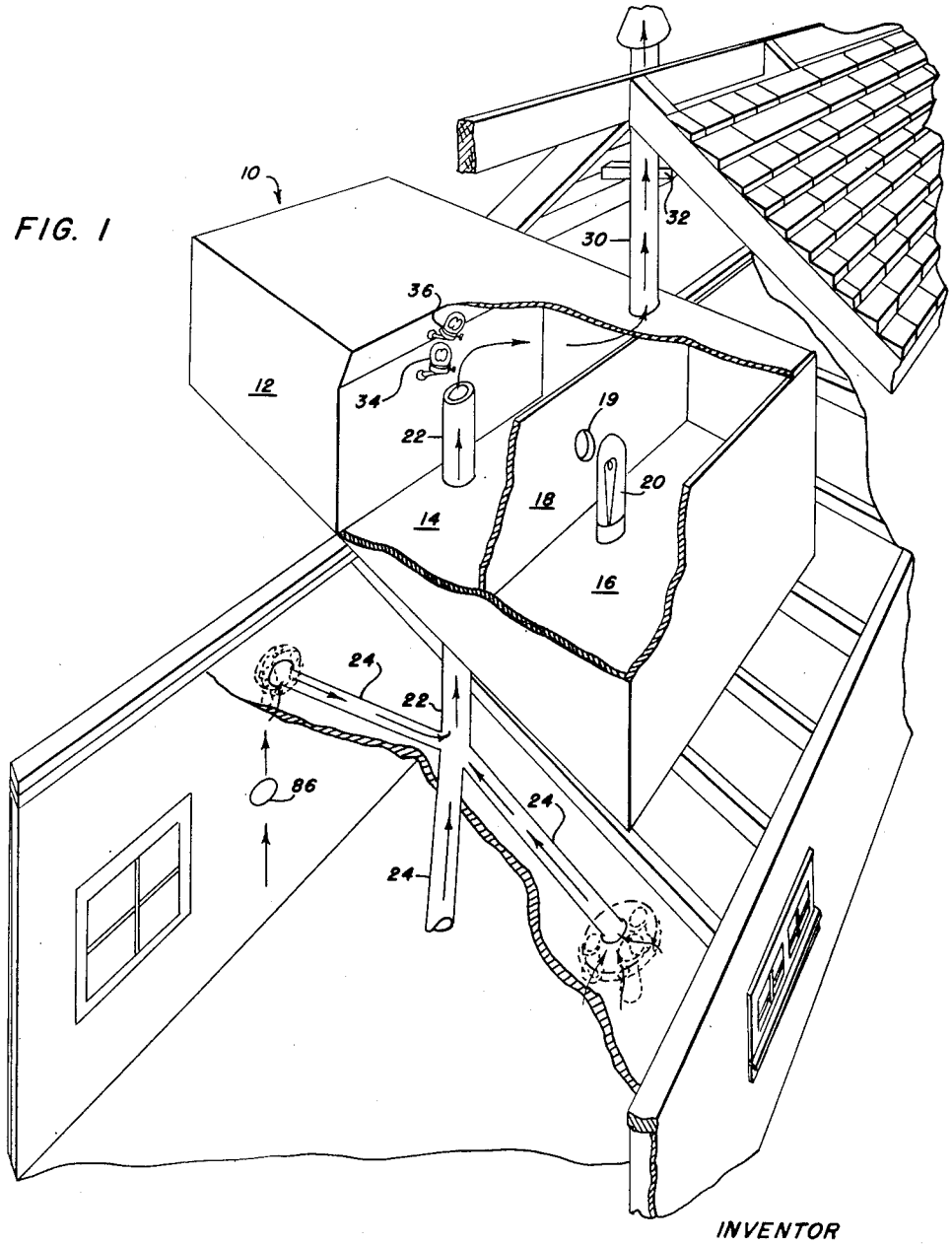
Jan. 11, 1955 H. G. NICKEL 2,699,538

SMOKE DETECTION SYSTEM AND APPARATUS

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FIG. 1



INVENTOR
HOWARD G. NICKEL.

