United States Patent

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[54] **WINDOW SECURITY SYSTEM**
18 Claims, 9 Drawing Figs.

[52] **U.S. Cl.** **340/274,** 200/61.62, 340/273
[51] **Int. Cl.** **G08b 13/04,** G08b 13/22
[50] **Field of Search** 340/274, 276, 273; 200/61.08, 61.62, 61.84, 61.93; 250/71.5

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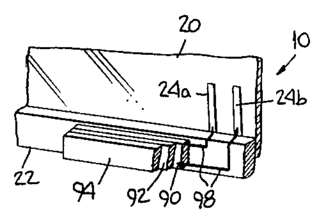
ABSTRACT: A window protection system in which a pair of electrically conductive strips extend across a window with a bias voltage source connected across one end of the strips and an alarm-actuating circuit connected across the other end of the strips, the alarm-actuating circuit being capable of energizing the alarm if the strips are broken or if they are bridged; and a battery which converts ray energy from radioactive materials to electricity through the intermediary of visible light.



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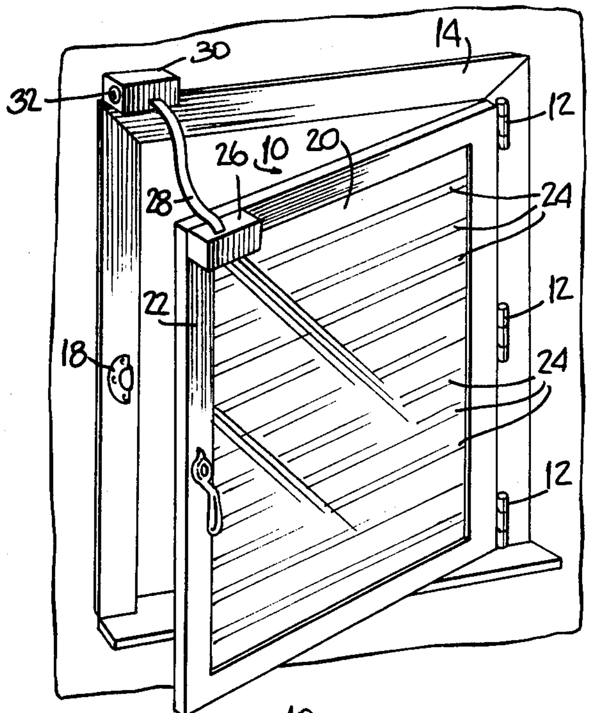

Fig.1.

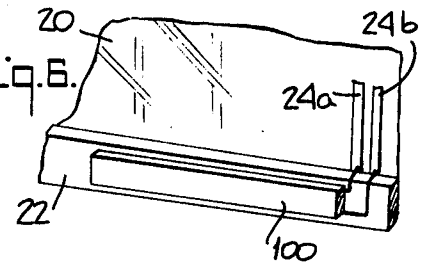

Fig.6.

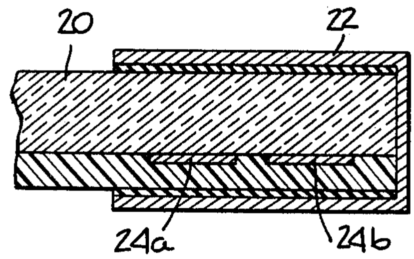

Fig.3.

