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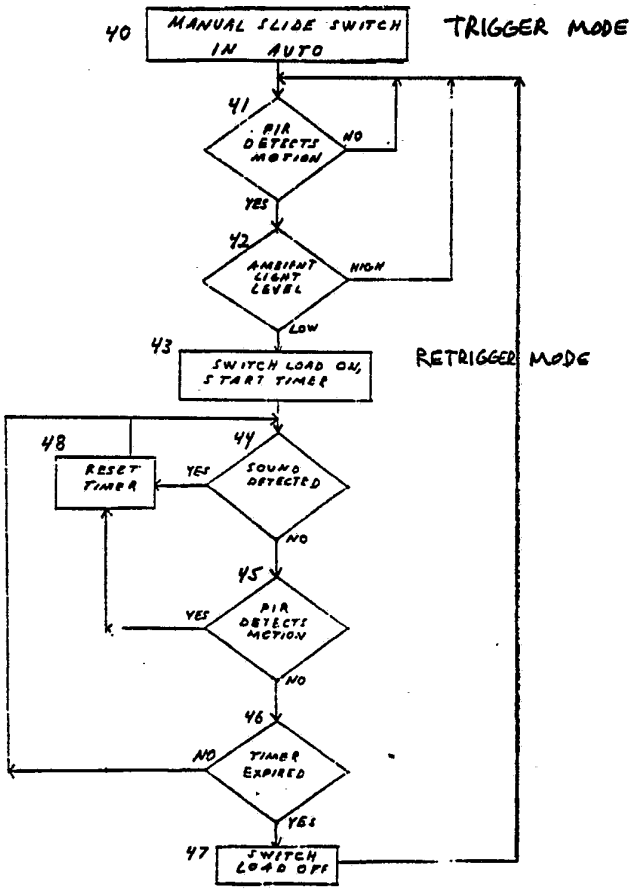
(54) Title: METHOD AND APPARATUS FOR DETECTING ENTRY

(57) Abstract

An apparatus and method for a sensing apparatus used for example in an illumination control monitoring a particular area. The sensing apparatus includes selectable and independent triggering and retriggering modes for activating and deactivating a lamp. Three sensors, a PIR, a sound and a light sensor cooperatively interact to cause triggering upon detecting motion in a low ambient light room. Thereafter, retriggering results upon either motion or sound being periodically detected in the room. No motion or sound within a predetermined duration results in deactivation of the light and a return to a pre-triggering configuration.



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METHOD AND APPARATUS FOR DETECTING ENTRY

BACKGROUND OF THE INVENTION

The present invention relates generally to security sensors and to energy-conservative sensors for sensing entry into a monitored area or room. More specifically, the present invention relates to passive sensors for automatically lighting and extinguishing lights when a person enters and leaves a room.

Passive infared (PIR) motion sensing is an expanding technology driven by security and energy conservation demands. One typical use of conventional PIR technology is automatic illumination of room lighting when a person enters a room. A timer will automatically extinguish the lights after a predetermined interval unless the PIR detects the person moving in the room. A disadvantage of these motion-only sensors is that the sensor may not detect a presence of person out of a line-of-sight of the PIR but still within the room. In this case, the sensor extinguishes the lights while the person remains in the room. The consequences of this premature loss of light range from inconvenience and annoyance to potential hazard and bodily injury, depending upon the particular room or area monitored. In some instances, a person may merely have to wave or stand to trigger the sensor while in other instances the person way have to move to a monitored part of the room in darkness.

These prior art room sensors typically employ the same mechanism for triggering and retriggering. That is, the sensor will illuminate room lights (trigger them) when it detects motion and will reset a timer (retrigger the lights) when it detects motion.

SUMMARY OF THE INVENTION

The present invention provides apparatus and method for sensing entry into a room or other monitored area. The present invention provides user-determinable preconditions of selected environmental conditions in the monitored area for triggering and retriggering. The triggering and the retriggering is independent from each other and are able to employ different sensors and monitor different parameters.

In one preferred embodiment, the sensing apparatus includes a motion sensor, an ambient light sensor, and a sound sensor. The preferred embodiment also includes an actuator and a timer, as well as logic circuitry to test for the desired preconditions for triggering and retriggering.

In operation, the preferred embodiment for controlling room illumination monitors for motion in low ambient light room. Upon detecting motion with low light, the logic circuitry triggers the actuator and initiates the timer. To determine when to retrigger, the sensor detects for sound or motion within the room. Without either sound or motion in the room, the timer will expire, extinguishing the lights. After extinguishing the lights, the sensor will wait for its predetermined triggering configuration of the environmental conditions monitored by its sensors.

