Sept. 23, 1958 J. E. JACOBS 2,853,651

LIGHT RESPONSIVE SYSTEM

Filed Dec. 14, 1953 2 Sheets-Sheet 1

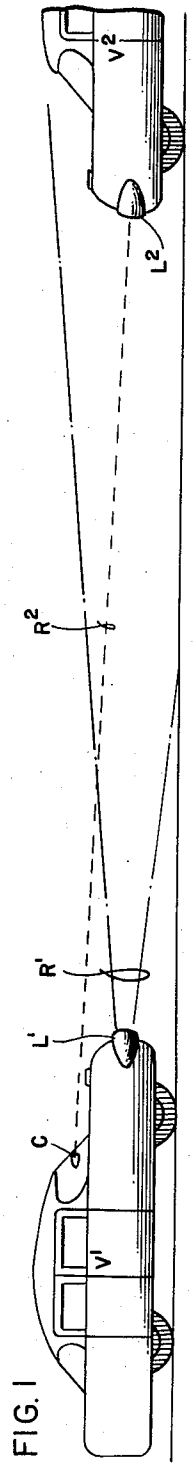


FIG. 1

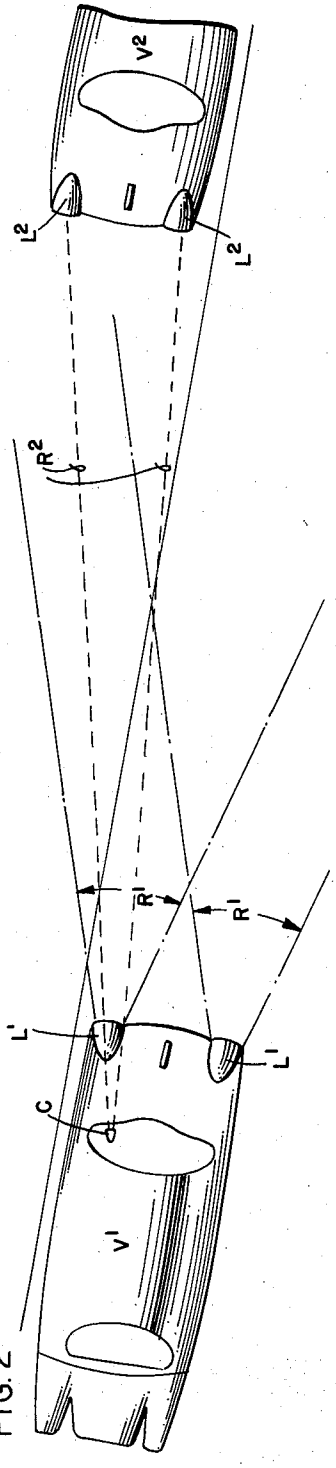


FIG. 2

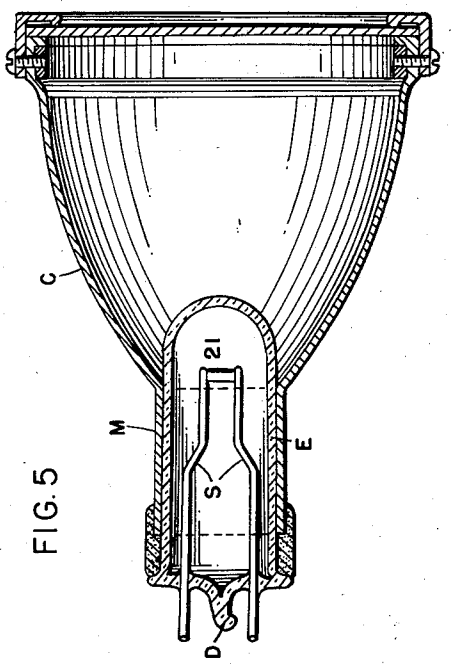


FIG. 5