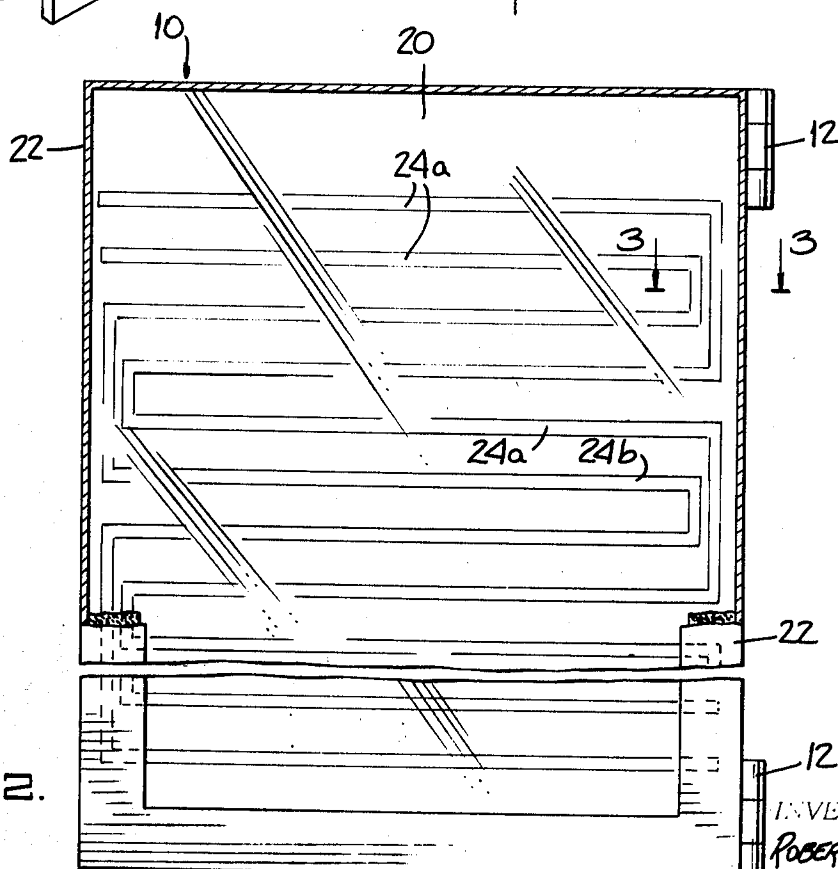

Fig.2.

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PATENTED JAN 11 1972 | 3,634,845

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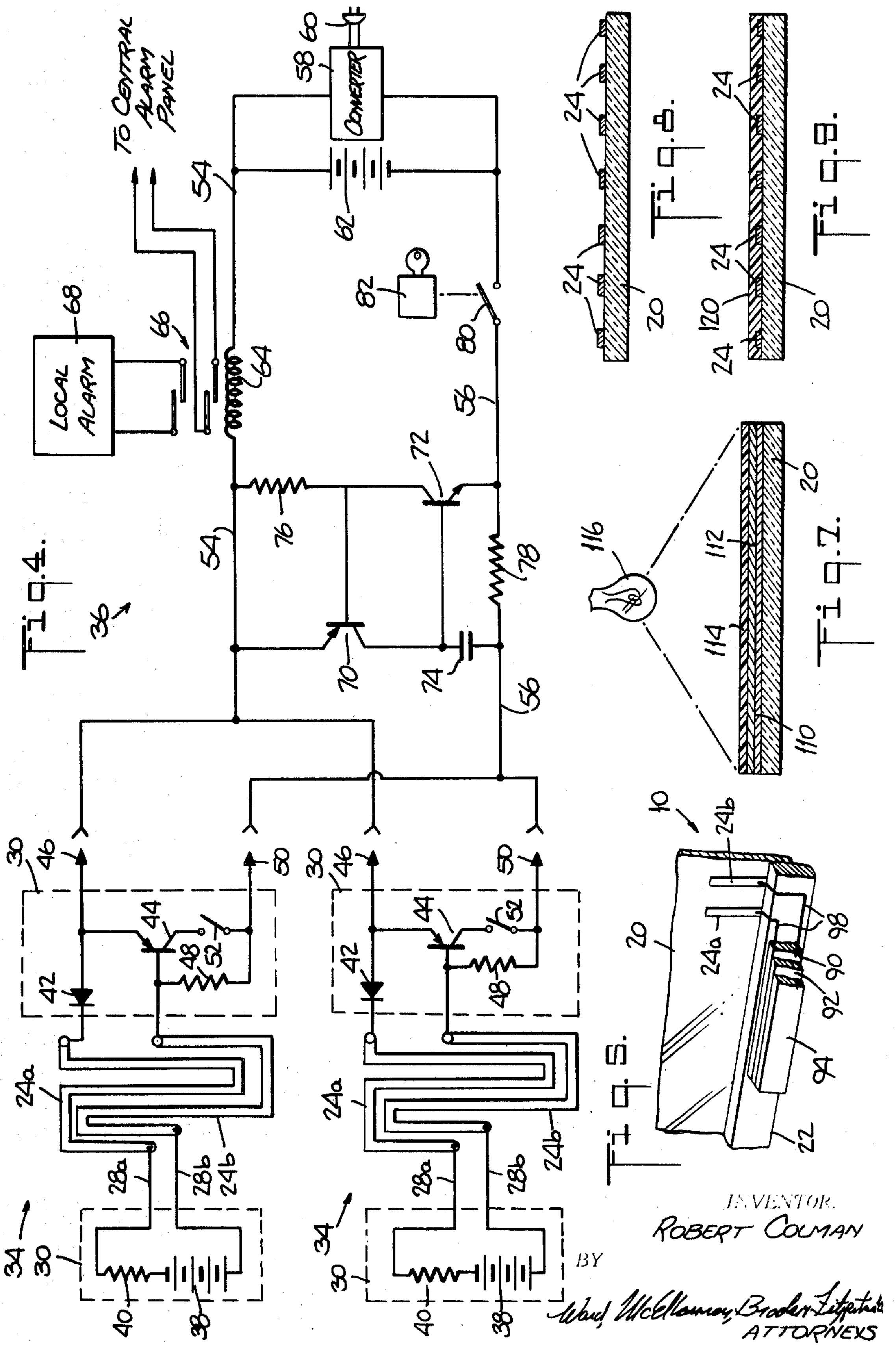

