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[54] **CIRCUIT FOR SWITCHING D. C. POWER**

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[58] **Field of Search**..... 307/41, 247 R, 247 A, 315; 315/200 A, 209, 210, 225, 226; 340/67, 74, 76, 81 R, 81 F, 82, 83

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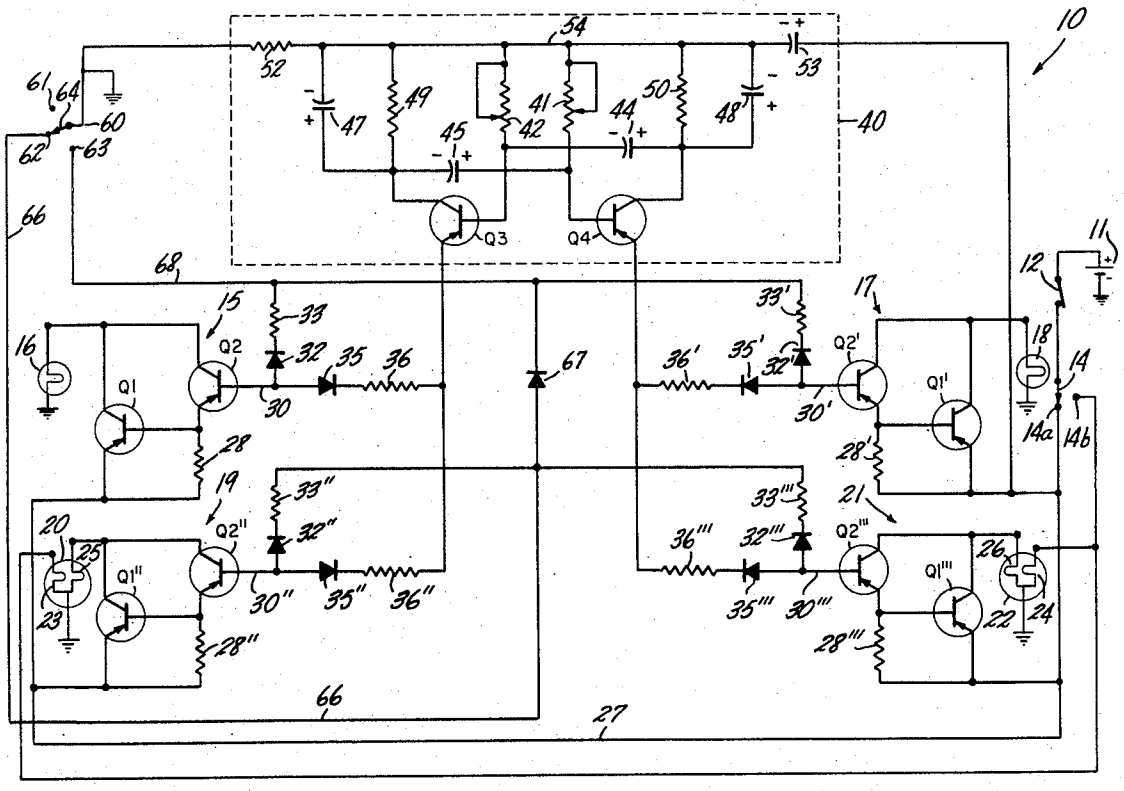
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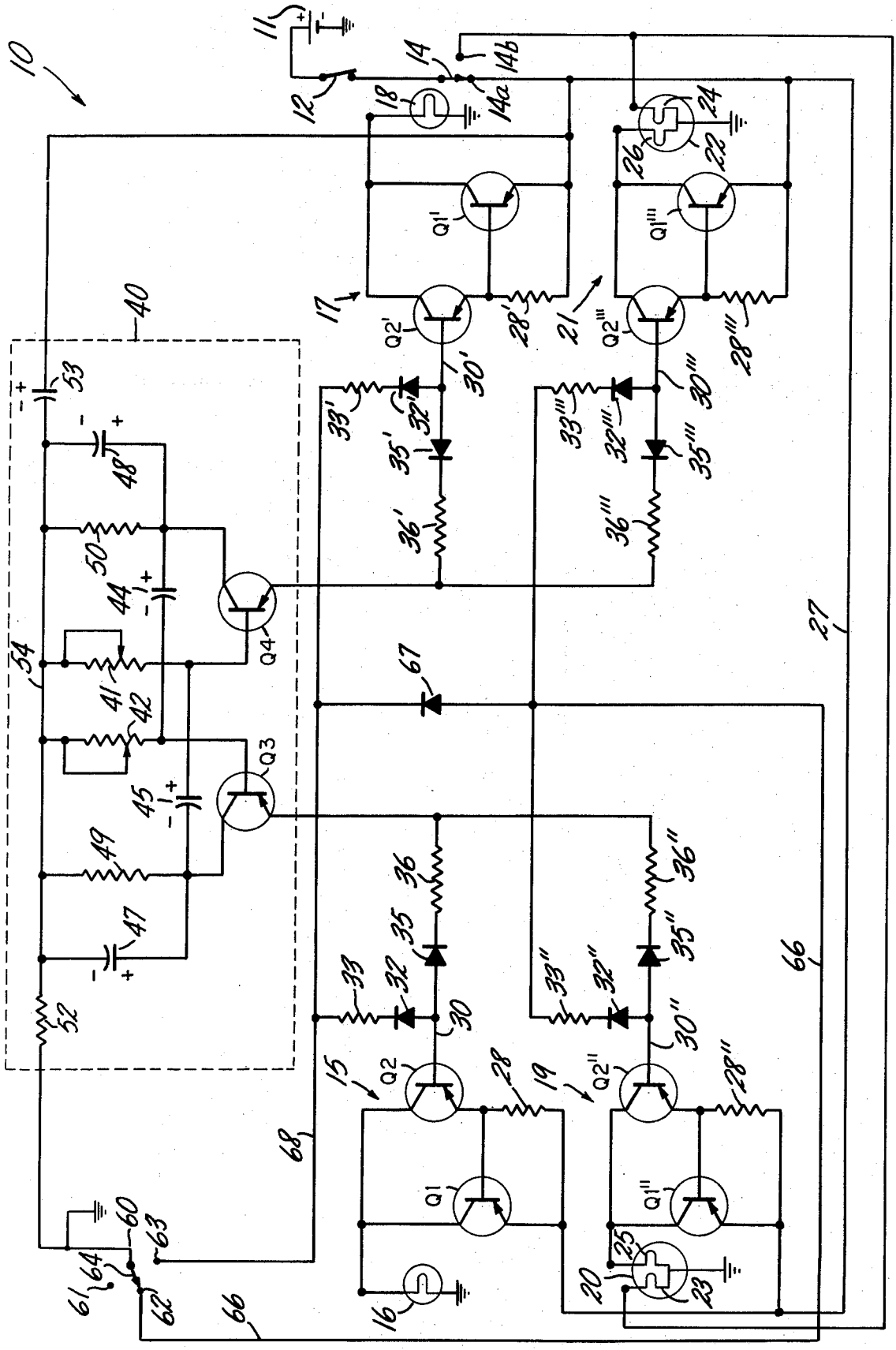
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[57] **ABSTRACT**