INVENTOR:-
JOHN E. JACOBS
BY:-
Junius F. Cook, Jr.
ATTORNEY

Sept. 23, 1958 J. E. JACOBS 2,853,651

LIGHT RESPONSIVE SYSTEM

Filed Dec. 14, 1953 2 Sheets-Sheet 2

FIG. 3

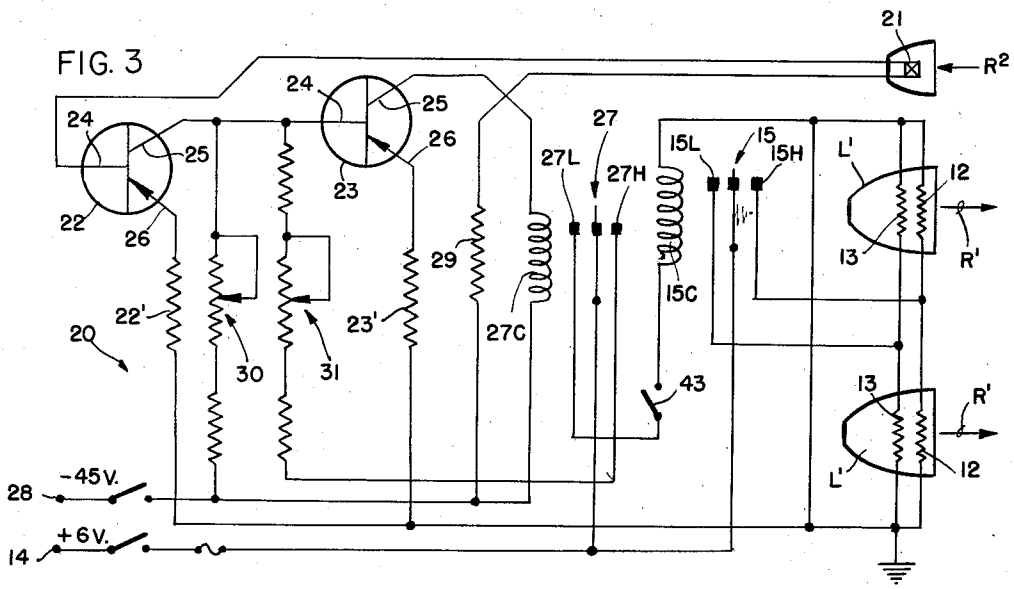
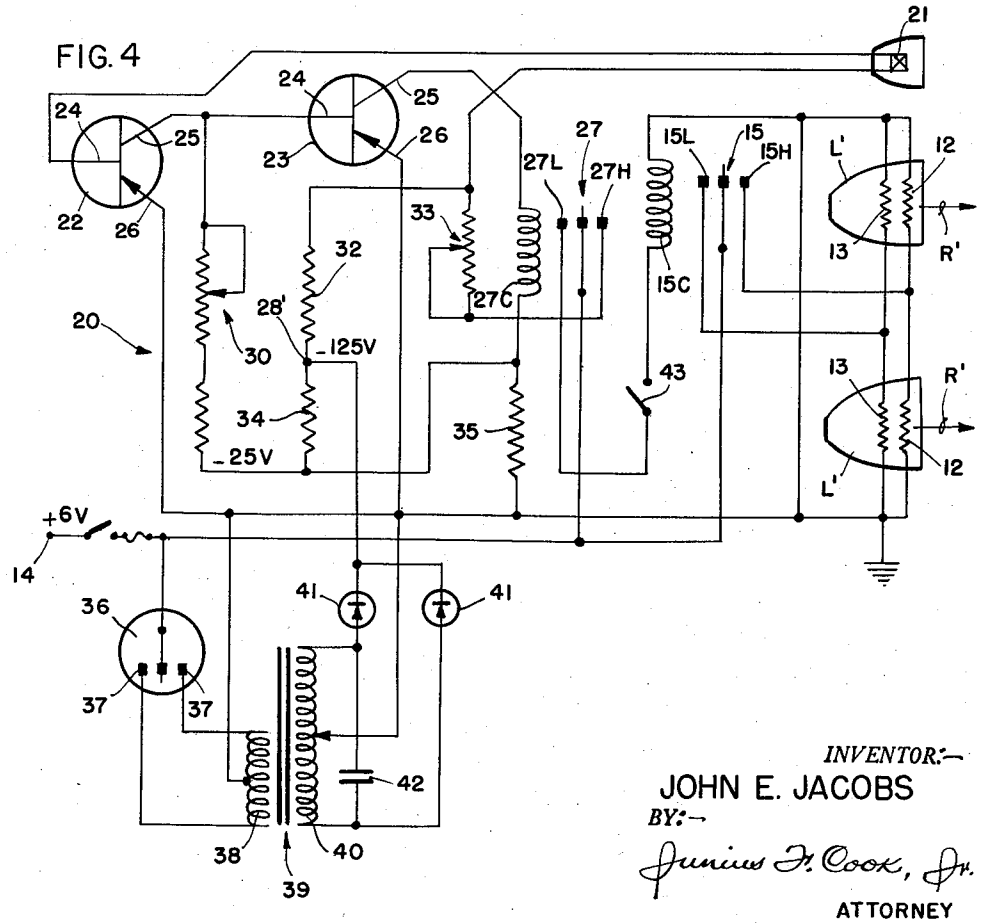