In other aspect of the invention, the sensitivities of the various sensors are adjustable, providing a large range of applications for the present invention. For instance, adjusting a sound sensitivity for a room permits retriggering simply by conversing with another person, or by turning pages of a book or newspaper. It is possible to adjust either mode of operation, triggering or retriggering, so that only a single sensor will monitor the desired environmental condition.

Additionally, the present invention permits priorities or particular orderings of selected environmental conditions to trigger or retrigger the sensor, independent of each other. One example sets the sensor so that retriggering results from

detecting sound only after first detecting motion. For security areas, in some instances it is desirable to trigger an actuator controlling an alarm or light after detecting motion, a flashlight beam and a sound of forced entry, for instance. In some instances, triggering results from first detecting motion, then forced entry, or vice versa. Proper order of the selected signals result in triggering and retriggering, with each independently selectable.

Another embodiment of the present invention employs radio frequency transmissions between the sensors and the actuator, allowing remote switching of desired load. The actuators may operate from power supplies independent from those of the sensors.

The present invention provides users with an ability to tailor entry sensors for particular applications. The improved entry sensor enhances convenience and safety of the user, permitting widespread acceptance of illumination and security controls using the present invention.

Reference to the remaining portions of the specification and drawings may realize a further understanding of the nature and advantages of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a view of a preferred embodiment of the present invention illustrating a configuration for room illumination control in a switch model mounted within a standard wall box;

Fig. 2 is a block diagram of a circuit employing the present invention;

Fig. 3 is a flow chart illustrating operation of a preferred embodiment of the present invention; and

Fig. 4 is an alternate preferred embodiment of the present invention illustrating separate use of light, PIR and sound sensors interconnected by a radio frequency (RF) link.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Fig. 1 is a view of a preferred embodiment of the present invention illustrating a configuration for room illumination control 10 in a switch model mounted within a standard wall box. The illumination control 10 includes a plastic body 20 and a metal mounting plate 21. Conventional mounting of the mounting plate 31 to a wall box 24 with mounting screws 25 through a cover plate 27. Power from a power source, such as household alternating current connects to one line of the illumination control 10 and a second line connects to another line of the illumination control 10.

A manual slide switch 37 has different positions (OFF, ON, and AUTO) for the different functions of the illumination control 10. In the OFF position, the illumination control 10 is incapable of activating a load regardless of particular environmental conditions in the room. In the ON position, the illumination control 10 activates the load, again without regard for particular environmental conditions. In the AUTO position, the illumination control 10 begins a passive infared (PIR), light and sound detecting process further explained below with reference to Fig. 3.

The illumination control 39 includes a fresnel lens 38 focussing infared radiation from a monitored area onto a pyroelectric infrared sensor, not shown. The illumination control includes a photoelectric sensor mounted behind transparent cover 32 and a microphone mounted behind holes 33. Sensitivity switches 36, 34 and 35 for each of the three sensors, PIR, photoelectric and microphone respectively adjust a sensitivity of their associated switches. For example, in the preferred embodiment, adjustment sensitivity for switch 35 (audio) permits triggering or retriggering from a range of 10dB to above 110dB.

Fig. 2 is a block diagram of a sensing circuit 50 employing a preferred embodiment of the present invention. The sensing circuit 50 includes three environmental sensors 52, 54

and 56 for monitoring various environmental conditions, such as motion, light and sound, for example. A logic circuit 60 monitors output signals from each of the sensors. The logic circuit 60 may be implemented in any number of well-known implementations, including microcontroller circuitry or hardwiring. Each sensor 52 has an associated sensitivity adjustment switch 62 used to set threshold levels. The logic circuit 60, responsive to particular configurations of environmental conditions measured by the sensors and a mode of operation, controls an actuator 64. The actuator 64 controls a load 66. The load 66, for example, may be a light, or an alarm. The logic circuit 60 deactivates the actuator 64 responsive to an assertion of a timing signal from a timer 68. A control switch 70 selects whether the sensing circuit is ON, OFF or in AUTOMATIC detection. When ON, the logic circuit 60 causes the actuator 64 to activate the load 66 irrespective of a condition of the output signals from the sensors 52, 54 and 56. When OFF, the actuator 64 deactivates the load 66. In AUTOMATIC, the logic circuit 60 operates as identified in the description relative to Fig. 3.

