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(54) **FULLY AUTOMATIC ENERGY EFFICIENT LIGHTING CONTROL AND METHOD OF MAKING SAME**

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Appl. No.: **07/799,490**
Filed: **Nov. 27, 1991**

U.S. Applications:

(63) Continuation-in-part of application No. 07/619,794, filed on Nov. 29, 1990, now Pat. No. 5,142,199.

(51) **Int. Cl.**[7] **H05B 37/02**; H05B 41/36

(52) **U.S. Cl.** .... **315/154**; 315/159; 250/221; 250/214 AL; 307/116

(58) **Field of Search** .... 315/154, 155, 315/149, 150, 159, 158, 307, 194, 291, 360, 361, 315, DIG. 4, 152, 153, 316, 312; 307/116; 250/214 AL, 221

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(57) **ABSTRACT**

A fully automatic and energy efficient lighting control or light switch comprises different settings, preset by a user, and activates all or a portion of at least one bank of lights upon detecting occupants within a room. In one embodiment, the light switch detects doppler-shifted, reflected ultrasonic waves caused by occupant motion within the room. In an automatic mode, the light switch is configured to automatically switch from an initial sensitivity level for detecting motion within a short range therefrom, to a higher sensitivity level for detecting motion anywhere within the room. After the room is empty or no motion is sensed, the light switch is configured to turn the lights off following a variable time delay. The light switch returns to its initial low sensitivity level following a predetermined grace period which begins once the lights are turned off. The lights can be turned off manually when the light switch is in its automatic mode, in which case, the light switch continues to operate at the higher sensitivity level. When motion is no longer detected, and following the variable time delay and predetermined grace period, the switch automatically returns to an automatic "on" state. In an alternative manual mode, the light switch can be activated manually and deactivated both manually and automatically. In its manual mode, the light switch is configured to deactivate the lights upon sensing no motion and is configured to reactivate the lights automatically within the predetermined grace period upon sensing motion.