FIG. 4



INVENTOR:—
JOHN E. JACOBS
BY:—
Junius F. Cook, Jr.
ATTORNEY

United States Patent Office 2,853,651 Patented Sept. 23, 1958

2,853,651

LIGHT RESPONSIVE SYSTEM

John E. Jacobs, Milwaukee, Wis., assignor to General Electric Company, a corporation of New York

Application December 14, 1953, Serial No. 397,926

5 Claims. (Cl. 315—83)

The present invention relates in general to illumination and has more particular reference to the control of light emitting lamps, especially vehicle headlights, the invention specifically pertaining to an improved automatically operable system for dimming vehicle headlights in response to the head-on approach of another headlighted vehicle.

An important object of the present invention is to provide control means automatically operable to dim the headlights of a vehicle, in response to the approach of another headlighted vehicle proceeding in the opposite direction, and to restore the vehicle headlights to bright condition immediately after the approaching vehicle shall have passed by; a further object being to provide automatic headlight control equipment of simple yet rugged character adapted to furnish trouble-free operation during extensive service life; a still further object being to provide equipment of the character mentioned adapted for ready installation and easy interconnection with existing headlight energizing circuits.

Another important object is to provide an improved photosensitive control system embodying a light detecting element and electrical translation means controlled by the detector element and operable in accordance with the response of the detector to light emitted by the approaching vehicle for the operation of a relay switch connected in the vehicle lighting system for headlight dimming purposes; a further object being to employ a crystalline semi-conductor material selected from the class including cadmium sulphide, mercury sulphide, and cadmium selenide, as a light detecting element for vehicle headlight dimming purposes; a still further object being to utilize transistors as amplifying devices in the translation system between the detecting element and the headlight dimming relay switch.

Another important object is to provide a control system of the sort mentioned for throwing a dimming switch in response to impingement of light rays at a selected intensity level upon the light detecting element, for maintaining the system in light dimming condition despite substantial reduction in the intensity of light energy caused to impinge upon the detector element, and for reversely throwing the dimming switch upon discontinuation of light impingement on the detector element.

Another important object is to incorporate in the translation system a sensitivity offset circuit adapted to change the response level or sensitivity of the system, so that the same may remain in light dimming condition after initial actuation of the lamp dimming relay even though the intensity of detector impinging light be reduced below the level initially required to cause operation of the relay; a further object being to provide a sensitivity offset circuit adapted, when active, to increase the sensitivity of the system on the order of eight times the sensitivity of the system when the offset circuit is inactive.

Another important object of the invention is to provide a control system of the sort mentioned, including a light sensitive detector, a lamp dimming relay switch,

and a translation system controlled by said detector for actuating the switch to one position when the detector is dark and to another position in response to illumination of the detector at above a selected intensity, and an overriding switch operable to actuate said relay switch independently of the said detector controlled translation system.

