.

It will be seen that the provision of an S.C.R., bridged by a resetting switch (not shown), in place of the transistor 25 enables an indication of lamp failure to be given after the switch controlling the non-operative lamp has opened. The transistor 25 may, within the scope of the invention, be replaced by another form of two-state device, for example by a bistable.

The electrolytic cell 52 provides, in effect, an integration or summing of the current flow through it. It will be seen, therefore that this may be replaced by any other device performing a similar integrating function, e.g. an accumulator or even a suitably connected pulse circuit driving a counter.

The circuits described may, in a road vehicle application, include a Zener diode shunted across the lines 11 and 12 to absorb voltage "spikes" caused, for example, by ignition surges. Again, the circuit may be used to monitor an a-c driven lamp or lamps provided suitable half-or full-wave rectification is effected. A common feature of all the above-described preferred embodiment is their suitability for manufacture by integrated circuit technology, and their adaptability for incorporation into the complete circuitry of motor vehicle electrical system.

It will be further appreciated that the invention is not limited to circuits monitoring the operation of one or two lamps only, but that by suitable connections any number of lamps may be checked. Also the indication of lamp failure may not be of necessity given visually, but may, for example, be given audibly, by operation of a hooter, bell or buzzer.

Finally, it will be understood that the above description with reference to the drawings has been given under the assumption that the road vehicle wiring is of the "negative-earth" type. However, if instead "positive-earth" wiring is used, then the circuitry must be suitably adapted, *inter alia* by replacing p-n-p transistors by n-p-n transistors and *vice versa*, and the accompanying claims should be so interpreted.

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2. An electrical circuit as claimed in claim 1 wherein the first semiconductor switch means includes at least one transistor the potential of the base of which is determined by one or more diodes.

3. An electrical circuit as claimed in claim 1 or claim 2 wherein the first semiconductor switch means includes a single p-n-p transistor the emitter terminal of which is connected to the or each said junction through a respective diode.

4. An electrical circuit as claimed in claim 1 or claim 2 wherein the first semiconductor switch means includes a single multi-emitter transistor some or all of the emitters of which are individually and directly connected to one of the said junctions.

5. An electrical circuit as claimed in claim 1 or claim 2 wherein the first semiconductor switch means includes a number of p-n-p transistors the emitter terminal of each of which is connected to a respective said junction, and the collectors of which are respectively connected to a common line.

6. An electrical circuit as claimed in any preceding claim wherein the second semiconductor switch means comprises a n-p-n transistor the collector circuit of which includes said indicating device and the base-emitter junction of which is connected across one or more resistors, the arrangement being such that in use the potential developed across the resistor when the first semiconductor switch means is conductive biases the n-p-n transistor ON.

7. An electrical circuit as claimed in any of claims 1 to 5 wherein the second semiconductor switch means comprises a switching device operable in either a conductive or a non-conductive state, and wherein the



device is in use operated to change from a non-conductive to a conductive state by the potential appearing across a resistor whenever the first semiconductor switch means conducts.

8. An electrical circuit as claimed in claim 7 wherein there is provided means operable by the second semiconductor switch means to indicate the length of time elapsed since failure of one or more of the lamps.

9. An electrical circuit substantially as herein described with reference to Figure 1

or Figure 2 or Figure 3 of the accompanying drawings.

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