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Bolinger

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[54] FLASHER CIRCUIT WITH OUTAGE INDICATION

[72] Inventor: **John F. Bolinger,** Michigan City, Ind.

[73] Assignee: **Meridian Industries, Inc.,** Southfield, Mich.

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[52] **U.S. Cl.**.....**307/202,** 307/240, 307/246, 307/247, 307/252 J, 331/113 S, 317/33 SC

[51] **Int. Cl.**.....**H02h 7/20**

[58] **Field of Search**.....307/202, 240, 246, 252 J, 247; 331/62, 113 B, 113 R; 315/209; 317/33 R, 33 SC, 148.5 R, 148.5 B

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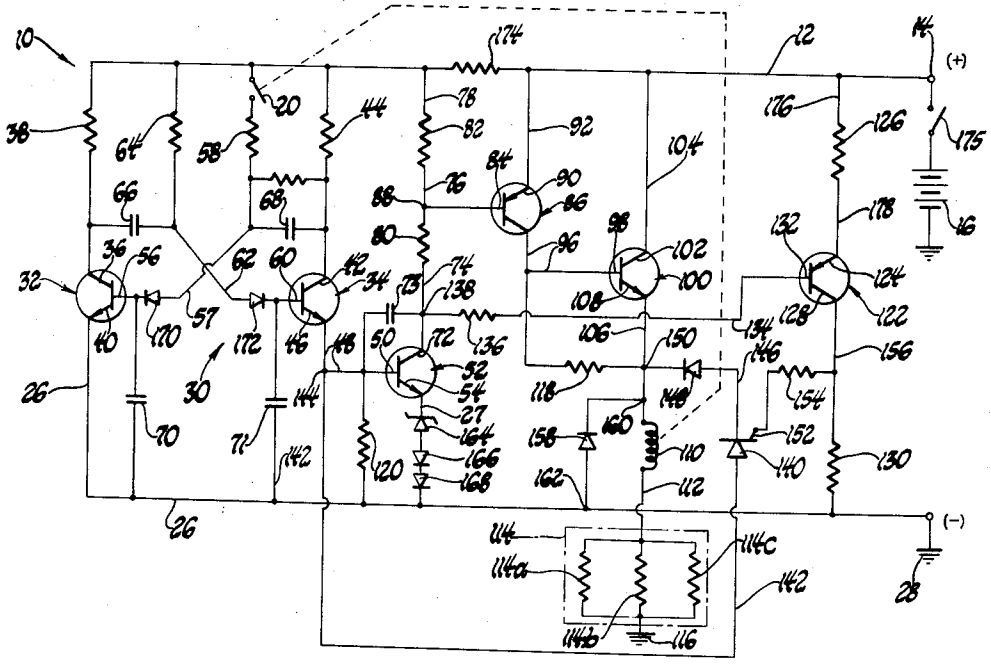
Primary Examiner—John S. Heyman

