

[54] ELECTRICAL INDICATING CIRCUITS

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3,408,625 10/1968 Skinner..... 340/251
3,421,157 1/1969 Atkins..... 340/251
3,660,813 5/1972 Rumpf..... 340/251

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Attorney—Warren, Rubin, Brucker and Chickering

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[52] U.S. Cl. 340/251, 340/66, 307/218

[51] Int. Cl. G08b 23/00

[58] Field of Search 340/251

[56] References Cited

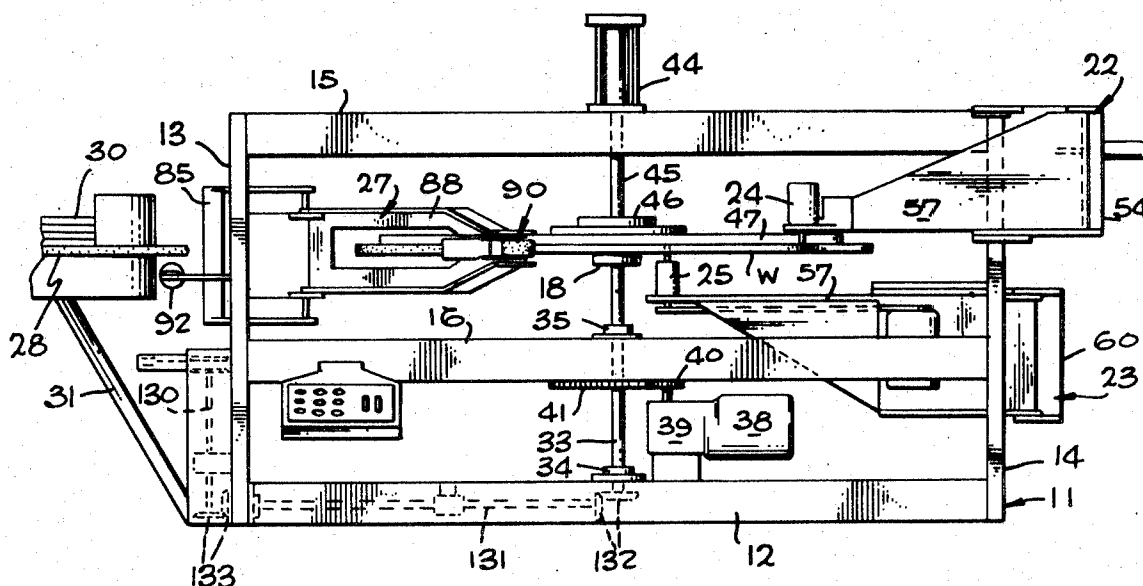
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[57] ABSTRACT

Lamp monitoring and failure indicating circuits are described which employ normally non-conducting semiconductor switches. The circuit potential sensed across a resistor connected to the monitored lamp biases a transistor OFF, holding a second transistor OFF. Thus in normal operation of the lamp the circuit draws no current. A fault turns both transistors ON.

