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HEADLIGHT CONTROL APPARATUS

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2 Sheets-Sheet 1

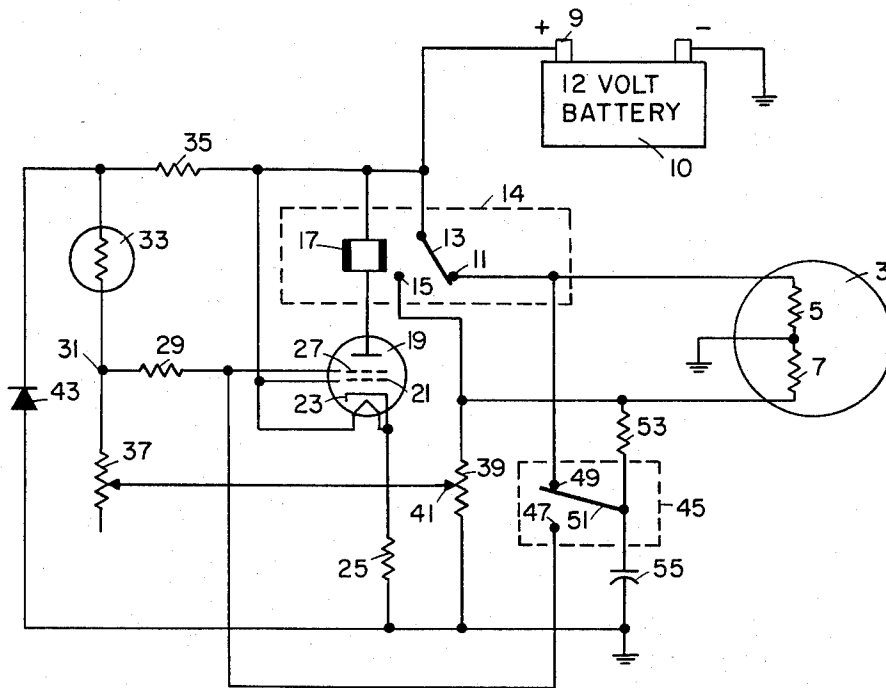


Fig. 1.

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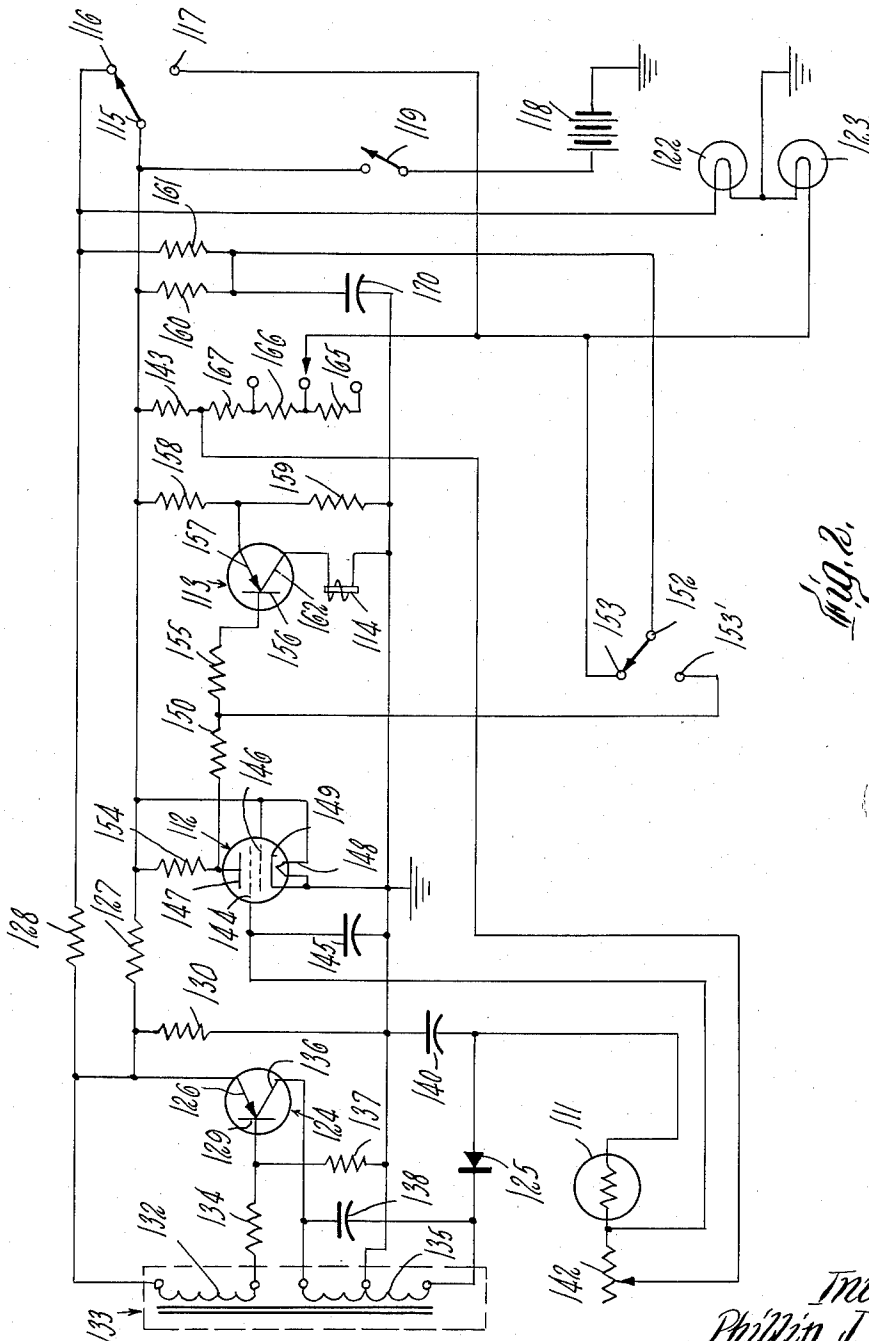
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HEADLIGHT CONTROL APPARATUS