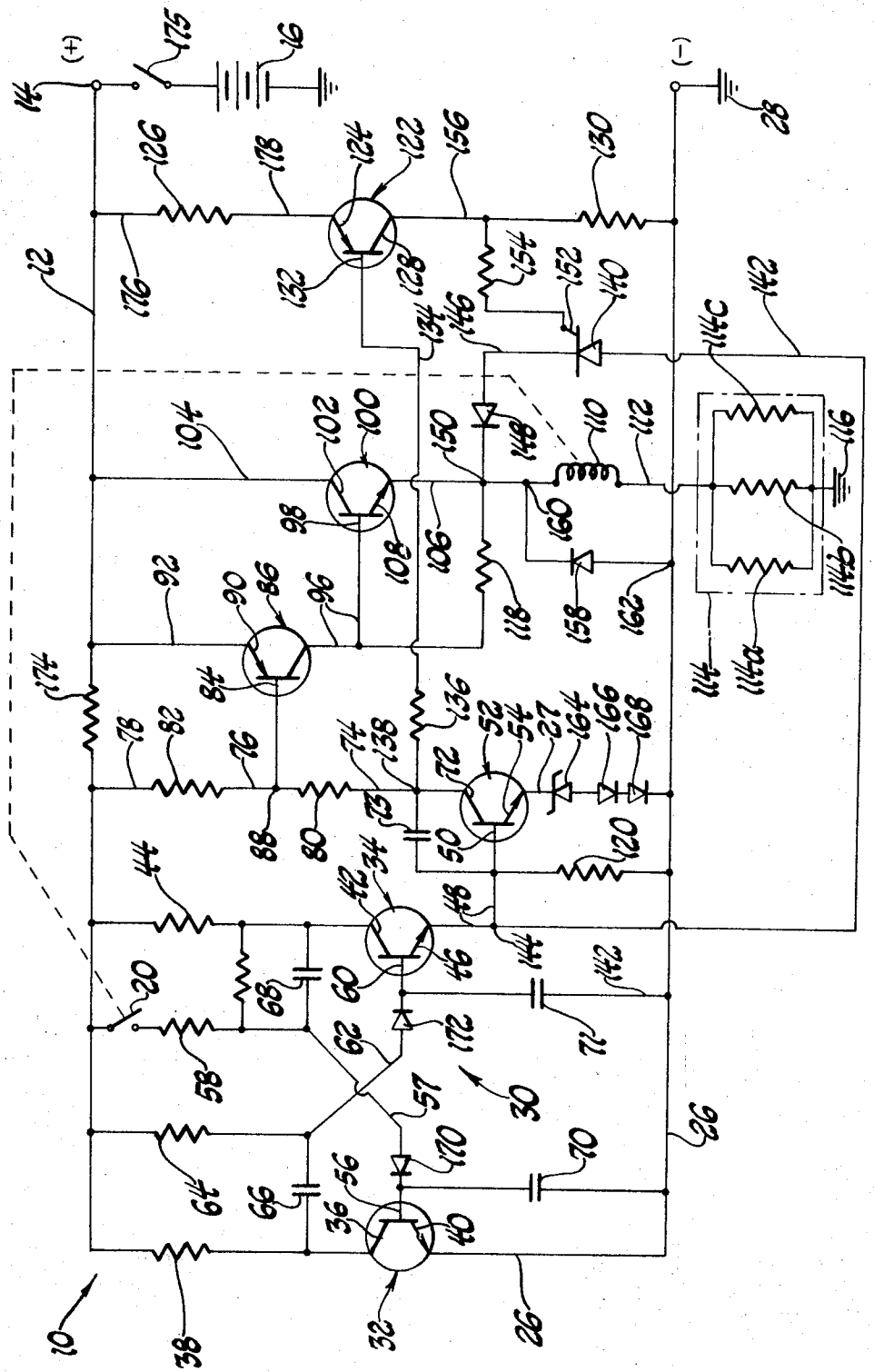
Attorney—McGlyma, Reising, Milton & Ethington, Martin J. Adelman, Allen M. Krass, Owen E. Perry, Thomas N. Young and Stanley C. Thorpe

[57] **ABSTRACT**

A flasher circuit has a power transistor controlling a circuit with a load therein; a multivibrator produces a timed pulse signal applied to the power transistor for turning the power transistor "on"; and additional current sensing means coupled to the load and sensitive to a reduction in the current flow therethrough, due to an outage, is operatively connected to the multivibrator for eliminating the timed occurrence of said signal.

8 Claims, 1 Drawing Figure




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INVENTOR.
John F. Bolinger
BY
Winnie & Comanski
ATTORNEYS

FLASHER CIRCUIT WITH OUTAGE INDICATION

BACKGROUND OF THE INVENTION

Heretofore various circuits have been proposed for use as flasher circuits. However, such flasher circuits have been, and often still are, susceptible to the occurrence of a particular lamp or bulb, within the overall load, becoming burned out. Such occurrences can become dangerous where, for example, the flasher circuit is employed as a directional turn indicator on motor vehicles or an emergency flashing system as on school buses or the like, because the vehicle operator may not have knowledge that a particular lamp or bulb is burned out and is assuming that all pedestrians as well as other vehicles are aware that he is signaling his particular intent to perform a particular vehicular maneuver.

