United States Patent [19]

Roselli

[11] **3,821,593**

[45] **June 28, 1974**

[54] **METHOD AND APPARATUS FOR TURNING VEHICLE LIGHTS ON AND OFF**

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[22] Filed: **Oct. 25, 1972**

[21] Appl. No.: **300,683**

[30] **Foreign Application Priority Data**

Oct. 27, 1971 Italy 30416/71

[52] **U.S. Cl.** **315/82,** 315/149, 328/2

[51] **Int. Cl.** **B60q 1/08**

[58] **Field of Search** 315/82, 83, 149; 356/209, 356/210, 239; 307/308, 311; 328/1, 2

[56] **References Cited**

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Assistant Examiner—James B. Mullins
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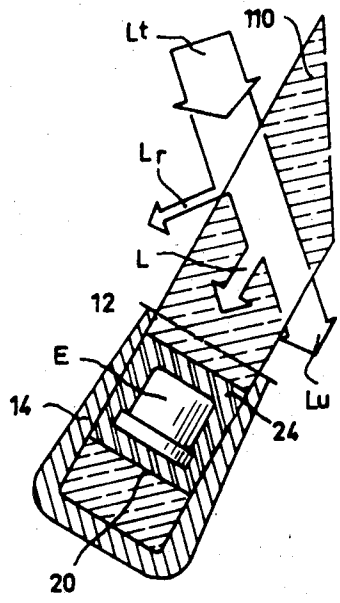
[57] **ABSTRACT**

A method of electrically activating apparatus from a variable source of light which comprises illuminating a pane of transparent material with the light from the variable source, illuminating a light responsive electric cell, shielded from other light, with the light that flows parallel to and within the broad surfaces of the pane, and utilizing the output of the cell to activate the apparatus.