10 Claims, 3 Drawing Figures

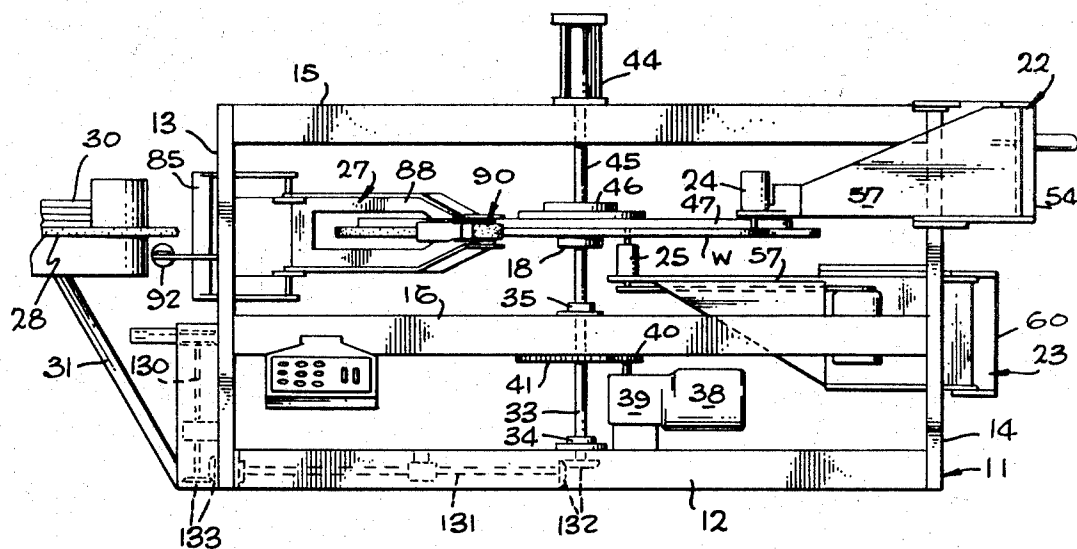


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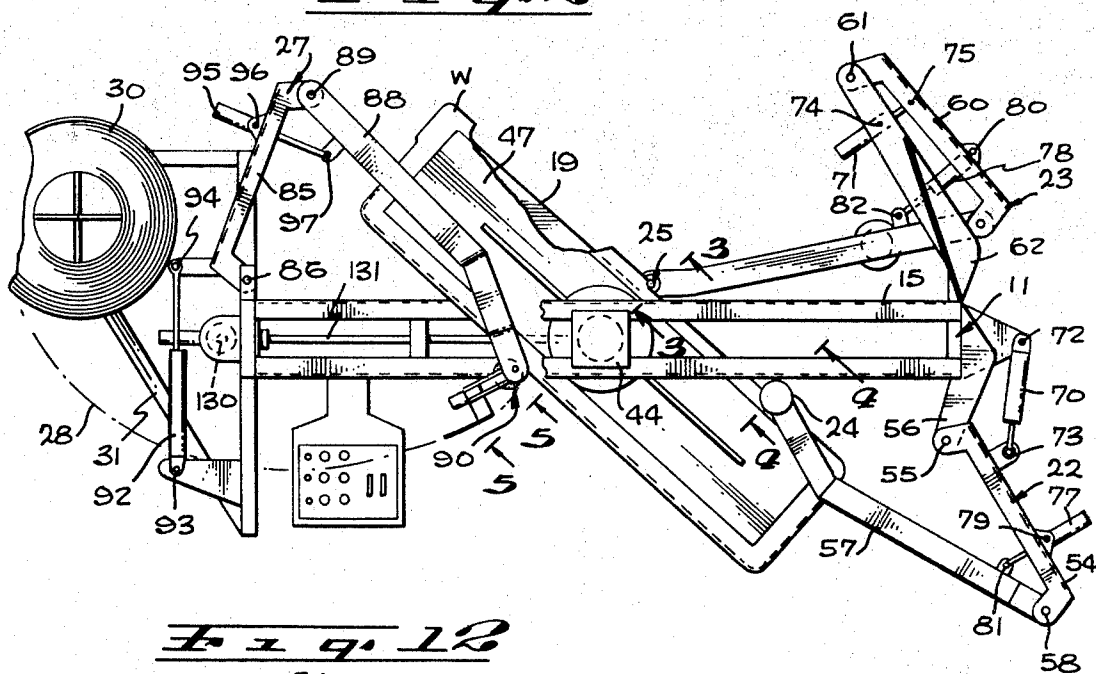
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SHEET 1 OF 2