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10 Claims. (Cl. 315—83)

This application is a continuation-in-part of my co-pending application Serial No. 705,958, filed December 30, 1957, relating generally to automatic control apparatus for automobile headlights and in particular to a foot switch arrangement for use with this kind of apparatus.

Drivers of automobiles having automatic headlight beam control apparatus may at times be dissatisfied with the selection of the high or low headlight beam made by the apparatus, and may want to bring the position of the headlight beam under their own voluntary control. Automatic headlight beam controls are, therefore, usually equipped with an auxiliary switch which in one position enables the automatic apparatus to control the headlights, and in the other position enables a beam shifting footswitch, located on the floor of the driver's compartment, to control the beam.

The principal object of this invention is to make use of a single switch such as a footswitch not only to shift the headlight beam position from high to low and vice-versa, but also to inhibit the automatic mode of control.

In accordance with the illustrated embodiments of this invention, actuation of the footswitch, which has two positions, from its automatic to its non-automatic position, shifts the beam of the headlights and "locks" them in the new position. Actuation of the footswitch back from its non-automatic to its automatic position brings the position of the headlight beam back under automatic control.

Other and incidental objects of the present invention will be apparent to those skilled in the art from a reading of the following specification and an inspection of the accompanying drawing wherein:

Fig. 1 is a circuit diagram of a beam control apparatus for automobile headlights in accordance with the invention, and

Fig. 2 is a circuit diagram of a modification of the embodiment shown in Fig. 1 also in accordance with the invention.

With reference first to Fig. 1, there is shown a headlight 3 having a high filament 5 and a low filament 7. The center tap between the filaments 5 and 7 is connected to ground. The high filament 5 is connected to the terminal 9 of a twelve volt battery 10 through fixed contact 11 and movable contact 13 of relay 14. The low filament 7 is connected to the battery terminal 9 through fixed relay contact 15 and movable contact 13. The movable contact 13 is actuated by the relay coil 17 which is connected in the plate circuit of an electron tube 19. The grid 21 of tube 19 is connected to the battery terminal 9 and the cathode 23 is connected to ground through the resistor 25. The grid 27 of tube 19, which acts effectively as a control grid, is connected through the resistor 29 to the junction 31. Junction 31 is connected to the battery terminal 9 through a photocell 33 and a resistor 35. Junction 31 is connected to ground through the variable resistor 37 and the portion of potentiometer 39 between its sliding contact 41 and its grounded end. The ungrounded end of potentiometer 39 is connected to the fixed relay

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contact 15. A regulating diode 43 is connected across the potential divider comprising photocell 33, variable resistor 37 and the lower portion of potentiometer 39.