18 Claims, 7 Drawing Figures



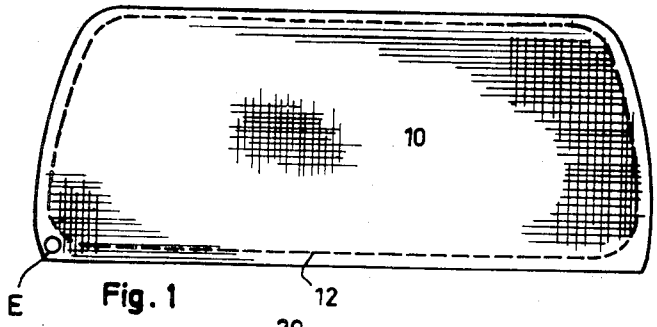


Fig. 1

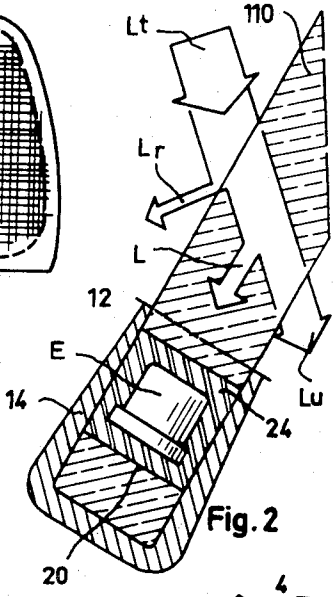


Fig. 2

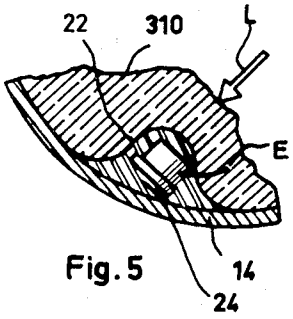


Fig. 5

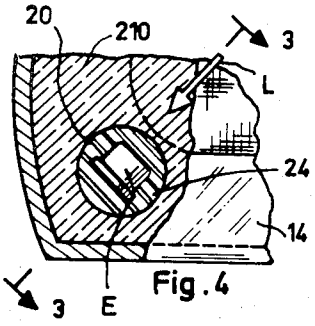


Fig. 4

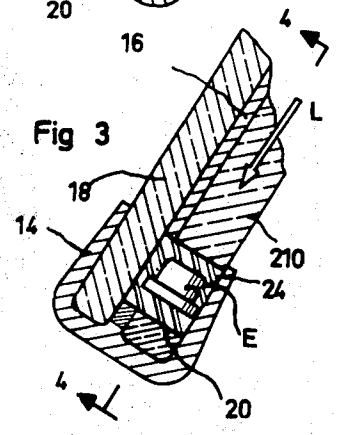


Fig 3

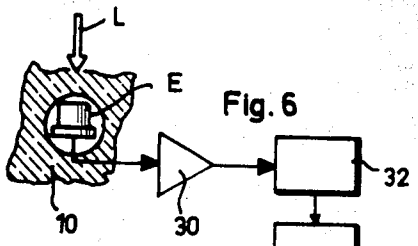


Fig. 6

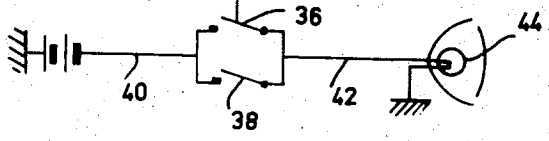


Fig. 7

METHOD AND APPARATUS FOR TURNING VEHICLE LIGHTS ON AND OFF

This invention relates to means and methods for activating apparatus by changes in the intensity of light. Although the invention can be put to many uses, it will be described in its application to the automatic control of the running lights of vehicles in response to changes in the intensity of daylight. A particularly important use is in the control of the head and rear lights of automobiles and the description will be particularly directed to that use.

Because drivers are forgetful and do not turn on the lights of their automobiles at twilight accidents occur because of low visibility and the high speed of vehicles; it is consequently desirable that the turning on and off of the lights should be done automatically when the intensity of daylight reaches a particular level of diminution, and that they should be automatically turned off when the intensity of exterior light becomes sufficient to permit safe driving. Such means is useful not only with variations in daylight but while entering and leaving tunnels, in fog and the like.

More specifically, the present invention relates to an improvement in methods and systems in which a photosensitive element susceptible of detecting exterior conditions of light is exposed to light in order to emit, surely and independently of temporary and local conditions, a signal which is really proportional to the mean intensity, at any instant, of the exterior illumination. The present invention pertains to systems of that type and it has for its object an improved means, methods and apparatus capable of responding to varied surrounding conditions.

Numerous apparatus for turning on and off vehicle lights automatically have been proposed and constructed, but always on a small scale and generally experimentally, because their success depends upon a variety of factors which make them relatively inefficient and unreliable in operation. In practice, the apparatus of that type have included a photosensitive element, which we shall call a cell, which may use a selenium element, a photoresistor, or a photoelectric transducer of other known type, of which the output signal is modified in a way which varies according to the type of transducer with the variation in luminous energy which strikes the sensitive part. The output signal is amplified by known electric means such as an electronic amplifier, which is used to command the opening and closing of a switch in the lighting circuit of the vehicle. Such apparatus have attempted to provide that at twilight or whenever the surrounding light is lowered below a chosen level of luminosity the lights of the vehicle will turn on automatically without the action of the driver, the lights being turned off automatically when the intensity of exterior light reaches a satisfactory level. There is abundant literature and there are numerous patents on the subject to which reference may be had.

There are many types of photosensitive apparatus, all of which we call cells, within which term are photodiodes, cells of emission, selenium cells, photo-piles and others, among which photoresistances and photoresistors are noteworthy, the latter being particularly advantageous because of their simplicity, and sureness in operation, and the power of the signal in comparison to their small dimensions. Similarly, there are numerous electrical and electronic amplifier systems which are well known which can be employed to use the output of the cell, the details of which can be learned by reference to numerous publications.

A principal cause of the poor results yielded by such apparatus in practice resides in the fact that the photoelectric transducer is not able in a number of situations to effectively detect the actual mean luminousity of the surrounding light at any instant. For example, it has already been proposed to place the photocell on the top of the vehicle, point it upward to eliminate the effect of approaching vehicles, on the inside or outside of the body, etc., each solution having its own difficulties. Furthermore, the active element of the cell is necessarily small, which is the source of other grave imperfections, e.g., a region of smoke, obstruction by an insect, mud from the road, any opaque object placed in front of the cell will impair its activity and induce an alteration in the electrical signal and a malfunction in the lighting circuits of the vehicle.

It is an object of this invention to overcome these imperfections and to devise a method and means which is not subject to malfunction through the operation of local conditions but which will operate satisfactorily and automatically at selected intensities of light.