The foregoing and numerous other important objects, advantages, and inherent functions of the invention will become apparent as the same is more fully understood from the following description, which, taken in connection with the accompanying drawings, discloses preferred embodiments of the invention.

Referring to the drawings:

Figs. 1 and 2 are diagrammatic showings illustrating the head-on approach of headlighted vehicles;

Figs. 3 and 4 are diagrammatic representations of light responsive control systems embodying the present invention; and

Fig. 5 is a sectional view through a light sensitive detector device employed in the systems shown in Figs. 3 and 4.

To illustrate the invention the drawings show a vehicle V′ carrying a pair of vehicle headlamps L′ for projecting beams of light R′ outwardly of the vehicle in which the lamps are mounted. Each of the lamps L′ may embody a high or bright beam filament **12** and a low or dim beam filament **13**, one end of each of said filaments being electrically connected to the preferably grounded side of a suitable electrical power source **14**. The ground remote ends of the high beam filaments may be electrically interconnected with one contact **15H** of a single pole, double throw dimmer switch **15**. The ground remote ends of the low beam filaments may also be interconnected with another contact **15L** of said dimmer switch, the pole of the dimmer switch being electrically connected with the ground remote side of the power source **14**, as through suitable circuit protection devices which may include a disconnecting switch, a fuse, and other desired circut devices, including a meter if desired.

The power source **14** may conveniently comprise a conventional storage battery of the sort commonly provided as standard equipment in automotive vehicles for the operation of headlights and other electrical equipment. When the pole of the switch **15** is connected with the power source **14**, it will be seen that the bright and dim beam filaments **12** and **13** may be alternately energized by operation of the dimmer switch **15**, as by selectively energizing the operating coil **15C** thereof. To this end, the switch **15** may be biased to normally close its blade with the contact element **15H**, the blade being movable in response to excitation of the coil **15C** to disengage the contact **15H** and to engage with the contact **15L**.

In order to provide for the automatic control of the headlights L′ in response to the head-on approach of another headlighted vehicle, such as the vehicle V^2, the present invention contemplates a light responsive, electrically actuated translation system **20** adapted to energize the relay coil **15C** in response to the head-on approach of said other headlighted vehicle V^2, when the intensity of the headlight beams R^2, which reach the vehicle V′ from the headlamps L^2 of the approaching vehicle V^2, attains a selected lamp dimming level. To this end, the system **20** may comprise a light sensitive detector **21** mounted in position to receive the impingement of light rays R^2 emitted by the headlights of the approaching vehicle, said detector **21** preferably comprising a semi-conductor material of the electron donor type, particularly crystalline material selected from the class comprising cadmium sulphide, mercury sulphide,

and cadmium selenide. These crystalline semi-conductors exhibit the power of altering the impedance of their constituent material as a function of the intensity of light rays impinging thereon. The detector 21, accordingly, may be made to control the system 20 in order to energize the coil 15C when the impedance of the detector reaches a predetermined value in response to the progressively increasing light intensity applied by the headlight beams R^2 of the approaching vehicle upon the detector 21.

The light sensitive crystal detector 21 is preferably sealed within a translucent, preferably glass envelope E, which may either be evacuated or else charged with a preferably inert gas, such as nitrogen. The envelope E may comprise a cylindrical member formed with an integral, preferably hemi-spherical closure wall at one end thereof. The crystal detector 21 may be electrically connected on and between the ends of a pair of spaced apart, electrically conducting support stems S mounted substantially parallel within the cylindrical member in position supporting the detector 21 substantially at and within the hemi-spherical end closure wall of the envelope E. The stems S preferably comprise metal members capable of being sealed to glass, and said stems remote from the detector 21 may form glass-to-metal seals with a stem supporting end closure wall sealing said envelope at the end thereof remote from said hemispherical closure wall. The detector mounting stems may extend through and outwardly of said stem supporting end closure wall for connection with the translation system 20. If desired, the stem supporting end closure wall may also be formed with sealable duct means D through which the envelope may be evacuated or charged with inert gas.