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WINDOW SECURITY SYSTEM

This invention relates to alarm systems and more particularly it concerns the protection of window closures and the like from unauthorized intrusion.

The protection of windows from unlawful entry presents special problems. In general, transparent substances such as plastic and glass which are used in windows are easily broken through. Further, the very transparency of these substances makes it difficult, if not impossible, to conceal any alarm system with which they are used. Also, it is generally undesirable from an aesthetic standpoint to maintain in association with the window any physical device which is designed either to prevent or to sense unlawful entry.

One widely used means for protecting windows from unlawful entry utilized electrically conductive tape. This tape, which is adhered to onto the window surface, forms a portion of an electrical alarm-actuating circuit. If the tape should be severed, as when the window is broken through, the condition of the alarm-actuating circuit is changed and the alarm is sounded.

The electrically conductive tape system of window protection has had only limited application in the past. One reason for this is that the use of electrical tape on the windows of a building tends to disfigure them; and, in fact, it imparts to the building a forbidding appearance and an atmosphere of inhospitability. Moreover, the electrical tape may be bridged rather easily with a conductive wire and is thereby rendered insensitive to the breakage.

The present invention overcomes the above-described difficulties of prior art window protection systems. With the system of the present invention, a transparent window element such as a glass pane is rendered electrically sensitive to breakage without the rather unsightly appearance which results from electrically conductive tape. In addition, the system of the present invention is not only not rendered insensitive by a bridging connection but rather it actually senses an attempted bridging operation and will sound an alarm when such bridging is attempted.

According to one aspect of the present invention, a window protection alarm is provided by means of a specially treated transparent pane, having electrically conductive yet transparent regions arranged according to a predetermined pattern. These transparent regions, which are in the form of strips, are connected in circuit with an alarm-actuating system which responds to any tampering with the window pane.

According to a further aspect of the present invention there is provided a pair of electrically conductive strips which extend across a window pane. A voltage source, such as a battery, is connected between one end of each of the strips so that a voltage appears across their opposite ends. This voltage is used to hold an electrical alarm in its off condition. If either of the conductive strips is broken, then the alarm will sound. Also, any attempt to bridge the strips will short circuit the battery and reduce the voltage on the opposite end of the strips, thereby actuating the alarm even without breakage of the conductive strips. The present invention also contemplates the use of special nuclear and light actuated bias voltage producing devices.

Various further and more specific objects, features and advantages of the invention will appear from the description given below, taken in connection with the accompanying drawings, illustrating by way of example a preferred form of the invention:

In the drawings:

FIG. 1 is a perspective view of a window arrangement in which the present invention is used;

FIG. 2 is a front elevational view, partially cut away and partially in section, of the main portion of the window arrangement of FIG. 1;

FIG. 3 is a fragmentary section view taken along line 3—3 of FIG. 2;

FIG. 4 is a schematic diagram illustrating circuits used in the window arrangement of FIG. 1;

FIG. 5 is a fragmentary perspective view illustrating a first modification to the arrangement of FIG. 1;

FIG. 6 is a fragmentary perspective view illustrating a second modification to the arrangement of FIG. 1; and

FIGS. 7–9 illustrate in edge section a portion of a window pane treated in accordance with the present invention.