F 1 q. 1



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Ex. 12

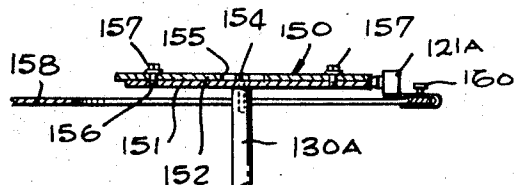


Fig. 3

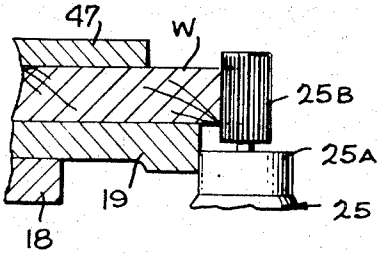


Fig. 4

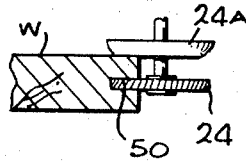


Fig. 5

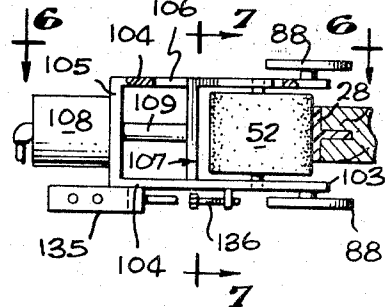


Fig. 6

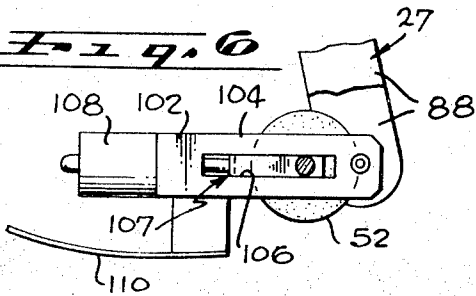


Fig. 7

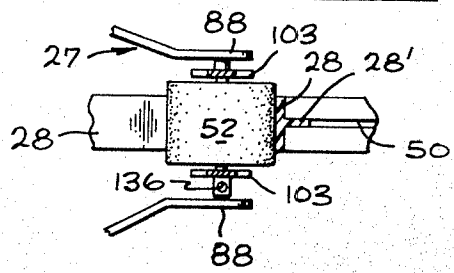
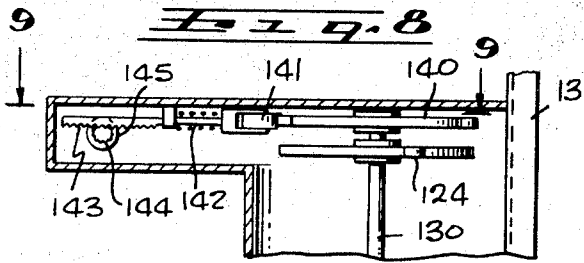


Fig. 9

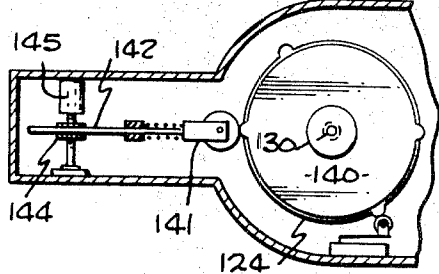


Fig. 10

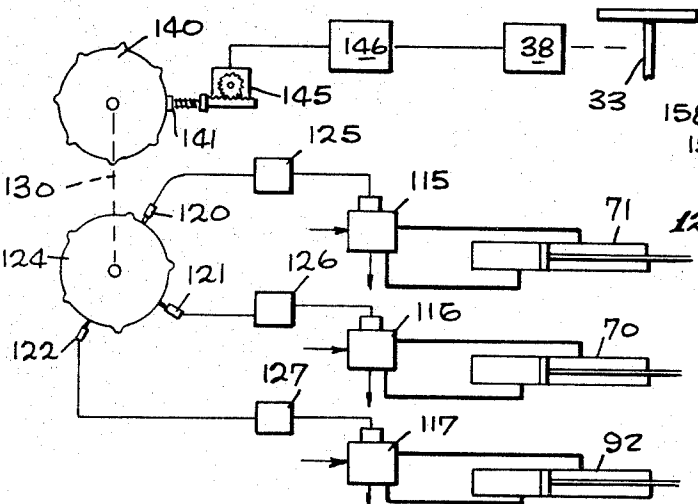
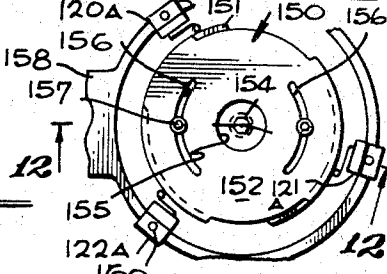


Fig. 11



ELECTRICAL INDICATING CIRCUITS

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.

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.

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.

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:

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

FIGS. 2 and 3 are circuit diagrams illustrating modified versions of the circuit of FIG. 1.