BY Gustave Miller
ATTORNEY

Jan. 11, 1955 H. G. NICKEL 2,699,538

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FIG. 2

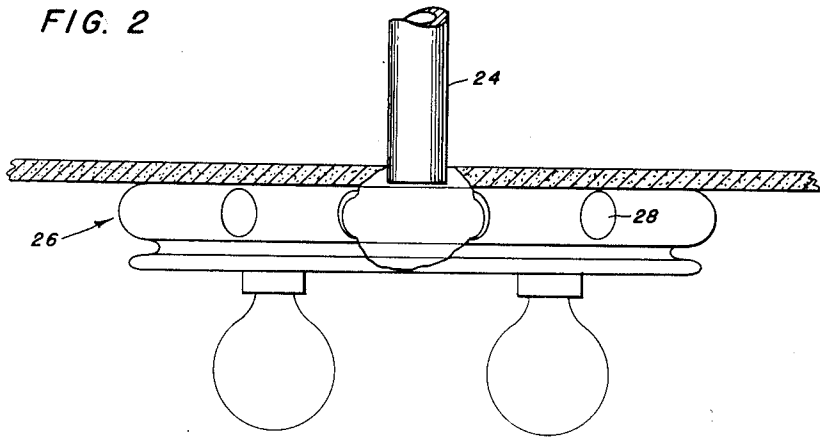
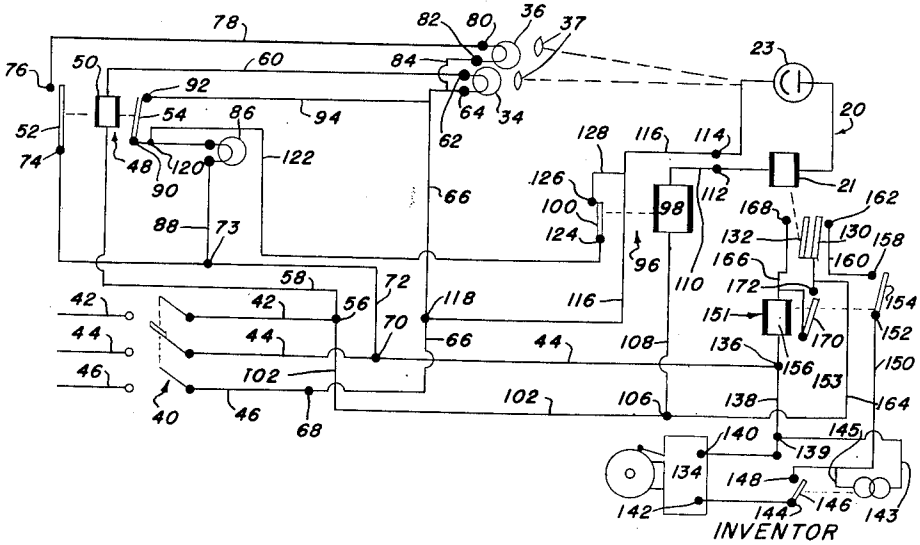


FIG. 3



INVENTOR
HOWARD G. NICKEL.

BY Gustave Miller
ATTORNEY

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2,699,538

SMOKE DETECTION SYSTEM AND APPARATUS

Howard G. Nickel, Battle Mountain, Nev.

Application July 27, 1953, Serial No. 370,373

1 Claim. (Cl. 340—237)

This invention relates to automatic alarm devices, and more particularly to an automatic system and apparatus for detecting the presence of smoke and actuating an alarm to indicate the presence of smoke.

Many lives are lost from the effects of breathing smoke, rather than due to the fire from which the smoke originated. It frequently happens that thermostatic controls which are intended to indicate the presence of a fire are not actuated by the presence of smoke, and persons subjected to the smoke perish before the thermostatic type of fire alarm is actuated. Smoke detection devices of the photoelectric type are also shown, but such systems generally use only a single light source and frequently have no means of indicating failure of the single light source or failure of the energization circuit of the photoelectric relay itself.

Accordingly, it is an object of this invention to provide a smoke detection system in which all parts of a building are in communication with a smoke detection apparatus.

It is a further object of this invention to provide an improved smoke detection apparatus of the photoelectric detection type which actuates an alarm upon the presence of smoke.

It is a still further object of this invention to provide a smoke detection apparatus using photoelectric detection means and having an emergency light source which is automatically switched into circuit upon failure of the normal light source for the photoelectric detection device.