Accordingly, the invention as herein disclosed and described is directly concerned with the solution of the above as well as other related problems.

SUMMARY OF THE INVENTION

According to the invention, a switching circuit comprises electrical load means, a load circuit containing said electrical load means, first load switching means in circuit with said load circuit, second means for cyclically producing a control signal for causing said first switching means to be at times rendered conductive, and additional means responsive to the occurrence of an outage condition in said load means and being effective in response thereto to prevent the said cyclic production of said control signal.

Various general and specific objects and advantages of the invention will become apparent when reference is made to the following detailed description considered in conjunction with the drawings.

DESCRIPTION OF THE DRAWINGS

The single drawing is a schematic wiring diagram of a flasher circuit employing the invention disclosed herein.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now in greater detail, the singe drawing illustrates a flasher circuit **10** comprised of a first conductor **12** having an end **14** suited for connection to a suitable source of electrical potential **16** and a second conductor **26** which leads to ground as at **28**.

A signal producing portion **30** of the circuit **10** is illustrated as comprising oscillator means composed of transistors **32** and **34**. Transistor **32** has its collector electrode **36** connected in series with a resistor **38** leading to conductor **12** while its emitter electrode **40** is connected to conductor **26**. Transistor **34** similarly has its collector electrode **42** connected, in series with a resistor **44**, to conductor **12** while its emitter electrode **46** is connected, via conductor **48**, to the base electrode **50** of a third transistor **52** which, in turn, has its emitter electrode **54** connected to conductor **26** via conductor means **27**.

Base electrode **56** of transistor **32** is electrically connected, via conductor **57**, in series with one end of a resistor **58** which has its other end adapted for connection to conductor **12** as through a switch **20**. Similarly, base electrode **60** of transistor **34** is electrically connected, via conductor **62**, in series with one end of a resistor **64** which has its other end connected to conductor **12**.

A first capacitor **66** has one end or side connected to a point electrically between resistor **38** and collector electrode **36** and the other end or side connected to conductor **62**. A second capacitor **68** similarly has one side connected to a point electrically between resistor **44** and collector electrode **42** of transistor **34** while its other side is connected to conductor **57**. Additionally, capacitors **70** and **71** may be provided so as to have their respective one sides connected to conductors **57** and **62** while their respective other sides are connected to ground through conductor **26**.

The collector electrode **72** of transistor **52** is connected to a voltage divider network comprised of conductors **74**, **76** and **78** between which are serially connected resistors **80** and **82**. Conductor **78** is connected to conductor **12** while the base electrode **84** of a fourth transistor **86** is connected to a point generally between resistors **80** and **82** as at **88** on conductor **76**. Transistor **86**, which may be considered as a switching transistor, has its emitter electrode **90** connected to conductor **12** as by means of a conductor **92** while the collector electrode **94** thereof is connected, via conductor **96**, to the base terminal **98** of a power or load switching transistor **100** the collector **102** of which is connected to conductor **12** by means of conductor **104**. A conductor **106**, connected at one end to the emitter **108** of transistor **100**, has its other end connected to one end of coil means **110** the other end of which is connected to a conductor **112** leading to related electrical load means **114** which, in turn, is connected to ground as at **116**. As shown, a resistor **118** has its opposite ends connected to conductors **96** and **106** while resistor **120** has its opposite ends respectively connected to conductors **48** and **26**.

The circuit **10** may also include short protection means comprised of a shutdown transistor **122** having its emitter **124** connected, through a resistor **126**, to conductor **12** while its collector **128** is connected, through a resistor **130**, to ground as by conductor **26**. The base electrode **132** of transistor **122** is connected, as by a conductor **134** and resistor **136** in series therewith, to conductor **74** as at **138**.