In FIG. 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 and 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, forming an AND circuit. 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 FIGS. 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 FIG. 2 which corresponds to the components shown in FIG. 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 FIG. 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 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 FIG. 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 FIG. 3 shows one way of "staticising" or rendering permanent the failure indication.

In the circuit of FIG. 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 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, forming an AND circuit 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 46 as shown.

In operation, failure of either lamp 33A, 33B will raise the emitter potential of the respective transistor 40A, 40B or 40C 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 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. in place of the transistor 25 enables an indication of lamp failure to be given after the switch controlling 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 embodiments is their suitability for manufacture by integrated circuit technology, and their adaptability for incorpora-

tion into the complete circuitry of a 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.

We claim as our invention:

1. An electrical circuit for mobile vehicles to monitor any of a plurality of lamps, said circuit including: a resistive element connected in series with each of said lamps, a normally non-conductive transistor means connected to the junction of each of said lamps and its associated resistive element to be biased conductive by the failure signal potential developed at such junction when that lamp fails, biasing means for said transistor means including at least one diode, said biasing means connected to said transistor means for setting the potential drop between the base and the emitter of said transistor means, said bias being substantially insensitive to temperature variations, a normally non-conductive semiconductor switch means arranged to be biased conductive whenever the transistor means conducts, AND circuit means coupled to said transistor means for determining actuation of said switch means by said lamp failure signals, and an electrical indicating device connected to be operated by said switch means when the transistor means conducts.

2. An electrical circuit as claimed in claim 1 wherein the transistor means is a single multi-emitter transistor having each of the emitters individually and directly connected to a different one of the junctions of said lamps and individually associated resistive elements, and said AND circuit means includes said emitters.

3. An electrical circuit as claimed in claim 1 wherein the transistor means includes a plurality of p-n-p transistors, the emitter terminal of each of said transistors connected to a different one of the junctions of said lamps and individually associated resistive elements, and a supply line, the collector of each of said transistors connected to said supply line.

4. An electrical circuit as claimed in claim 1 wherein a pair of series connected resistors is connected between the collector of the transistor means and a supply line, the junction of the said resistors connected to bias said semiconductor switch means.

5. An electrical circuit as claimed in claim 1 wherein the semi-conductor switch means comprises a n-p-n transistor, the collector circuit of said n-p-n transistor including said indicating device and the base-emitter junction of the n-p-n transistor connected across at least one resistor, whereby in use the potential developed across the resistor when the transistor means is conductive biases the n-p-n transistor ON.

6. An electrical circuit as claimed in claim 1 wherein the second semiconductor switch means comprises a switching device operable in either a conductive or a

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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 transistor means conducts.

7. An electrical circuit as claimed in claim 6 wherein an integrating device is connected to the semiconductor switch means to indicate the length of time elapsed since failure of one of said lamps.

8. An electrical circuit for monitoring and indicating lamp failure in any one or more of a plurality of lamps in mobile vehicles, comprising: a resistive element connected to each of said lamps, a normally non-conducting sensing transistor connected to a different one of the junctions of each of said lamps and said resistive element connected thereto, first potential divider means connected to and providing the base potentials of each of the sensing transistors, a first diode

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and a resistive element constituting said first potential divider means for each transistor, a second diode connected to the collector of each transistor, second potential divider means connected to said second diode, a normally non-conducting semiconductor switch means having a control terminal and output terminal, the control terminal of said switch means connected to said second potential divider means, and a warning/indicating device connected to said output terminal.

9. An electrical circuit as in claim 8 wherein said warning/indicating device includes an electrolytic cell to indicate the period of time said warning/indicating device has been actuated.

10. An electrical circuit as in claim 8 wherein said normally non-conducting semiconductor switch means comprises a silicon-controlled rectifier.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,774,188 Dated November 20, 1973

Inventor(s) Wolfgang Bial et al.

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

Cancel the drawings and insert Figures 1, 2 and 3, as shown on the attached sheets.