It is another object of this invention to provide an automatic photoelectric smoke detection system in which a warning signal or trouble light is actuated whenever the normal light source for the photoelectric device fails, the photoelectric detection system becomes inoperative due to failure of the photoelectric relay.

In accordance with these objectives, this invention provides a smoke detection apparatus in which smoke is carried by ducts having inlets in various parts of the building to a housing for the smoke detection apparatus which is located at the highest level of the building, such as in the attic, for example. The smoke detection apparatus comprises a photoelectric cell and a light source which is directed toward the photoelectric cell, subject to interruption by the presence of smoke conducted through the ducts to the housing of the detection system. An emergency light source is provided which is automatically switched into circuit upon failure of the normal light source. Means are also provided to energize a warning signal, such as a trouble light to indicate either a failure of the normal light source or an operating failure of the photoelectric detection system.

The features of this invention which are believed to be novel are set forth with particularity in the appended claims. The invention itself, both as to its organization and use, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawings in which:

Fig. 1 is a perspective view of the general arrangement of a smoke detection system in accordance with the invention, showing the housing for the photoelectric detection device and the ducts which carry the smoke to the housing;

Fig. 2 is an enlarged detail view showing a light fixture having inlets for conducting smoke to a duct which leads to the smoke detection device housing; and

Fig. 3 is an electrical circuit diagram showing the electrical control system for the photoelectric smoke detection system in accordance with the invention.

Referring now to the drawing, there is shown in Fig. 1 a housing generally indicated at **10** for the smoke detection apparatus. The housing **10** is shown in exaggerated size in the drawing for purposes of clarity and is shown positioned at the uppermost part of the building or house having the smoke detection system. Thus, in the view of Fig. 1, the smoke detection housing **10** is shown located in the attic of a house. The housing **10** is preferably divided into three compartments, one of which, indicated at **12**, houses the electrical components, such as the relays which will be described hereinafter. The intermediate compartment **14** is the smoke chamber through which the smoke passes, and compartment **16**, which is separated from compartment **14** by a wall **18** having an aperture **19**, houses the photoelectric relay means generally indicated at **20**. The housing **10** is of leak-proof construction so that any smoke passing into the smoke chamber **14** will pass out only through the outlet duct **30**.

The smoke chamber **14** is connected to an inlet duct **22** which conducts any smoke which may be present in the building or house to the smoke chamber **14**. The inlet duct **22** is connected to auxiliary ducts **24** which communicate with various parts of the building, such as, for example, each room in the house if the building is a house. The auxiliary ducts **24** may be connected in the manner shown in Fig. 2 in which an auxiliary duct **24** is shown connected to a light fixture **26** provided with circumferentially arranged port holes **28** through which any smoke present in the room or adjacent the light fixture passes to the duct **24**. Smoke which enters the light fixture **26** travels upwardly through the auxiliary duct **24** and the duct **22** due to natural draft until the smoke finally reaches the smoke chamber **14**. An outlet duct **30** to the outside atmosphere communicates with the upper portion of the smoke chamber **14**, being disposed at the opposite side of the chamber to the location of the inlet duct **22** and adjacent the wall **18**, so that the natural path of the smoke in passing through chamber **14** to the outlet duct **30** is from one side to the other of the smoke chamber **14**. A draft regulator **32** is provided in the upper portion of the outlet duct **30** to permit adjustment of the draft as desired.

A light source is provided in the smoke chamber **14** in the form of two small electric light bulbs or lamps **34** and **36**. Lamp **34** is the normal light source and lamp **36** is the emergency light source. Each of these lamps may be, for example, 6 watt light bulbs, and may be provided with swivel masking shades which may be adjusted to control the amount of light directed from either of the light bulbs **34** or **36** to the photoelectric relay device **20** in the compartment **16**. A suitable lens **37** is positioned adjacent each of the light bulbs **34** and **36** in the path of the rays emitted from the respective bulbs to direct the light rays toward the photoelectric relay means **20**. The wall **18** which divides smoke compartment **14** from the photoelectric relay compartment **16** is provided with an aperture **19** through which light rays from either the normal light source **34** or the emergency light source **36** pass to the photoelectric relay means **20**.