In accordance with the illustrated embodiments of this invention, a single-pole double-throw switch such as the footswitch 45 has one fixed contact 47 connected to the grid 27 and the other fixed contact 49 connected to the relay contact 11 and to the high filament 5. The movable contact 51 of the footswitch 45 is connected through resistor 53 to the relay contact 15 and to the low filament 7 and to ground through the storage capacitor 55.

The operation of the circuit shown in Fig. 1 is as follows: The photocell 33, the variable resistor 37 and the lower portion of the potentiometer 39 form a potential divider across which the voltage remains relatively constant due to the action of the regulating diode 43. The variable resistor 37 and the potentiometer 39 are sensitivity and differential controls respectively, as will be explained in greater detail below, but once adjusted may be regarded as fixed resistors. When no light impinges upon the photocell 33, the potential at junction 31 (and at the grid 27) is such that the tube 19 is near cut-off. With little or no current through the relay coil 17, the movable relay contact 13 and the relay contact 11 are closed, the high filament 5 being energized as shown in the drawing. When light from an oncoming automobile impinges upon the photocell 33, its resistance goes down and the potential at junction 31 (and on grid 27) becomes more positive, so that the tube 19 conducts. With substantial current through the relay coil 17, the movable contact 13 moves from contact 11 to contact 15, thus de-energizing the high filament 5 and energizing the low filament 7. When light from the oncoming automobile ceases to impinge upon the photocell 33, its resistance goes up, the potential on grid 27 goes down, tube 19 goes back to near cut-off, and the movable contact arm 13 moves from contact 15 back to contact 11, thus de-energizing the low filament 7 and re-energizing the high filament 5.

The resistance of the variable resistor 37 may be of the order of one megohm, while that of potentiometer 39 may be of the order of one thousand ohms. Thus, with the tube 19 near cut-off and the movable relay contact 13 energizing the high beam filament 5 through contact 11, the level of illumination necessary to make the tube 19 conduct is determined almost entirely by the variable resistance 37 which is, therefore, a sensitivity control. However, when the tube 19 is conducting and the movable relay contact 13 energizes the low beam filament 7 through relay contact 15, the decrease in level of the light impinging upon photocell 33 which must occur before the tube 19 goes back to near cut-off is determined almost entirely by the potential at the sliding contact 41, the potentiometer 39 being placed across the battery supply through the movable relay contact 13 and the contact 15. The potentiometer 39 is, therefore, a "differential" control.

In the operation so far described it has been assumed that the movable contact 51 of the footswitch has been in the "automatic" position shown in the drawing, i.e. in contact with the contact 49. Let us now assume that the high filament 5 is energized, and that the driver is unhappy with this condition as called for by the operation of the automatic control. When the high filament 5 is energized, a positive charge builds up on capacitor 55 through movable contact 13, fixed contact 11, fixed contact 49 and movable contact 51. The driver, to change this condition, may depress the footswitch so that the movable contact 51 switches from contact 49 to contact 47. The positive charge on capacitor 55 then appears as a positive pulse on the grid 27 of tube 19 and causes tube 19 to conduct. With current through the relay coil 17, the movable relay contact 13 switches from

contact 11 to contact 15, the high filament 5 becomes de-energized and the low filament 7 becomes energized. A positive voltage sufficient to keep the tube 19 conductive remains on grid 27 through movable contact 13, fixed contact 15, resistor 53, movable contact 51 and fixed contact 47. The headlights are thus "locked" in the low position. If the footswitch 45 is depressed again so that the movable contact 51 moves from contact 47 to contact 49, previous circuit conditions are restored and the headlight conditions are determined again by the level of the light impinging upon photocell 33.

Let us now assume that the footswitch is in the automatic position, and that the amount of light impinging upon the photocell 33 is such that the low beam filament 7 is energized. This may happen even though there are no oncoming vehicles approaching, for instance because light from the driver's own headlights is reflected from objects such as snowbanks or white fences. The driver may then prefer to use his high beam even though his automatic control is calling for the low beam. With the low beam energized, the potential at grid 27 is sufficiently positive to keep tube 19 conductive. If now the movable contact 51 of the footswitch 45 is switched from contact 49 to contact 47, the capacitor 55 provides a transient path to ground and momentarily cuts off the conduction through tube 19. Relay contact 13 switches from contact 15 to contact 11, the low beam filament 7 becomes de-energized and the high beam filament 5 becomes energized. A biasing voltage sufficient to keep the tube 19 near cut-off is impressed on its grid 27 across a voltage divider comprising resistor 35, photocell 33, high resistance 29, lower resistance 53 and low filament 7. The headlights are thus "locked" in the high position. If the footswitch 45 is depressed again, the movable contact 51 moves from contact 47 to contact 49, previous circuit conditions are restored, and the headlight conditions are again determined by the amount of light impinging upon photocell 33.

The following circuit values, which are given as an example only, may be used in the embodiment of Fig. 1:

Tube 19	12 K5.
Relay coil 17	300 ohms.
Photocell 33	CL 404 cadmium selenide.
Resistor 25	5 ohms.
Resistor 29	1 megohm.
Resistor 35	1000 ohms.
Resistor 37	1 megohm.
Potentiometer 39	1000 ohms.
Resistor 53	47,000 ohms.
Capacitor 55	25 microfarads.
Diode 43	Zener SV-9.

With reference now to Fig. 2, it will be observed that the modified apparatus embodies a photo-conductive cell 111, a vacuum tube voltage amplifier stage featuring a tetrode 112, and a power amplifier which uses a transistor 113. The latter, in turn, serves to control a relay whose coil has been designated 114 and whose contacts have been designated 115, 116, and 117. Movable contact 115 is connected to the automobile battery 118 through the same switch 119 as is normally used to turn on the automobile headlights. Stationary contact 116 is connected to the low beam filament 122 of the automobile headlights while the other stationary contact 117 is connected to the filament 123 which produces the high beam. A ground connection which is common to the filaments and to the negative terminal of the battery completes the headlight circuit.

Power to operate the amplifier stages is obtained from the battery 118 while the voltage to which the amplifier stages are responsive is obtained from a transistor 124 adapted to serve as an oscillator and a diode 125 which rectifies the oscillator output. To this end, the emitter 126 of transistor 124 is connected to movable relay contact 115 through a resistor 127 and also to stationary

contact 116 through a resistor 128. The junction of the resistors is connected to ground through a resistor 130 thereby forming a voltage dividing arrangement. The reason for this arrangement lies in the differential operation of the relay, as will be described in detail hereinafter.

Connecting the emitter 126 to the base 129 of the transistor is a resistor 134 and a feedback winding 132 on a transformer 133 in series therewith. The primary winding 135 of the transformer has one of its ends connected to the collector 136 of the transistor and the other of its ends connected to the cell through the diode 125. It also has a center tap which is grounded as is a biasing resistor 137 tied to the base. Finally, a capacitor 138 is connected across the winding 135 and a capacitor 140 is connected from the diode to ground for filtering purposes.

To apply the voltage which is developed by the transistor oscillator stage to the voltage amplifier stage in a manner whereby the value of the voltage is controlled by the cell, there is connected in series relation to the cell a potentiometer 142 having one of its ends open-circuited in the manner of a rheostat. The potentiometer in turn is connected to the movable relay contact 115 through a resistor 143 while the junction of the potentiometer and the cell is connected to the control grid 144 of the tetrode 112. There is also a filter capacitor 145 connected between grid and ground.

Tetrode 112 has another grid 146 which is used to produce a virtual cathode, and in this way make it possible to obtain a relatively large amount of amplification with the relatively low voltage for the plate 147 which the battery 118 provides, namely twelve volts. Tetrodes of this type are known to those skilled in the art, such as for example the 12 K5 whose filament and cathode have been designated 148 and 149, respectively. As shown one end of the filament is connected to the movable contact 115 as is the grid 146, while the other end of the filament is connected to ground along with the cathode 148. The plate 147 is connected directly to relay contact 115 through a load resistor 154 and it is selectively connectable to the relay contact 115 through a pair of contacts 152, 153' and a pair of resistors 160 and 150 disposed in series with the respective contacts. The contact 152 is intended to represent the movable one of the contacts in a single-pole double-throw type of high-low beam foot switch and contact 153' together with a contact 153 represent the stationary contacts. There is also provided a resistor 161 connecting switch contact 152 to relay contact 116 and a capacitor 170 connected between contact 152 and ground.

To apply the output of the tetrode 112 to the power amplifier stage the plate side of the load resistor 154 is connected through resistor 150 and a resistor 155 in series therewith to the base 156 of the power transistor 113. The emitter 157 of the power transistor is biased by means of a voltage dividing arrangement comprising resistors 158 and 159 which are connected between the movable relay contact 115 and ground. The relay coil itself is connected directly in the load circuit between the collector 162 and ground.

Completing the system is an adjustable feed-back arrangement which comprises a series of resistors 165-167, a selected one of which is adapted to be connected between the relay contact 117 and the resistor 143. This feed-back arrangement will likewise be covered in detail in the description of the operation of the system which follows.

In operation, it will be assumed first that the footswitch is conditioned as shown in the drawing, with movable contact 152 and stationary contact 153 together. The rectified output voltage from the oscillator which may range, for example, between -16 and -40 volts, appears across the capacitor 140, and the same voltage augmented by the voltage of the battery appears across

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the series combination of the cell, the potentiometer and resistor 143. Accordingly, the potential of the junction between the potentiometer and the cell is dependent upon the relative resistances of the cell and the potentiometer. For example, when the amount of light impinging upon the cell increases, thereby decreasing the cell's resistance, the junction becomes more negative. Conversely, with less light on the cell, the junction is more positive. Increasing and decreasing the resistance of the potentiometer to change the sensitivity of the system has just the reverse effect.

The tetrode is controlled in the usual way by the amount of bias applied to the grid 144, which bias is derived from the junction of the photocell and the potentiometer. If it be assumed that the photocell "sees" a relatively large amount of light so that its resistance is low, tetrode 112 becomes heavily biased, preferably to cut-off. As a consequence, the base of transistor 113 will be placed at a potential substantially equal to that of the battery, while the emitter is held at a significantly lower potential by the voltage dividing action of resistors 158 and 159. In other words, transistor 113 will likewise be heavily biased so that very little current is permitted to flow in its load circuit incorporating the relay coil. With relay coil 114 de-energized, the relay contacts assume their normal positions wherein contact 115 makes with contact 116, connecting the low beam filament in circuit with the battery. Now if it be assumed that the amount of light falling on the photocell decreases, as for example when an oncoming headlighted car is passed, the cell resistance will increase, making the control grid of the tetrode more positive and causing it to conduct. This will lower the potential of the base of the transistor 113 so that it likewise will conduct and energize the relay coil 114. In consequence, contact 115 will make with contact 117 which will close the circuit to the high beam filament and open the low beam circuit.

In order to insure that a substantial change in light conditions must take place to cause the relay contacts to open once they have closed and vice versa, the circuit features two feed-back arrangements. A first of these feed-back arrangements involves the oscillator stage. Thus, when the light level on the photocell falls to the extent that the relay contact 115 which was in its low beam position is caused to move towards its high beam position, resistor 128 becomes open-circuited. In consequence thereof, the emitter voltage of transistor 124 decreases, causing it to oscillate less strongly and its output voltage to decrease. This corresponds to a decreased amount of bias on the tetrode 112 so that it conducts more strongly as does transistor 113. In other words, the overall effect is to increase the tendency of the relay to pull in by way of the increased output of transistor 124.

Now when the contact 115 makes with contact 117, that is, when the high beam is turned on, one of the resistors 165-167 becomes tied to the high side of the battery depending upon the initial selection of a resistor for connection to the high contact. In any event, whichever resistor it is will cause the voltage at the junction of the photocell and the potentiometer to increase, thereby decreasing the amount of bias on the tetrode. As before, this causes transistor 113 to conduct more strongly so that there is less tendency for the relay to return to its normal state.

Thus far only the automatic mode of operation of the apparatus has been described. Now if it be assumed that the footswitch is actuated to inhibit this mode of operation what happens is the following. As soon as footswitch contact 152 makes with contact 153', the charge which the capacitor 170 has accumulated is applied to the junction of resistors 150 and 155. If the high beam was on initially so that the relay contacts 115 and 117 were together, the charge will be equivalent to

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twelve volts, the same as the voltage across the high beam filament. As a result, the base of the power transistor becomes heavily biased by the charge on the capacitor, turning off the transistor and de-energizing the relay. With the relay de-energized, that is with contacts 115 and 116 together and the low beam on, the voltage at the junction of resistors 160 and 161 also becomes equal to twelve volts. This voltage serves to maintain the power transistor non-conducting and the relay de-energized, irrespective of the amount of light impinging on the photo cell.

If it be assumed now that the relay contacts 115 and 116 were together so that the low beam was on when the foot switch was actuated, virtually no charge is applied to the junction of resistors 160 and 161. This is because of the very low impedance path to ground that the high beam filament provides in this case. In consequence, the capacitor acts as a momentary short circuit to ground which causes the power transistor to conduct sufficiently heavily, to close the relay and turn on the high beam in place of the low beam. When this happens, the voltage at the junction of resistors 160 and 161 becomes equal to a sufficiently low value to maintain the transistor conducting strongly and the relay energized irrespective of the amount of light present. Specifically, the circuit comprising resistors 160 and 161 and the low beam filament is adapted to establish this voltage at a value of about six volts in the embodiment illustrated. Thus, no matter what the condition of the relay is, which controls the headlight beam, actuation of the footswitch from its automatic to its non-automatic position effects a change in the beam and at the same time prevents the apparatus from responding to the photocell. Upon the return of the footswitch to its automatic position, the selection of the high or low beam is once again made to depend solely upon the amount of light impinging on the photocell.

Although the system of the invention has been described in connection with just two preferred embodiments, it will be appreciated that various other embodiments are possible that are within the spirit and scope of the invention. For example, with circuit modifications known to those skilled in the art, the embodiment of Fig. 1 can be transistorized and so also the embodiment of Fig. 2 converted to use with electron tubes. Therefore the invention should not be deemed to be limited to the details of what has been described herein by way of illustration but rather it should be deemed to be limited only by the scope of the appended claims.

What is claimed is:

1. Apparatus for the automatic control of a headlight having high and low beam filaments, said apparatus comprising a photoelectric detector, relay means responsive to the output of said photoelectric detector, said relay means having first contact means to energize said high filament and second contact means to energize said low filament, a signal storage device, a switch having first and second contact means, means to supply to said storage device through the first contact means of said relay and the first contact means of said switch a signal which when applied to said relay means through the second contact means of said switch closes the second contact means of said relay, means to supply through the second contact means of said relay and the second contact means of said switch a bias to said relay means sufficient to hold the second contact means of said relay in its closed position, means to supply to said storage device through the second contact means of said relay and the first contact means of said switch a signal which when applied to said relay means through the second contact means of said switch closes the first contact means of said relay, and means to supply through the first contact means of said relay and the second contact means of said switch a bias to said relay means sufficient to hold the first contact means of said relay in its closed position.
2. Apparatus for the automatic control of a head-

to energize said high and low filaments, and switching means which when in the first position make the relay means responsive to the output of said photoelectric detector and in the second position make the relay means insensitive to the output of said photoelectric detector and cause said relay to energize the filament other than that which was energized just before the switch was moved from said first to said second position.

9. Apparatus for the automatic control of a headlight having high and low beam filaments, said apparatus comprising a photoelectric detector, circuit means including an amplifying device to derive from said detector, a control signal representative of the amount of light impinging thereon, said amplifying device including an input circuit and an output circuit, relay means coupled to said output circuit to energize said filaments selectively in response to said control signal, said relay means having first contact means which when closed, energize one of said filaments and second contact means which when closed, energize the other of said filaments, a capacitor, a switch having selectively closing, first and second contact means, means to charge said capacitor when the first contact means of said relay and the first contact means of said switch are closed, said capacitor being coupled to the input circuit of said amplifying device when the second contact means of said switch is closed causing the second contact means of said relay to close and the first contact means of said relay to open when said capacitor is charged, means to supply to said input circuit when the second contact means of said relay and the second contact means of said switch are closed, a bias voltage to maintain said relay means in condition with the second contact means of said re-

lay closed, means to discharge said capacitor when the second contact means of said relay and the first contact means of said switch are closed, said capacitor being coupled to the input circuit of said amplifying device when the second contact means of said switch is closed causing the first contact means of said relay to close and the second contact means of said relay to open when said capacitor is discharged, and means to supply to said input circuit when the first contact means of said relay and the second contact means of said switch are closed, a bias voltage to maintain said relay means in condition with the first contact means of said relay closed.

10. Apparatus according to claim 9 wherein said means to supply bias voltages to the input circuit of said amplifying device comprise a voltage dividing circuit having its ends connected to the first contact means of said relay and to said first headlight filament, said voltage dividing circuit having an intermediate point connected to the input circuit of said amplifying device when the second contact means of said switch is closed, said intermediate point assuming a potential corresponding to a portion of the potential across said voltage dividing circuit when said first contact means of said relay are open.

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