In the arrangement of FIG. 1, a casement-type window **10** is hung by means of hinges **12** in a frame or casing **14** to pivot between open and closed positions. A latch **16** is mounted on the outer edge of the window **10** and is arranged to engage a keeper **18** mounted on the casing **14** so that the window may be held in closed condition.

The window **10** itself comprises a pane **20** of transparent material such as glass, and a sash **22** in which the pane **20** is mounted. As indicated by parallel lines extending across the pane **20**, there are provided a plurality of electrically conductive strips **24** which form a portion of an alarm-actuating circuit. The construction and operation of this circuit will be described more fully hereinafter. The strips **24** are nearly transparent in spite of the fact that they possess a certain degree of electrical conductivity. Thus their presence on the window does not affect its overall appearance. The manner in which the strips **24** are formed on the pane **20**, (which constitutes a further aspect of the present invention), will also be described hereinafter.

As shown in FIGS. **2** and **3**, there are actually provided two individual conductive strips **24*a*** and **24*b*** on the pane **20**; and these strips extend in more or less parallel fashion back and forth across the pane. The strips **24*a*** and **24*b*** extend vertically on the pane **20** along edge regions covered by the sash **22**. This arrangement makes it possible to conceal the pattern followed by strips over the window. As a result, it is not possible to ascertain which horizontal portions of the strips can be bridged without setting off an alarm.

Reverting to FIG. 1, it will be seen that there is provided on the sash **22** a bias source container **26**. A cord **28** extends from the bias source container **26** to an alarm actuate device **30** mounted on the window frame or casing **14**. The cord **28** contains a pair of electrical wires which are plugged into both the bias source container **26** and the alarm actuate device **30**. As shown in FIG. 1, the cord **28** is not long enough to permit the window **10** to open fully without the cord breaking or becoming unplugged. This arrangement, as will be explained, permits the maintenance of an operational alarm even when the window **10** is partially opened for ventilation. In addition, there is provided a key cylinder **32** in the alarm actuate device. This key cylinder is operative to disable the alarm circuit so as to permit the cord **28** to become unplugged without setting off an alarm when an authorized person desires to pen the window **10** to its fullest extent.

In operation of the system as above described, the alarm actuate device **30** may either be self contained or it may be connected into the central console of an overall protection system. In either event, the window **10**, when closed, will provide protection against penetration. Any attempt to break the glass pane **20** will result in the severance of the one or more of the conductive strips **24**, and, as will be explained hereinafter, this serves to actuate an alarm. Any attempt to defeat the system by bridging the conductive strips will fail if the bridging wire connects one of the two strips to another for this will short circuit the system and will immediately sound an alarm.

Finally, even if the window **10** is opened, whether legitimately or illegitimately, the cord **28** will limit the amount of opening to less than that which would be required to gain admittance through the window. Any attempt to gain admittance either by severing the cord **28** or by bridging its conductors will also result in alarm actuation. As pointed out above, however, a key may be used by an authorized person to disable the alarm and permit full opening of the window.

The circuit arrangements for the above-described window protection system are shown in FIG. 4. As can be seen in FIG. 4, there are provided a plurality of window protection circuits **34**, each of which is connectable to a common alarm actuation circuit **36**.

Each window protection circuit 34 includes a pair of conductive strips 24a and 24b which are arranged on a window pane as above described. One end of each of the strips is connected to a corresponding wire 28a and 28b which together form the cord 28 between the window and the bias source container 26 (indicated schematically in dashed outline in FIG. 4). Inside the container 26 there is provided a bias battery 38 and a bias resistor 40 connected in series with the wires 28a and 28b.

The other end of each of the conductive strips 24a and 24b is connected to the alarm actuate device 30 (also shown schematically in dashed outline in FIG. 4). One of the strips, 24a, is connected via a diode 42 to the emitter terminal of a PNP-type sensor transistor 44 and to a plus-voltage input terminal 46. The other strip 24b, is connected to the base terminal of the sensor transistor 44. The transistor base terminal is also connected, via a start resistor 48, to a minus-voltage input terminal 50. Additionally, the collector terminal of the transistor 44 is connected via a local disconnect switch 52 to the minus-input voltage terminal 50. The local disconnect switch 52 is operated by the key cylinder 32 to control the activation of the associated portion of the system.