The detector enclosing envelope E may be mounted in position presenting the detector element 21 at the focus of a light collecting reflector C, which may conveniently comprise a parabolic shell formed with internal light reflecting mirror surfaces adapted to deliver, at the focus of the device, all light rays entering the open end of the shell. The shell, at its apex, opposite the open end thereof, may be fitted with a mounting sleeve M sized to snugly yet slidingly receive the cylindrical envelope E, and said envelope may be secured and anchored in the sleeve, presenting the crystal 21 at the focus of the light collecting device C, as by means of any suitable preferably quick drying cement B, such as malachite basic cement.

The translation system 20 preferably embodies a pair of transistors 22 and 23 interconnected to form successive amplifying stages. To this end, each transistor embodies a base element 24, a collector element 25, and an emission element 26, the base of the transistor 22 being connected with one side of the detector element 21, the collector of the transistor 22 being connected with the base of the transistor 23. The collector of the transistor 23, in turn, may be connected with one side of the operating coil 27C of a single pole, double throw relay switch 27. The switch 27 may comprise a movable pole electrically connected with the ground remote side of the power source 14 and adapted normally to engage a switch contact 27H, said pole being shiftable to disengage said contact 27H and to engage with a contact 27L whenever the operating coil 27C is energized. The actuating coil 15C of the switch 15 may be electrically connected between ground and the contact 27L of the relay switch 27. Accordingly, under normal conditions which exist when the coil 27C is not energized, the switch 27 will be in position engaged with the contact 27H and disengaged from the contact 27L. The coil 15C, accordingly, also will be de-energized, whereby the pole of the switch 15 will be engaged with the contact 15H, thus energizing the lamps L' for bright beam operation.

As shown more particularly in Fig. 3, the translation system 20 may include a power source 28 of relatively high voltage uni-directional potential that is relatively negative with respect to ground, the transistor remote end of the coil 27C being electrically connected with the power source 28. The transistor remote side of the detector element 21 may also be electrically connected, as through a suitable ballast resistor 29, with said power source 28. The emission elements 26 of both transistors in the system shown in Fig. 3 may be electrically connected to ground through ballast resistors 22' and 23'. The interconnected element 25 of the transistor 22 and the element 24 of the transistor 23 may be connected with the source of negative potential 28 through adjustable resistance means 30 and with the relay switch contact 27H through preferably adjustable resistance means 31.

When the light beam R^2 of an approaching vehicle V^2 impinges upon the detector 21, the impedance thereof will decrease as a proportional function of the intensity of impinging light. The decrease in impedance allows correspondingly larger amounts of current to flow in the detector circuit from the voltage source 28 through the resistor 29, the detector 21, thence through the transistor 22 to ground from the base 24 thereof, through the emitter 26 and the ballast resistor 22'. This current varies directly with the intensity of visible light applied upon the crystal detector 21 and is substantially zero when the crystal is dark. The flow of current in the detector circuit and through the transistor 22 produces corresponding voltage changes at the collector 25 of the transistor 22, the voltage thus produced at the collector being variably adjustable by means of the variable sensitivity control resistor 30. Since the collector 25 of the transistor 22 is connected with the base 24 of the transistor 23, current flow between the collector 25 and emitter 26 of the transistor 23 will be controlled precisely in accordance with the voltage fluctuations produced on the collector 25 of the transistor 22 as the result of light induced impedance changes in the detector 21.

The collector 25 and emitter 26 of the transistor 23, however, are interconnected between ground and the power source 28 in series circuit with the ballast resistor 23' and the operating coil 27C of the relay switch 27. The transistors thus, in effect, form a two-stage amplifier for actuating the relay switch 27 by energizing the coil 27C in response to light impingement at and above a predetermined intensity value on the detector 21. Accordingly, when the crystal 21 is dark and the transistors inoperative to energize the coil 27C, the blade of the switch 27 will be closed with the contact 27H and open with respect to the contact 27L. The operating coil 15C of the relay switch 15 will accordingly be inactive and the blade of the switch 15 will be engaged with the contact 15H, thus connecting the lamps L' for bright or high beam operation.