It will be seen that whenever smoke occurs anywhere within the building provided with the illustrated smoke detection system, the smoke is conducted through the ducts **22** and **24** to the smoke chamber **14** of the housing **10**. The smoke will pass out of the inlet duct **22** and pass across the chamber **14** to the outlet duct **30**. In so doing, the smoke will interrupt the light rays from the normal light source **34** or the emergency light source **36** in such manner as to affect the condition of the photoelectric cell of the photoelectric relay means **20**.

The control circuit for the smoke detection system of the invention is shown in Fig. 3. The various circuit components shown in Fig. 3 are housed in the compartment **12** of the housing **10**.

The smoke detection circuit is connected through a switch **40** to a three wire source of electrical power comprising the three lines **42**, **44**, and **46**. The line **44** is at an electrical potential midway between that of the outer lines **42** and **46** so that a potential difference of 110 volts,

for example, may exist between line 42 and 44, or between line 46 and line 44, with a difference of potential of 220 volts existing between the outer lines 42 and 46.

The normal light source 34 for the photoelectric relay 20 is connected across the outer power lines 42 and 46 in series with the coil 50 of a relay generally indicated at 48. Relay 50 controls two normally closed contacts 52 and 54. The circuit of the normal light source 34 may be traced as follows: from junction 56 of power line 42, through conductor 58 to one side of relay coil 50, through coil 50 through the conductor 60 to terminal 62 of the normal light source 34, from terminal 64 through conductor 66 to junction 68 of the outer power line 46.

The emergency light source 36 is connected between intermediate power line 44 and power line 46 in series with normally closed relay contact 52 which is controlled by relay coil 50. This circuit may be traced as follows: from junction 70 on intermediate power line 44, through conductor 72 to terminal 74 of normally closed contact 52, from terminal 76 of contact 52 through conductor 78 to terminal 80 of the emergency light source 36, from terminal 82 of the emergency light source through the jumper conductor 84 to conductor 66, and thence to junction 68 of power line 46.

The relay coil 50 also controls a normally closed contact 54 which is in series with a trouble light 86 across power lines 44 and 46. The trouble light 86 may be located at some convenient place in the building where it may be readily seen. This circuit may be traced as follows: from junction 70 on intermediate power line 44, through conductor 72 to junction 73, through conductor 88, through the trouble light 86, to the terminal 90 of relay contact 54, through contact 54 to terminal 92 of the relay contact, through conductor 94 to conductor 66 and thence to junction 68 of power line 46. This circuit causes the trouble light 86 to become lighted when the contact 54 bridges terminals 90 and 92 in its normally closed position. As will be explained in more detail later, this happens when the relay coil 50 becomes deenergized due to a failure of the normal light source 34.

The photoelectric relay generally indicated at 20 may comprise a conventional photoelectric relay arrangement having a photoelectric cell 23 whose output is communicated to an amplifier tube having a relay coil 21 in its output circuit. In the circuit arrangement shown in Fig. 3, the amplifier tube is not shown for the sake of simplicity and the relay coil 21 is shown connected directly in series with the photoelectric cell 23.

Photoelectric relay 20 is provided with an electrical input circuit across power lines 42 and 46, this electrical input serving as a source of biasing potential for the amplifier circuit of the relay, as is well known in the art. The electrical input circuit to the photoelectric relay 20 in series with a coil 98 of a relay generally indicated at 96 which controls a normally closed contact 100. The electrical input circuit to the photoelectric relay 20 may be traced as follows: from junction 56 of power line 42 through conductor 102, to junction 106, through conductor 108 to relay coil 98, through the relay coil 98, through conductor 110 to terminal 112 of the photoelectric relay 20, from terminal 114 of the relay 20, through conductor 116, to junction 118, through conductor 66 to junction 68 of power line 46. Thus, it will be seen that the electrical input to the photoelectric relay 20 is connected in series with relay coil 98 across power lines 42 and 46.

The relay coil 98 controls a normally closed contact 100 which is in series with the trouble light 86 across power lines 44 and 46 to indicate failure of the electrical input to the photoelectric relay 20. The circuit by means of which closure of relay contact 100 energizes trouble light 86 will now be described. Closure of contact 100 completes a circuit through the trouble light as follows: from junction 70 of power line 44, through conductor 72, to junction 73, through conductor 88 to the trouble light 86, through the trouble light to junction 120, through conductor 122 to terminal 124 of contact 100, through the contact 100 to terminal 126 of the contact, through conductor 128 to conductor 116, through conductor 116 to junction 118, through conductor 66 to junction 68 of power line 46.