A silicon-controlled rectifier (SCR) **140** has its anode connected, via conductor **142**, to conductor **48**, as at **144**, while its cathode is connected by means of a conductor **146**, which may include a diode **148** serially arranged therewith, to conductor **106** as at **150**. The gate electrode **152** of SCR **140** is connected through a resistor **154** to conductor **156** leading between collector **128** and resistor **130**.

Generally, in order to make an SCR conductive, forwardly, it is necessary to apply a voltage across the anode to cathode terminals of the SCR (making the anode positive, +, with respect to the cathode) and at the same time apply a voltage (or current flow) to the gate-to-cathode circuit by making the gate positive, +, with respect to the cathode. Of course, if after the SCR is made conductive, current flow from the anode to cathode is interrupted, the SCR will again go into its nonconductive state.

In addition to the above, a diode **158** may be connected to conductor **106**, as at **160**, and to conductor **26**, as at **162**. Such a diode **158** has been found to be desirable where the particular circuit employed exhibited high inductance whenever the load was turned "off." The provision of such means as diode **158** serves to reduce such circuit-created high inductance at load turnoff.

Further, it has been found that a zener diode **164** and diodes **166** and **168** are preferably serially provided in conductor means **27** when the associated short protection means disclosed herein is employed. Diodes **170** and **172** respectively connected in the base circuits of transistors **32** and **34**, although not essential to the practice of the invention, are nevertheless preferred in order to serve as voltage limiters for such transistors. In this connection, resistor **174**, in series with conductor **12**, may also be employed as a means of reducing the line voltage to the oscillator or multivibrator section **30**. Capacitors **70**, **71** and **73** are primarily provided as a means of noise suppression in order to prevent transistors **32**, **34** and **52** from going into conduction as a result of stray signals.

OPERATION OF THE INVENTION

In view of the above, it can be seen that each of transistors, **32**, **34**, **52** and **100** are of the NPN type while transistors **86** and **122** are of the PNP type. Accordingly, during normal conduction, in the NPN type, the emitter will be negative with respect to both the collector and base while the collector is positive with respect to both the emitter and base. In the PNP type, normal operation or conduction is achieved when the

emitter is positive with respect to both the collector and base while the collector is negative with respect to both the emitter and base.

Further, transistors **32** and **34** comprise a multivibrator the operation of which is generally as follows. First, for ease of presentation, let it be assumed that switch **20** is nonexistant and that resistor **58** is connected to conductor **12**; further, assuming that a related control switch **175** is closed, let it be assumed that transistor **32** has just switched "on," creating current flow through the emitter-collector circuit **40, 36**, and that transistor **34** has switched "off" or to its nonconducting state. It can be seen that at this particular instant capacitor **66** was fully charged and that the side thereof connected to resistor **64** was negative with respect to the other side of capacitor **66** which is connected to resistor **38** and collector **36**. The circuit through emitter-collector circuit **36, 40** is completed to ground **28** as by conductor **26**. At this time capacitor **68** will be discharged.

Capacitor **66** now starts charging toward the opposite polarity through resistor **64** by virtue of being essentially connected to conductor **26** when transistor **32** is conducting and the emitter-collector circuit thereof is completed. It can also be seen that because of the charge existing on capacitor **66**, at the instant that transistor **32** went into conduction, and its connection to base electrode **60** of transistor **34** via conductor **62**, the emitter-base electrodes of transistor **34** are reverse biased (the base being negative with respect to emitter **46**) thereby keeping transistor **34** in an off or nonconducting state. At this same time, capacitor **68** will start to charge essentially through the emitter-base circuit of transistor **32** and resistor **44**. This charging current holds transistor **32** conductive or "-hard-on"; further, even when charging of capacitor **68** is completed, the transistor **32** will remain conductive by virtue of the base current provided by resistor **58**.