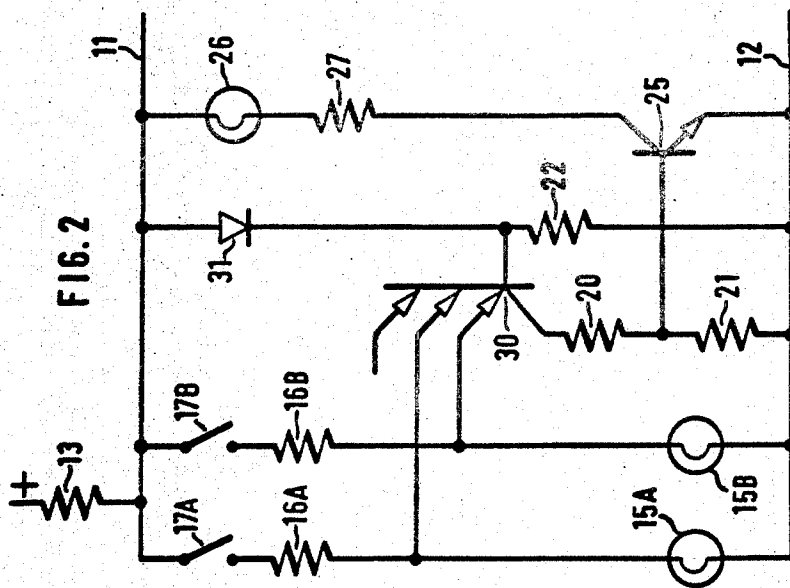
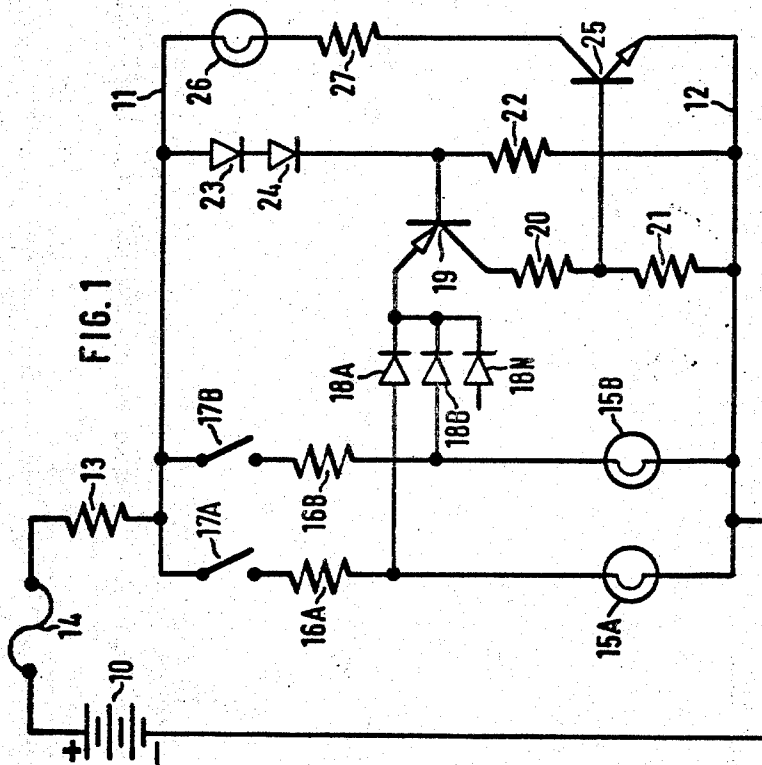
Signed and sealed this 15th day of October 1974.