The relay coil 21 controlled by the output of the photoelectric cell 123 controls a normally closed contact 130, and a normally open contact 132. When the photoelectric cell 123 is energized by the uninterrupted passage of light from either of the light sources 34 or 36 to the photoelectric cell, the normally open contact 132 becomes closed and the normally closed contact is opened.

The normally open contact 132 controlled by the photoelectric relay 20 is in series with a relay generally indicated at 151 and comprising a relay coil 156 which controls normally open relay contacts 153 and 154. When the normally open contact 132 becomes closed due to uninterrupted passage of light from the light source to the photoelectric cell, the following circuit is completed through relay coil 156: from junction 70 of power line 44 through power line 44 to one side of the relay coil 156, through the relay coil 156 to conductor 166, to terminal 168 of contact 132, through contact 132 to conductor 164 and thence through conductor 102 to junction 56 of power line 42. Energization of the relay coil 156 closes the normally open contacts 153 and 154. Closure of contact 153 completes a sealing-in circuit for the relay coil 156 which may be traced as follows: from power line 44, through relay coil 156, to terminal 170 of contact 153, to terminal 172 of contact 153, thence through conductor 164 to conductor 102 to junction 56 of power line 42. Energization of relay coil 156 also closes normally open contact 154 and "sets up" the circuit of the alarm bell so that if and when the normally closed contact 130 recloses due to interruption of the light beam by smoke in the smoke chamber 14, the alarm bell circuit will be completed through contacts 154 and 130, subject to the timing device 141 as will be explained hereinafter.

The normally closed contact 130 operated by relay 20 is connected in series with the alarm bell 134 in a circuit which may be traced as follows: from junction 136 of power line 44, through conductor 138 to terminal 140 of the alarm bell 134, from terminal 142 of the alarm bell to terminal 144 of a time controlled contact 146, from terminal 148 of contact 146, through conductor 150 to terminal 152 of contact 154 controlled by relay coil 156, through contact 154 to terminal 158 of the contact, through conductor 160 to terminal 162 of the normally closed contact 130, through normally closed contact 130, through conductor 164 to conductor 102 and thence to junction 56 of power line 42.

Relay 151 also serves to "hold off" the alarm bell from ringing during the warming up period of the photoelectric relay 20. When the system is initially energized, a short time is required to warm up the photoelectric cell 23 sufficiently to energize relay coil 21 in the circuit of the photoelectric cell. During this warming up period, normally closed contact 130 in the bell circuit is closed. However, relay coil 156 is still unenergized, since normally open contact 132 has not yet been closed by relay coil 21. Hence, normally open contact 154 in the circuit of alarm bell 134 is still open and the bell does not ring.

A further feature of the circuit arrangement shown in Fig. 3 is the provision of a time delay device 141 in parallel with the alarm bell to hold off operation of the alarm bell for a predetermined period of time, such as three seconds, for example.

As will be seen in Fig. 3, the timing device, generally indicated at 141, controls a contact 146 which bridges terminals 144 and 148 in the circuit of the alarm bell after the lapse of the predetermined interval of time. This feature prevents the bell from ringing for a predetermined period after interruption of the light beam from either of the light sources 34 or 36 to the photoelectric cell 23. This time delay prevents the bell from ringing during the change-over period from the normal light source 34 to the emergency light source 36.

The operation of the circuit of Fig. 3 will now be explained. Assume first that the smoke detection device is operating on the normal light source 34 and that no smoke has entered the smoke chamber 14. The following conditions will then prevail: the light source 34 will be lighted and will cause light rays to pass uninterruptedly toward the photoelectric cell 23 of the relay 20. The light source 34 is electrically connected in series with the coil 50 of relay 48 across the power lines 42 and 46, or, in other words, across the full 220 volt power supply. Since relay coil 50 is energized, the normally closed contacts 52 and 54 will be maintained in an open position. Hence, the circuit of the emergency light source 36 which is in series with the contact 52, will be open, and the emergency light source 36 will not be lighted. Also, since normally closed contact 54 is maintained open by relay coil 50,

the trouble light **86** will not be energized through the path provided by the normally closed contact **54**. Hence, the trouble light **86** will not be lighted to indicate that the normal light source **34** has failed, although, of course, it may be lighted through the alternative path provided through contact **100**, which becomes closed when the energization circuit of the photoelectric relay **20** fails.