The objects of the invention are accomplished, generally speaking, by a method of electrically activating apparatus from a variable source of light which comprises illuminating a pane of transparent material with the light from the variable source, illuminating a light responsive electric cell, shielded from other light, with the light that flows parallel to and within the broad surfaces of the pane, and utilizing the output of the cell to activate the apparatus, and by apparatus responsive to a source of variable light which comprises a pane of transparent material confronting the source, a photoelectric cell facing the edge of the pane, means to shield the cell from light other than that flowing through the pane parallel to its broad surfaces, and means to utilize the output of the cell to do work.

The invention is characterized by the fact that the photocell is at all times in optical communication with a large surface exposed to the surrounding light, in particular in optical contact with the whole area of the windshield or any other window of the vehicle, such as the rear window, the cell being so placed that it receives indirectly a fraction of the luminous energy incident on the surface, that fraction being such that its value is consequently in proportion with the mean of all the values of incident energy upon every one of the points of the said surface.

In particular, this novel system is characterized by the use of a definite fraction, the light falling upon the exterior surface of the glass windshield, a fraction of the light which it receives being channeled laterally through the glass of the windshield to the place where the photocell is located in optical contact with the edge of the windshield. The axis of the light sensitive element of the cell is aligned with an axis traversing the windshield parallel to its broad surfaces.

The apparatus is highly effective if the photocell, of which the dimensions may be very small, is placed so that it is near or on the periphery of the glass, preferably masked and protected by the frame of the windshield. In this way it attains the double effect of shielding the sensitive element from direct illuminations and of affording it the best protection.

The photosensitive element may advantageously be lodged or fixed in a hole or recess in the transparent material, usually glass, of the windshield, e. g. in one of the sheets of sandwich glass, frequently the inner, or in a recess formed in the edge of the pane. The windshields so constructed are a part of the present invention.

The optical connection between the light sensitive element and the pane is completed by filling the space between the photosensitive element and the edge of the glass with a light transmitting material having an index of refraction equal to or approximating that of the glass or plastic constituting the pane; among such materials the mastic used in the assembling of lens elements is favored, as it serves both to mount the element and to transmit the light to it. Such mastics are found on the market, of which one type is called "Araldite."

The output of the photocell is used to turn the running lights of the vehicle, for instance an automobile or a boat, on and off, its output being transmitted by systems known in themselves, for instance including an amplifier, a command station which is connected on one side to the amplifier and on the other to a relay operating a switch in the light circuit and which operates the relay when the selected intensity is attained. It is an advantage of the invention that the turning on and off of the lights occurs automatically as soon as a given intensity of light is reached. Ordinarily in automotive work the turning on will be set to occur at the beginning of twilight when there is no cloud cover, and the turning off will be set to occur when quasi-complete daylight has returned.

Another important feature of the invention is the inclusion in the electrical system of a period of delay between the receipt of a turn-off command and its execution, in order to compensate for the momentary bright illumination of the light screen (windshield) by the lights of vehicles passing in the other direction. In other words, the turn off mechanism should respond, in a vehicle for highway driving, only to a prolongation of light of turn-off intensity sufficient in time to exclude activation by transient flares such as the headlights of cars travelling the other way. An exposure for a time of several seconds to five minutes, to light of the selected degree of intensity, before the relay switch turns off the light is acceptable in most cases. This eliminates the turning on and off in rapid succession, or prematurely, of the running lights in response to transient excitation such as by tunnels, avalanche sheds, and passing cars.

In the construction of the apparatus of the invention engineers will be able to assemble the amplifier and command units from those available on the market, among which are the transistorized electronic command amplifiers and operative switching circuits of R.S.M. Spa de Lugnacco Cavanese of Turin, Italy.

The above and further objects and novel features of the present invention will more fully appear from the following detailed description when the same is read in connection with the accompanying drawings. It is to be expressly understood, however, that the drawings are for the purpose of illustration only and are not intended as a definition of the limits of the invention.

In the drawings, wherein like reference characters refer to like parts throughout the several views,

FIG. **1** is a plan view of a windshield according to the invention;

FIG. **2** is a cross section, on a scale enlarged over that of FIG. **1**, through the corner of the windshield of FIG. **1** which contains a photo resistor cell aligned with the edge of a glass windshield;

FIG. **3** is a similar section showing the mounting of a photo cell in a windshield of sandwich type;

FIG. **4** is a part section on line **4—4** of FIG. **3**;

FIG. **5** is a section similar to that of FIG. **2** illustrating a modified windshield structure using the principles of the invention;

FIG. **6** is a diagrammatic view, partly in section, of apparatus for operating the lighting system of a car; and

FIG. **7** is a graph representing the relationship between the electrical resistance offered by a photoresistor of known type and the intensity of daylight, with indication of satisfactory levels for turn-on and turn-off.