The plus-voltage input terminal 46 of each of the individual window protection circuits 34 is connectable to a common plus-voltage line 54 in the alarm actuate circuit 36. Similarly, each minus-voltage input terminal 50 is connectable to a common minus-voltage line 56 in the alarm actuate circuit 36. The opposite ends of the common plus and minus-voltage lines 54 and 56 are connected to a converter 58 which operates to transform alternating current household electrical energy, received via a plug 60, to low-voltage direct current across the lines 54 and 56. An auxiliary power source, such as a battery 62, is connected across the converter 58 to maintain the alarm system in operation in the event of failure of household power.

An alarm relay coil 64 is connected serially into the plus-voltage line 54; and this coil, when energized by the passage of current through the line 54, operates to close a plurality of switch contacts 66. The contacts 66 when closed, permit energization of a local alarm 68 and/or a remote central alarm (not shown).

A regenerative switch arrangement is provided in the alarm actuate circuit 36. This switch arrangement includes a first, PNP-type switch transistor 70, and a second, NPN-type switch transistor 72. The first transistor 70 has its emitter connected directly to the plus-voltage line 54 on the window protection circuit side of the alarm relay coil 64. The collector of the first transistor 70 is connected, via a capacitor 74, to the minus-voltage line 56. The second transistor 72 has its collector connected via a resistor 76 to the plus-voltage line at a point adjacent the emitter of the first transistor 70. The emitter of the second transistor 72 is connected directly to the minus-voltage line 56. A further resistor 78 is connected serially along the minus-voltage line 56 between the points of connection leading to the transistors 70 and 72. The base and emitter terminal of the first and second transistors 70 and 72, as shown in FIG. 4, are cross-connected.

A master turnoff switch 80 is connected serially in the minus-voltage line 56 between the battery 62 and the regenerative switch arrangement. As indicated schematically at 82 a key-operated mechanism is provided to open the switch 80 so as to turn off the alarm once it is sounded. The alarm, however, cannot be turned off except by one having a proper key. This is because, as will be explained, the regenerative switch arrangement is inherently self-latching; and once turned on, it will remain on until power to it is interrupted by opening of the master turnoff switch 80.

In operation of the above-described system, each of the window protection circuits 34 operates to maintain a high impedance between the plus and minus voltage lines 54 and 56 in the common alarm actuation circuit 36. This high impedance simulates an open-switch condition. The high impedance presented by each window protection circuit 36 is achieved by maintaining the sensor transistor 44 biased to a nonconducting state. This in turn is accomplished by maintaining a bias voltage by means of the bias battery 38. This bias voltage is applied via the conductive strips 24a and 24b to the emitter and base terminals of the transistor 44.

It will be appreciated that if either of the conductive strips 24a or 24b is broken, or if the two strips are short circuited, then the bias battery 38 will fail to apply a bias voltage to the sensor transistor 44. When this occurs the base and collector voltages of the transistor will equalize and the transistor will begin to conduct.

The passage of current through the sensor transistor 44 of one of the window protection circuits 34 will cause current to flow through the further resistor 78 in the minus-voltage line 56. This flow of current will initiate, via the capacitor 74, a positive-going voltage on the base terminal of the second transistor 72 of the regenerative switch. This starts the second transistor conducting; and as a result, current flows through the resistor 76 and produces a voltage drop across it. This voltage drop is applied to the base terminal of the first transistor 70 and starts it conducting. The conduction of the first transistor 70 produces an even more positive voltage on the base terminal of the second transistor 72 with the result that the two transistors 70 and 72 urge each other toward a full conducting condition.

The above-described regenerative switch action allows current to flow through the alarm relay coil 64 so that the alarm may be sounded. As pointed out above, the alarm may be turned off only be operation of the master switch 80 which requires a special key for its operation. Thus, no matter which is done to any of the individual window protection circuits 34 following the initiation of an alarm, the alarm will continue to sound until it is turned off in an authorized manner.

It will be appreciated that the window protection system of the present invention is capable of sounding an alarm upon either the severing or the crossing, (i.e., short circuiting) of the conductive strips 24a and 24b. Thus, the system cannot be defeated by the expedient of providing bridging wires across the two strips 24a and 24b prior to breaking them.

Although a bias voltage source is required in the individual window protection circuits 34, this bias voltage source is required to put out only a very minute current level. Accordingly, its lifespan is quite high. Moreover, it will be appreciated that the system has a built-in fail-safe feature in that when any battery fails to provide its required bias voltage, its associated window protection circuit will sound the alarm.