Fig. 3 is a flow chart of the operation of the sensing circuit 50 for implementation of an illumination control. Steps 40 through 48 are process steps implemented by the logic circuit 60 of Fig. 2. Sensor_1 52 is a PIR sensor, sensor_2 54 is a photoelectric sensor, and sensor_3 is an audio sensor. The load 66 is a lamp. At step 40, the logic circuit 60 determines whether the control switch 70 is in AUTOMATIC or not. If in AUTOMATIC, the logic circuit 60 determines whether the output signal from the PIR sensor falls within a prespecified range indicating motion within a monitored area, at step 41. The range may optionally include upper and lower bounds. If the PIR sensor does not detect motion, the logic circuit 60 cycles back to the step 40, continually testing for motion within the monitored area. If at step 41, the PIR sensor indicates motion, the logic circuit 60 advances to step 42 to test an ambient light level with the photoelectric sensor. For the preferred embodiment, if

the ambient light exceeds a predetermined threshold, the monitored area is sufficiently illuminated so the logic circuit 60 will not trigger the lamp, but return to step 41. However, if at step 42 the ambient light is below the threshold, the logic circuit will proceed to step 43. At step 43, the PIR sensor detected motion, followed by the photoelectric sensor determining that the monitored area was sufficiently dark to warrant further illumination. Thus, at step 43, the logic circuit 43 causes the actuator 64 to activate the lamp. Additionally, the logic circuit 60 resets and starts the timer 68. Passing the logic tests at step 41 and step 42 triggers the illumination control. The timer 68 measures a lapse of a predetermined interval. If the illumination control has not been retriggered before expiry of the timer 68, as indicated by assertion of a timer signal to the logic circuit 60, the logic circuit 60 will cause the actuator 64 to turn the lamp off. The retrigger mode cycles through the steps 44 through 48.

In the preferred embodiment, the retriggering begins at step 44 with the audio sensor checking for any sound in the monitored area. Sound falling within an identified range results in the logic circuit 60 resetting the timer 68 at step 48. After resetting, the logic circuit returns to step 44.

If the sound level falls outside the identified range, the logic circuit 60 advances to step 45 to test for motion. An output signal from the PIR sensor within a second (retriggering) range will cause the logic circuit 60 to reset the timer 68 at step 48 and return to step 44. Absent sound or motion within the proper ranges, the logic circuit 60 advances to step 46 to test a status of the timer 68. If the timer 68 has not expired, the logic circuit 60 returns to the step 44. However, finding the timer 68 expired, the logic circuit 60 causes the actuator 64 to deactivate the lamp. Thereafter, the logic circuit 60 returns to step 41, waiting for the particular combination of environmental conditions as measured by the particular combination of sensors.

As the preferred embodiment of the present invention includes multiple sensors monitoring different environmental conditions, it is contemplated that different environmental conditions include two sensors which both detect motion, but in different areas of a monitored area. The term "configuration of environmental conditions" refers to any permutation or combination of the various parameters measured by the particular sensors employed. Ordering is an important part of a preferred embodiment of the present invention.

Fig. 4 is an alternate preferred embodiment of the present invention illustrating separate use of light, PIR and sound sensors interconnected by a radio frequency (RF) link.

The alternate embodiment includes a transmitting sensor 102, a receiving sensor 104 and a handheld remote control 106. The transmitting sensor 102 of this preferred invention includes either a combination motion/light sensor 102a or a combination motion/sound sensor 102b. The transmitting sensors 102 operate from either conventional a.c. power (such as by a bulb socket) or battery operated. These transmitting sensors 102 are positioned separate from a cooperating receiving sensor 104. The transmitting sensor 102 provides the sensor signals from its sensors to the receiving sensor 104 via radiofrequency, or equivalent such as infrared signalling.

The cooperating receiving sensor 104, which is a receiving sound sensor 104a for transmitting sensor 102a or a receiving sound/light sensor 104b for transmitting sensor 104b. In this preferred embodiment, the logic circuitry 60 is included within the receiving sensor 104. The system operates similarly to the sensing system described above, except that the radiofrequency intercommunications permits a wider range of environmental conditions for triggering or retriggering events as the sensors are able to be physically separated. To control a system according to the alternate preferred embodiment, the remote control 106 can place the system in any of the ON, OFF or AUTOMATIC states.

In conclusion, the present invention provides many advantages over existing devices, including more versatile, convenient and customable operation. The present invention offers differing triggering and retriggering configurations for various environmental conditions. While the above is a complete description of the preferred embodiments of the invention, various alternatives, modifications, and equivalents may be used. For example, other remote interconnection systems other than radiofrequency can allow communication of the sensor signal. Therefore, the above description should not be taken as limiting the scope of the invention which is defined by the appended claims.