As soon as the headlight beams R^2 of an approaching vehicle V^2 impinge upon the detector 21 at a predetermined intensity level, the system 20 may become operative to energize the coil 27C and actuate the switch 27 to release its pole from the contact 27H and engage the same with the contact 27L. Engagement of the pole of the switch 27 with the contact 27L completes the energizing circuit of the switch actuating coil 15C, thereby releasing the pole of the switch 15 from the contact 15H and engaging the same with the contact 15L to thus dim the lamps L'.

As soon as an approaching vehicle V^2 passes behind the vehicle V', impingement of the beams R^2 upon the detector 21 will be discontinued. When the detector 21 thus becomes dark, the translation system 20, including the transistors 22 and 23, will become inoperative. Accordingly, the switch operating coil 27C will become de-energized, thus allowing the switch 27 to return to its normal position to thereby de-energize the switch actuating coil 15C. The switch 15 thus also will be allowed

to return to its normal position controlling the lamps L' for high beam operation, when the detector **21** becomes dark.

When the system **20** is in its normal or stand-by condition with the switch operating coils **15C** and **27C** in inactive condition, the switch **27** will complete an offset circuit from the power source **14**, through the switch contact **27H** and the adjustable resistance means **31**, to the interconnected collector **25** of the transistor **22** and the base **24** of the transistor **23**. So long as the pole of the switch **27** is closed with the contact **27H**, the voltage developed at the collector **25** of the transistor **22** will be reduced by the action of the offset circuit. Such voltage reduction appreciably affects the sensitivity of the translation system, the resistance means **31** being so selected, in conjunction with the operating potentials afforded by the power sources **14** and **28**, so that the sensitivity of the system, when the pole of the switch **27** is disengaged from the contact **27H**, may be of the order of eight times the sensitivity of the system when the pole of the switch **27** is closed with the contact **27H**.

It is desirable to thus provide for increasing the sensitivity of the system in order to avoid flutter or hunting due to recycling of the system, in the event that the approaching vehicle V^2 should dim its lights and thus reduce the intensity at which the same impinge upon the detector **21** after the switch **27** shall have been actuated to dim the lights L'.

The system shown in Fig. 4 is generally similar to that illustrated in Fig. 3 in that a pair of transistors **22** and **23** are interconnected as a two-stage amplifying system for the operation of the relay switch **27** in response to the application of light upon the detector **21**, the operation of the relay switches **15** and **27** in the Fig. 4 embodiment being precisely as described supra in connection with the embodiment shown in Fig. 3. In the Fig. 4 embodiment, however, the emission elements **26** of the transistors are connected directly to ground, and the sensitivity varying offset circuit controlled by the switch contact **27H** is arranged to function by changing the voltage applied across the detector **21** when the system is operated to dim the lamps L'.

To this end, the transistor remote side of the detector element **21** is electrically connected, as through a ballast resistor **32**, with a power source terminal **28'** preferably providing negative potential of the order of −125 volts with respect to ground, said transistor remote side of the detector **21** being also electrically connected through a variable resistor **33** with the switch contact **27H**. Accordingly, when the system is in stand-by condition, the detector **21** being dark, the voltage applied through the detector and the transistor **22** comprises the resultant of the potential of the power source terminal **28'** applied through the resistor **32**, as modified by the potential of the power source **14** applied through the switch contact **27H** and the adjustable resistor **33**. Under such conditions the system is sufficiently sensitive to energize the coil **27C** and dim the lamps L' by actuating the switch **27** when the intensity of light impinging on the detector **21** reaches a predetermined value. Upon actuation of the switch **27** in dimming the lamps L', the pole of the switch **27**, in disengaging the contact **27H**, will disconnect the power source **14** from the detector circuit, which thereafter will remain connected only with the power source terminal **28'** through the resistor **32**. Under such circumstances, the system becomes substantially more sensitive so that it will not return or cycle to bright headlight condition in response merely to the reduction of the intensity of impinging light on the element **21**, as by the dimming of the headlamps of the approaching vehicle V^2.