Because of the very minute current level required from the bias source, a nuclear battery will operate successfully in this environment and will provide several years of useful life without requiring recharging. FIG. 5 shows a bias voltage arrangement utilizing a novel nuclear battery. As shown in FIG. 5, there is provided on the window frame 14 a light-sensitive photovoltaic strip 90 such as a silicon solar cell. The strip 90 converts incident visible light radiation to an electrical voltage in substantially the same manner as does the sensing cell of a lightmeter used in photographic operations. A phosphor layer 92, such as zinc sulphide, is coated on the light-sensitive strip 90. The phosphor layer 92 reacts to incident high-energy radiation, such as that from a radioactive source emitting alpha, beta or gamma radiation, to produce visible light. This reaction is similar to that obtained in ordinary fluorescent lamps wherein u.v. and similar high-energy rays resulting from impingement of electrons on gaseous molecules, are converted by a fluorescent material to visible light. A microencapsulated radioactive isotope, for example, Americium, is mixed in a dielectric binder such as plastic and is coated on the phosphor layer 92 to form a radiation layer 94.

It will be seen that the radiation emanating from the radiation layer 94 will impinge on the phosphor layer 92, causing it to emit visible light. This light impinges on the light-sensitive strip 90 causing it to generate a voltage. This voltage is applied via a pair of leads 98 on the light-sensitive strip to the conductive strips 24a and 24b, and through these strips to the sensor transistor 44 in the associated window protection circuit 34.

The above-described bias arrangement is especially advantageous since, with a radioactive isotope such as Americium, a half-life in excess of 10 years can be expected. Moreover, the bias voltage is substantially unaffected by changes in ambient conditions such as pressure, temperature, humidity, etc.

The above-described nuclear battery system, wherein nuclear radiation is converted to electricity via the intermediary of visible light, is especially advantageous in the present environment. This is because the radiation source may be chosen to have a low, and therefore safe, radiation output intensity, and yet the electrical energy derived therefrom will be of a useful magnitude. This is achieved in part due to the fact that the phosphor layer **92** is able to make use of nearly the entire spectrum of radiation from the radioactive layer and to concentrate this broad band input energy into a relatively narrow band of visible light. The resulting light intensity is therefore sufficient to excite a voltage in the light-sensitive strip **90**.

FIG. 6 illustrates a still further arrangement for obtaining biasing in connection with the window protection circuit of the present invention. In the arrangement of FIG. 6 there is provided a strip **100** of light-sensitive photovoltaic material. In the present case, however, the strip **100** may form a part of the electrically conductive strips **24***a* and **24***b* on the window. While the strip **100** is supplied with either natural or artificial light, it will maintain a bias voltage via the strips **24***a* and **24***b* sufficient to maintain the associated sensor transistor **44** in its nonconducting state. If, however, either the light source is removed or if the strip **100** is short circuited or broken, the bias voltage will be interrupted and the alarm will sound as before described.

FIGS. 7–9 illustrate the steps used in providing the conductive strips **24** on the transparent pane **20** of the window **10**. As shown in FIG. 7 a transparent electrically conductive film **110**, such as tin oxide, is formed, as by chemical deposition, on one surface of the pane **20**. This may be done in a manner similar to that described in British Pat. No. 632,256, or in U.S. Pat Nos. 2,118,795 and 2,583,000.

The transparent, electrically conductive film **110** is thereafter coated with a light-sensitive polymer, or photoresist **112**. A full-size photographic negative **114** is then prepared and is placed on the photoresist layer **112**. The negative **114** is patterned according to the shape and position of the strips **24** to be formed on the glass pane **20**.

The assembly as thus far described is exposed to a light source **116** as shown in FIG. 7. It is then subjected to a developing agent, such as trichlorethylene vapor, which develops the exposed image to leave an insoluble resist pattern duplicating the pattern of the negative **114**.

An etchant of zinc-hydrochloric acid is then used to remove the unexposed portions of the resist layer **112** as shown in FIG. 8, thus leaving on the surface of the pane **20** the transparent electrically conductive strips **24** which are connected to the various circuits in the alarm system as above described.

In order to protect the strips **24** from deterioration, the pane **20** may be coated over as shown in FIG. 9 with a transparent film **120** of silicon monoxide or a transparent polymer.