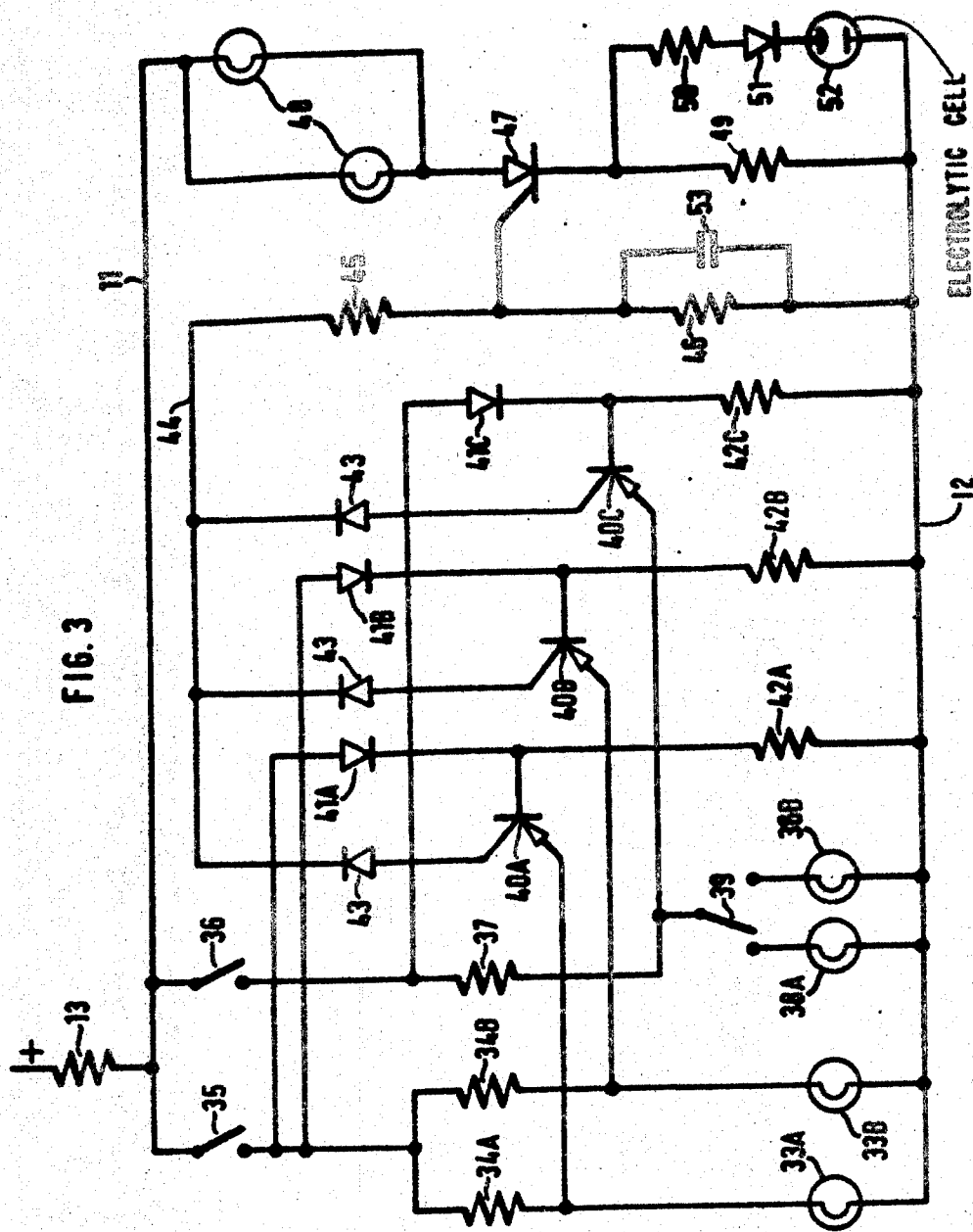
(SEAL)

Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents



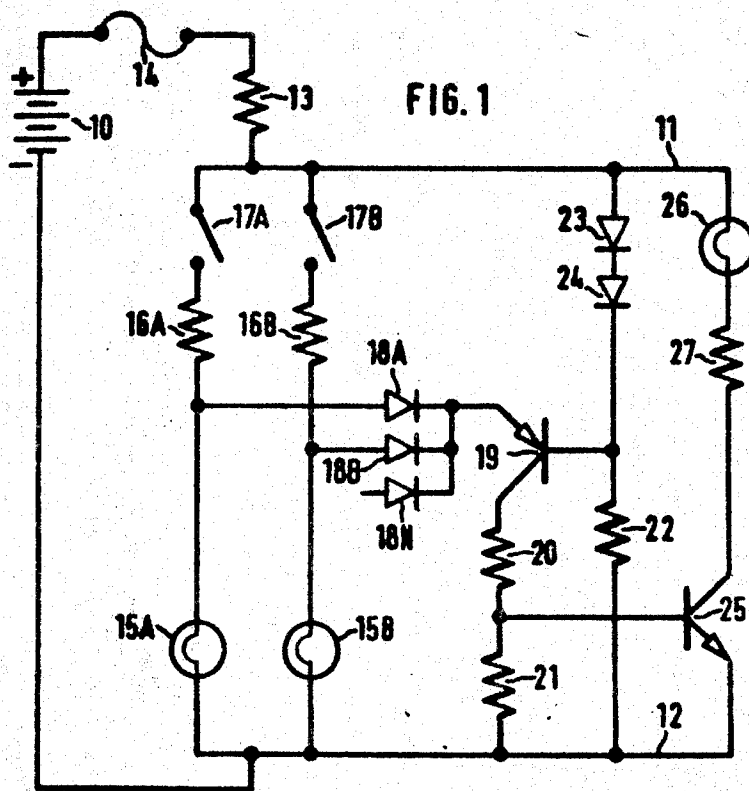


UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,774,188 Dated November 20, 1973
Inventor(s) Wolfgang Bial et al.

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

Delete the figure on the cover sheet and Sheets 1 and 2 of the drawings. Substitute the attached Figs. 1 - 3.



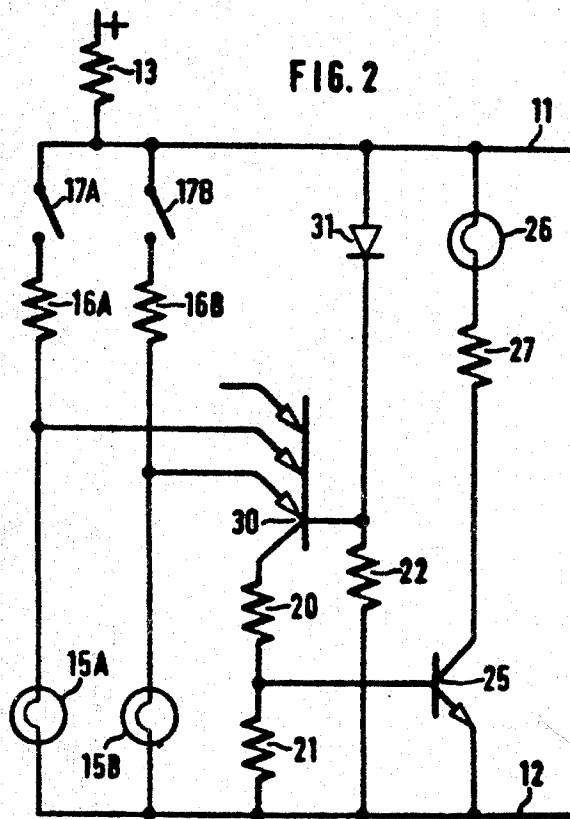
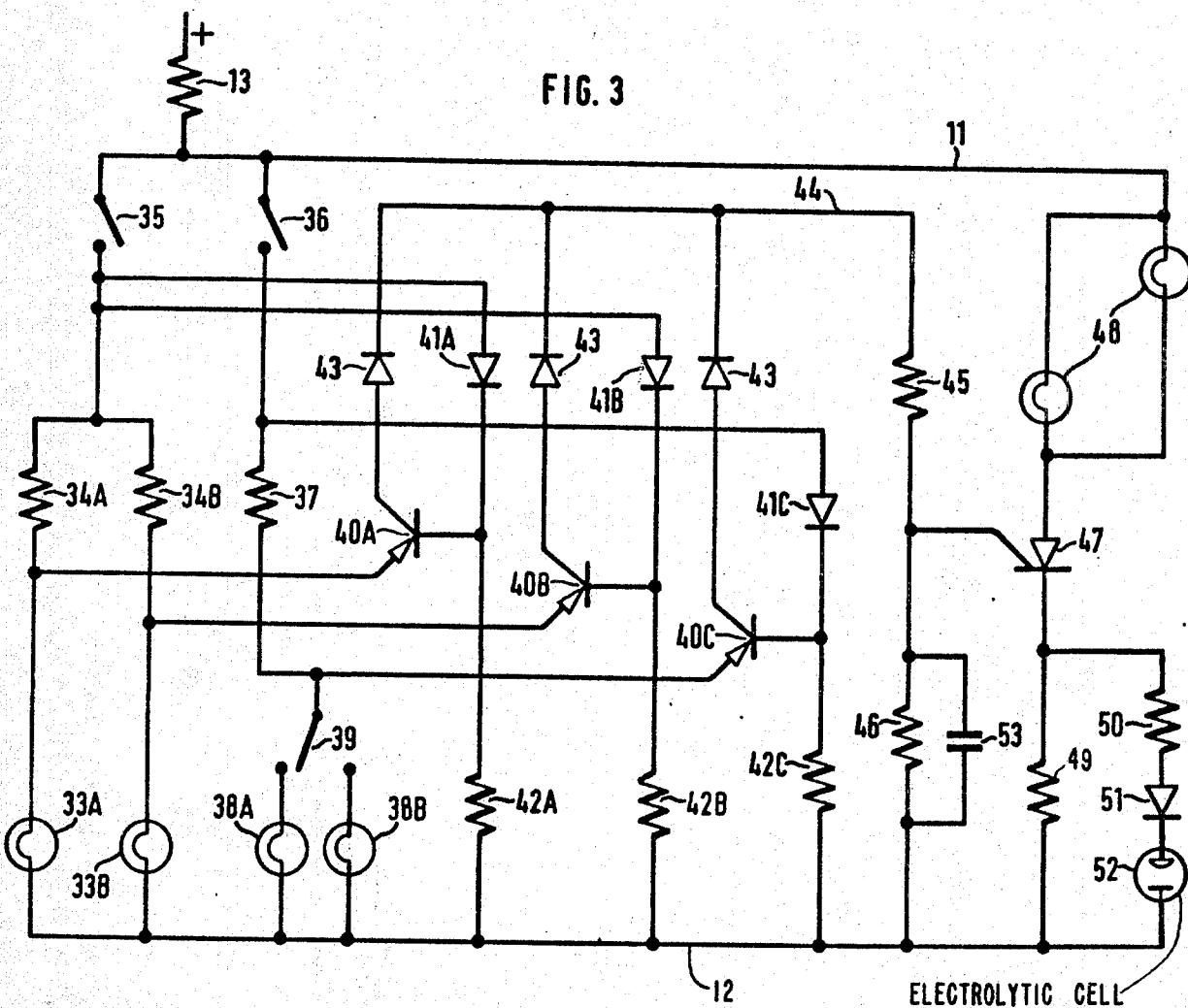