In the system as shown in Fig. 4, the transistor remote end of the switch actuating coil **27C**, as well as the transistor remote side of the adjustable sensitivity control resistance means **30**, are both connected with the power source terminal **28'**, as through a resistor **34** sized to provide a negative voltage of the order of **25** volts with respect to ground at the transistor remote sides of the coil **27C** and of the resistance means **30**, said transistor remote sides of said coil **27C** and said resistance means **30** being interconnected to ground through a resistor **35**.

Any suitable or preferred means may, of course, be employed for supplying power at desired negative potential for the operation of the systems herein illustrated. As shown more particularly in Fig. 4 of the drawings, such electrical power at desired negative potential may be developed from the conventional 6 volt power source **14** by means of a vibrator device **36**, having a pole electrically connected with the ground remote side of the power source **14** and a pair of contacts **37** adapted to be alternately engaged by the pole of the vibrator device, said contacts **37** being electrically connected with the opposite ends of the primary winding **38** of a transformer **39**, said primary winding having a center tap electrically connected with the grounded side of the power source **14**.

The secondary winding **40** of the transformer **39** may also be provided with a center tap connected to ground, the opposite ends of said secondary winding being electrically connected, as through rectifiers **41**, with the power source terminal **28'** to thereby deliver the desired negative voltage with respect to ground at said terminal. If desired, a condenser **42** may be electrically connected between the opposite ends of the transformer winding **40**.

In order to allow dimmed lights to be brought to bright condition while the detector **21** is illuminated at light dimming intensity, a switch **43** may be provided for opening the actuating circuit of the coil **15C** between said coil and the contact **27L** of the switch **27**, thereby de-energizing the coil **15C** and allowing the switch **15** to assume its bright light position, while the coil **27C** remains energized and the pole of the switch **27** closed against the contact **27L**. The switch **43** thus comprises an overriding switch for de-energizing the coil **15C** in the event that the oncoming vehicle V^2 should fail to dim its lamps L^2 in response to the dimming of the lamps L'.

It is thought that the invention and its numerous attendant advantages will be fully understood from the foregoing description, and it is obvious that numerous changes may be made in the form, construction and arrangement of the several parts without departing from the spirit or scope of the invention, or sacrificing any of its attendant advantages, the forms herein disclosed being preferred embodiments for the purpose of illustrating the invention.

The invention is hereby claimed as follows:

1. Control apparatus for automatically dimming vehicle lamps in response to the approach of another vehicle, comprising relay switch means for controlling bright and dim operation of said vehicle lamps and embodying an operating coil, a photosensitive detector disposed in position to be illuminated by a light beam emitted by the approaching vehicle, a translation system embodying a transistor forming an amplifier and having a base controllingly associated with said detector, a collector and means to electrically connect same with a source of electrical energy through the operating coil of said switch means to energize the same under the control of said amplifier, and an emitter, means for applying to said base an electrical bias potential appreciably negative with respect to said emitter, said relay switch means serving normally to apply positive electrical potential on said base to thereby reduce the negative value of said bias to a selected level such that said relay switch means may operate to dim said vehicle lamps in response to light impingement on said detector at a selected intensity, said switch means when in light dimming position serving to disconnect said source of positive potential from said system to thereby increase the response sensitivity of the amplifier.