As the potential across capacitor **66**, holding transistor **34** off, is reduced, a condition is finally attained where the capacitor **66** voltage can no longer maintain transistor **34** in the nonconducting state. As transistor **34** starts to become conductive, by virtue of a biasing current through resistor **64**, the collector to emitter voltage thereof drops and the charged capacitor **68** now starts to discharge through the emitter-base circuit of transistor **32**, resulting in a reverse bias driving transistor **32** into nonconduction.

When transistor **32** is thusly driven into nonconduction, the voltage across its emitter **40** and collector **36** increases causing capacitor **66** to again start charging through the emitter-base circuit of conductive transistor **34**.

In this new state (transistor **34** being conductive) capacitor **68** starts to charge toward the opposite polarity through resistor **58** by virtue of being connected to conductor **26** through the conducting transistor **34**. When transistor **34** was switched into conduction, capacitor **68** was negatively charged on its side connected to conductor **57**, with respect to its side connected between resistor **44** and collector **42**. Further, the polarity on capacitor **68**, at the time of switching transistor **34** "on," produces a reverse bias on transistor **32**.

During the time that transistor **34** is conducting capacitor **66** is being charged so that its end or side connected to resistor **64** and conductor **62** will become negative with respect to its side connected between resistor **38** and collector **36**. Such charging of the capacitor **66** is the consequence of the base current flow through transistor **34** which also serves to hold the transistor **34** in its "on" or conductive state. It should be apparent that transistor **32** is also maintained conductive for some period after capacitor **66** has been fully charged because of the base bias provided by resistor **64**.

However, as capacitor **68** continues to discharge and the voltage thereacross approaches zero, the voltage holding transistor **32** in a nonconducting state decreases and transistor **32** starts to again become conductive. This initiates the regenerative cycle which results in the rapid "turn on" of transistor **32** and "turnoff" of transistor **34** as well as the subsequent rapid "turnoff" of transistor **32** and "turn on" of transistor **34**. In this arrangement resistors **38** and **44** serve to respectively limit the collector currents of transistors **32** and **34** while resistor **64** and capacitor **66** combine to determine the "off" or nonconducting time of transistor **34** and, similarly, resistor **58** and capacitor **68** combine to determine the off or nonconducting time of transistor **32**.

It can be seen that when transistor **34** is in its conducting state, the emitter-base circuit of transistor **52** is biased into conduction thereby completing the circuit through the emitter **54** and collector **72** of transistor **52**. When transistor **52** is thusly driven into conduction, a circuit is completed through conductors **78, 76** and **74**, collector electrode **72**, emitter **54** and conductor means **27** causing a voltage drop to occur across resistor **82** thereby causing point **88** and base **84** to be negative with respect to emitter **90** which is exposed to plus (+) potential of conductor **12**. Consequently switching transistor **86** is turned "on" completing a circuit through the emitter **90** and collector **94** thereby, through conductor **96**, placing the base electrode **98** of load or power transistor **100** effectively at the plus (+) potential of conductor **12**. The emitter **108** is, in turn, at negative potential of ground **116**. Accordingly, with emitter **108** negative with respect to base **98**, transistor **100** is turned "on" completing the load circuit comprised of conductors **104**, collector **102**, emitter **108**, conductor **106**, coil **110** and conductor **112** so as to energize the electrical load means **114**. As should be apparent, the diagrammatically depicted load means **114** may in fact be comprised of, for example, one or a plurality of lamps or bulbs and, as is often the case, some of such bulbs could be located within the interior of the vehicular passenger compartment, as operator signal readouts, while others could be located externally of the vehicle as indicators to pedestrians and vehicular traffic.

In view of the preceding, it can be seen that, in the embodiment disclosed, every time that oscillator or multivibrator transistor **34** is turned "on" the buffer transistor **52**, switching transistor **86** and load transistor **100** are likewise turned "on." The contrary is, of course, true; that is, whenever transistor **34** is in its "off" or nonconductive state, transistors **52, 86** and **100** are also in their "off" or nonconductive state.