WHAT IS CLAIMED IS:

1. A sensing apparatus, comprising:

a first sensor for providing a first signal indicating a status of a first environmental condition;

a second sensor for providing a second signal indicating a status of a second environmental condition;

a timer for asserting a timer signal upon a lapse of a predetermined interval after a reset of said timer by assertion of a reset signal;

an actuator for activating a load responsive to an assertion of a trigger signal and for deactivating said load responsive to a deassertion of trigger signal; and

logic means, coupled to said first sensor, to said second sensor and to said actuator, for:

asserting said trigger signal to said actuator to activate said load, and initiating said timer, upon detection of a first predetermined configuration of said first and second environmental conditions as respectively indicated by said first and second sensors when in a trigger mode;

retriggering said actuator by asserting said reset signal to said timer upon detection of a second predetermined configuration of said first and second environmental conditions as respectively indicated by said first and second sensors prior to assertion of said timer signal when in a retrigger mode;

deasserting said trigger signal to said actuator, responsive to an assertion of said timer signal, to deactivate said load; and

returning to said trigger mode after deactivating said actuator.

2. A sensing apparatus, comprising:

a first sensor for providing a first signal indicating a status of a first environmental condition;

a second sensor for providing a second signal indicating a status of a second environmental condition;

a third sensor for providing a third signal indicating a status of a third environmental condition;

a timer for asserting a timer signal upon a lapse of a predetermined interval after a reset of said timer by assertion of a reset signal;

an actuator for activating a load responsive to an assertion of a trigger signal and for deactivating said load responsive to a deassertion of trigger signal; and

logic means, coupled to said first sensor, to said second sensor and to said actuator, for:

asserting said trigger signal to said actuator to activate said load, and initiating said timer, upon detection of a first predetermined configuration of said first and second environmental conditions as respectively indicated by said first and second sensors when in a trigger mode;

retriggering said actuator by asserting said reset signal to said timer upon detection of a second predetermined configuration of said first and third environmental conditions as respectively indicated by said first and third sensors prior to assertion of said timer signal when in a retrigger mode;

deasserting said trigger signal to said actuator, responsive to an assertion of said timer signal, to deactivate said load; and

returning to said trigger mode after deactivating said actuator.

3. A sensing apparatus, comprising:

a first and a second sensor, each said sensor indicating a particular environmental condition;

an actuator for activating and deactivating a load responsive to a control signal; and

a logic circuit, coupled to said first and second sensors and to said actuator, for triggering said actuator when said sensors indicate a first particular configuration of said environmental conditions, and retriggering said actuator when said sensors indicate a second particular configuration of said environmental conditions.

4. The sensing apparatus of claim 3 wherein said first and second sensors are physically separated and communicate remotely via radio frequency signals.

5. A sensing method, comprising the steps of:

monitoring for a first predetermined configuration of a first and second environmental condition respectively indicated by a first sensor and a second sensor;

activating a load when said first and second sensors indicate said first predetermined environmental conditions exist;

starting a timer measuring a lapse of a predetermined interval;

monitoring for a second predetermined configuration of said first and second environmental conditions while said timer measures said predetermined interval;

resetting said timer if said first and second sensors indicate said second environmental conditions exist prior to lapse of said predetermined interval to retrigger said load;

determining when said timer measures said lapse of said predetermined interval;

deactivating said load when said timer lapses; and

returning to a trigger mode to monitor for said first predetermined configuration of said first and second environmental conditions.

6. A sensing method, comprising the steps of:

triggering a load when a first and a second sensor detect a first predetermined configuration of a first and second respective environmental condition;

initiating a timer to measure a predetermined interval;

retriggering said load when said first and said second sensors detect a second predetermined configuration of said first and second respective environmental condition prior to a lapse of said predetermined interval;

resetting said timer after retriggering said load; and

deactivating said load when said timer measures said predetermined interval.

7. A sensing method, comprising the steps of:

monitoring for a first predetermined configuration of a first and second environmental condition respectively indicated by a first sensor and a second sensor;

activating a load when said first and second sensors indicate said first predetermined environmental conditions exist;

starting a timer measuring a lapse of a predetermined interval;

monitoring for a second predetermined configuration of said first environmental condition and a third environmental condition indicated by a third sensor while said timer measures said predetermined interval;

resetting said timer if said first and third sensors indicate said second environmental conditions exist prior to lapse of said predetermined interval to retrigger said load;

determining when said timer measures said lapse of said predetermined interval;

deactivating said load when said timer lapses; and

returning to a trigger mode to monitor for said first predetermined configuration of said first and second environmental conditions.