Although a certain specific embodiment of the invention is herein disclosed for purposed of explanation, further modifications thereof, after study of this specification, will be apparent to those skilled in the art to which the invention pertains. Reference should accordingly be had to the appended claims in determining the scope of the invention.

What is claimed and desired to the secured by Letters Patent is:

1. A window protection alarm system comprising at least one pair of electrically conductive strips extending across a window, means at one end of said strips for connecting a bias voltage across the pair of strips, an alarm, an electrical alarm actuation control circuit including a voltage responsive alarm-actuating switch also connected across the pair of strips at the other end thereof, said alarm-actuating switch being responsive to said bias voltage to maintain said alarm deactuated, said switch further being responsive to removal of said bias voltage from across said strips to produce actuation of said alarm whereby said window is protected by alarm actuation upon either short circuiting or open circuiting of said strips, said alarm-actuating switch including a resistor connected serially along one of said conductors, a first, PNP-type transistor having its collector connected via a capacitor to one side of said resistor and its emitter connected directly to the other of said conductors, and a second, NPN-type transistor having its emitter connected directly to the other side of said resistor and its collector connected via a further resistor to said other electrical conductor, the base and collectors of said transistors being cross-connected

2. A window protection alarm system as in claim **1** wherein said means for connecting a bias source comprises a bias source holding means mounted on a window casing and a cord including a pair of wires extending from said holding means to said strips whereby said strips may carry a bias voltage even when the window is partially opened.

3. A window protection alarm system as in claim **2** wherein there is provided in conjunction with said electrical alarm actuation control circuit a further switch for disabling said alarm actuation control circuit.

4. A window protection alarm system as in claim **3** wherein said further switch is key operated.

5. A window protection alarm system as in claim **1** wherein said electrical alarm actuation control circuit comprises a single alarm-actuating switch and a plurality of individual window protection circuits each including a pair of said electrically conductive strips, means for connecting a bias voltage source across said strips at one end thereof in each pair and means for connecting said alarm-actuating switch across said strips at the other end of each pair of strips.

6. A window protection alarm system as in claim **5** wherein said means connecting said alarm-actuating switch across each pair of strips comprises individual switch means connected across each of said pairs of strips and operable to prevent control of alarm actuation by the short circuiting or open circuiting of their respective strips.

7. A window protection alarm system as in claim **1** wherein said alarm actuation control circuit further comprises a pair of electrical conductors connected at one end, respectively, to said other end of each of said strips, and means connecting the opposite ends of said conductors across a source of electrical power, said alarm-actuating switch being responsive to a change in electrical impedance across said conductors to switch to an alarm-actuating condition.

8. A window protection alarm system as in claim **7** wherein said alarm-actuating switch includes a relay having its coil connected serially along one of said conductors, said relay having switch contacts connected to actuate said alarm when said coil is energized and means responsive to a change in impedance across said conductors to electrically connect said leads and permit current to flow through said relay.

9. A window protection alarm system as in claim **7** wherein said window protection circuit includes a sensor switch electrically connected across said one end of said electrical conductors, said sensor switch being normally closed and held to open condition by the application thereto of bias voltage applied via said strips.

10. A window protection alarm system as in claim **9** wherein said sensor switch comprises a transistor having its emitter and collector terminals connected respectively to said conductors and one of said terminals and its base connected respectively to said other end of said strips.

11. A window protection alarm system as in claim **1** wherein said bias voltage source comprises a photovoltaic cell connected across said one end of said electrically conductive strips and arranged to have light incident thereon.

12. A window protection alarm system according to claim **2** wherein said strips extend side by side in parallel fashion across said window.

13. A window protection alarm system as in claim 1 wherein said bias voltage comprises a ray energy voltage-generating means.

14. A window protection alarm system as in claim 13 wherein said voltage-generating means comprises a radioactive isotope, a phosphor adjacent to and responsive to radiation from said isotope for generating visible light and a photovoltaic cell adjacent to said phosphor for generating a voltage in response to light from said phosphor.

15. A window protection system according to claim 1 wherein said strips are in the form of an electrically conductive transparent coating on the surface of said window.

16. A window protection alarm system as in claim 15 wherein said electrically conductive coating comprises tin oxide.

17 A window protection alarm system as in claim 15 wherein said pane including said transparent coating is further covered over with a transparent electrically nonconductive protective coating.

18. A window protection alarm system as in claim 17 wherein said protective coating comprises silicon monoxide.

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