2. Control apparatus for automatically dimming vehicle lamps in response to the approach of another vehicle, comprising relay switch means for controlling bright and dim operation of said vehicle lamps and embodying an operating coil, a photosensitive detector disposed in position to be illuminated by a light beam emitted by the approaching vehicle, a translation system embodying a pair of transistors forming a two stage amplifier and each having a base, a collector and an emitter, the base and collector of one transistor being connected respectively with said detector and with the base of the other transistor, means to electrically connect the collector of said other transistor with a said other transistor being electrically connected with a source of electrical energy through the operating coil of said switch means to energize the same under the control of said amplifier, the emitters of said transistors being connected to ground, means for applying an electrical bias potential at a selected level appreciably negative with respect to ground upon the collector of one transistor and the interconnected base of the other, said relay switch means serving normally to apply positive electrical potential on said base to thereby reduce the negative value of said bias potential to a selected level such that said relay switch means may operate to dim said vehicle lamps in response to light impingement on said detector at a selected intensity, said switch means when in light dimming position serving to disconnect said source of positive potential from said interconnected collector and base to thereby increase the response sensitivity of the amplifier.

3. Control apparatus for automatically dimming vehicle lamps in response to the approach of another vehicle, comprising relay switch means for controlling bright and dim operation of said vehicle lamps and embodying an operating coil, a photosensitive detector disposed in position to be illuminated by a light beam emitted by the approaching vehicle, a translation system embodying a transistor forming an amplifier and having a base controllingly associated with said detector, a collector and means to electrically connect same with a source of electrical energy through the operating coil of said switch means to energize the same under the control of said amplifier, and an emitter, means including an adjustable resistor for applying to said base an electrical bias potential appreciably negative with respect to said emitter, said relay switch means serving normally to apply positive electrical potential on said base to thereby reduce the negative value of said bias to a selected level such that said relay switch means may operate to dim said vehicle lamps in response to light impingement on said detector at a selected intensity, an adjustable resistor for regulating the value of positive potential applied in said system, said switch means when in light dimming position serving to disconnect said source of positive potential from said system to thereby increase the response sensitivity of the amplifier.

4. Control apparatus for automatically dimming vehicle lamps in response to the approach of another vehicle, comprising relay switch means for controlling bright and dim operation of said vehicle lamps and embodying an operating coil, a photosensitive detector disposed in position to be illuminated by a light beam emitted by the approaching vehicle, a translation system embodying a transistor forming an amplifier and having a base controllingly associated with said detector, a collector and means to electrically connect same with a source of electrical energy through the operating coil of said switch means to energize the same under the control of said amplifier, and an emitter, means for applying to said base an electrical bias potential appreciably negative with respect to said emitter, said relay switch means serving normally to apply positive electrical potential on said base to thereby reduce the negative value of said bias to a selected level such that said relay switch means may operate to dim said vehicle lamps in response to light impingement on said detector at a selected intensity, said switch means when in light dimming position serving to disconnect said base from said source of positive potential to thereby increase the response sensitivity of the amplifier.

5. Control apparatus for automatically dimming vehicle lamps in response to the approach of another vehicle, comprising relay switch means for controlling bright and dim operation of said vehicle lamps and embodying an operating coil, a photosensitive detector disposed in position to be illuminated by a light beam emitted by the approaching vehicle, a translation system embodying a transistor forming an amplifier and having a base controllingly associated with said detector, a collector and means to electrically connect same with a source of electrical energy through the operating coil of said switch means to energize the same under the control of said amplifier, and an emitter, means for applying to said base an electrical bias potential appreciably negative with respect to said emitter, said relay switch means serving normally to connect a source of positive electrical potential with the source of said bias potential to thereby reduce the negative value of said bias to a selected level such that said relay switch means may operate to dim said vehicle lamps in response to light impingement on said detector at a selected intensity, said switch means when in light dimming position serving to disconnect said source of positive potential from said bias potential source to thereby increase the response sensitivity of the amplifier.

References Cited in the file of this patent

UNITED STATES PATENTS

2,476,389	Schmidt	July 19, 1949
2,582,850	Rose	Jan. 15, 1952
2,598,420	Onksen	May 27, 1952
2,604,496	Hunter	July 22, 1952
2,660,624	Bergson	Nov. 24, 1953
2,679,616	Onksen et al.	May 25, 1954