31 Claims, 6 Drawing Sheets

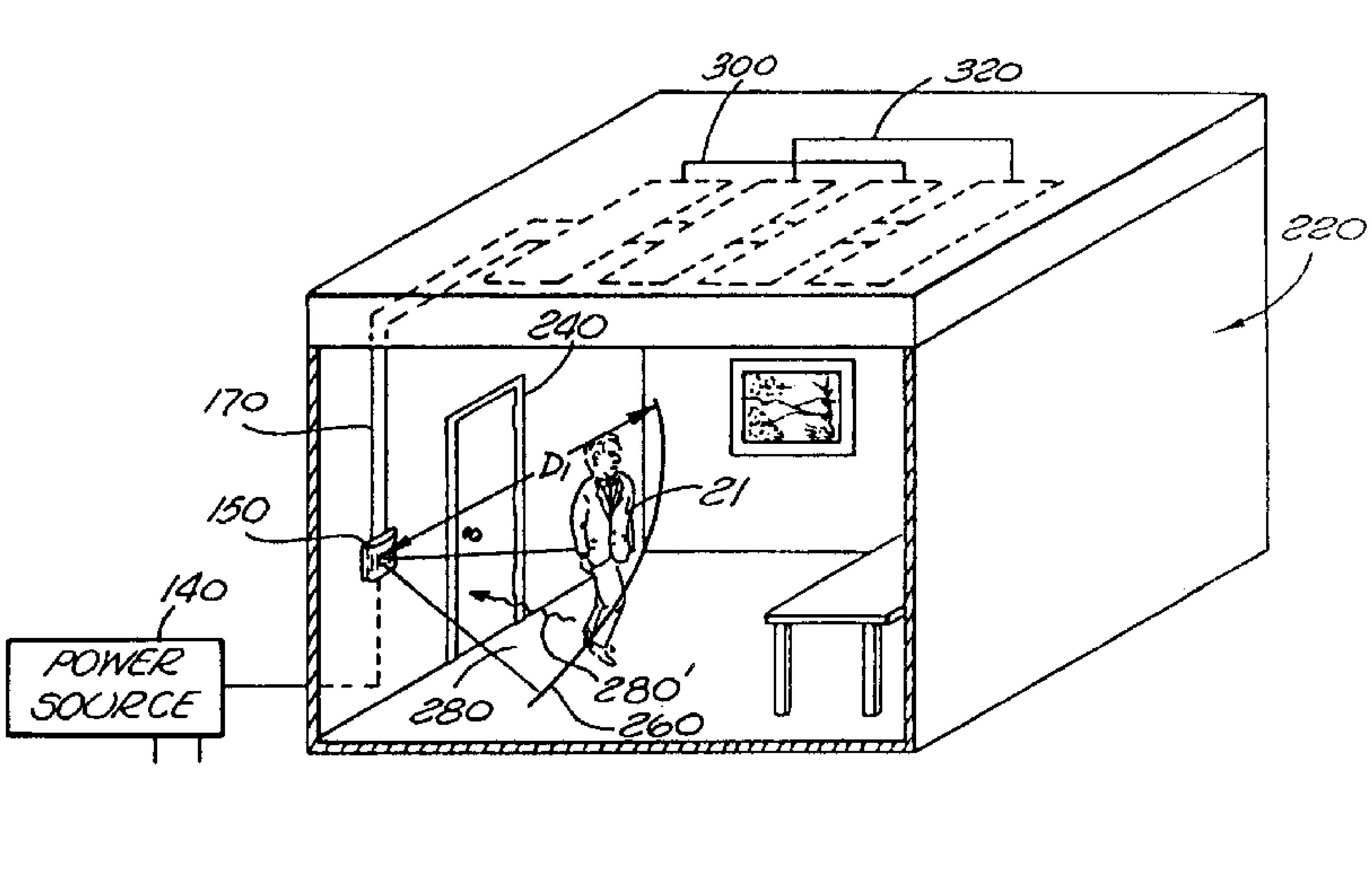


FIG. 1A

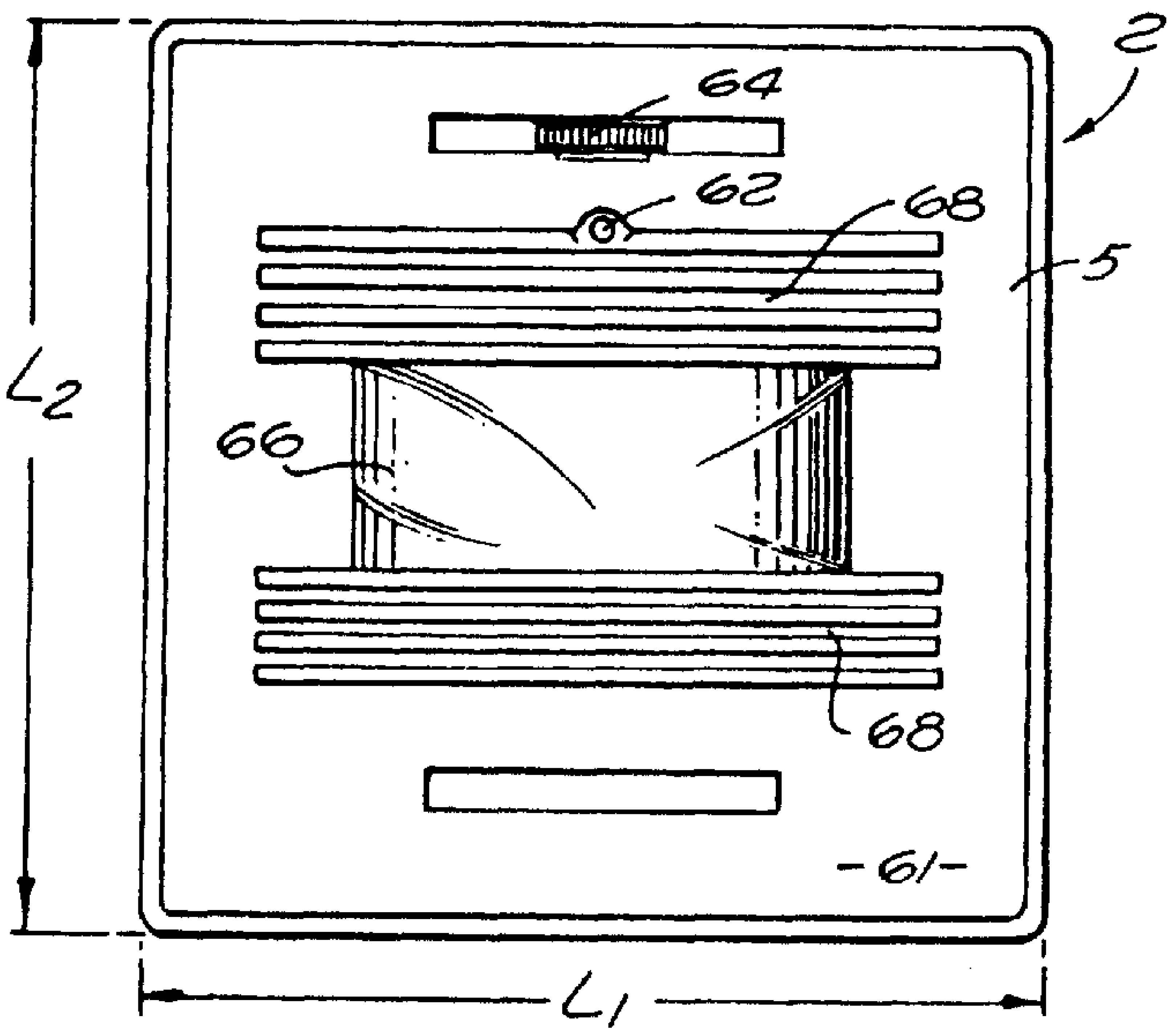


FIG. 1B

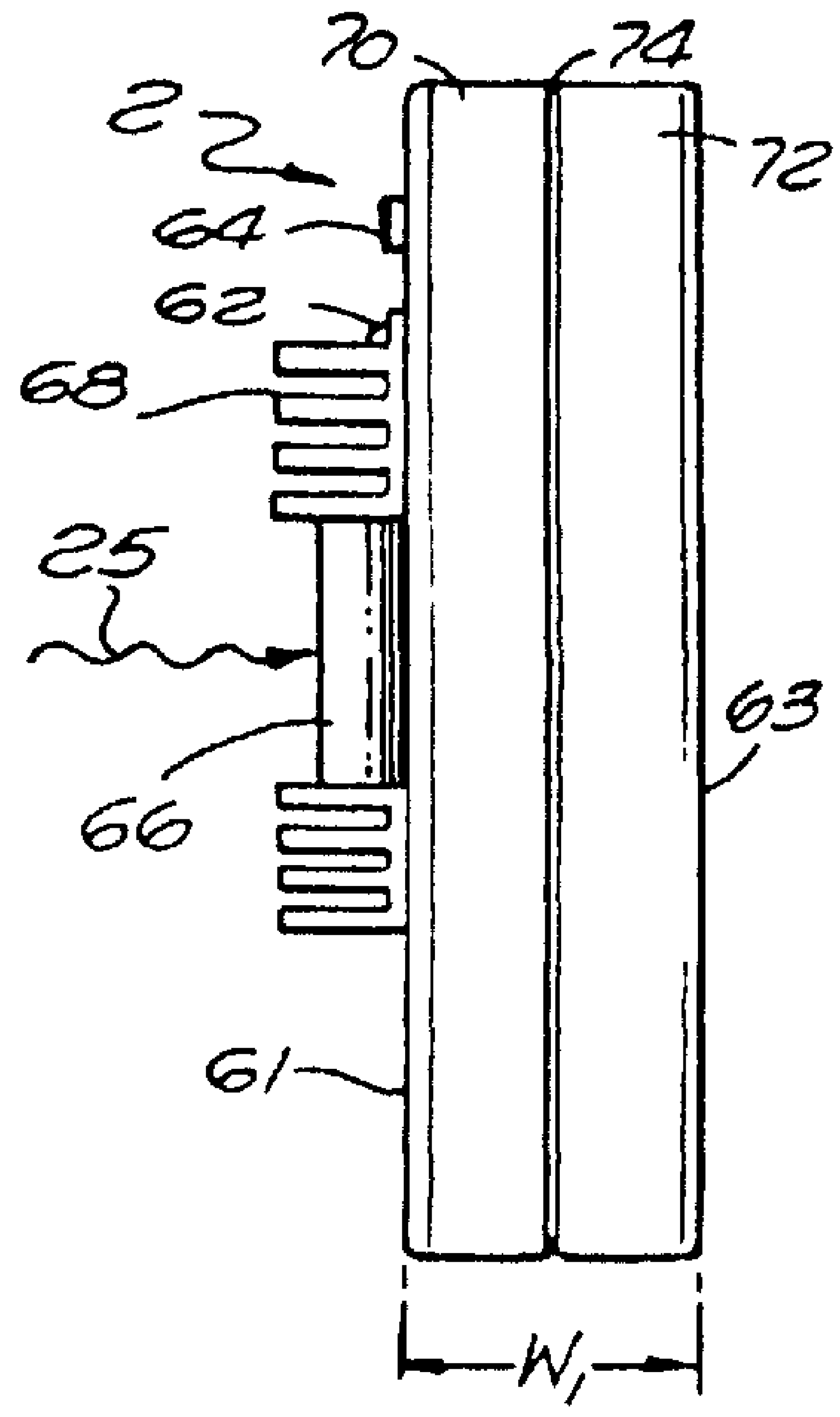
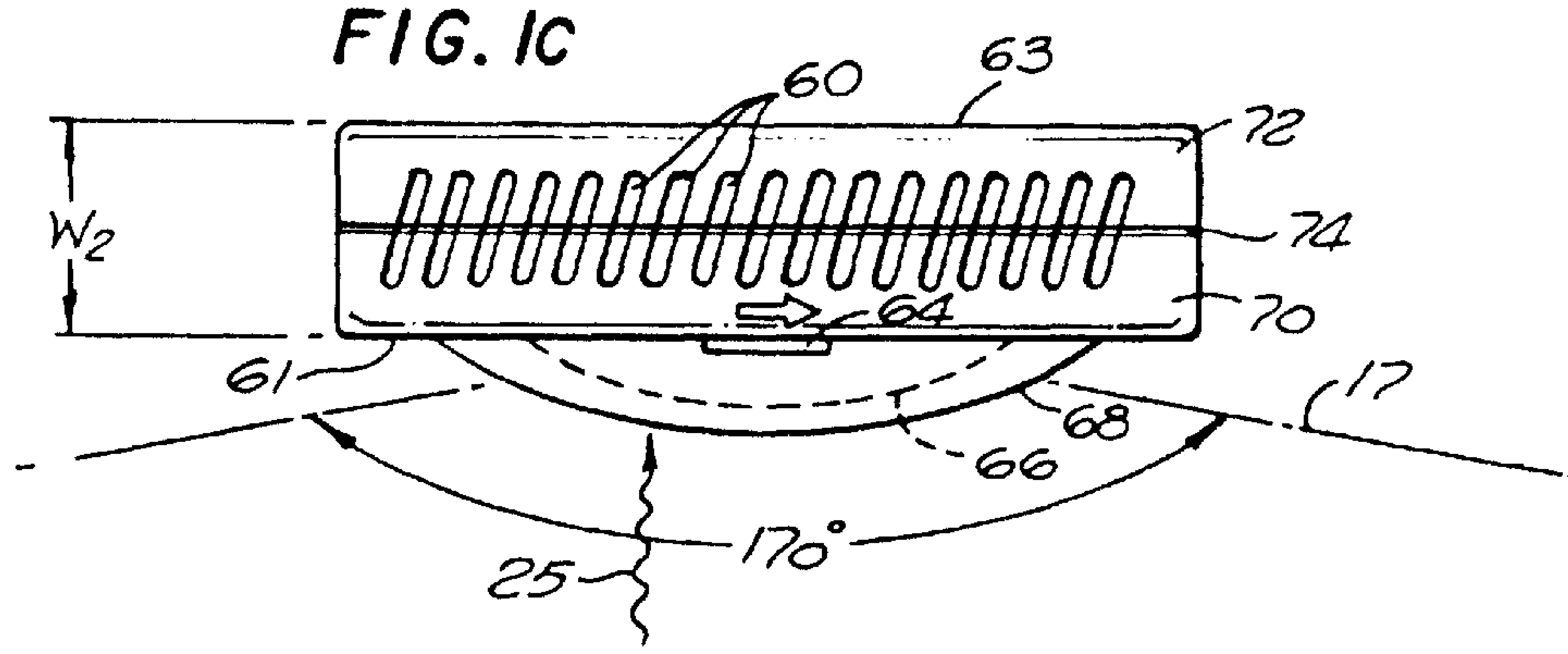


FIG. 1C



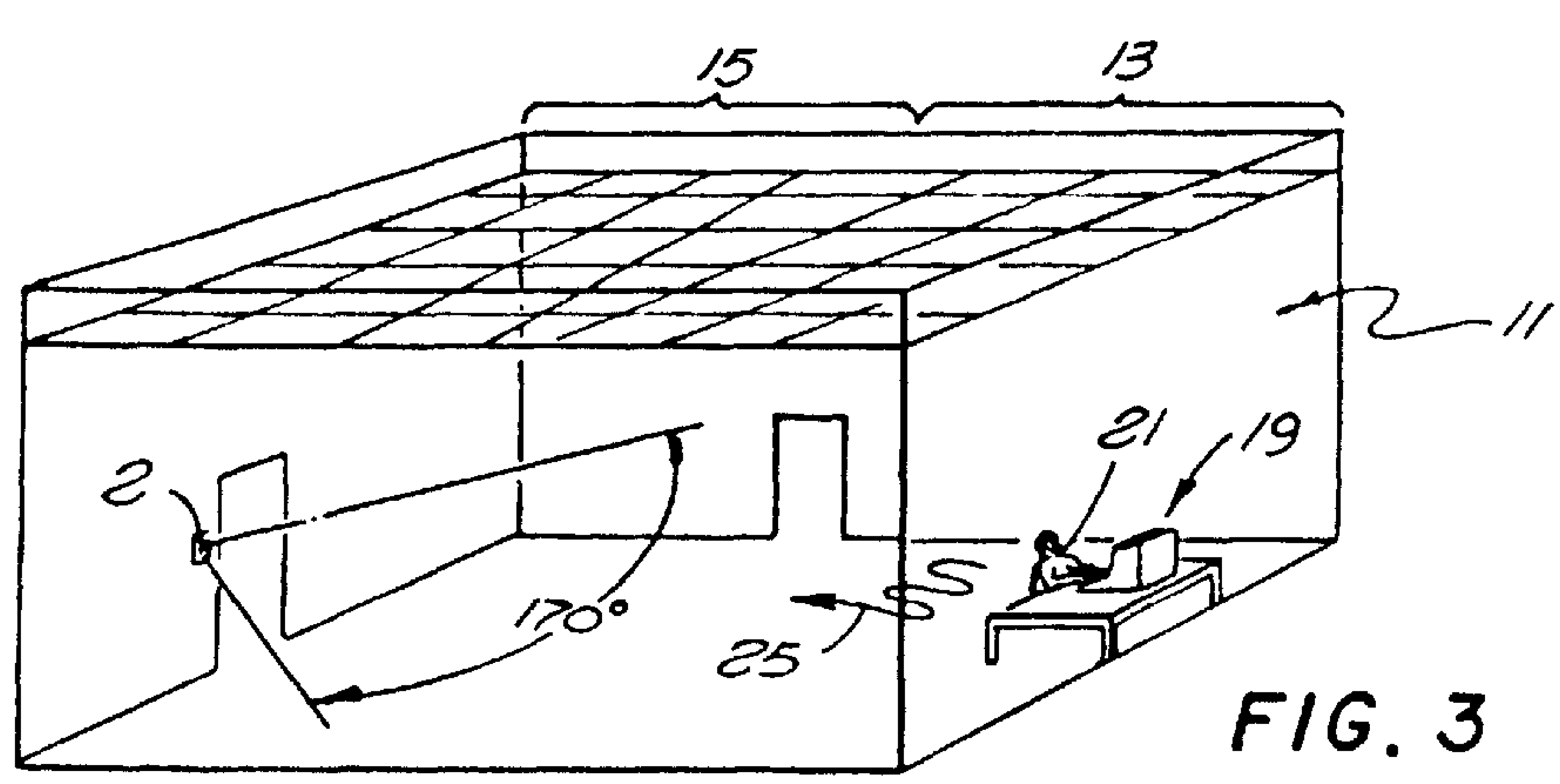


FIG. 3

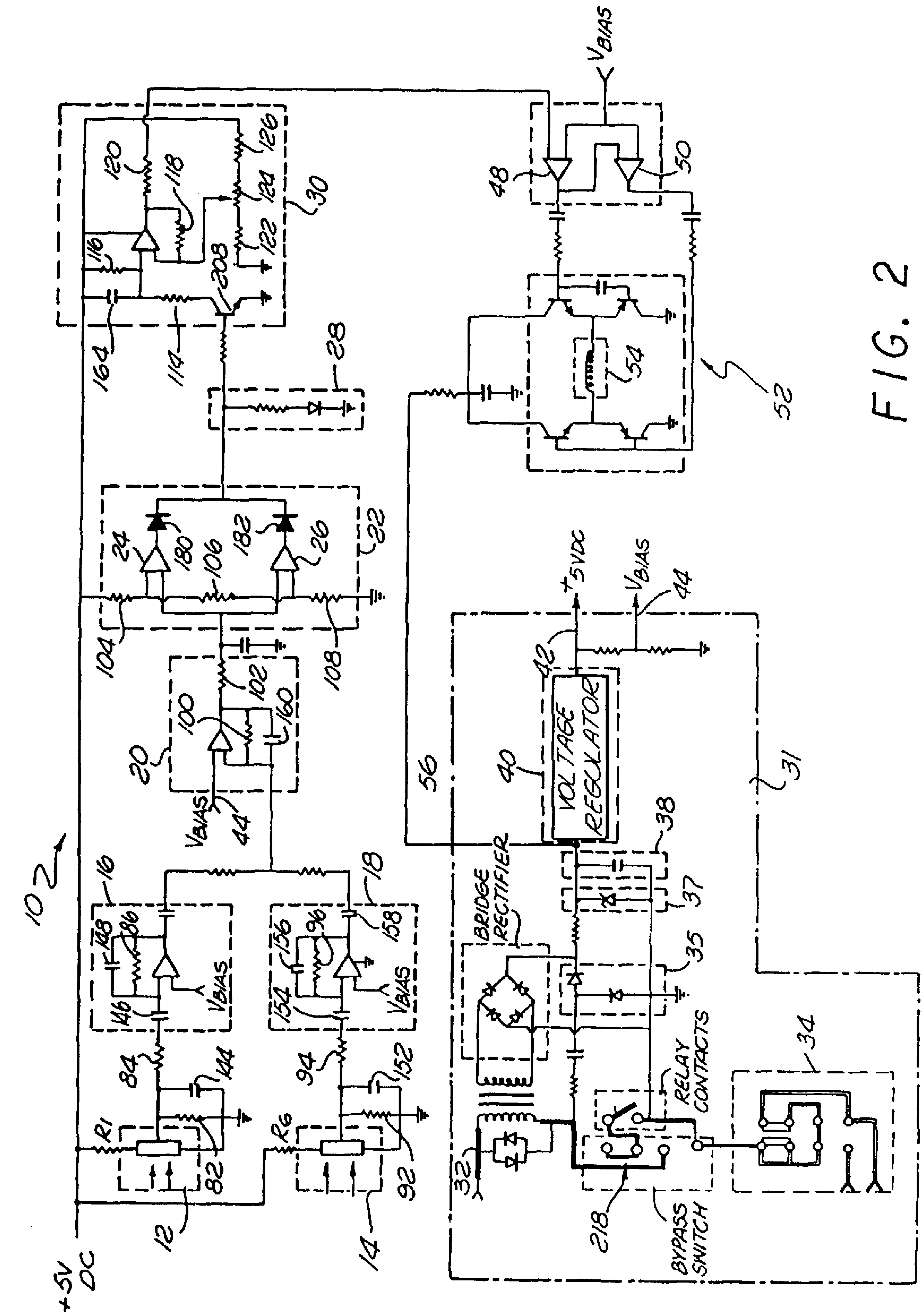

VBIAS
48
50
120
118
126
124
122
116
208
30
164
114
28
54
52
24
180
106
182
26
22
104
108
+5VDC
VBIAS
44
42
102
100
160
20
VBIAS
44
40
VOLTAGE
REGULATOR
56
31
10
16
18
38
37
35
BRIDGE
RECTIFIER
148
86
156
96
158
146
154
VBIAS
VBIAS
84
144
94
152
34
R1
R6
82
92
RELAY
CONTACTS
32
12
14
218
BYPASS
SWITCH
+5V
DC