Referring more particularly to the figures of the drawing, there is shown on FIG. **1** a photosensitive cell E of tiny dimensions mounted in proximity to an edge of the windshield **10**, and more precisely in the marginal zone inside the frame which holds the glass, the inner circumference of the frame being indicated by dash line **12**. The cell is hidden within the frame **14** and is thus shielded from light other than that which comes through the glass of the windshield (FIGS. **2** to **5**). The frame is constituted generally, by a rubber channel clamped within the metal frame forming a part of the body. The cell E is thus shielded and protected against shock and is invisible.

In FIGS. **2** to **5** the photosensitive element is shown in varying scales as a type of photo-resistor of tiny dimensions, for example from 5 mm. in diameter and 3 mm. in height. A type P 401 of Hamamatsu TV Co. of Japan is satisfactory. However, other types of photocells and other dimensions are compatible with this use.

In FIG. **2** is schematically represented the optical phenomenon which is exploited according to the invention to activate the photocell E. In this figure the transparent part of the windshield **110** is made of a single sheet of glass of which the exterior surface fronts and is struck by daylight which, particularly at twilight, may be considered as essentially diffuse but coming mainly from the sky. The photocell E is aligned so that its optical axis is prolonged into the thickness of the glass, that is to say, along a line within and parallel to the broad surfaces. The total light Lt which strikes the outer surface of the windshield is only transmitted in part (a preponderant part) into the interior of the vehicle body. This light is indicated by the symbol Lu. Another part of the light Lr is reflected by the outer surface of the windshield while the remainder of the luminous energy flows through the glass of the windshield parallel to its surfaces as shown at L. The ratio between the total quantity of light Lt and the quantity of light L flowing through the glass toward the cell varies according to several factors, notably the angle of incidence of the light on the windshield.

Positioning the photocell in the lower part of the windshield favorably influences this ratio and, also, it makes the electrical connection easier and more economic, for instance by shortening the lines between the cell and the apparatus excited thereby.

This positioning of the cell has the surprising effect of making the system practically insensible to the light

thrown by the headlights of an automobile approaching in the other direction, a result which is in part due to an angle of incidence which is not favorable to the transmission of light through the glass into the cell even when the approaching vehicle is very close.

When a windshield of sandwich type is involved the photosensitive element E is preferably mounted in the thickness of the inner strata **210**, as shown in FIG. **3** wherein it is shown as mounted within the arms of the channel **14** and in an aperture **20** which penetrates the inner glass strata **210** and the intermediate layer **16** of polyvinyl butyral.

The photocell E is mounted preferably in a hole **20** (FIGS. **2**, **3** and **4**) which passes through the sheet of glass **110** or **210**, or the sheets **210** and **16**, or is mounted in a recess **22** in the edge of the glass **310**, as shown in FIG. **5** at **24**. In the case of sandwich glass, the recess may extend completely through all layers or through only part of them. The photocell in all cases may be mounted in its recess by means of transparent mastic which grips it, protects it, and assures the complete optical conduction between it and the glass which is essential to the best operation.

As previously indicated, the photocell E is connected to the lighting circuit of the vehicle by any convenient means. As shown in FIG. **6**, this apparatus includes an amplifier **30** to which the output of the cell E is fed, a command circuit **32** which is set to operate the turn-on and turn-off of the lighting system when the intensity of current derived from amplifier **30** attains certain selected levels of intensity. The command circuit **32** acts on electromagnetic relay **34** to operate a switch **36** which is in the lighting circuit **42, 44** of the vehicle and is disposed in parallel with the manual switch **38** which is always available for use by the driver of the car. As indicated herebefore, the command circuit **32** preferably includes a retarder system which operates only when the lights are to be turned off, preventing the turn-off of the lights **44** except after the intensity of the turn-off signal has been maintained continuously for a selected period of time, in each instance a period sufficient to prevent the turning off of the lights by transient excitation.