Now, considering the short protection means, it will be remembered that in order to make the SCR **140** conductive, both the anode and gate thereof have to be made positive with respect to the cathode. Accordingly, it can be seen that whenever the shutdown transistor **122** is "off" or in a nonconductive state, the circuit described by conductor **176**, resistor **126**, conductor **178**, conductor **156** and resistor **130** is open by virtue of no conduction through the emitter-collector circuit of transistor **122**. Consequently, the gate electrode **152** of SCR **140** will be at negative or ground potential by virtue of its connection to conductor **156**.

However, it will be noted that each time transistor **52** goes into conduction base **132** of transistor **122** is effectively brought to ground potential as at point **138** thereby causing transistor **122** to become conductive thereby completing the circuit through conductors **176, 178** and **156**. Gate **152** is therefore made positive by virtue of resistors **126** and **130** acting as a voltage divider. However, SCR **140** does not go into conduction because its cathode is effectively at positive potential by virtue of its connection to conductor **106** as at **150** which, because of transistor **100** being "on," is at the plus (+) potential of conductor **12**.

Now, let it be assumed that a short has occurred in the load **114** and that transistor **34** has just turned "on" which, as explained above, causes the transistor **122** to be simultaneously turned "on." Therefore, gate **152** of SCR **140** is made positive (+) and the cathode of SCR **140**, by virtue of the short in the load **114**, is placed effectively at ground potential. Further, with transistor **34** being "on" the anode of SCR **140** is at same plus (+) value relative to its cathode. This, of course, as previously explained, causes SCR **140** to become conductive completing a circuit from point **144** through conductors **142, 146** and **112**.

When the SCR thereby becomes conductive, the forward bias on the base-emitter circuit of transistor **52** is eliminated or so reduced as to prevent transistor **52** from going to conduction which, in turn, prevents transistors **86** and **100** from being turned "on" thereby eliminating the possibility of damage to the load transistor **100** as a consequence of such a short in the load.

As was previously stated, it has been found advantageous to provide means such as the zener diode **164**. That is, when SCR **140** is made conductive, a voltage drop, in the order of possibly 1.0 volts, will occur across the SCR **140**. However, this voltage drop would also appear across the base-emitter diode of the transistor **52** and would be sufficient to cause the transistor **52** to become conductive. Accordingly, by including the zener diode **164** in the emitter circuit of transistor **52** such possible "turn-on" of the transistor will be positively prevented until the potential across the base-emitter-zener becomes of a value distinctly in excess of the voltage drop across SCR **140** when in its conducting state.

Having described the operation of the signal producing section **30** and the normal load switching operation as well as the function and operation of the related short protection means, the remaining circuitry and operation of the related outage indication means will now be considered.

The concern with the occurrence of shorts arises because of the loss of effective resistance in the load circuit; in contrast, with the occurrence of an outage condition, at least some portion of the electrical load is, for example, burned out and therefore such portion appears as an open switch in the circuit.

The operation of the circuitry remains the same as previously described except that now switch **20** is again considered as being in the location illustrated, and operatively connected, as by means **180**, to coil **110**. (Switch **20** and winding **110** may, in fact, comprise a reed-type switch wherein member **20** is moved, without benefit of mechanical connections, to open and closed positions in response to the generation of an associated magnetic field.)

Switch **20** can be considered as a normally open switch in the sense that it will be open, as shown, whenever there is either no current flow through coil **110** or current flow below a predetermined value.

Accordingly, when the associated master switch **175** is closed current will not be permitted to flow through resistor **58** because of the open switch **20**; however, as previously described, current flow through resistor **64** causes transistor **34** to be turned "on" thereby causing transistors **52, 86** and **100** to be also driven into conduction. If the load **114** is normal (no outage present) the current flow through winding **110** will be sufficient to cause switch **20** to become closed thereby permitting the oscillator or multivibrator to function normally, as previously described, causing the transistor **34** to be cyclically energized.

However, should one or more of the individual loads **114*a***, **114*b***, or **114*c*** (if in fact the load **114** is comprised of a plurality of loads) create an outage as by becoming burned out, the effective resistance of the electrical load means will increase thereby reducing the magnitude of the current flow therethrough as well as through the winding or field generating means **110**. Therefore, if the winding or field generating means **110** is so constructed or calculated as to develop sufficient force or energy to close switch **20** only when all of the electrical loads in the load means **114** are normal, it can be seen then that upon the occurrence of an outage in the load means, the current therethrough will diminish to a value less than a predetermined minimum value resulting in switch **20** again becoming opened and remaining open.

When this happens, the base circuit of transistor **32** loses its forward bias and therefore remains in a nonconductive state while transistor **34** becomes continuously forwardly biased through resistor **64** thereby remaining "on" or in its conductive state. As a consequence of transistor **34** being held "on" the remaining transistors **52, 86** and **100** are also held "on" thereby serving to keep the normal electrical loads (the ones which have not burned out) in a continuously energized state which would indicate to the vehicle operator that an outage had occurred. A resistor **182** arranged in parallel with capacitor **68** serves as a bleed resistor permitting the capacitor **68** to be discharged therethrough whenever switch **20** is opened.

In view of the preceding, it should be apparent that functional equivalents could be substituted for the various sections of the circuitry as well as components or elements contained therein. Also, as should be apparent, the circuitry disclosed could be practical employing NPN transistors for those that are shown as PNP and vice versa where appropriate polarity changes are made as is well known in the art.

Although only one embodiment of the invention has been disclosed and described, it should be apparent that other embodiments and modifications of the invention are possible within the scope of the appended claims.

I claim:

1. A flasher circuit of the type adapted to intermittently energize a signal lamp load from a voltage source including an oscillator for producing intermittent control signal impulses, a switching device adapted to be switched between on and off conditions in response to said control signal impulses to connect and disconnect the load and the voltage source, the improvement comprising control means connected in circuit with said load and effective to change from a first condition to a second condition when the magnitude of the current through the load decreases below a predetermined value, said control means being effective in said second condition to hold said switching device in said on condition whereby a decrease of said current below said predetermined value causes the remaining signal lamps to be continuously energized from said voltage source to indicate the outage of one of said signal lamps.

2. The invention as defined in claim **1** wherein said control means is a current-responsive device having an input circuit connected with said load circuit and an output circuit operatively connected with said switching device.

3. The invention as defined in claim **2** wherein said control means comprises a relay having an energizing winding in said load circuit and having switch contacts operatively connected with said switching device.

4. The invention as defined in claim **3** wherein said oscillator is a multivibrator comprising a pair of cross-coupled transistors and the switch contacts of said relay are connected in the input circuit of one of said transistors.

5. A flasher circuit for automotive vehicles and adapted to intermittently energize a load circuit including signal lamps from a voltage source, an oscillator for producing intermittent control signal impulses, a switching device connected with the oscillator and adapted to be switched between on and off conditions in response to the intermittent control signal impulses to connect and disconnect the load circuit and the voltage source, first control means having an input connected across the load and having an output connected to the switching device, said first control means being adapted to change from a first conductive state to a second conductive state when the voltage across the input thereof decreases below a predetermined value and being effective in said second conductive state to hold said switching device in said off condition to deenergize the load in the event of a short circuit, second control means having an input connected with the load circuit and an output operatively connected with said switching device, said second control means being adapted to change from a first conductive state to a second conductive state when an open circuit occurs in one of the signal lamps and the current through said load decreases below a predetermined value, said second control means being effective in the second conductive state to hold said switching device in the on condition and continuously energize the remaining signal lamps in the load circuit.

6. The invention as defined in claim **5** wherein said first control means is a voltage-responsive device and said second control means is a current responsive device.

7. The invention as defined in claim 6 wherein said current responsive device is a relay having an energizing winding in circuit with the load and having switch contacts operatively connected with the switching device.

8. The invention as defined in claim 7 wherein said oscillator is a multivibrator comprising a pair of cross-coupled transistors and the switch contacts of said relay are connected to the input of one of said transistors to hold the multivibrator in one stable state when the contacts are closed.

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