FIG. 2

FIG. 4

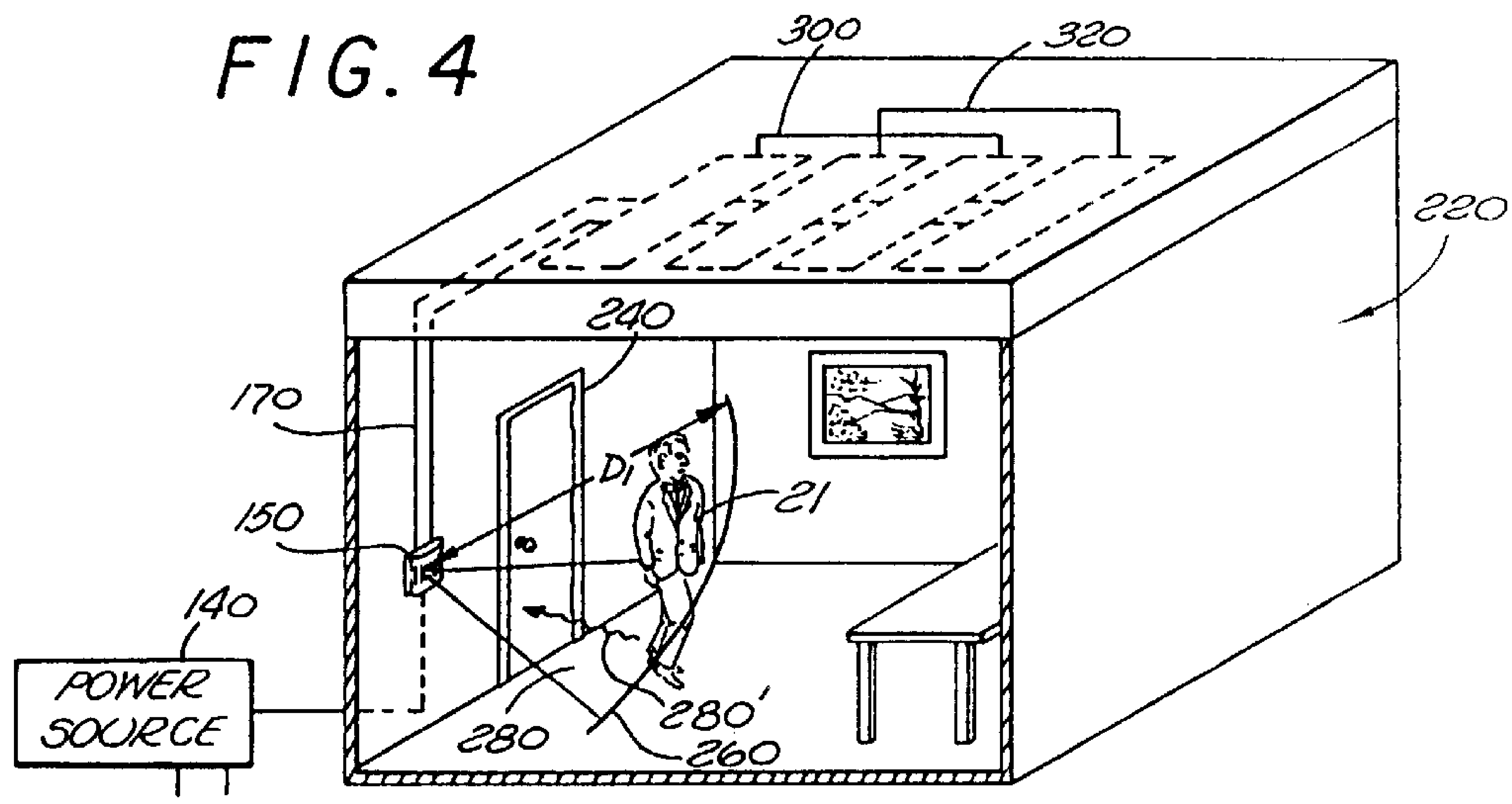
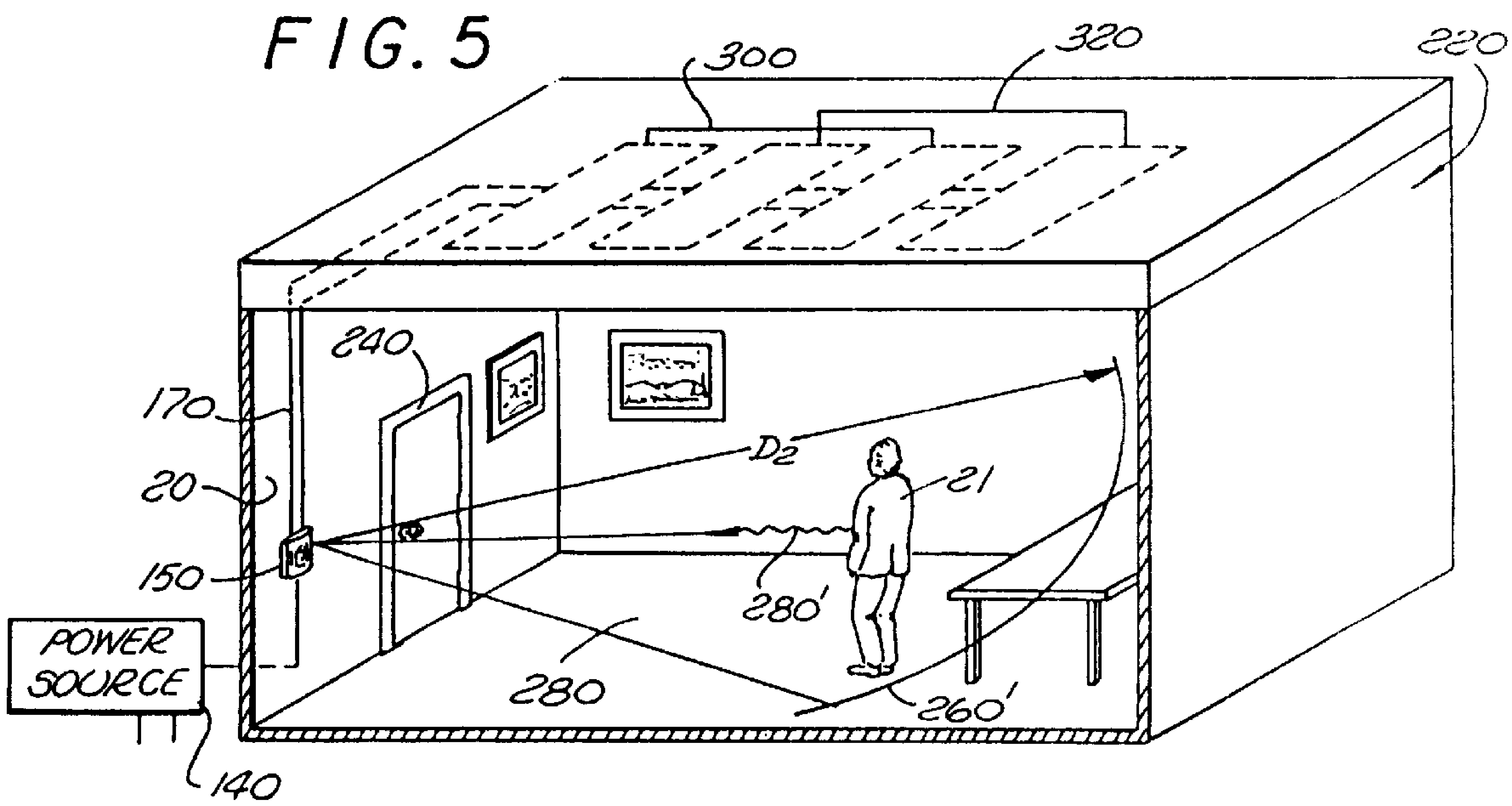