In FIG. **7**, the curve C indicates the relation between the intensity of exterior light expressed in lux and measured separately by a light meter of which the cell is located for instance on the dashboard of an automobile, and the resistance expressed in megohms presented by the photo resistor of the type described above and installed as in FIGS. **3** and **4**. Such resistances represent the variation of light energy flowing through the glass toward the cell quantatively as a function of the intensity of the daylight. Under these conditions, it has been established that it is advantageous to balance the system so as to obtain the turn-on A of the running lights when the intensity of daylight falls below a level of about **200** lux, and to turn them off at S about 30 seconds after the intensity of exterior lights has exceeded 500 lux.

The system has been tested for sensitivity to the bright lights of an approaching car proceeding in the other direction by mounting the windshield according to this invention in a standard automobile and measuring the intensity of the light transmitted to the cell through the windshield. The intensity of light energy impinging upon the windshield has not exceeded the value F of about 100 lux, which is well outside of the region of sensitivity of the apparatus. Thus, in normal operation, the period of delay preceding the actual turn-off would not be necessary, but it is preferably included to protect against exceptional cases which do not conform to the usual norm.

As many apparently widely different embodiments of the present invention may be made without departing from the spirit and scope thereof, it is to be understood that the invention is not limited to the specific embodiments.

What is claimed is:

1. A method of electrically activating apparatus from a variable source of light which comprises illuminating a pane of transparent material with the light from the variable source, illuminating a light responsive electric cell, shielded from other light, with the light from that source that flows parallel to and within the broad surfaces of the pane, and utilizing the output of the cell to activate the apparatus.

2. A method according to claim **1** in which the output of the cell is amplified, and operates a relay in the apparatus circuit in conformity to the output commands of the cell.

3. A method according to claim **1** wherein said utilizing step includes amplifying the output of the cell and operating a relay with the output of the cell so amplified.

4. A method of turning lights of a vehicle on and off which comprises receiving upon a lightresponsive-electric cell, shielded from other light, the light which flows parallel to and between the broad surfaces of a window of the vehicle, utilizing the output of the cell at a chosen low level to turn the lights on, and utilizing the output of the cell at a chosen higher level to turn the lights off.

5. The method of claim **4** which includes the additional step of delaying the turn-off of the lights, beyond the time at which the turn-off is initiated by the cell, sufficiently to compensate for unsustained bursts of light.

6. Apparatus responsive to a source of variable light which comprises a pane of transparent material confronting the source, a photoelectric cell aligned with the edge of the pane, means to shield the cell from light other than that flowing through the pane parallel to its broad surfaces, and means to utilize the output of the cell to do work.

7. Apparatus according to claim **6** in which the pane is a vehicle window and the cell is set in the window frame in alignment with a long axis of the pane.

8. Apparatus according to claim **6** in which the pane is a vehicle windshield, in which the means to utilize the output of the cell to do work include means to amplify the output of the cell, a relay operable by the amplified output of the cell, and means connecting the relay to a switch in the circuit which connects lights of the vehicle to a source of power, the apparatus further including a manually operable switch electrically connected in parallel to said first-named switch.

9. Apparatus according to claim **6** in which the pane and the cell are mounted in the frame of a vehicle windshield, and in which the cell is shielded by the frame from the source of variable light.

10. A vehicle windshield comprising a frame, a transparent pane held by the frame, a light responsive cell held by the frame in alignment with the edge of the pane in a position to receive light flowing in and paral-

lel to the surfaces of the pane, and conductor means connected to the cell.

11. A vehicle windshield according to claim **10** including means to shield the cell against light from the said source other than that flowing within the pane substantially parallel to the surfaces thereof.

12. A vehicle windshield according to claim **10** in which the cell is mounted within the transparent material of the windshield.

13. A vehicle windshield comprising frame means of channel type, a transparent pane gripped thereby, an aperture in the pane within the frame channel, and a light responsive cell mounted in the aperture with its light responsive part fronting the edge of the pane.

14. A vehicle windshield according to claim **13** in which the aperture is a hole through the pane and the cell is mounted therein by transparent optical mounting means.

15. A vehicle windshield according to claim **13** in which the aperture is an indentation in the edge of the windshield and the cell is mounted therein in optical contact with the edge of the pane.

16. A windshield according to claim **13** in which the windshield is of sandwich type and the cell is mounted in alignment with at least one of its laminae.

17. A windshield according to claim **16** in which the cell is mounted in a recess in two of the laminae.

18. A method of generating an electric current in response to light of a selected intensity which comprises arranging a broad pane of transparent sheeting fronting the light, and activating photo-responsive means for that part of the light which travels through the material of the sheet substantially parallel to the surface thereof.

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