A circuit for delivering pulsed or constant power to a set of loads, particularly headlamps whose flashing serves as an alert. A number of transistor amplifiers serves as switches to switch moderately high power to the loads from a D.C. source. Two alternating, out-of-phase outputs of a continuously running astable multivibrator bias associated transistor switches into and out of conduction. This causes out of phase pulsed or flashing actuation of loads. An overriding, continuous bias potential, supplied to some, all, or none of the transistor switches, causes steady energization of some, all, or none of the loads. A remote switch controls the delivery of the continuous bias potential to selected transistor switches. When less than all loads operate continuously, the remaining pulsed loads include loads from both out-of-phase groups.

4 Claims, 1 Drawing Figure




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14a
14b
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CIRCUIT FOR SWITCHING D. C. POWER

BACKGROUND OF THE INVENTION

This invention relates to a circuit for controlling the alternate application of constant or pulsed power to several load devices, and more particularly to a circuit that selectively causes all, less than all, or none of the load devices to be constantly energized while the remainder is pulsed.

For emergency vehicles, police cars, fire vehicles, ambulances, and the like, flashing headlamps are known to be effective in alerting the public, drivers and pedestrians. In other instances, as well, the ability to energize one or more electrical devices to receive power at a constant level or at pulsed or alternating rates may be desired. Examples include audible devices, such as horns, bells, and buzzers.