300
320
220
240
170
D1
21
150
140
POWER SOURCE
280'
280
260

FIG. 5


300
320
220
240
170
20
D2
21
150
POWER SOURCE
280'
280
260'
140

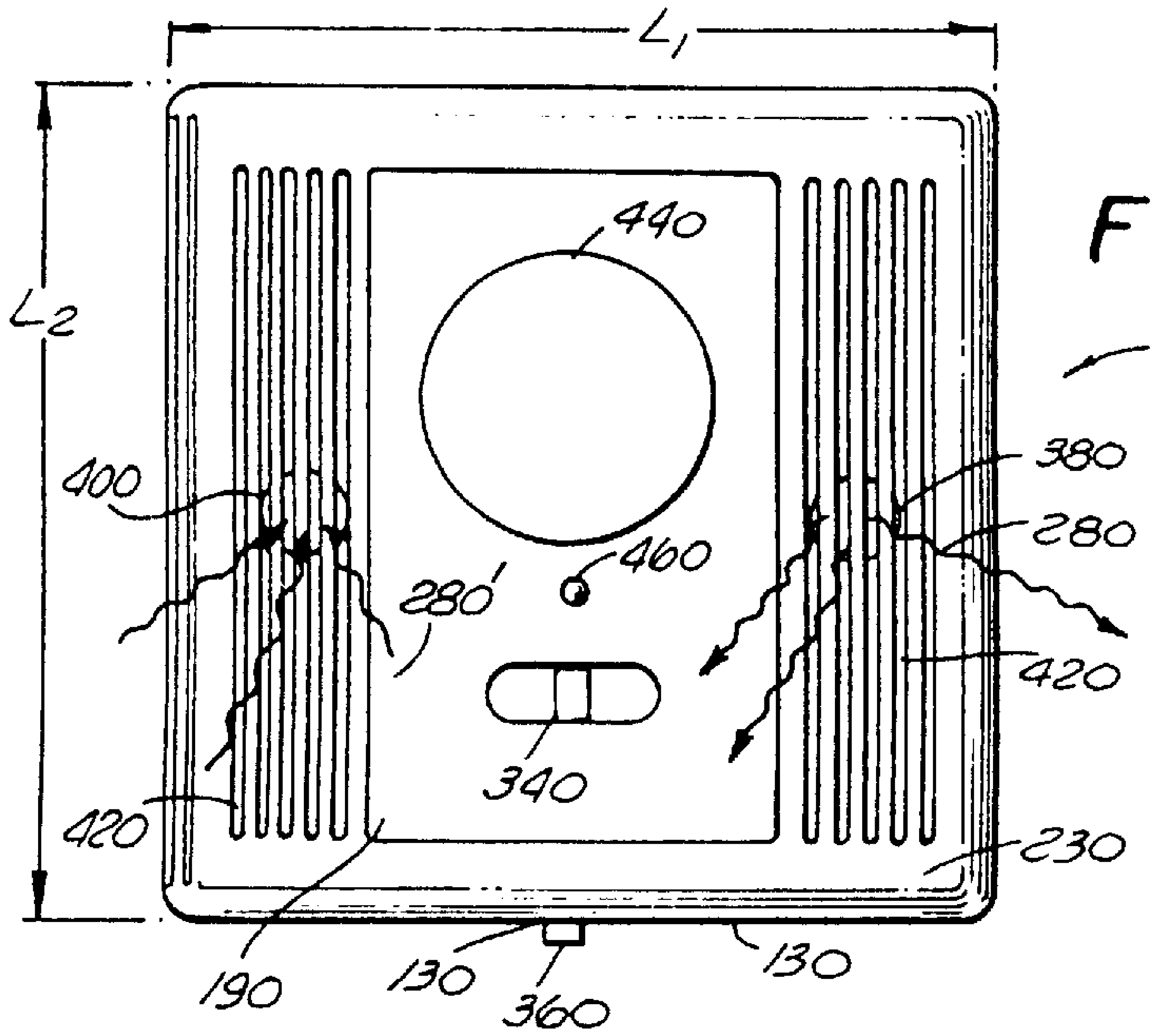


FIG. 6

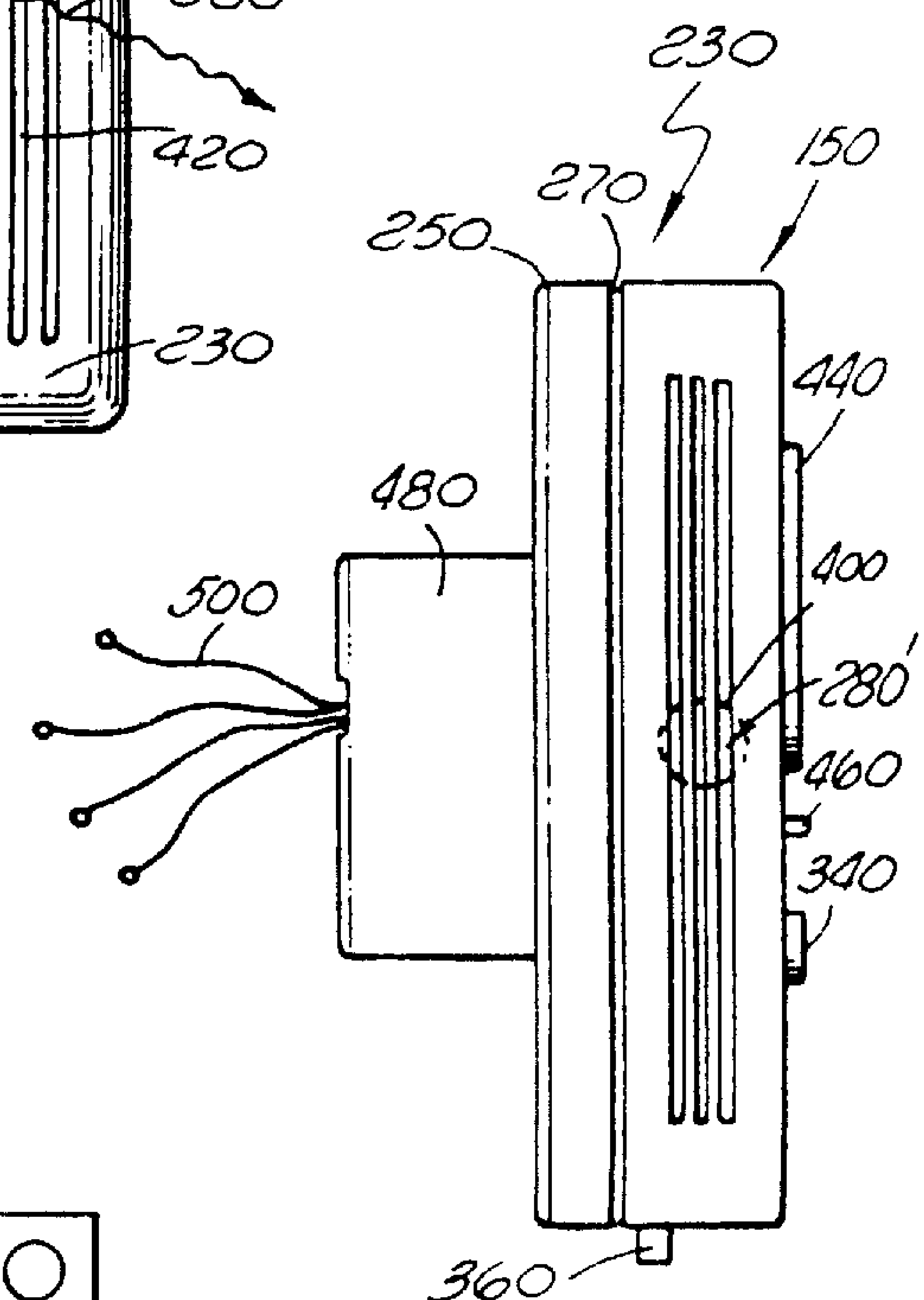


FIG. 7

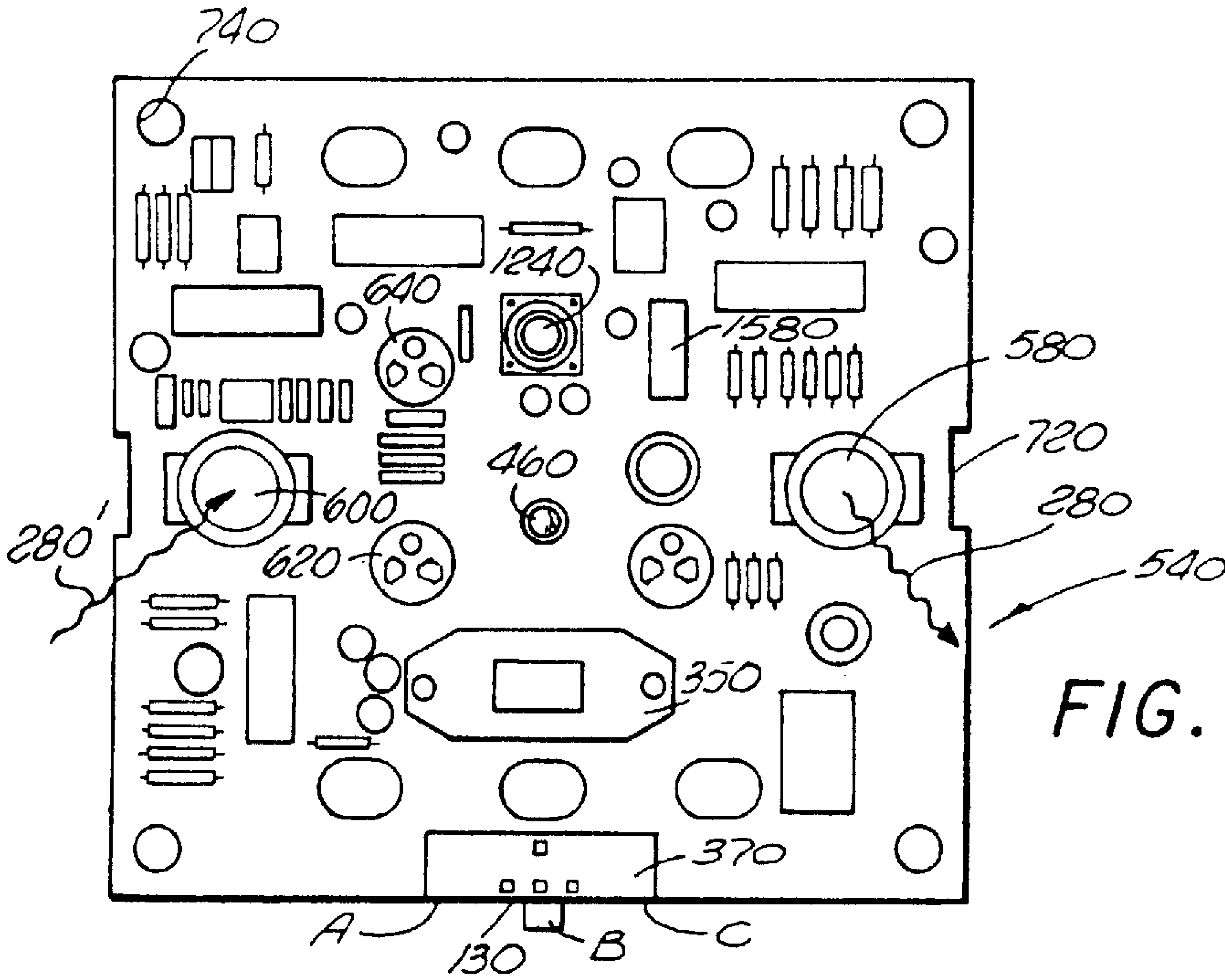


FIG. 8

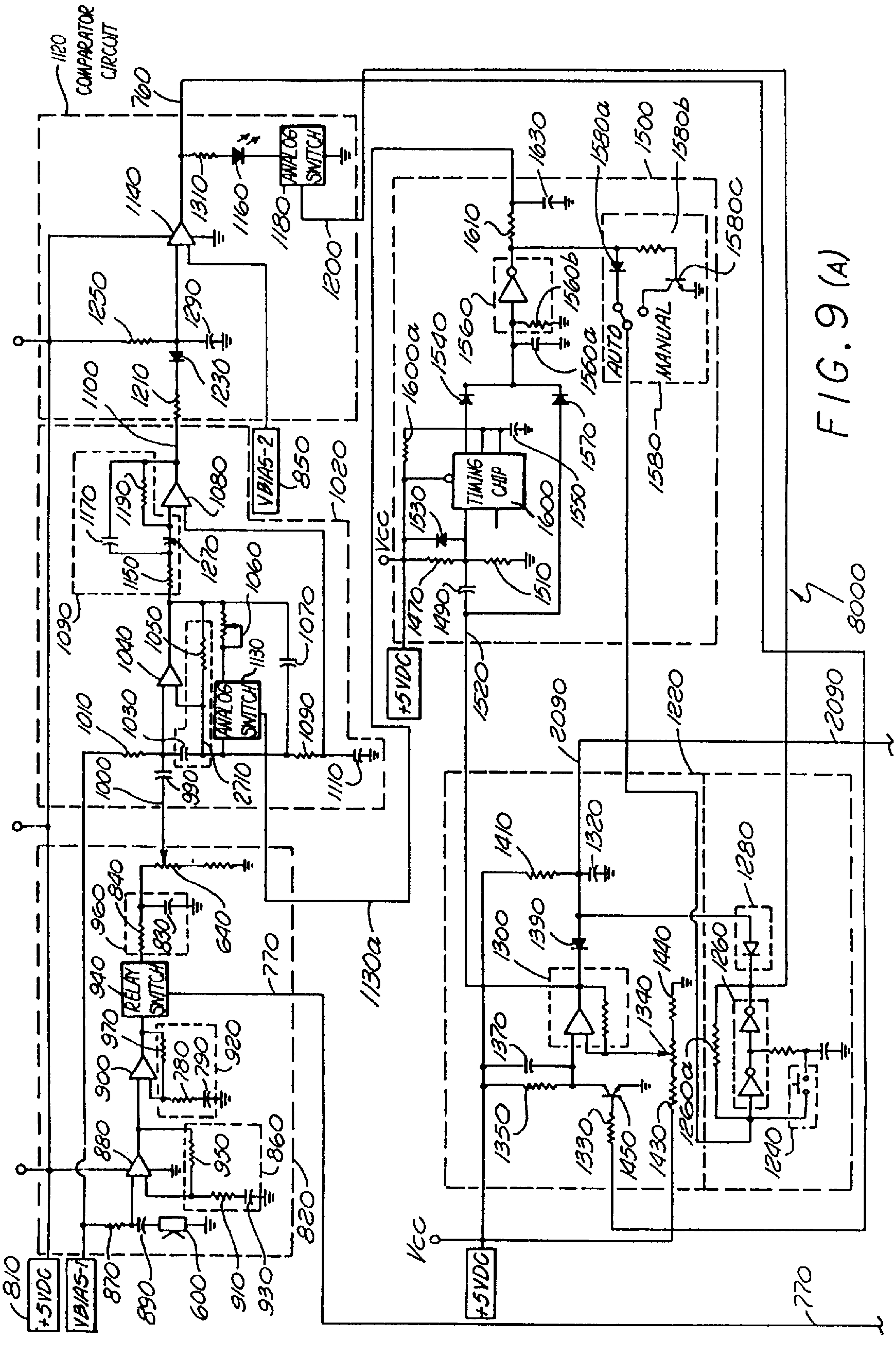
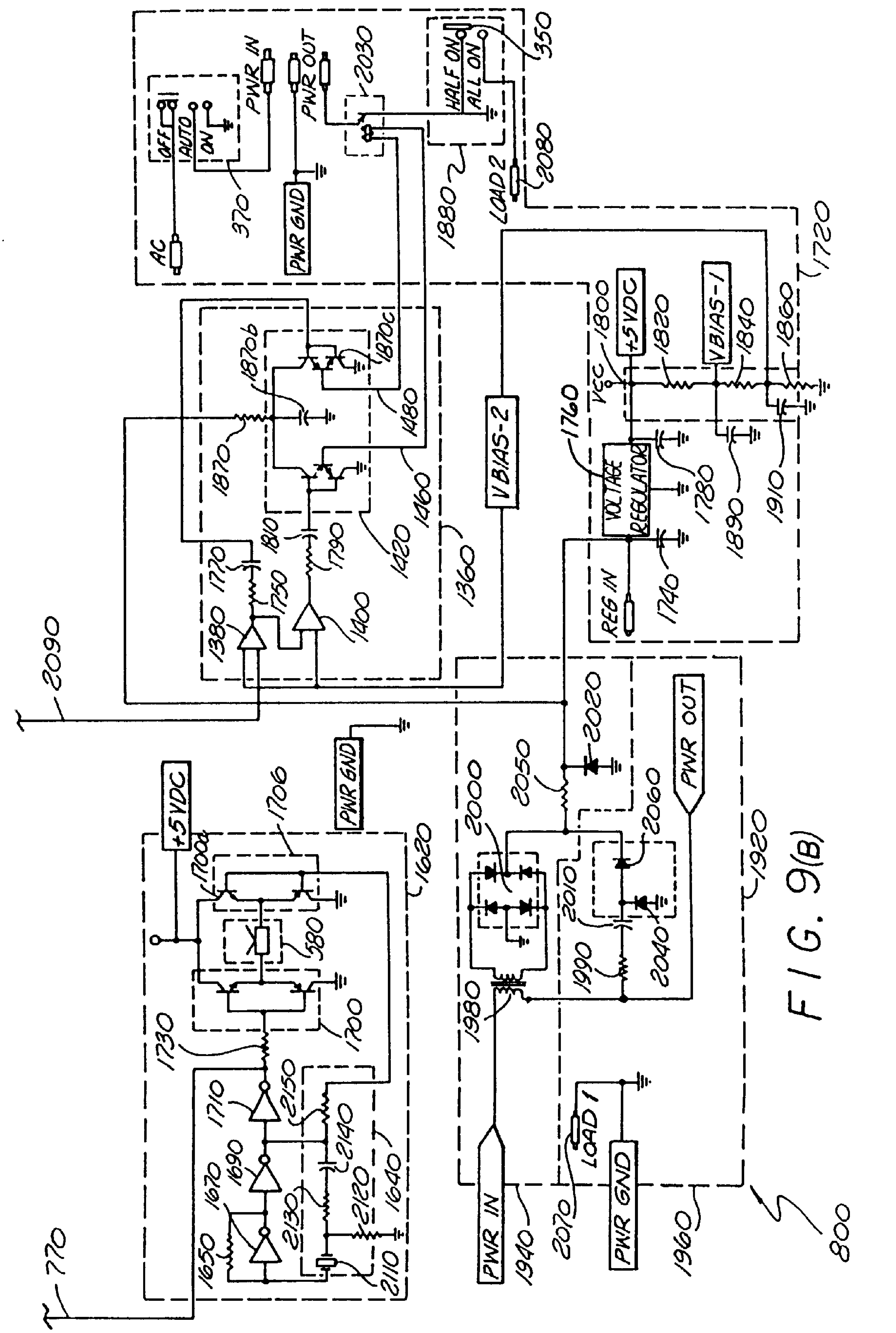

COMPARATOR CIRCUIT
ANALOG SWITCH
ANALOG SWITCH
RELAY SWITCH
VBIAS-2
VBIAS-1
+5VDC
+5VDC
+5VDC
Vcc
Vcc
TIMING CHIP
AUTO
MANUAL

FIG. 9(A)


AC
OFF
AUTO
ON
370
PWR IN
PWR OUT
PWR GND
2030
HALF ON
ALL ON
350
1880
LOAD 2
2080
1720
VCC
1800
+5VDC
1820
V BIAS-1
1840
1860
1760
VOLTAGE REGULATOR
1780
1890
1910
REG IN
1740
V BIAS-2
1870c
1870b
1480
1870
1460
1420
1810
1790
1770
1750
1380
1400
1360
2090
2020
2050
2000
2060
2010
2040
1990
1980
1920
LOAD 1
PWR IN
1940
2070
PWR GND
1960
800
+5VDC
PWR GND
1700a
1700b
1620
580
1730
1700
1710
2150
2140
1690
1670
1640
2130
2120
1650
2110
770

F I G. 9(B)

FULLY AUTOMATIC ENERGY EFFICIENT LIGHTING CONTROL AND METHOD OF MAKING SAME

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

REFERENCE TO CROSS RELATED APPLICATIONS

This application is a continuation-in-part of application Ser. No. 07/619,794 filed Nov. 29, 1990, now U.S. Pat. No. 5,142,199 and entitled "ENERGY EFFICIENT INFRARED LIGHT SWITCH AND METHOD OF MAKING SAME".

FIELD OF THE INVENTION

The present invention relates generally to lighting controls. More specifically, the present invention relates to a lighting control or light switch which is automatic and energy efficient and provides automatic control of at least one bank of lights within a room, for example by detecting doppler-shifted, ultrasonic waves reflected by persons entering into and moving within the room.

BACKGROUND OF THE INVENTION

Conservation of energy is a critical national and worldwide concern. Continuous lighting in empty rooms is an unnecessary waste of energy. Some state and local energy conservation/building codes require installation of two light switches in the construction or reconstruction of offices, each to control a different portion of the overhead lighting. The reasoning behind such requirements is that in the interest of energy conservation, employees and janitorial personnel may be offered the opportunity to use approximately one half of the light they would normally require in their day-to-day activities. Depending upon the amount of ambient light available, employees working in a room may select to use only one half of the available bank or banks of lights.

Further, employees may tailor their specific lighting needs to their activities and location in the room. For example, employees working in an area not receiving sufficient ambient light may require more artificial light, depending upon their specific activities. Similarly, employees located in an area receiving sufficient ambient light may require less artificial light. Utilizing office lighting effectively, such that only approximately fifty percent is sometimes used and only in occupied offices, results in substantial energy savings. In addition, for computer applications, it is advantageous to reduce the level of light to eliminate the glare on cathode ray tubes (CRT). Conventional manual switches are inefficient because they depend upon human judgment to turn all or only a portion of the lights on and off. Existing automatic wall switches have also proven to be inefficient. For example, currently available light switches or the like used in offices emit an ultrasonic wave into a room and detect motion of persons by sensing a doppler-shift in the reflected ultrasonic wave. The doppler-shift in the reflected wave is caused by persons moving within the room.