If the normal light source **34** were to fail, it would open the series circuit which includes the relay coil **50**, causing the deenergization of relay coil **50**. This would cause the normally closed contacts **52** and **54** to return to their normally closed positions. The return of contact **52** to its normally closed position would cause the energization of the emergency light source **36** through the path previously described. The closure of the normally closed contact **54** would complete the circuit of the trouble light **86** through the path previously described.

Under the normal operating conditions, with power input at terminals **112** and **114** of the photoelectric relay **20**, the relay coil **98** in series with the electrical input circuit of the photoelectric relay **20** is energized. Energization of relay coil **98** causes normally closed contact **100** to be opened so that an energization path for trouble light **86** is not provided through contact **100** when relay **20** is obtaining its proper input energization. However, if, for any reason, a flow of current from terminal **114** to terminal **112** of the photoelectric relay **20** should fail, relay coil **98** becomes deenergized, and thereby permits contact **100** to return to its normally closed position, which completes a circuit through the trouble light **86** from power line **44** to power line **46**, as previously described.

In the event that smoke enters the smoke compartment **14** and interrupts the light passing from either of the light sources **34** or **36** to the photoelectric cell **23** of the relay **20**, the relay coil **21** becomes deenergized and permits normally closed contact **130** to return to its normally closed position. Also, normally open contact **132** is returned to its normally open position. However, since relay coil **156** has sealed itself in through its own contact **153**, both normally open contacts **153** and **154** remain closed despite the opening of contact **132** controlled by relay **20**.

The return of normally closed contact **130** to its normally closed position upon the deenergization of the photoelectric relay due to the presence of smoke closes the circuit of the timing device **141**, which, in turn, closes the circuit of the alarm bell, as follows: from junction **136** of power line **44**, through conductor **138** to junction **139**, through conductor **143** to one side of the timing device **141**, through the timing device **141**, through conductor **145** to conductor **150**, through conductor **150** to terminal **152** of contact **154**, through closed contact **154** to terminal **158**, through conductor **160**, through normally closed contact **130**, through conductor **164** to conductor **102**, and thence, to junction **56** of power line **42**. The circuit of the timing device **141** is completed first by the reclosing of contact **162** and after the lapse of a predetermined interval, such as three seconds, the contact **146** controlled by timing device **141** bridges the terminals **144** and **148** to complete the circuit of the alarm bell **134**.

The principal purpose of the time delay device **141** is to permit a slight time delay before ringing the bell **134** to permit the automatic change-over from the normal light source **34** to the emergency light source **36**.

It can be seen from the foregoing that there is provided in accordance with this invention a smoke detection system which automatically rings an alarm bell upon the presence of smoke. In accordance with the invention, a normal light source and an emergency light source are both provided and means are provided for automatically energizing the emergency light source upon failure of the normal light source. Furthermore, signal means, which may be in the form of a trouble light, are provided to indicate failure of the normal light source, and also to indicate the failure of the energization circuit of the photoelectric relay means. It can be seen that this invention has great practical utility and may prove a valuable aid in preventing loss of life due to the presence of smoke.

While there has been shown and described a particular embodiment of the invention, it will be obvious to those skilled in the art that various changes and modifications can be made therein without departing from the invention, and, therefore, it is aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

Having thus set forth and disclosed the nature of this invention, what is claimed is:

A smoke detection apparatus comprising a photoelectric relay means including a photoelectric cell, a normally closed contact and a normally open contract controlled by said relay means, an auxiliary relay means controlled by said photoelectric relay, closure of said normally open contact by said photoelectric relay being effective to energize said auxiliary relay means, a first and a second normally open contact means operable to closed position upon energization of said auxiliary relay means, closure of said first contact means being effective to maintain said auxiliary relay means energized independently of said photoelectric relay means, said second contact means closed by said auxiliary relay being in the input circuit to an alarm device, said normally closed contact controlled by said photoelectric relay means being in series with said second contact means in the input circuit to said alarm device, reclosure of said normally closed contact upon deenergization of said photoelectric relay being effective to actuate said alarm device.

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