Drivers of emergency vehicles have been known to flash the headlamp as a warning by rapidly operating the off-on switch by hand. This is a dangerous practice in a situation demanding the driver's full attention and use of both hands. Some automatic flashing arrangement is clearly desirable.

Circuits using repeatedly opened and closed mechanical switches have been proposed. Mechanical switching defects are only too well known, particularly at moderately high current levels. For example, dirty or pitted switch contacts affect both the life and reliability of mechanical switches. Sparking, when even moderate currents are switched, may limit the use of mechanical switches. This latter defect can be dangerous in the presence of explosive or flammable materials, for example gasoline at the scene of an accident.

Thermally actuated switches have been tried. In addition to the defects outlined above, which result from repeated mechanical making and breaking of the contacts, thermal actuation suffers further deficiencies. The rate of flash cannot adequately be controlled, and when thermal actuation depends on heat generated by the current being switched, lamp failure, the drain on the battery from other ordinary loads, and any other occurrence affecting the current being switched change the lamp flashing rate.

Particularly in a circuit that controls the energization of emergency vehicle lights, the ability to cause pulsating operation of some and constant operation of others is desirable. If four high beams are used these may be operated for normal high beam use. Two may be so operated leaving two to flash, or all four may be flashed. The low beams can be left unaffected.

In addition, alternately flashing lamp pairs are particularly effective alerts. Out-of-phase alternating energization is therefor another important feature in a circuit which is to be used to flash lamps.

SUMMARY OF THE INVENTION

A control circuit according to this invention provides each of the desirable features and capabilities just discussed. Briefly, plural transistor switching arrangements connected between plural loads and a source are selectively activated to energize selected loads. An alternating bias source repeatedly applies bias voltages appropriate to cause pulsed energization of the loads by repeated alternations of the transistor switching arrangements between conduction and nonconduction. A manually operable switch applies a constant bias voltage to all, less than all, or none of the transistor switching arrangements. The manual switch's constant bias voltage overrides the pulsed signal wherever applied and causes constant or uninterrupted energization of a load.

The multivibrator has out-of-phase outputs which provide out-of-phase or "wig-wag" flashing if applied to transistor switches controlling a pair of lamps. The steady rate at which the multivibrator alternates is independant of the loads or the currents being switched. The transistor switching arrangement offers greater reliability than mechanical switching, and of course contact sparking is precluded. Amplifier connections for the transistor switches, Darlington amplifiers in the specific preferred embodiment that follows, give the transistor switches a current capability adequate to the initial high current surge characteristic of cold headlamp filaments.

The use of an astable multivibrator permits pulse rate adjustment. This adds to the flexibility of the circuit. Perhaps more importantly this permits the rate at which current is switched to a particular set of lamps to be adjusted so that the off time is insufficient to cause excessive filament cooling. Repeated excessive surges are eliminated and significantly less power dissipated. Because the transistor switching arrangements require only low level signals for actuation, the power consumption of the control circuit, itself, is very low.

The manually operable switch controls the mode in which the circuit operates. If vehicle lamps are controlled, the switch is remote, located in the vehicle's passenger compartment. Steady energization of all loads occurs when the switch applies the constant overriding bias voltage to all transistor switches. When less than all loads are to be pulsed the manual switch supplies the overriding bias voltage only to those transistor switches which supply loads to be operated continuously, and the multivibrator outputs drive the remaining transistor switches, alternately switching the remaining loads off and on in a pulsed or flashing manner. If all loads are to be pulsed, the manual switch supplies no signal to any transistor switch.

When four headlamps are controlled and two or four can flash, a blocking diode connected between the associated pairs of transistor switches affords a preferred arrangement to supply the overriding bias to the two or four lamp control transistor switches. Supplied to one terminal of the diode, the bias voltage switches on less than all transistor switches; supplied to the other, all transistor switches conduct. A single two-wire connection to the manual switch in the passenger compartment then simplifies the installation of the circuit. And because the manual switch supplies only low currents to control the transistor switches, light wiring only is brought into the passenger compartment, making switch location and installation easy.