Typically, these ultrasonic light switches are preset to a sensitivity level such that a person moving anywhere within the room is detected. Because the preset sensitivity level for the reflected ultrasonic wave is fixed, a wall switch located adjacent an open door can detect persons moving outside the door and unnecessarily turn on the lights within the room.

Although a wall switch that turns lights on automatically is preferable in most instances, in some applications occupants prefer a manual option for activating lights. For example, in situations where a person enters the room for a very brief period of time, such as a secretary delivering papers, the lights do not need to be turned on. Another example is a situation in which there is adequate ambient light.

SUMMARY OF THE INVENTION

The present invention provides a light switch, preferably an ultrasonic light switch or the like for a lighting system which is automatic and energy efficient and alleviates the problems associated with prior light switches. The light switch comprises different settings which are preset by a user.

In one aspect of the invention, the light switch in an automatic mode is configured to automatically activate lights upon detecting motion of any type within a room. In accordance with this aspect, in an exemplary embodiment, the light switch is set to an initial sensitivity level so that only motion within a short range (also referred to as an initial detection range) from the light switch is detected. An ultrasonic transmitter transmits acoustic energy or an ultrasonic wave of predetermined frequency into the room and an ultrasonic receiver receives a doppler-shifted, ultrasonic reflected wave indicating motion within the room.

Once the light switch detects motion within the short range, it automatically adjusts to a higher sensitivity level so that it is able to detect motion anywhere within the room. After motion is no longer detected during a variable time delay, the light switch automatically turns the lights off and initiates a predetermined grace period during which the light switch maintains the higher sensitivity level and continues to detect motion anywhere within the room. If no motion is detected during the predetermined grace period, the light switch returns to its initial sensitivity, thereby reducing the detection range in order to detect only persons entering the room.

In the event the lights are turned off inadvertently, such as if a person remains motionless during the entire variable time delay period, the predetermined grace period advantageously allows an occupant to wave an arm or otherwise make simple motions anywhere within the room to turn the lights back on.

In another aspect of the invention, the lighting can be turned off manually while the light switch is in its automatic mode, in which case it remains at its high sensitivity level while there are occupants in the room. After no motion is detected during the variable time delay and the predetermined grace period, the automatic light switch resets to its "automatic on" state and returns to its initial sensitivity level.

In yet another aspect of the invention, in a manual mode, the light switch is activated manually. In its manual mode, the light switch is configured to keep the lights off until someone activates the light switch. The lights will automatically turn off upon not sensing motion during the entire variable time delay period. If the occupant makes a motion within the predetermined grace period, the lights will automatically turn back on. If no motion is sensed during the predetermined grace period, the wall switch must be manually reactivated.

In still another aspect of the invention, the light switch comprises a load control switch that causes the light switch to activate at least one bank of lights within a room. The light switch operates at various voltages including, but not limited to 120 and 277 volts.

In yet another aspect of the invention, the light switch comprises a three position bypass switch which is used in the rare event of product failure. The bypass switch has an "off" setting for deactivating the light switch and the lights, an "automatic" setting for normal use in which the lights are controlled by the light switch, and an "on" position for electrically bypassing the light switch and leaving the lights on.

BRIEF DESCRIPTION OF THE DRAWINGS

A complete understanding of the present invention and the above and other features of the invention may be gained from a consideration of the following description of the preferred embodiments taken in conjunction with the accompanying drawings in which like reference numerals indicate like parts, and in which:

FIG. **1**A is a front plan view of the exterior of an energy efficient infrared light switch in accordance with one embodiment;

FIG. **1**B is a side plan view of the energy efficient infrared light switch;

FIG. **1**C is a top plan view of the exterior of the energy efficient infrared light switch;

FIG. **2** is a schematic representation of the electric circuit for the energy efficient infrared light switch;

FIG. **3** is a schematic representation of the energy efficient infrared light system incorporating the switch detecting a computer operator in a room and activating at least one bank of available lights.

FIG. **4** is a schematic representation of an automatic and energy efficient lighting system or control in accordance with another embodiment of the present invention, showing a light switch, preset to an initial sensitivity level for detecting a person entering a room and activating all or a portion only of at least one bank of available lights;

FIG. **5** is a schematic representation of the automatic and energy efficient light system shown in FIG. **4**, illustrating the light switch preset to a higher sensitivity level for detecting a person moving anywhere within the room;

FIG. **6** is a front plan view of an exterior housing or front case of the light switch shown in FIG. **4**;

FIG. **7** is a side plan view of the exterior housing of the light switch shown in FIG. **6**;

FIG. **8** is a front plan view of a circuit board of the light switch of the present invention;

FIG. **9**A is a schematic representation of a portion of an electric circuit for the light switch of the present invention; and

FIG. **9**B is a schematic representation of the remaining portion of the electric circuit for the light switch of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

An energy efficient light switch, such as an infrared light switch in accordance with one embodiment, replaces an existing standard wall switch and consists of at least two infrared detectors which can provide the device with a sweep of 170° to 180° within a bounded area. The infrared light switch is preset by the user to selectively activate all, none or a portion of the lights activated by the switch using the three-position switch. Through the use of two passive infrared detectors, the energy received by those detectors is converted to signals which are then separately amplified, mixed and then jointly amplified. The mixed and amplified signal is sent to a window comparator which compares the amplified and mixed signals to two predetermined known voltage signals. If the received, amplified and mixed signal is greater than the high setpoint of the window comparator, or lower than the low setpoint of the window comparator, a signal indicator is initiated indicating motion detection. The dual power supply in conjunction with a push-pull circuit and latching relay, then selectively actuates all, none or a portion of the lamps available within the bounded area.

FIG. **1**A is a front plan view of the exterior case **5** of the energy efficient infrared light switch **2**. The exterior case **5** has a light emitting diode (LED) **62** as a signal detection indicator. A three-position switch **64**, located upon the front of the exterior case **5**, facilitates the individual setting of the light efficient switch **2** to selectively activate all, none or a portion of the lights. The infrared detectors **66**, **66**' can be seen beneath the surface of the casing **5** within a protective cover. A stylus groove **68** provides ornamental decoration, but more importantly, also facilitates the receipt of infrared energy from the bounded area under detection. The front surface **61** of the energy efficient infrared light switch **2** has a height indicated at L2 and a width indicated at L1. In one exemplary configuration the front surface **61** is square in configuration and L1 and L2 are 4.25 inches each.

FIG. **1**B is a side plan view of the exterior of the energy efficient infrared light switch **2**, where its front surface **61** is exposed to a room and its back surface **63** is fixably mounted to a wall or corner. An interfitting seal **74** joins the front faceplate portion **70** of the switch and its rear cover portion **72**. The stylus groove **68** can be seen inscribed upon the surface of the faceplate portion **70** where the three-position switch **64** is located above the light emitting diode **62**. As shown in FIG. **1**B, infrared energy **25** strikes the surface of the infrared detector **66**. The energy efficient infrared light switch **2** is shown in this example as being mounted to the surface of a wall interior to the bounded area.

As can be seen clearly in FIG. **1**C, the faceplate **70** is interconnected with an interfitting seal **74** to a portion of the rear cover **72**. The front surface **61** of the faceplate **70** faces the interior of a bounded area or room. The back surface **63** attaches or mounts to a wall or a corner within that bounded area. The field of view **17** or sweep range, in the illustrated embodiment using two detectors, is between 170° to 180°. Infrared energy is indicated at **25** as striking the detector **66**. As shown above the stylus groove **68**, this three position switch **64** is operable to allow the detector switch **2** to be set to activate all, none or one half of the lights.

Referring now to FIG. **2** the circuit **10** comprises a first infrared detector **12** and a second infrared detector **14** which are operable to provide a combined sweep range of 170° to 180°. This sweep range is sufficiently wide to facilitate detection within a bounded area. The front end or first amplifier **16** for the first detector **12** includes an operational amplifier which converts and amplifies the infrared energy **25** received by the first infrared detector **12**. The front end or first amplifier **18** for the second infrared detector **14** is also an operational amplifier and receives radiated infrared converted energy detected by the second infrared detector **14**. Resistors R1 and R6 both having a resistance value of 100 kΩ, are connected in series, respectively, with the first and second infrared detectors **12** and **14**. The first and second detectors **12** and **14**, respectively, are not active since they do not emit infrared energy which is then redetected upon its return to the system. Rather the detectors passively await the receipt of infrared energy **25** emitted from within the bounded area. The signals received by the passive detectors **12** and **14** are filtered through a resistant capacitance filter having a resistor **82** with a resistance value of 220 kΩ, a capacitor **144** having a capacitance value of, 0.022 μF and a third resistor **84** having a resistance value of 10 kΩ.

As shown in FIG. **2**, the second infrared detector **14** also includes a second filtering system wherein a resistor **92** having a resistance value of 220 kΩ, a capacitor **152** having a capacitance value of 0.022 μF and a second resistor **94** having a resistance value of 10 kΩ, also serve to filter the received signal.

As shown in FIG. **2**, the front end amplifier **16** for the first infrared detector **12** contains an operational amplifier and two capacitors **146** having a capacitance value of 10 μF, a capacitor **148** having a capacitance value of 0.01 μF and a resistor **86** having a resistance value of 2.7 MΩ. A parallel system, a front end amplifier **18** for the second infrared detector **14**, also contains capacitors **154** having a capacitance value of 10 μF, a capacitor **156** having a capacitance value of 0.01 μF, a resistor **96** having a resistance value of 2.7 MΩ, and a third capacitor **158** having a capacitance value of 10 μF. Operational amplifiers in both front end amplifiers **16** and **18** receive a bias voltage **44** from the dual power system **31**.

In FIG. **2**, the signals that have been filtered and amplified individually, from the first and second infrared detectors **12** and **14**, are combined prior to entering the second amplification stage **20**. The signal enters a second operational amplifier and a resistive capacitance circuit, having a resistor **100** with a resistance value of 2.2 MΩ, a capacitor **160** having a capacitance value of 0.01 μF, and a second resistor **102** having a resistance value of 2.2 kΩ. Again, the operational amplifier of the second amplification stage **20** is driven by a voltage bias **44** which is received from the dual power supply **31**.

The twice-amplified, mixed, combined and received signal from the first and second infrared detectors **12** and **14**, respectively, finally enters a window comparator **22**, containing first and second comparator circuits **24** and **26**, respectively, which includes operational amplifiers and resistors **104**, **106** and **108**, which have resistance values of 22 kΩ, 10 kΩ and 15 kΩ, respectively. The comparator circuit also includes two diodes, **180** and **182** which are both 1N4148 diodes. The double amplified signal is compared in a comparator circuit **22** to the setpoint voltages established by the voltage divider network of resistors **104**, **106** and **108**. If the received, amplified signal is either greater than the high setpoint or lower than the low setpoint of the window comparator circuit **22**, the indicator detector, such as a light emitting diode (LED) **28**, is actuated to the "on" position demonstrating that infrared energy has been detected. The output signal from the comparator **22** after it illuminates the LED **28** when motion is detected, enters into a timing circuit **30** which includes a transistor **208**, a resistor **114** which has a resistance value of 100 Ω, a capacitor **164** which has a capacitance value of 100 μF, a resistor **116** which has a resistance value of 6.8 MΩ, a resistor **120** which has a resistance value of 100 Ω, a resistor **118** which has a resistance value of 100 kΩ, and three resistors, **122**, **124** and **126**, having respective resistance values of 620 Ω, 10 kΩ and 3.9 kΩ. The timing circuit **30** provides a time delay for the detection of infrared energy variable between 30 seconds and 15 minutes, once the variable resistor **124** is set.

As shown in FIG. **2**, the electrical circuit for the energy efficient switch includes a dual power supply circuit **31** which is activated by placing slide switch **218** into the center or automatic position. The power supply functions differently with the lights on than with the lights off. With the lights on, power is converted with the current transformer and full wave rectified with the bridge rectifier. When the lights are off, power is converted via a resistor and capacitor and then half wave rectified in the circuit **35**. The voltage is then preregulated in the circuit **37** and filtered with capacitor **38**. The voltage is then regulated with voltage regulator **40** which provides the circuitry with a maintained 5 VDC source and the bias voltage used by circuits **16**, **18** and **20** and operational amplifiers **48** and **50**.

Load control switch **34**, which is a double pole, three position slide switch, is provided so that all, none or a portion of the lights are activated upon infrared energy detection. As shown in FIG. **2**, power line **56**, which contains the DC voltage signal after it has been rectified, preregulated, and filtered, leaves the dual power supply circuit and enables the latching relay control circuit **52** to activate the control of the lights.

Operational amplifiers **48**, **50** function as comparators driven from the timing circuit **30**, to provide a pulse to the latching relay through the latching relay control circuit **50**. Once the time delay period is over, the operational amplifiers **48** and **50** will change to the opposite state and cycle the relay contacts open, thereby turning the lights off.

FIG. **3** is a schematic representation of an energy efficient light system detecting a person operating a computer in a bounded area or room containing two banks of lights. A standard room **11** has first and second banks of lights **13** and **15**. In actual use, the lights are wired so that one half or approximately one half of the lights in each fixture are connected to each circuit and can be controlled independently. The switch **2** replaces the conventional single or dual toggle switch generally mounted into the wall proximate the door. A computer work station **19** is positioned within the field of view. The person **21** seated at the computer console emits infrared energy **25**, which is detected within the sweep view of the detector **2**. Upon infrared energy detection, the switch **2** either turns on the first bank of lights **13** or the second bank of lights **15** dependent upon the detection of the individual and the setting of the switch **2** to activate all, none or one half of the available lights. In the exemplary embodiment, the two detectors of the switch **2** provide a field of view of approximately 170°.

FIGS. **4** through **9B** illustrate another embodiment of the present invention. FIGS. **4** and **5** illustrate generally a fully automatic and energy efficient lighting system comprising a light switch **150**, for example ultrasonic or the like, in accordance with another embodiment of the present invention, mounted adjacent a door **240**, of a room **220** or other such confined area. The embodiments illustrated herein merely exemplify the invention which may take forms different from the specific embodiments disclosed. The light switch **150** of the present invention replaces a standard wall mounted single or dual toggle switch.

In an automatic mode, the light switch **150** is preset by a user to an initial sensitivity level, at which it detects motion only within an initial limited range, indicated by curve **260**, and distance from the door **240**, indicated by D_1. The initial limited range **260** is sufficient to detect a person **21** entering the room **220**, but not spurious movement outside the room **220**, and to turn on at least one bank of available lights. For illustration purposes, only two alternating banks of lights, **300**, **320** are shown. Each light bank consists of all lamps, which are connected to a single lighting power circuit. The lights **300, 320** may be of any type, for example fluorescent or incandescent.

When the light switch **150** detects a person **21** entering into the initial limited range **260**, the light switch **150** is configured to automatically adjust to a higher sensitivity level, at which the light switch **150** detects motion within an expanded or extended range, beyond the initial limited range **260**, indicated at **260'**. The expanded range **260'** preferably covers the entire room **220**. This higher sensitivity level can be varied as desired and is preset by a user when the light switch **150** is installed. The light switch **150** keeps the lights **300, 320** on for as long as it senses motion within the room **220**. When motion is no longer detected, such as when a person **21** leaves the room **220**, the lights **300, 320** are automatically turned off after a variable time delay anywhere less than 60 minutes which can be varied and preset by a user. In the illustrated embodiment, the time delay is variable anywhere from 30 seconds to 15 minutes.

After the lights **300, 320** have been turned off, there is a predetermined grace period anywhere less than 12 seconds, preferably 5 seconds, during which the light switch **150** continues to detect motion within the expanded range. This is an advantageous safety feature in instances where the lights **300, 320** turn off inadvertently because the person was not moving sufficiently to be detected during the variable time delay. During the predetermined grace period, a person can wave an arm or otherwise cause motion to be detected, anywhere within the room **220** to reactivate the lights **300, 320**. After the predetermined grace period, the light switch **150** resets to its initial low sensitivity level. The light switch **150** can be turned off manually in its automatic mode, in which case it automatically resets to its initial low sensitivity level following the variable time delay and the predetermined grace period if no motion is sensed during that time.

In an alternative manual mode, the light switch **150** can also be operated manually to turn the lights **300, 320** on and off. In its manual mode, when no motion is sensed, the light switch turns off the lights **300, 320** automatically and is configured to reactivate the lights automatically within the predetermined grace period only upon sensing motion. This is a safety feature because it saves a person from walking to and groping in the dark for the light switch **150** to reactivate the lights **300, 320** manually.

Referring now to FIG. **4**, in the automatic mode the light switch **150**, preset to the limited detection range **260**, detects an individual entering the room **220** and activates at least one bank of lights from the two available banks **300, 320**, depending upon which one is connected thereto. The light switch **150** is connected between a power source **140** and the banks of lights **300, 320** by electrical lines **170**. The light switch **150** emits ultrasonic acoustic energy **28** into the room **220** at a predetermined frequency, preferably 25,000 Hz (Hertz). At the initial sensitivity level it only receives doppler-shifted reflected waves **280'** when a person **21** is within the initial detection range **260** or distance D_1 from the door **240**, preferably between one and five feet.

Referring now to FIG. **5**, the light switch **150** is configured to automatically adjust its sensitivity level, once a person **21** moving within the limited detection range **260** is detected and all or a portion only of the lights **300, 320** are turned on. This second sensitivity level allows the light switch **150** to detect motion within an extended detection range, indicated by curve **260'**, at locations within the room **220** which are remote from the light switch **150** and beyond the initial detection range **260** in order to keep the lights **300, 320** on. At the higher sensitivity level, the light switch **150** receives doppler-shifted reflected ultrasonic waves **280'** when a person **21** is within the expanded detection range **260'** or within a distance D_2 from the door **240**. In an exemplary embodiment, distance D_2 is preferably between five and twenty-five feet. Depending upon the size of the room **220**, the higher sensitivity level can be varied to detect persons at any distance. The detected motion may be as little as motion caused by a person writing or turning his or her head.

The light switch **150** is preset to keep the lights **300, 320** on as long as a doppler-shift is detected in the reflected ultrasonic waves **280'**. The lights **300, 320** turn off when a person **21** leaves the room **220** and no more motion is detected during the variable time delay, preferably anywhere from 30 seconds to 15 minutes. The variable time delay is preset when the ultrasonic switch **150** is installed and may be varied by a user as desired. After the lights **300, 320** have been turned off, the light switch **150** continues to detect motion within the expanded range during the predetermined grace period. This is an advantageous safety feature in instances where the lights **300, 320** are turned off inadvertently because the person within the room **220** is not moving sufficiently to be detected during the variable time delay. During the predetermined grace period, a person can wave an arm or otherwise cause motion to be detected, anywhere within the room **220** to reactivate the lights **300, 320**. After the predetermined grace period, the light switch **150** resets to its initial low sensitivity level.

Referring now to FIG. **6**, a touch sensitive control cover **440** can be manually operated by users to turn the lights **300, 320** (shown in FIGS. **1** and **2**) on or off, when illumination is not desired or necessary. The touch sensitive control cover **440**, disposed on an exterior housing or front case **230** of the light switch **150**, is fabricated preferably from a medium impact plastic.

In the event the lights **300, 320**, are intentionally or manually turned off, while the light switch is in its automatic mode, for example, if a user wants to darken the room to view slides or for any other reason, the light switch remains at its higher sensitivity level in order to detect motion anywhere within the room while occupants are present. The light switch resets to "automatic on" returning to its initial sensitivity level after no motion is detected during the variable time delay and predetermined grace period.

In an alternative manual mode, the light switch **150** can also be operated manually to turn the lights **300, 320** on and off. In its manual mode, when no motion is sensed, the light switch turns off the lights automatically and is configured to reactivate the lights automatically within the predetermined grace period only. This is a safety feature because it saves a person from having to walk to the light switch **150** in the dark to reactivate the lights **300, 320**. After the predetermined grace period has lapsed which begins when the lights **300, 320** have been turned off, the light switch **150** resets to its initial low sensitivity level.

The light switch **150** has three settings which can be preselected by a user. First, a push button touch sensitive switch **1240** (shown in FIG. 9A) disposed under the control cover **440** can be manually operated. The lights **300, 320** are turned on and off by depressing the control cover **440** to contact the touch sensitive switch **1240**. Second, a dual position, load control switch **350** (shown in FIG. **8**) is mounted under a load control switch cover **340**. The load control switch **350** is displaced between a left position and a right position, by a user, to preselect whether all or only a portion of the lights **300, 320** connected to the light switch

150 are activated. Third, an automatic or manual two position mode switch **1580** sets the light switch **150** in its "automatic" or "manual" mode.

Referring also to FIG. **8**, a three position bypass switch **370** is located on a circuit board **540** housed within the exterior housing **230**. An actuator **360** of the bypass switch **370** protrudes beyond a peripheral edge **130** to facilitate manual positioning. A user can move the actuator **360** to an extreme left position, indicated at A, to turn off or deactivate the ultrasonic switch **150**, a center position, indicated at B, to set the switch **150** in its automatic mode, or an extreme right position, indicated at C, to bypass the ultrasonic switch **150** and turn on the lights in case of failure or for any other reason such as those discussed above.

As shown in FIG. **6**, the exterior housing **230**, upon its front face **190**, has a motion detection indicator **460**, preferably a LED (light emitting diode), which lights up upon detecting motion. The motion detector indicator **460** is located on the exterior housing **230** between the touch sensitive control cover **440** and the two position load control switch **340**. The exterior housing **230** includes at least one transmitter vent **380**, preferably a plurality as shown in FIG. **6**, through which ultrasonic waves **280** are emitted into the room **220**. The exterior housing **230** has at least one receiver vent **400**, preferably a plurality, through which the light switch **150** receives doppler-shifted reflected waves **280'** from the room **220**.

A stylus groove **420** over both transmitter and receiver vents **380**, **400**, respectively, provides ornamental decoration to the exterior housing **230** but, more importantly, allows the ultrasonic waves **280** to be emitted and received within the room **220**. The stylus grooves **420** are inscribed upon the front surface **190** of the exterior housing **230**, adjacent touch sensitive switch control cover **440**. The exterior housing **230** of the light switch **150** has a suitable length, indicated at L_1 and a suitable width, indicated at L_2. In an exemplary embodiment, the exterior housing **230** has a square configuration wherein L_1 and L_2 have equal dimensions, preferably approximately 4.25 inches.

Referring now to FIG. **7**, the front surface **190** of the exterior housing **230** faces the room **220** and a back surface **250** is mounted to a wall. An interfitting seal **270** joins the front surface **190** and the back surface **250** of the exterior housing **230**. A cavity **480** accommodates a power supply board (not shown) and extends from the back surface **250** of exterior housing **230**. Power input supply wires **500** enter the cavity **480** and electrically connect the light switch **150** to the power supply **140** (shown in FIGS. **4** and **5**) and the lights **300**, **320**. The light switch **150** in the illustrated embodiment is operated at a supply voltage of preferably 120 volts or 277 volts.

Referring again to FIG. **8**, an ultrasonic transmitter **580** and an ultrasonic receiver **600** are positioned upon opposing sides of the circuit board **540**. The ultrasonic transmitter **580** emits ultrasonic waves **280**, preferably at a frequency of 25,000 Hz, through the transmitter vent **380** (shown in FIG. **6**) into the room **220**. The ultrasonic receiver **600** receives reflected waves **280'** from the room **220**. Movement is detected by detecting a doppler-shift in the reflected ultrasonic waves **280'** caused by persons moving within the room **220**. The initial sensitivity level **260** of the light switch **150** is preset by an entry sensitivity control **620** so that the light switch **150** initially detects movement only within a limited detection range **260**. As described above, the limited detection range **260** is between one to five feet so that the light switch **150** advantageously detects a person entering the room **220** without causing the light switch **150** to activate unnecessarily as a result of spurious motion occurring beyond that range.

An area sensitivity control **640** sets the higher detection sensitivity level and is preset to cause the light switch **150** to detect motion within the expanded detection range **260'** at a distance of preferably five feet and beyond within the room **220**. Area sensitivity control **640** enables the light switch **150** to detect motion within the room after a person **21** has traversed beyond the initial detection range **260**. Motion detection indicator **460** lights up when the lights **300**, **320** are turned on, indicating that motion is detected.

In operation, the three position bypass switch **370** can be preset by a user in three distinct positions: "bypass off" position A, "bypass automatic" position B and "bypass on" position C, to determine if and how the lighting within the room **220** is activated. When the bypass switch **370** is in the "bypass off" position A, the light switch **150** does not turn on the lights **300**, **320** automatically. When the bypass switch **370** is in the "automatic" position B, the lights **300**, **320** connected to the switch **150** turn on automatically upon detecting motion within the initial detection range and turn off automatically upon sensing no motion during the variable time delay. When the switch **150** is in the "bypass on" position, the lights are turned on regardless of whether or not motion is detected.

The touch sensitive switch control cover **440** can be activated by a touch to turn the connected banks of lights **300**, **320** on or off. The load control switch **350** which is a two position switch, can be preset by a user to manually or automatically activate, all or a portion of the banks of lights **300**, **320** electrically connected to the light switch **150**. The load control switch **350** is set in a left position to turn a portion of the banks of lights **300**, **320** on during automatic or manual activation. Likewise, it is set in a right position to turn on all of the banks of lights **300**, **320** connected to the light switch **150**.

Referring now to FIG. **9**A, a circuit **8000** of the light switch **150** comprises a preamplification circuit **820** having the ultrasonic receiver **600** which receives the doppler-shifted reflected ultrasonic waves **280'** caused by a person **21** moving within the room **220**. These doppler-shifted reflected ultrasonic waves **280'** are amplified and filtered before they are compared to the ultrasonic sound waves **280** emitted by the light switch **150**. A pull-up resistor **870**, having an exemplary resistance value of 33 kΩ, provides the bias voltage for the preamplifier stages. The receiver **600** is connected in series with a capacitor **890**, having an exemplary capacitance value of 0.01 μF, and is connected to the input of an amplifier **880**.