8. A sensing method, comprising the steps of:

triggering a load when a first and a second sensor detect a first predetermined configuration of a first and second respective environmental condition;

initiating a timer to measure a predetermined interval;

retriggering said load when said first sensor and a third sensor detect a second predetermined configuration of said first environmental condition and a third environmental condition prior to a lapse of said predetermined interval;

resetting said timer after retriggering said load; and

deactivating said load when said timer measures said predetermined interval.

9. A sensing apparatus, comprising:

a first sensor for providing a first signal indicating a status of a first environmental condition;

a second sensor for providing a second signal indicating a status of a second environmental condition;

a timer for asserting a timer signal upon a lapse of a predetermined interval after a reset of said timer by assertion of a reset signal;

an actuator for activating a load responsive to an assertion of a trigger signal and for deactivating said load responsive to a deassertion of trigger signal; and

logic means, coupled to said first sensor, to said second sensor and to said actuator, for:

asserting said trigger signal to said actuator to activate said load, and initiating said timer, upon detection of a first predetermined permutation of said first and second environmental conditions as respectively indicated by said first and second sensors

when in a trigger mode;

retriggering said actuator by asserting said reset signal to said timer upon detection of a second predetermined permutation of said first and second environmental conditions as respectively indicated by said first and second sensors prior to assertion of said timer signal when in a retrigger mode;

deasserting said trigger signal to said actuator, responsive to an assertion of said timer signal, to deactivate said load; and

returning to said trigger mode after deactivating said actuator.

10. A sensing apparatus, comprising:

a first sensor for providing a first signal indicating a status of a first environmental condition;

a second sensor for providing a second signal indicating a status of a second environmental condition;

a third sensor for providing a third signal indicating a status of a third environmental condition;

a timer for asserting a timer signal upon a lapse of a predetermined interval after a reset of said timer by assertion of a reset signal;

an actuator for activating a load responsive to an assertion of a trigger signal and for deactivating said load responsive to a deassertion of trigger signal; and

logic means, coupled to said first sensor, to said second sensor and to said actuator, for:

asserting said trigger signal to said actuator to activate said load, and initiating said timer, upon detection of a first predetermined permutation of said first and second environmental conditions as respectively indicated by said first and second sensors when in a trigger mode;

retriggering said actuator by asserting said reset signal to said timer upon detection of a second predetermined permutation of said first and third environmental conditions as respectively indicated by said first and third sensors prior to assertion of said timer signal when in a retrigger mode;

deasserting said trigger signal to said actuator, responsive to an assertion of said timer signal, to deactivate said load; and

returning to said trigger mode after deactivating said actuator.

11. A sensing method, comprising the steps of:

triggering a load when a first and a second sensor detect a first predetermined permutation of a first and second respective environmental condition;

initiating a timer to measure a predetermined interval;

retriggering said load when said first sensor and a third sensor detect a second predetermined permutation of said first environmental condition and a third environmental condition prior to a lapse of said predetermined interval;

resetting said timer after retriggering said load; and

deactivating said load when said timer measures said predetermined interval.

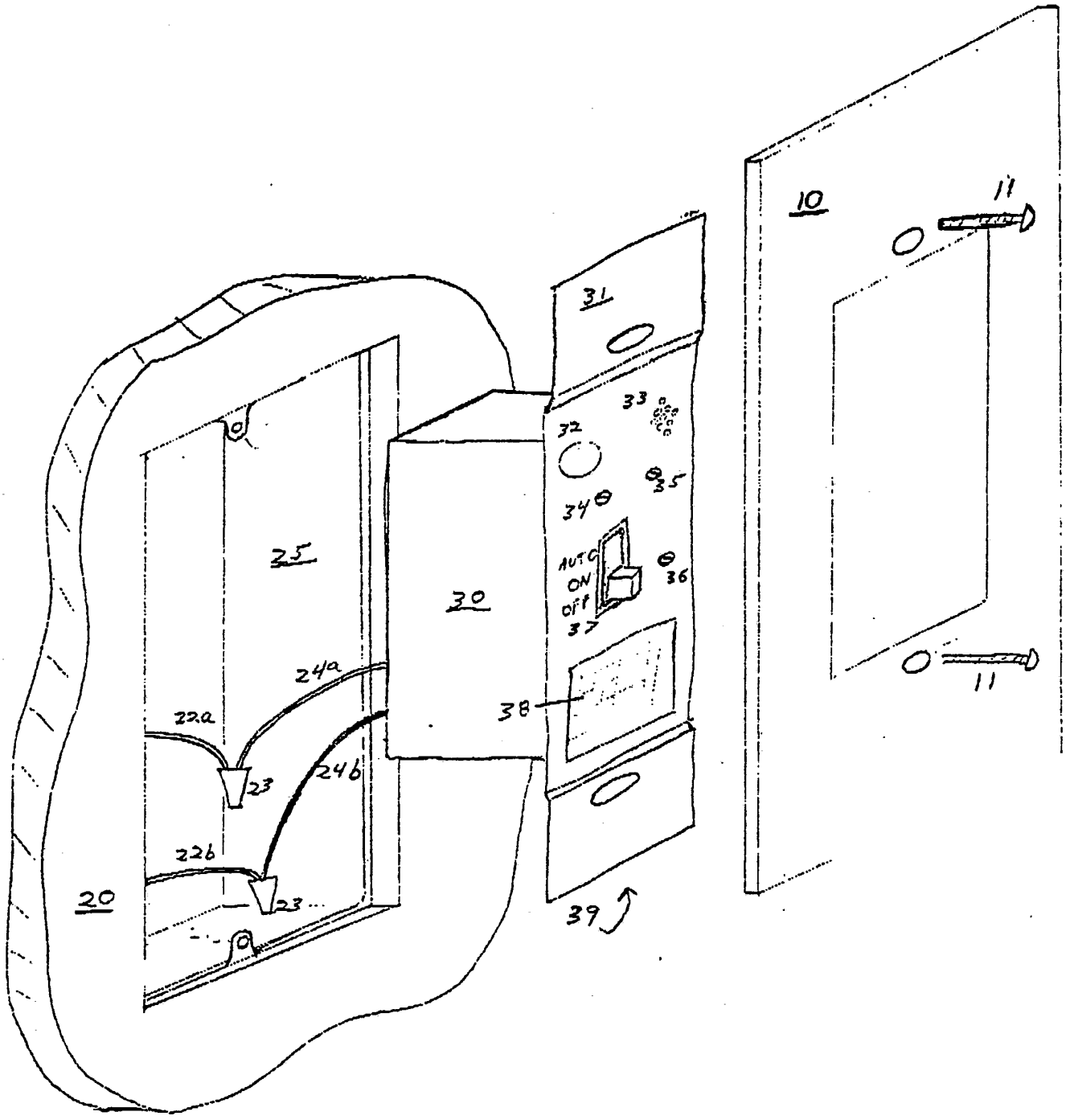

10
11
11
31
33
32
35
34
AUTO
ON
OFF
36
37
38
39
25
30
24a
22a
23
24b
22b
23
20

FIG. 1

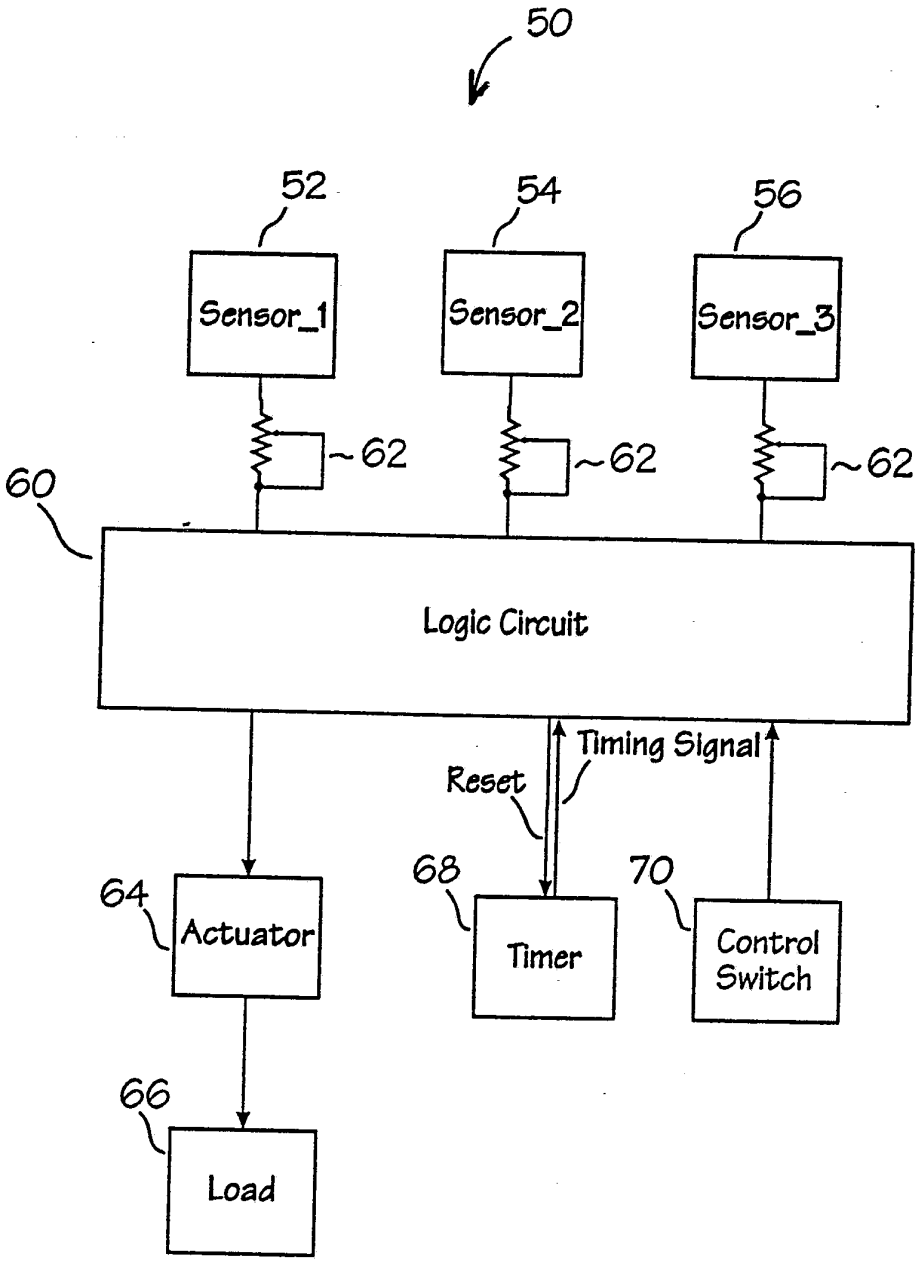

50
52
54
56
Sensor_1
Sensor_2
Sensor_3
62
62
62
60
Logic Circuit
Timing Signal
Reset
64
Actuator
68
Timer
70
Control Switch
66
Load

Fig. 2

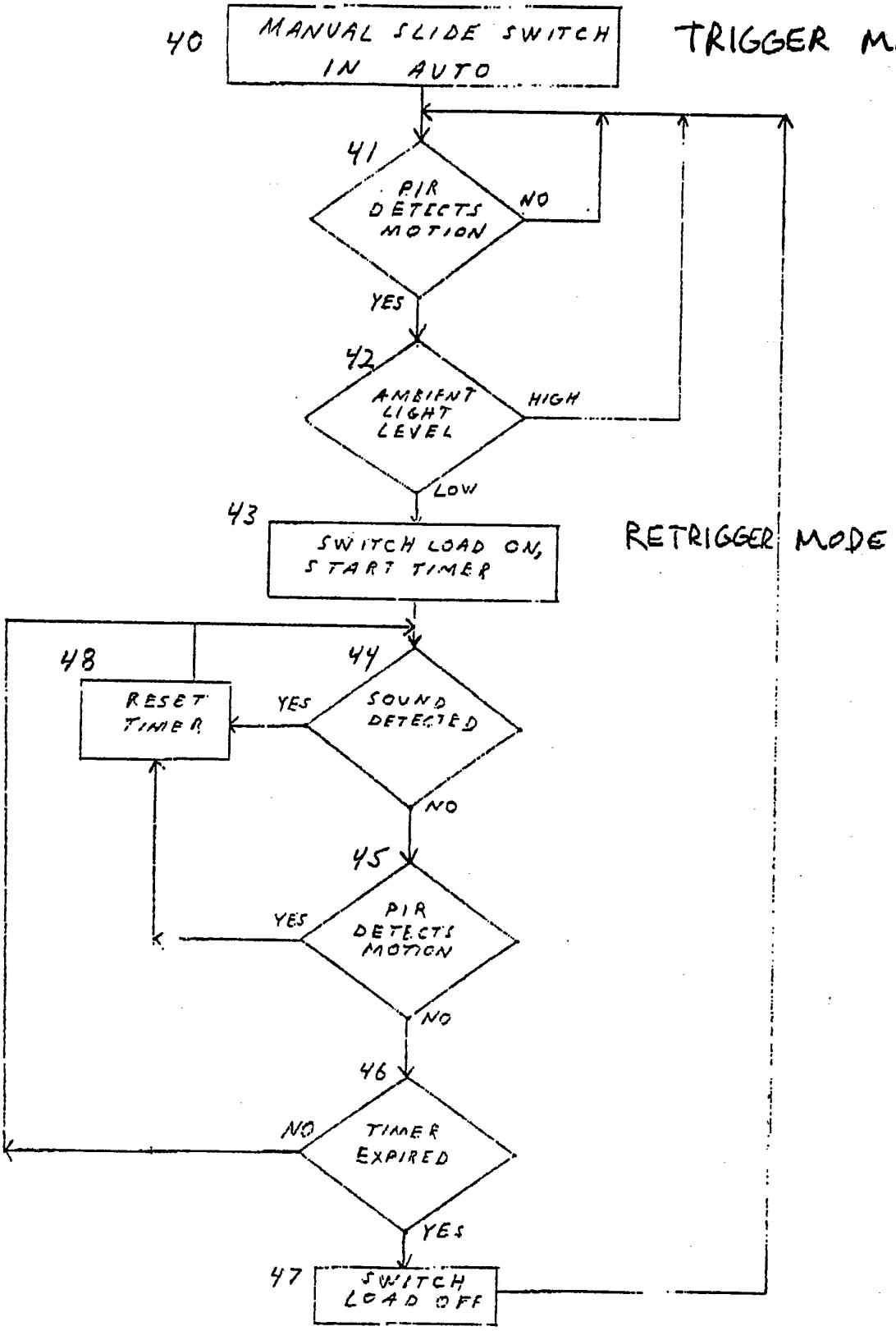
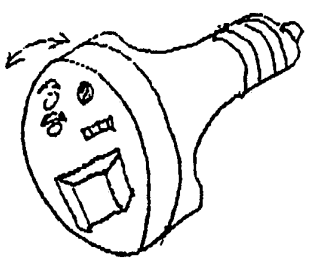
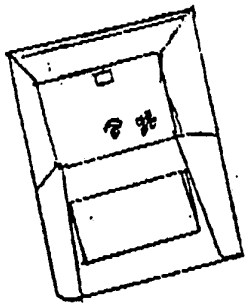

40
MANUAL SLIDE SWITCH IN AUTO
TRIGGER MODE
41
PIR DETECTS MOTION
NO
YES
42
AMBIENT LIGHT LEVEL
HIGH
LOW
43
SWITCH LOAD ON, START TIMER
RETRIGGER MODE
48
RESET TIMER
44
SOUND DETECTED
YES
NO
45
PIR DETECTS MOTION
YES
NO
46
TIMER EXPIRED
NO
YES
47
SWITCH LOAD OFF

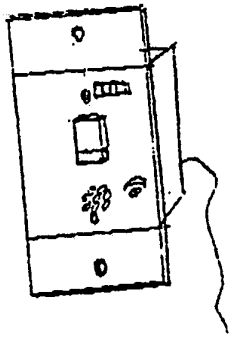
FIG. 3

TRACK LAMP SOCKET
MOTION SENSOR WITH LIGHT SENSOR
RF TRANSMISSION

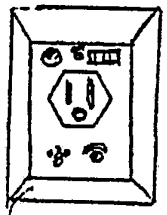




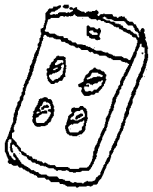
BATTERY OPERATED MOTION/SOUND SENSOR
WITH RF TRANSMISSION



WIRE IN SWITCH RECEIVER
WITH SOUND SENSOR TO
BE USED WITH PIR/LIGHT
SENSOR UNITS



PLUG IN RECEIVER
WITH SOUND/LIGHT
SENSOR TO BE
USED WITH
PIR/LIGHT UNITS



HAND HELD
REMOTE CONTROL

EXAMPLES OF HOW LIGHT, PIR, SOUND SENSORS CAN BE USED SEPARATELY USING A R.F. LINK.

FIG. 4

INTERNATIONAL SEARCH REPORT

International Application No PCT/US 92/07293

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 H05B37/02

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	H05B

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category °	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No.[13]
X Y	GB,A,2 239 742 (NEW WORLD ELCTRONIC) 10 July 1991 see abstract see page 3, line 17 - page 6, line 2; figures 1-3	1,3,5-9 2,10,11
Y	DE,U,9 105 106 (BRUCK) 27 June 1991 see page 1, line 7 - page 3, line 17	2,10,11
A,P	WO,A,9 210 074 (NOVITAS) 11 June 1992 see abstract; figures 4,5	1,2,10, 11

° Special categories of cited documents :[10]

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
20 NOVEMBER 1992	03 DEC 1992
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	SPEISER P.

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. US 9207293 SA 64360

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 20/11/92
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB-A-2239742	10-07-91	None	
DE-U-9105106	27-06-91	DE-U- 9005794	02-08-90
WO-A-9210074	11-06-92	US-A- 5142199	25-08-92