The control circuit according to the invention also is capable of switching a range of voltages and currents, lending versatility to the circuit. Finally, with appropriate selection of PNP or NPN transistors and associated circuit components, well within the ordinary artisan's capabilities, the control circuit may be used with either a positive or a negative D.C. supply.

BRIEF DESCRIPTION OF THE DRAWING

For a better understanding of the invention, refer-

ence may be made to the following description of an exemplary embodiment, taken in conjunction with the accompanying drawing, in which:

The solitary FIGURE is a circuit diagram of a circuit according to the invention as used to control the headlamps of a vehicle.

DESCRIPTION OF EXEMPLARY EMBODIMENT

In the exemplary embodiment shown in the drawing, a control circuit arranged according to the invention is generally designated by the numeral **10.** A battery **11** serves as the D.C. power source for the control circuit of the invention. The battery **11** may be an ordinary vehicle battery, serving all of its ordinary uses in addition to supplying the control circuit according to the invention. The positive terminal of the battery **11** is connected in series with an "off-on" headlight control switch **12** which is the ordinary headlight control switch located on a vehicle's dashboard and which is manually closed by a driver to light a vehicle's headlights. Also in series with the battery **11** and the headlight switch **12** is a high beam switch **14.** The high beam switch **14** may be conventional, being ordinarily available to operate the high beam once the headlights have been turned on by closing the headlight switch **12.**

Normally, the switch **14** is connected to each high beam lamp or to the high beam filaments of each dual filament lamp and serves directly to activate the vehicle's high beams. However, in the present invention, the switch **14** supplies power to the control circuit **10** from the contact **14***a*. The actual application of voltage to the high beam lamps is controlled by the control circuit in the manner described below, once the headlight switch **12** has been closed and the high beam switch **14** has switched power to the contact **14***a* in the "high beam on" position.

The circuit **10** controls four lamps, **16, 18, 20,** and **22.** For the purpose of this discussion, lamps **16** and **18** shall be called the inboard pair, lamp **16** being the left inboard lamp, and lamp **18** being the right inboard lamp. Lamps **20** and **22** shall be referred to as the outboard pair, lamp **20** being the left outboard lamp and **22** the right outboard lamp. Also the lamps **16** and **18** are illustrated as single filament high beam lamps. Lamps **20** and **22** are dual filament high and low beam lamps with low beam filaments **23** and **24** in addition to the high beam filaments **25** and **26.** Voltage to energize the low beam filaments is supplied from contact **14***b* of the high beam switch **14.** This arrangement then leaves the low beam operation unchanged.

Four transistor switching arrangements control the lamps **16** and **18,** and the high beam filaments **25** and **26** of lamps **20** and **22.** All of the transistor switching arrangements operate in the same manner, and therefor the discussion of the operation of the transistor switch **15** will suffice. Because a negative ground system has been assumed in the illustrated embodiment, all of the transistors in the control circuit **10** are PNP type. A positive ground system requires only replacement of the PNP transistors with NPN transistors and the appropriate, conventional changes in the circuit components.

In the switching arrangement **15,** a pair of transistors Q1 and Q2 are connected with the collectors of each transistor in common. The emitter of transistor Q1 is connected with line **27** which is +12 volts D.C. when switches **12** and **14** are closed. Line **27**'s **12** volt potential is connected through a resistor **28** to both the base of the transistor Q1 and the emitter of transistor Q2. The base connection **30** of the transistor Q2 serves as a trigger or gate connection for the switching arrangement **15,** effecting conduction through both Q1 and Q2 when an appropriate bias potential is applied there. So connected, the two transistors form a Darlington amplifier arrangement.

The biasing of the base to emitter voltages of the transistors Q1 and Q2 is such that the transistors Q1 and Q2 operate in either the cutoff or the saturation regions. Hence the Darlington amplifiers act essentially as switches. The parallel conduction of the transistors Q1 and Q2 makes this arrangement particularly suitable for headlight control, or for that matter the control of other moderately high current incandescent lamps. A current capability of 10 amperes is easily attained with commercially available transistors, and this current capability will be adequate to the current surge which ordinarily occurs when energizing cold incandescent lamp filaments.

A potential at or near ground level applied to the base **30** of the transistor Q2 causes conduction of the transistor switch **15.** Therefore, as used herein, "bias potential" or "bias voltage" is not meant to exclude a zero volt connection. A higher positive voltage applied to the base connection **30** or an open base connection there blocks conduction through the transistor switch **15.**

Bias potentials appropriate to cause conduction may be applied to the base connection **30** via either of two gate paths. Diode **32** and resistor **33** form one such path; diode **35** and resistor **36** form another. These paths provide lamp energizing circuit control connections. A ground or near ground connection to either of these paths will cause the transistor switch **15** to conduct and lamp **16** to light.

Each of the remaining transistor switches **17, 19,** and **21** cooperate with identical gate paths. Like the individual components of the transistor switching arrangements, then, the associated gate paths have like diodes and resistors designated by similar reference numerals.

An astable multivibrator **40** operates continuously when switches **12** and **14** are closed to activate the control circuit **10.** The multivibrator **40** controls the flashing rate of the lamps when they are flashed. The circuitry of the astable multivibrator is conventional and requires no detailed description other than the general explanation that follows.

In the multivibrator **40,** a pair of transistors Q3 and Q4 are driven alternately into saturation and cutoff. As the transistor Q3 is in saturation, the transistor Q4 is in cutoff and vice versa. The rate at which the two transistors switch into and out of conduction is selectively controlled by RC networks in the base circuit of the respective transistors. Adjustment of the variable resistors **41** and **42** alters the time constants of the RC networks made up of those resistors and their respective associated capacitors **44** and **45.** In addition, a pair of capacitors **47** and **48** serve conventionally as filters, and a pair of resistors **49** and **50** establish the collector bias for the transistors Q3 and Q4, respectively. Resistor **52** is a current limiting resistor and capacitor **53** smoothes the reference voltage at line **54,** holding that voltage substantially independent of momentary current changes through the multivibrator.

The reference voltage at the line **54** is nearly ground potential. Conduction of the transistor Q3 in the multivibrator **40** biases the transistor switches **15** and **19** into conduction. Conduction of the transistor Q3 opens a current path from the base connection **30** through the first control connection to the energizing circuit, at the diode **35** and resistor **36,** to bias the transistor switch **15** into conduction and simultaneously opens a current path from the base connection **30''** through the first control connection to the transistor switch circuit **19,** via diode **35''** and the resistor **36''** to bias switch **19** into conduction. Conduction of the transistor Q4 acts similarly to bias transistor switches **17** and **21** into conduction. Because the outputs of the multivibrator **40** are out of phase, the left transistor switches **15** and **19** alternate between conducting and blocking conditions in out-of-phase relationship to the two right transistor switches **17** and **21.** Hence under the control of the multivibrator **40** lamps **16** and **20** flash in out-of-phase relationship to the lamps **18** and **22.**

The control of the modes of operation of the control circuit **10** is provided by a manual mode selector switch **60.** This may be any of a number of commercially available manually operable multiple connection switches. For purpose of illustration, the switch **60** is shown to include three fixed contacts **61, 62** and **63,** and a manually operable wiper arm **64,** connected to ground. In the embodiment shown, the switch **60** is the only additional element which must be made available to the vehicle operator.

With the movable wiper arm **64** located in contact with the fixed contact **61,** control of the four transistor switching arrangements **15, 17, 19,** and **21** is left entirely to the astable multivibrator **40.** This then is the first mode of operation in which all four high beam lamps **16, 18, 20,** and **22** flash.

A second lamp control mode occurs when the movable wiper arm **64** of the switch **60** contacts the fixed contact **62** as shown. A ground connection is applied via line **66** to resistors **33''** and **33'''**, which with diodes **32''** and **32'''**, respectively, form the second control connections of the two switching circuits via gate paths to the base connections **30''** and **30'''** of transistor switches **19** and **21.** Now the path to ground from the base connections **30''** and **30'''** biases transistor switches **19** and **21** into conduction continuously, overriding the pulsating or alternating control of transistors Q3 and Q4 of the multivibrator **40.** Lamps **20** and **22** are thus continuously or steadily on in this mode. No continuous path to ground is provided to the base connections **30** and **30'** of the transistor switches **15** and **17,** a central blocking diode **67** preventing conduction to ground via the line **66.** Hence the first set of switches **15** and **17** continue alternately to conduct, lamps **16** and **18** alternately to flash.