FIG. 3



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CERTIFICATE OF CORRECTION

Patent No. 3,774,188 Dated November 20, 1973

Inventor(s) Wolfgang Bial et al. Page - 4

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

The title of invention should read -- ELECTRICAL BULB FAILURE INDICATING CIRCUITS --. Column 1, after 21, insert the following paragraph:

~~More~~ More particularly, in accordance with the invention, an electrical circuit for mobile vehicles is provided for monitoring any one of a plurality of lamps, and the circuit includes a resistive element connected in series with each lamp and a normally non-conductive transistor means connected to the junction of each lamp and its associated resistive element,

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,774,188 Dated November 20, 1973

Inventor(s) Wolfgang Bial et al. Page - 5

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

to be biased conductive upon the failure of an associated lamp. The biasing means for the transistor means includes at least one diode, and the biasing means is connected to the transistor means to set the potential drop between the base and emitter of the transistor means, the bias being substantially self-compensating for temperature variations. A normally non-conductive switch means is arranged to be biased conductive when the transistor means conducts, and OR circuit means is coupled to the transistor means to determine actuation of the switch means upon failure of a lamp. Electrical indicating means is connected to be operated by said switch means when the transistor means conducts.--

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,774,188 Dated November 20, 1973

Inventor(s) Wolfgang Bial et al. Page - 6

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 47, "AND" should read -- OR --. Column 3, line 14, "AND" should read -- OR --. Column 4, lines 30 and 31, "insensitive to" should read -- self-compensating for --; lines 34 and 44, "AND", each occurrence, should read -- OR --; line 55, after "resistors" insert -- being --; line 55, delete "bias". Column 5, line 7, "elaped" should read -- elapsed --.

Signed and sealed this 4th day of February 1975.

(SEAL)

Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents