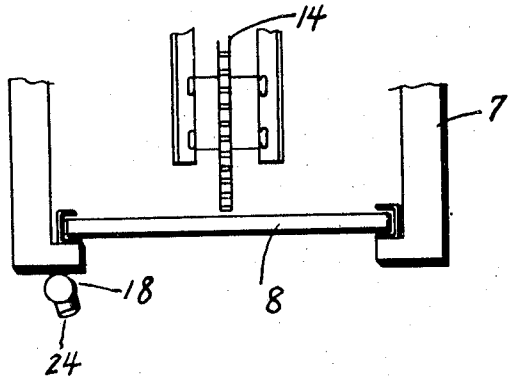
Sept. 28, 1948. C. T. SCHIRMER ET AL 2,450,021

AUTOMATIC DOOR OPERATOR

Filed Aug. 27, 1945 3 Sheets-Sheet 1



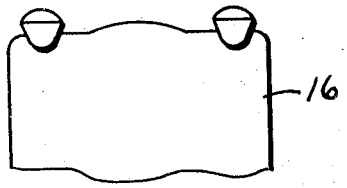


Fig. 1.

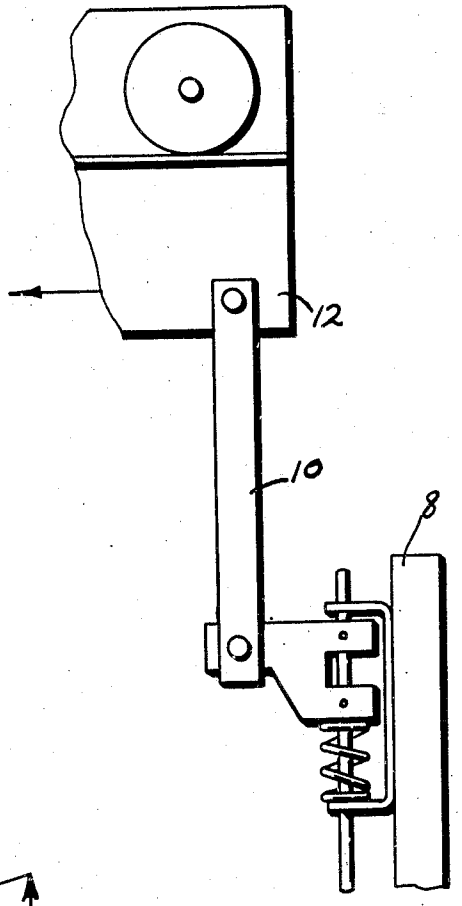


Fig. 2.

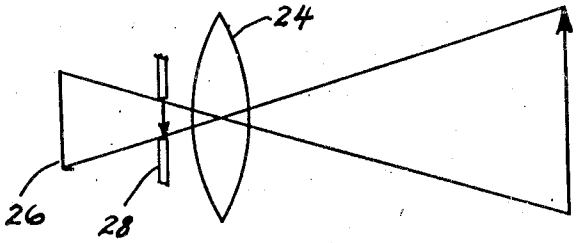


Fig. 7.

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AUTOMATIC DOOR OPERATOR

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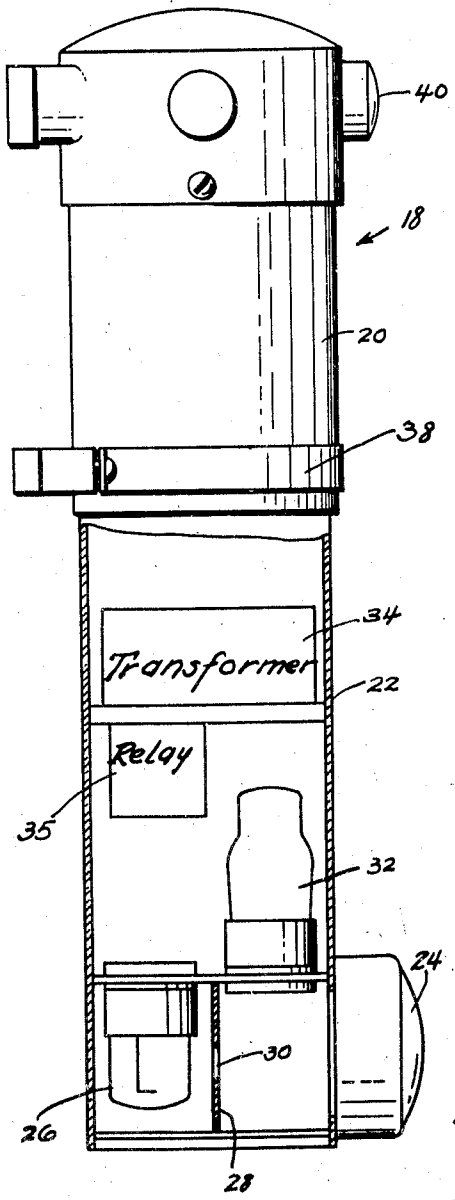


Fig. 3.

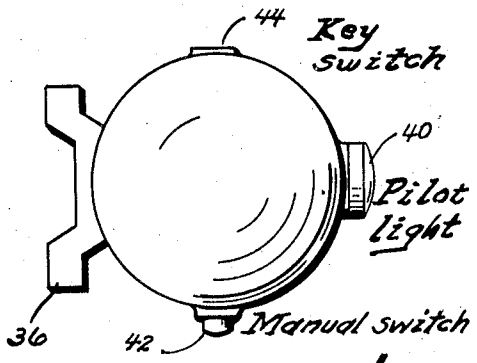


Fig. 4.

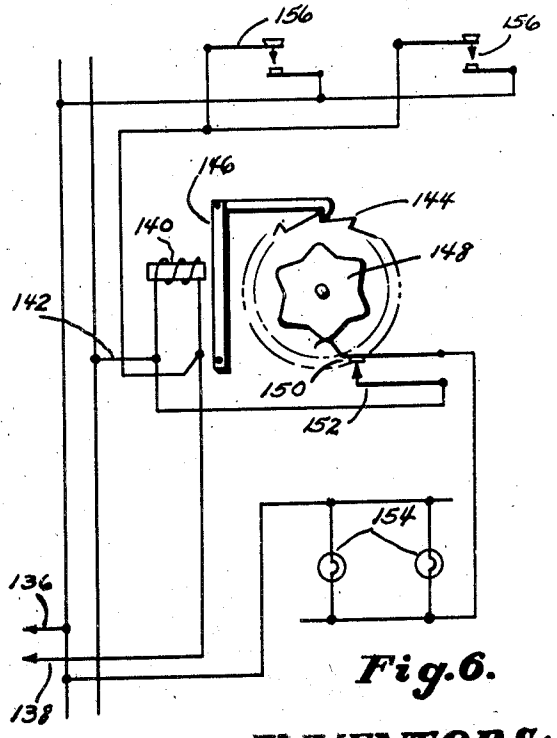


Fig. 6.

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AUTOMATIC DOOR OPERATOR

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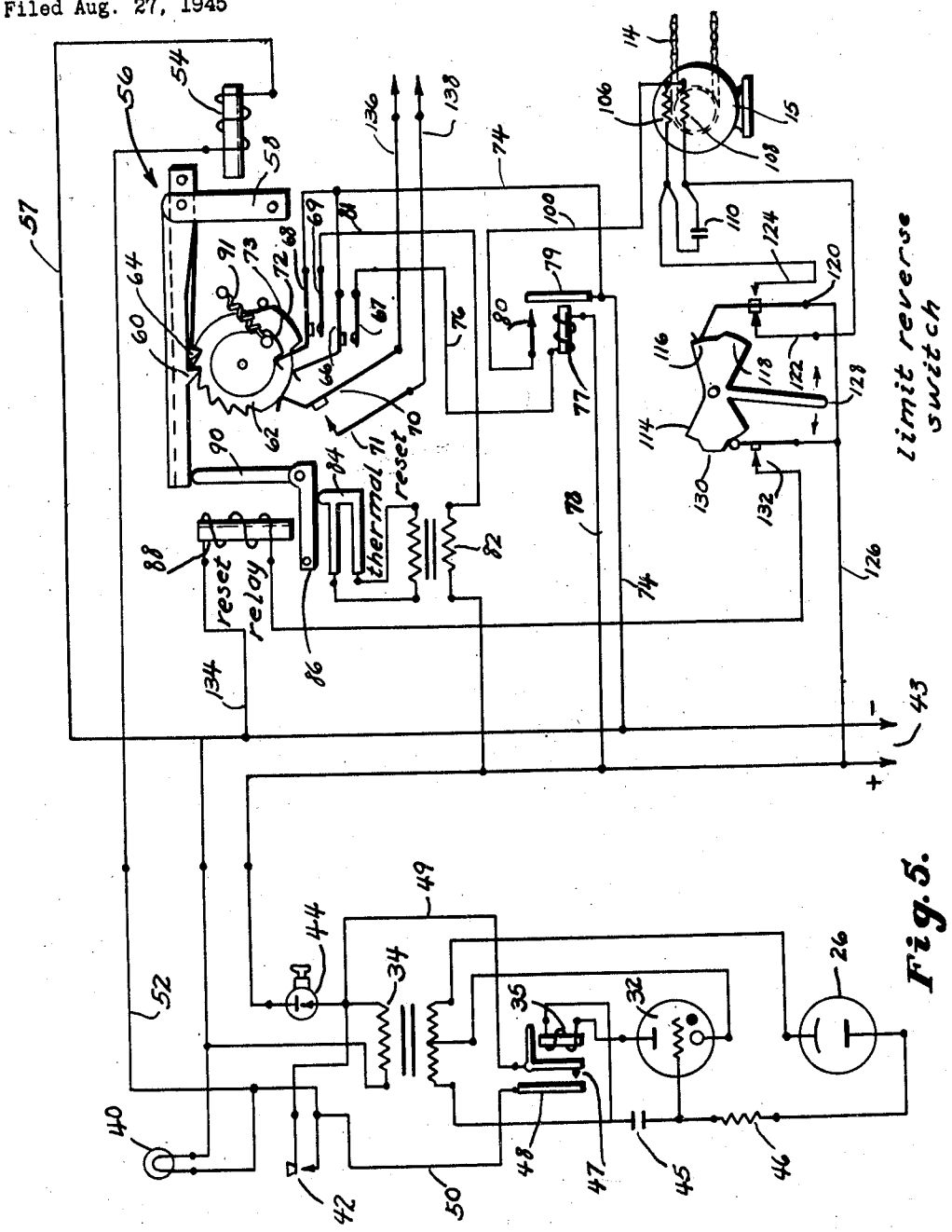


Fig. 5.

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UNITED STATES PATENT OFFICE

2,450,021

AUTOMATIC DOOR OPERATOR

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Application August 27, 1945, Serial No. 612,924

6 Claims. (Cl. 318—452)

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The present invention relates to automatic door operators, more particularly to apparatus under control of the driver for opening and closing garage doors without requiring him to leave the vehicle.

Various devices have been suggested for automatic operation of garage doors but, so far as we are aware, most of them have proved impractical either because of complexity or uncertainty of operation.

The principal object of the present invention is to provide a door operator particularly useful for automatic garage door operation which requires no special attachments to the vehicle and which is capable of certain operation for either opening or closing the door. To this end the principal feature of the invention comprises a photoelectric control which may be operated by blinking the headlights several times within a definite period. Another feature comprises means whereby the device is rendered sensitive only to light directed on the photoelectric control from a predetermined direction or within a small angle therefrom in order that the device will be substantially insensitive to extraneous light sources and will respond to the blinking operations.

Another object is to provide a device so arranged that the automatic apparatus can be rendered inoperative by means of a key switch.

In the accompanying drawings, Fig. 1 is a diagram showing the relation of an automobile to the garage when the door is to be opened or closed; Fig. 2 is a detail illustrating a part of the door operating mechanism; Fig. 3 is an elevation, partly in section, of the control apparatus; Fig. 4 is a plan view of the apparatus shown in Fig. 3; Figs. 5 and 6 are diagrams of the electrical connections; and Fig. 7 is a diagram illustrating the means for obtaining directional sensitivity.

As shown in the diagram of Fig. 1 a garage indicated diagrammatically at 7 is provided with a door 8 of the overhead type. The door construction and the motor connectons for operating it are described in detail in co-pending application of Schirmer, Serial No. 612,921, filed August 27, 1945. It is sufficient to note here as shown in Fig. 2 that when the door is closed a vertical link 10 prevents the door from being lifted manually. The link 10 is connected to a carriage 12, operated by a chain 14 which is driven by a motor 15 (Fig. 5). To open the door the carriage is drawn to the left, thus pulling the link 10 toward a horizontal position and drawing the door into

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overhead position. To close the door the carriage is moved in the opposite direction.

Referring again to Fig. 1, this shows an automobile 16 stopped in front of the garage with one of the headlights directed toward a control device 18 on the door frame. Fig. 3 is a sectional view of the control device 18. It comprises two telescoping tubes 20 and 22. The bottom tube 22 carries a protruding lens 24 to focus light from the headlights on to the sensitive element of a phototube 26. Between the lens and the tube there is mounted a diaphragm 28 having an aperture 30 arranged to insure that light coming only from a certain direction will reach the tube, as will be explained in detail later with reference to Fig. 7. Mounted within the telescoping tube 22 are also a cold-cathode amplifier 32, a transformer 34, and a relay 35, connected as shown in the wiring diagram of Fig. 5 to be presently explained. The telescoping tube 22 is adjustable for height and orientation within the tube 20, so that the light from the car may be directed on the lens 24 when the car is stopped at a certain position in the driveway. The upper tube is secured to the door frame by brackets 36. The tubes 20 and 22 may be secured together in adjusted position by means of a clamp 38.

In the top of the upper tube 20 is mounted a pilot light 40 which is arranged to give a suitable indication when the phototube is activated. The invention also includes a manual push button operating switch 42 and a lock switch 44 which may be conveniently mounted in the same assembly with the pilot light. The remaining parts of the equipment will be described in connection with the wiring diagram of Fig. 5.

In Fig. 5, the alternating current supply lines are shown at 43, and are designated + and — for convenience, although those symbols have no significance as to polarity. The line is connected to one side of the primary of the transformer 34 through the normally closed lock switch 44, and the — line is directly connected to the other side. One side of the transformer secondary is connected to the cathode of the phototube 26 in the conventional manner, a center tap on the transformer is connected to the cathode of the amplifier 32, and the other side of the secondary is connected through a series condenser 45 and resistor 46 with the anode of the phototube, the junction of 45, 46 being connected to the amplifier grid. The winding of relay 35 is connected between the amplifier anode and the transformer secondary. The relay has normally open contacts 47, 48 which are closed when the phototube is activated. The

contact 47 is connected by a wire 49 with the + line below the lock switch, and the contact 48 is connected by wires 50 and 52 with the step coil 54 of a ratchet relay indicated generally at 56, the coil being connected by a wire 57 with the — line. The push-button switch 42 has its contacts connected across the relay contacts so that the operations which are performed by the main relay may alternatively be performed manually.

The ratchet relay 56 has an armature 58 connected with a pawl 60 to drive a ratchet wheel 62. A detent pawl 64 is also provided in accordance with usual ratchet construction. The relay is provided with a set of main contacts 66, 67 by which the operation of the motor is controlled. Furthermore, as will hereinafter appear, the system preferably is provided with time controlled reset means for which purpose the relay has a pair of contacts 68, 69. Auxiliary contacts 70, 71 may also be provided for controlling garage lights as will later be described.

The ratchet wheel 62 is provided with a cam surface 72 which closes contacts 66, 67 together on the third step to determine operation of the motor. The auxiliary contacts 70, 71 are arranged to be closed by the cam 72 on the fourth step. Contacts 68 and 69 are together connected to the — line by wire 74. Contact 67 is connected by wire 76 with the winding 77 of a motor relay which is connected to the + line through a wire 78. The armature 79 is connected to the wire 74 which as heretofore described, connects with the — line. A contact 80 on which the armature 79 closes is connected with the motor 15 in a manner to be described later. It will be seen that upon closure of the contacts 66, 67 on the third step the motor relay is energized by a circuit running from the + line through connection 78, winding 77, contacts 67, 66 and connection 74 to the — line.

As stated above, a time controlled reset device is preferably included in the system, in order to reset the ratchet in the event that three stepping operations of the relay are not completed within a specified time. To this end, contact 69 is connected by a wire 81 through the primary of a transformer 82 which in turn is connected with the + line. The secondary of the transformer 82 is connected to a bimetallic thermal reset device 84, which if energized for a sufficient period of time, flexes into engagement with a pivoted armature 86, forming a part of a reset relay 88. The armature has an arm 90 to lift and release the pawls 60 and 64 after the thermal device has been energized for a predetermined time. A spring 91 is provided to restore the ratchet to the position shown in Fig. 6, whenever the pawls are tripped.

The motor relay contact 80 is connected by a wire 100 with the motor 15. The motor is herein shown as a split-phase condenser motor having windings 106 and 108 both connected to the wire 100. A condenser 110 is connected between the two windings.

A door limit reverse switch is provided to determine opening and closing movements of the door. It comprises a rocking cam member 114 having cam surfaces 116 and 118 to close a movable contact 120 on either of two fixed contacts 122 and 124 respectively. The fixed contacts are connected to the windings 108 and 106 respectively, and the movable contact is connected to the + line by a wire 126. The cam 114 has an arm 128 engageable by dogs on the door operating chain to rock the cam from one position to the other at the end of an opening or closing movement.

The limit switch cam is provided with a projection 130, arranged to close contacts 132 momentarily in the shift from one position to the other. The contacts are connected between wire 126 and the reset relay 88, which is connected to the — line by a connection 134. Thus momentary closure of the contacts 132 during movement of the limit switch in either direction energizes the relay 88 and lifts the pawls 60 and 64.

The auxiliary contacts 70 and 71 of the ratchet relay are for the purpose of lighting a garage lamp and will later be described in detail.

The pilot lamp 40 is connected between the — line and the connection 52 whereby it will light whenever the contacts of the main control relay 35 or the manual switch 42 are closed.

The operation of the door-operating parts is explained as follows: Assuming that the doors are closed and the car drives up for access, the driver will stop the car at a designated position in the driveway. The exact position of stopping is not critical and any position within the limits of about five feet will serve to operate the system. The control device 18 will have been adjusted so that when the car is within the correct stopping range the light from at least one headlight will be directed toward the phototube. At this time the limit switch is in the position shown in Fig. 5. The driver after stopping at the proper position turns his headlights on and off three times. The system operates equally well in daylight and at night, but at night the impingement of the already lighted headlights on the phototube causes the first actuation of the relay.

Each time the headlight is lighted the phototube is activated and through the amplifier 32 causes energization of the main relay 35 and closure of its contacts 47, 48. Upon closure of the relay contacts a circuit is traced from the + line below the key switch through the connection 49, the relay contacts 47, 48, and the connections 50 and 52 to the step magnet 54, which in turn is connected through 57 to the — line. Thus the step magnet is energized for each blink of the headlights. The pilot lamp 40 is also energized in unison with the step magnet, so that the driver is advised of correct operation. Each energization of the step magnet advances the ratchet wheel 62 by one tooth. On the first advance the contacts 68 and 69 are closed, thereby energizing the thermal time delay reset member 84 through the transformer 82. The thermal member 84 is adapted to engage the armature 86 and trip the pawls at the end of a specified time, say about 20 seconds, so that if the proper door-operating signal is not completed within that time, the ratchet will automatically reset without causing any operation of the motor. The thermal reset thus distinguishes between desired operation and such accidental illumination of the phototube as might occur, for example, from the sun shining on it at a particular time of day or by illumination from a passing vehicle.

On the second step of the ratchet none of the electrical connections are changed. On the third step, however, contact 68 drops off the cam and opens the thermal reset circuit, thus preventing the thermal reset from interfering with the opening of the door. Also on the third step, contacts 66 and 67 are closed, thereby energizing the motor relay to close its armature 79 on contact 80. The circuit from the motor is then traced from the —line, through connection 74, contacts 79 and 80,

connection 100, motor winding 108, limit switch contacts 122, 126 and connection 126 to the +line. The winding 108 is at this time the main winding while winding 106 constitutes the condenser winding of the motor. The motor then operates to open the door.

At the limit of the opening movement the limit switch cam 114 is rocked to its opposite position. During the rocking motion the cam projection 130 closes contacts 132 momentarily, thus energizing the reset magnet 38 and attracting the armature 36 to trip the ratchet and thus to open all of the previously described circuits. The operation of the limit switch leaves contact 126 closed on 124, thus changing the motor connections in readiness for operation of the motor for a closing movement. The operator may then drive into the garage.

To close the door the operator simply presses the manual button 42 three times. Since the contacts of this button are connected directly across the relay contacts 47, 48, the same operations are performed as if the phototube were actuated by the headlights, except that the motor connections are changed by the limit switch. The winding 106 is now the main winding while 108 is the condenser winding. The motor operates in the reverse direction to close the door and upon reaching the limit of its closing movement, the limit switch is rocked to place the contacts in position for a subsequent opening movement. The push button switch 42 may be located on the top of the control assembly 18 as indicated in Fig. 3; or if the garage has another door commonly used for access the switch may preferably be placed at a convenient position in the garage.

When the door is to be opened to permit egress of the vehicle this is accomplished by operating the manual button 42 three times. The car is backed out, and then, by blinking the lamps three times, the system is automatically operated to close the door.

The system may be disabled at any time by the key switch 44 which simply opens the supply line to the main transformer 34. The door cannot then be opened from the outside by any unauthorized persons since the vertical link connection shown in Fig. 2 prevents its being lifted manually. The system may later be restored for automatic operation by closing the key switch. The key switch is preferably placed at the top of the unit 18 as shown in Fig. 4. The above-mentioned copending Schirmer application describes means for gaining access to the garage when the electrical system is disabled, as by failure of the supply.

The auxiliary contacts 70 and 71 of the step relay are provided for optional operation of other devices. Preferably these contacts are used to light or extinguish lamps in the garage or driveway. The auxiliary contacts remain open on the first three steps of the ratchet but on a fourth step, which is optional, they are closed by the cam surface 72. The contacts 70 and 71 are connected with wires 136 and 138 which, as shown in Fig. 6, are connected respectively to one side of the supply line and to a step relay magnet 140, which in turn is connected by a wire 142 with the other side of the line. The step relay includes a ratchet wheel 144 operated by an armature 146. The ratchet operates a multiple-lobe cam 148 to control contacts 150 and 152. The shape of the cam is such that successive steps of the ratchet alternately open and close the contacts. The contacts are connected in series with the lamps to be controlled, which are indicated diagrammatically at 154. It will be seen that one step of the ratchet will light the lamps, the next step will extinguish them, and so on.

Manual control of the lamps is provided by push button switches 156 which may be located at convenient positions in the house and garage. The contacts of the push button switches are in parallel to each other and to the relay contacts 70 and 71, so that closure of any of the contacts will simply result in advancement of the ratchet 144 by one step, thus either lighting or extinguishing the lamps 154.

If the operator desires to control operation of the lamp 154 from the car, he will simply blink the headlights four times. The first three blinks cause operation of the door as heretofore described. The fourth blink advances the ratchet 52 by one step. This does not affect the door control contacts but does close the auxiliary contacts 70, 71. Thus, without leaving the car, the driver may turn the lamps on before driving into the garage or turn them off after leaving the garage.

Since the ratchet 144 is merely advanced one step for each energization of the step magnet 140, the lamp contacts are not affected by release of the pawls 60 and 64 of the ratchet relay 58. Hence, the lamps will remain either on or off until a subsequent energization of the magnet 140, by closure of the auxiliary contacts 70, 71 or the push button contacts 156.

With respect to the lock switch 44, it will be noted that after door operation is initiated by the ratchet relay, the lock switch may be opened, even before completion of the door movement. The door will complete its movement but thereafter the system will be disabled until the lock switch is again closed. Thus, after driving the car in, the driver may initiate door closure by the switch 42, then immediately open the lock switch, with assurance that when the door is closed, it is free from tampering.

A feature of importance to which attention has been briefly directed is the diaphragm 28 having the aperture 30. This will now be described in greater detail with reference to Fig. 7 wherein the lens 24, diaphragm 28 and the cathode of tube 26 are shown diagrammatically. The plane of the diaphragm 28 is spaced from the lens so that the center of the aperture 30 is one of the conjugate points for the center of head lamp of the vehicle when the vehicle is stopped at the proper position in the driveway. Thus, the image of the head lamp is formed in the plane of the diaphragm 28; in other words, the diaphragm is substantially in the focal plane. This is indicated by the conventional geometric construction of Fig. 7 wherein the object (head lamp) is shown as an arrow, and the image is indicated by an inverted arrow in the plane of the diaphragm 28. Beyond the aperture the light diffuses on to the cathode of the tube, and preferably the cathode is spaced at such a distance that it is substantially covered by the light coming through the aperture. The device is sensitive only to light included within the cone whose elements pass from the center of the lens to the edge of the aperture, thus for a lens of 3" focal length and an aperture of 0.25", the "field" of the device is a cone having an angle of about 2.5° between its axis and any element. For any source of light outside the cone, rays which, without the diaphragm, would be refracted by the lens on to the cathode, are stopped by the diaphragm.

The maximum directional selectivity is obtained

when the aperture is of such a size as exactly to frame the image of the head lamp. Thus, for the specific example given above, an eight-inch lamp spaced 8 feet from the lens with its center on the lens axis would form an image just filling the aperture. To take care of normal variations in the stopping position of the vehicle, as well as lens aberrations, the aperture is preferably somewhat larger than the minimum; thus an aperture of two or three times minimum diameter may be used, and will have a sufficiently restricted field.

The principal importance of this arrangement is that it makes the system sensitive only to the blinking operation. If the phototube were allowed to have a much wider field, it might be continuously illuminated by an extraneous source (skylight, street lamps, etc.) at a considerable angle from the predetermined direction and hence might not respond to the changes of illumination caused by the blinking operation. But within the narrow field defined by the aperture 28, the vehicle itself will shield the device from any extraneous illumination. For example, consider an extraneous light source in the field of the device at a time when the car is not in door-operating position. The phototube is continuously illuminated and the step magnet 54 is continuously energized. The ratchet will have advanced one step. If the timing reset is used, the ratchet will have returned to its original position, but the pawl will be held attracted by the magnet 54, so that the ratchet will not be thereafter operated. If no timing reset is used the ratchet will remain on the first step. In any case, when the vehicle drives into proper position for door operation, the body of the vehicle will shade the lens from the extraneous source. The system will then respond to the blinking operation.

It will be seen that the timing reset means is not essential to guard against the condition described above, but is preferably provided to guard against false operation by variations in extraneous illumination.

The door operating means of the present invention provides for positive operation of the door, with minimum hazard of false operation from accidental causes. The results are attained by a minimum of control equipment, and without roadway contacts, and without the necessity of applying any special equipment to the car. The system operates without any appreciable power drain, since the primary of transformer 34 is the only part connected to the lines during inactive periods. Ample security is afforded by the provision of the lock switch 44.

Having thus described the invention, we claim:

1. An automatic garage door operator comprising a phototube adapted to be activated by the headlight of an automobile, a step relay operable upon each activation of the tube, reset means for restoring the step relay, timing means for operating the reset means a predetermined time after operation of the step relay, motor control contacts operable on a selected number of steps of the relay, in a time less than said predetermined time, and limit and reverse switch means for controlling the motor.

2. An automatic garage door operator comprising a phototube adapted to be activated by the headlight of an automobile, a step relay operable upon each activation of the tube, reset means for restoring the step relay, timing means for operating the reset means a predetermined time after operation of the step relay, motor control contacts operable on a selected number of steps of the relay, in a time less than said predetermined time, and auxiliary contacts to be optionally operated upon an additional step of the relay following closure of the motor control contacts.

3. An automatic garage door operator comprising a phototube adapted to be activated by the headlight of an automobile, a step relay operable upon each activation of the tube, reset means for restoring the step relay, timing means for operating the reset means a predetermined time after operation of the step relay, motor control contacts operable on a selected number of steps of the relay, in a time less than said predetermined time, and auxiliary contacts to be optionally operated upon an additional step of the relay following closure of the motor control contacts, a second step relay controlled by said auxiliary contacts, and contacts alternately opened and closed upon successive steps of said second relay.

4. An automatic garage door operator comprising a motor, a phototube, a step relay operable upon each activation of the phototube, a reset device for the step relay, thermal timing means controlled by the step relay to operate the reset device a predetermined time after initiation of operation of the step relay, motor control contacts operable upon a selected number of steps of the relay, within said predetermined time, and an automatic reversing limit switch having provision for determining the direction of motor operation.

5. An automatic garage door operator comprising a motor, a phototube, a step relay operable upon each activation of the phototube, a reset device for the step relay, thermal timing means, contacts controlled by initial steps of the relay to energize the thermal timing means, motor control contacts controlled by a subsequent step of the relay, the timing means being deenergized upon operation of the motor control contacts, and an automatic reversing limit switch having provision for determining the direction of motor operation.

6. An automatic garage door operator comprising a phototube adapted to be activated by the headlight of an automobile, a step relay operable upon each activation of the tube, reset means for restoring the step relay, timing means for operating the reset means a predetermined time after operation of the step relay, motor control contacts operable on a selected number of steps of the relay, an optical system for the phototube including a lens, and a field-limiting diaphragm in the neighborhood of the focal plane of the lens, the phototube being disposed in back of the diaphragm to receive diffuse light passed therethrough.

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