Finally, with the movable wiper arm **64** contacting the fixed contact **63** of the mode selector switch **60,** a path to ground is completed through line **68,** and the second of the two control connections for each transistor circuit, from the base connections **30** and **30'** of transistor switches **15** and **17,** and from the base connections **30''** and **30'''** of the transistor switches **19** and **21,** as well, the blocking diode **67** now being forward biased. In this third mode the switch **60** applies a continuous bias to all transistor switches activating both sets of lamp circuits, and overriding the pulsed or alternating biasing of the multivibrator **40,** whereupon all four lamps **16, 18, 20,** and **22** are on continuously.

For ordinary high beam use, then, the mode selector switch **60** is left with its wiper arm **64** on the fixed contacts **63,** the lights are turned on as usual by closing the headlight switch **12,** and the high beams are activated in their normal fashion by closing switch **14.** Once this is done, the other two modes of operation are available by manual adjustment of the switch **62** to its two positions.

Additional vehicle lamps may be driven from the various transistor switches as well, and many other uses of the control circuit **10** are available. The embodiment of the present invention that is described above is intended to be merely exemplary, and those skilled in the art will be able to make numerous variations and modifications of it without departing from the spirit and scope of the invention. All such variations and modifications embodying the invention are intended to be included within the scope of the invention as defined in the appended claims.

I claim:

1. A multiple lamp energizing circuit having three lamp energizing modes and including:

a. a first set of at least **2** lamp energizing circuits,

b. a second set of at least **2** lamp energizing circuits,

c. each of said lamp energizing circuits including control means responsive to an electrical input signal for activating the energizing circuit and each having first and second control connections,

d. a means for producing two alternating out-of-phase outputs at first and second output terminals,

e. a selector switch including

1. a bias connection,

2. a first switch output,

3. a second switch output, and

4. means for selectively connecting the bias connection with one of the first output, the second output, and neither output,

f. a unidirectional current conductor means in addition to and distinct from the control means of the energizing circuits and conductive in one direction between first and second connections,

g. said first output terminal of said alternating producing means being connected to the first control connection in at least one and less than all energizing circuit control means of said first and second sets of energizing circuits,

h. said second output terminal of said alternating output producing means being connected to the first control connection of the remaining energizing circuit control means of both sets of energizing circuits,

i. the second control connection of all of the first set of energizing circuits being connected to the first connection of the unidirectional conductor means and to said first switch output,

j. the second control connection of all of the second set of energizing circuits being connected to the second connection of the unidirectional conductor means and to the second switch output,

whereby in operation, (1) with the selector switch bias applied to neither switch output, said alternating output means activates energizing circuits of both sets that are connected with the first input terminal of the alter-

nating output producing means, alternately and out of phase with the remaining energizing circuits of both sets that are connected with the second output terminal of the alternating output producing means, (2) with the switch bias connection connected to the first switch output, an overriding bias is applied to the second control connections of all of the circuits in the first set and blocked by the unidirectional conductor means from the circuits of the second set, to continuously activate only the circuits of the first set while the second set continues to be alternately activated out-of-phase, and (3) with the bias connection connected to the second switch output, the overriding bias is applied to the second control connections of all of the second set of circuits and, via the unidirectional conductor means, to the second control connections of the first set to cause all circuits continuously to be activated.

2. The lamp energizing circuit according to claim **1** wherein the means for producing first and second out-of-phase electrical output signals is a continuously running astable multivibrator.

3. The lamp energizing circuit according to claim **1,** wherein energizing circuits from each of the two lamp energizing circuit sets controlled by the two out-of-phase outputs are connected with lamps on the opposite sides of a vehicle to cause a distracting out-of-phase flashing.

4. The lamp energizing circuit according to claim **2,** wherein each lamp energizing circuit is connected with a lamp, at least two lamps connected with the first energizing circuit set are located on opposite sides of a vehicle, and at least two lamps connected with the second energizing circuit set are located on opposite sides of the vehicle, whereby when only the first set of lamp energizing circuits are biased continuously into activation, at least one lamp on each side of the vehicle is continuously lighted, while at least one lamp on each side of the vehicle flashes.

* * * * *