The amplifier **880** and an amplifier **900** amplify the reflected ultrasonic waves **280'** received by the receiver **600**. A feedback network **860** comprising a resistor **910**, a resistor **950** and a capacitor **930**, having exemplary resistance and capacitance values of 1 kΩ, 33 kΩ and 0.01 μF, respectively, support the amplifier **880**. A feedback network **920** including a resistor **780**, a resistor **970** and a capacitor **790**, having exemplary resistance and capacitance values of 33 kΩ, 200 kΩ and 0.01 μF, respectively, support the amplifier **900**.

An analog switch **940**, controlled by an input **770**, controls whether the amplified, received signals are connected to the remainder of the circuit **800**. The output of the analog switch **940** is connected to a low pass filter **960** including a resistor **840**, having an exemplary resistance value of 10 kΩ, and a capacitor **830**, having an exemplary capacitance value of 0.01 μF. The output of the low pass filter **960** is connected to the area sensitivity control **640**, preferably a variable resistor having an exemplary resistance value of anywhere between 10 kΩ and 500 kΩ.

In operation, the area sensitivity control **640** is set such that as its variable contact is set toward ground, no signal is output from the preamplifier circuit **820**. If the variable contact is set high, away from ground, a high preamplifier output **1000** connects to a bandpass circuit **1020**. The area sensitivity control **640** is set to cause the circuit **8000** to detect motion occurring within the entire room **220**. The bandpass circuit **1020** receives the preamplifier output **1000** from the area sensitivity control **640**, amplifies and filters the same, passing only the doppler-shift frequency characteristics of the reflected ultrasonic waves **280**'.

A pull-up resistor **1010**, having an exemplary resistance value of 33 kΩ, provides the bias voltage for the bandpass circuit **1020**. A capacitor **990**, having an exemplary capacitance value of 2.2 μF, passes the preamplifier output **1000** into an amplifier **1040** of the bandpass circuit **1020**. The amplifier **1040** and an amplifier **1020** amplify the preamplifier output **1000**. Amplifier **1040** has a feedback network **2710** comprising a resistor **1050** and a capacitor **1030**, having exemplary resistance and capacitance values of 510 kΩ and 0.01 μF, respectively. Amplifier **1080** has a feedback network **1090** consisting of a resistor **1150**, having an exemplary resistance value of 6.2 kΩ, a capacitor **1170**, having an exemplary capacitance of 0.0068 μF, a capacitor **1270**, having an exemplary capacitance value of 0.1 μF and a resistor **1190**, having an exemplary resistance value of 3.3 MΩ. A resistor **1090**, and capacitors **1070** and **1110** of the bandpass circuit **1020** have exemplary resistance and capacitance values of 10 kΩ, 0.001 μF and 0.1 μF, respectively.

The entry sensitivity control **620** comprises a variable resistor **1060** having an exemplary resistance value of 50 kΩ. The variable resistor **1060** is used to preset the initial sensitivity level representative of the limited detection range **260**, for example, one to five feet within the room **220**. An analog switch **1130** connects the variable resistor **1060** in parallel with the feedback resistor **1050** when input **1130**a is logically high. A bandpass output **1100** carries the filtered, demodulated and amplified wave to a comparator circuit **1120**.

The comparator circuit **1120** compares the bandpass output signal **1100** to a predetermined second bias voltage **850** (VBIAS-2). The response time of the comparator circuit **1120** is preset by a resistor **1210**, a diode **1230**, a resistor **1250**, and a capacitor **1290**. The diode **1230** is preferably a 1N4148 diode, the resistor **1250** has an exemplary resistance value of 1 MΩ, the capacitor **1290** has an exemplary capacitance value of 2.2 μF. A resistor **1310** has an exemplary resistance value of 330 Ω. When the comparator output signal **1100** is high, indicating no detection of motion, an output **760** of a comparator **1140** is low. When the bandpass output signal **1100** is sufficiently low to discharge the capacitor **1290** to a value lower than the predetermined second bias voltage **850**, indicating detection of motion, the output **760** of the comparator **1140** is high, thereby resetting a timer circuit **1220**. The comparator output **760** is connected to an analog switch **1180** via a resistor **1310**, having an exemplary resistance value of 330 Ω, and an LED **1160** of any conventional type known to those skilled in the art. The analog switch **1180** has an input **1200** which is connected to the output of the toggle circuit **1260**. The LED **1160** serves as the motion detection indicator **460**.

The comparator output **760** from the comparator circuit **1120** is connected to the timer circuit **1220**. Comparator output **760** is connected via a resistor **1330**, having an exemplary resistance value of 2.2 kΩ. When motion is detected, a transistor **1450**, having an exemplary part number of 2N3904, turns on, which in turn charges a capacitor **1370**, which has an exemplary capacitance of 100 μF.

If motion is not detected, the transistor **1450** turns off and capacitor **1370**, having an exemplary capacitance of 100 μF discharges its stored electrical charge through a resistor **1350**, having an exemplary resistance of 6.8 MΩ. When the voltage is higher than the voltage set by a voltage divider comprised of a resistor **1430**, a variable resistor **1340** and a resistor **1440**, having exemplary resistance values of 6.8 kΩ, 10 kΩ, 510 Ω, respectively, an amplifier **1300** resets the grace timer circuit **1500**. The variable resistor **1340** adjusts the variable time delay between approximately 30 seconds and 15 minutes. The amplifier **1300** includes a hysteresis resistor having an exemplary resistance value of 100 kΩ. After the variable time delay period has elapsed with no motion being detected, the output of amplifier **1300** goes low, causing the grace timer circuit **1500** to reset, and discharges capacitor **1320**.

The timer circuit **1220** includes the push button touch sensitive switch **1240** in parallel with an inverter stage **1260** having two digital inverters. A resistor **1260**a, having an exemplary value of 10 kΩ, is connected between the input and the output of the inverter stage **1260**. If the output of the second inverter in series with a diode **1280**, having an exemplary part number of 1N4148, is low, a capacitor **1320**, having an exemplary capacitance value of 2.2 μF, is discharged through the diode **1280**.

The circuit **8000** activates the lights **300**, **320** when both the output of the amplifier **1300** and the output of the inverter stage **1260** are high. If either output is low, the capacitor **1320** discharges and does not enable the lights **300**, **320** to be turned on. The output of the amplifier **1300** is connected via a diode **1390**, having an exemplary part number 1N4148, to the capacitor **1320**, the diode **1280** and a resistor **1410**, having an exemplary resistance value of 10 kΩ.

A grace reset signal **1520** from the timer circuit **1220** is input to a grace timer circuit **1500**. The grace timer circuit **1500** includes a timing chip **1600**, preferably a **555** timer, which receives the grace reset signal **1520**, via a capacitor **1490**, having an exemplary capacitance value of 2.2 μF. The grace timer circuit **1500** maintains the sensitivity of the light switch **1500** to detect motion anywhere in the room for the predetermined grace period, which is approximately 5 seconds in this embodiment. A resistor **1470**, having an exemplary resistance value of 100 kΩ, is connected between the supply voltage and the capacitor **1490**. A resistor **1510**, having an exemplary resistance value of 510 kΩ, is connected between the capacitor **1490** and ground. A diode **1530**, having an exemplary part number 1N4148, is connected in parallel with the resistor **1470**. A resistor **1600**a, having an exemplary resistance value of 3.9 MΩ, is connected between the supply voltage and an input of the timing chip **1600**. A capacitor **1550**, having an exemplary capacitance value of 2.2 μF, is connected between the resistor **1600**a and ground.

An output of the timing chip **1600** is connected to a diode **1540**, having an exemplary part number 1N4148. The grace reset signal **1520** is connected to a diode **1570**, having an exemplary part number 1N4148. The outputs of the diode **1540** and the diode **1570** are connected together and are connected to the input of an inverter **1560**. A capacitor **1560**a, having an exemplary capacitance value of 2.2 μF, and a resistor **1560**b, having an exemplary resistance value of 220 kΩ, are connected in parallel between the input of the inverter **1560** and ground. The output of the inverter **1560** is connected via a resistor **1610**, having an exemplary resistance value of 33 kΩ, to the input **1130**a of the analog switch **1130**. A capacitor **1630**, having an exemplary capacitance value of 22 μF, is connected between the resistor **1610** and ground.

The output of the inverter **1560** is connected to the automatic or manual two position mode switch **1580** for setting the light switch **150** in its "automatic" or "manual" mode. An exemplary part number 1N4148, is connected between the output of the inverter **1560** and the "automatic" switch terminal. A resistor **1580**b, having an exemplary resistance value of 2.2 kΩ is connected between the output of the inverter **1560** and the base of a transistor **1580**c, having an exemplary part number 2N3904. The collector of the transistor **1580**c is connected to the "manual" switch terminal. The center terminal of the mode switch **1580** is connected to the input of the inverter stage **1260**.

In the "automatic" mode, while either of the outputs from the amplifier **1300** or the grace timer circuit remain high, the output of inverter **1560** is low. When the outputs of the amplifier **1300** and the grace timer circuit are both low, the output of the inverter **1560** goes high, causing the analog switch **1130** to turn on, resetting the switch **150** to the initial sensitivity setting. Also, when the inverter **1560** output goes high, the output of toggle circuit **1260** is forced high regardless of its present state. When in the "manual" mode, a high output from inverter **1560** turns on transistor **1580**c via resistor **1580**b thereby forcing the output of the toggle circuit **1260** to go low regardless of its present state.

Referring now to FIG. **9**B, a relay control circuit **1360** controls two comparators **1380** and **1400** and push-pull circuits **1420** which turn the banks of lights **300, 320** on and off. A signal **2090** from the timer circuit **1220** is connected to an input of the comparator **1380**. The comparators **1380** and **1400** feed respective push-pull circuits **1420** through a resistor **1750**, a capacitor **1770**, a resistor **1790**, and a capacitor **1810**, respectively. Resistors **1750** and **1790** each have an exemplary resistance value of 1 kΩ, while capacitors **1770** and **1810** each have an exemplary capacitance value of 10 μF. Push-pull circuits **1420** include a resistor **1870** having an exemplary resistance value of 47 kΩ, a capacitor **1870**b having an exemplary capacitance value of 220 μF and four transistors **1870**c. In an exemplary embodiment, two of the four transistors are preferably part number 2N3904 and the other two are part number 2N3906. The output signals of the push-pull circuits **1420**, a relay open signal **1460** and a relay closed signal **1480**, activate a relay **2030** in a main power supply circuit **1720**.

A transmitter circuit **1620** utilizes a crystal controlled circuit **1640** to generate the ultrasonic waves **280** of preferably 25,000 Hz. The crystal controlled circuit **1640** includes a crystal **2110**, a capacitor **2140** and resistors **2120, 2130** and **2150**. Capacitor **2140** has an exemplary capacitance value of 22 pF, while resistors **2120, 2130** and **2150** have exemplary resistance values of 1 MΩ, 1 MΩ and 2.2 kΩ, respectively. The 25,000 Hz signal is emitted through the ultrasonic transmitter **580**. Push-pull circuits **1700, 1700**' each contain two transistors **1700**a which drive the ultrasonic transmitter **580**. One transistor has a part number 2N3904 and the other has a part number 2N3906. Inverters **1670, 1690** and **1710** each have exemplary part number **4069**. Resistors **1650** and **1730** have exemplary resistance values of 3.3 MΩ and 2.2 kΩ.

The main power supply circuit **1720** incorporates a voltage divider chain **1800**. The voltage divider chain **1800** divides the main voltage for the circuit, which is preferably 5 volts DC, into the two biasing voltages, VBIAS-1 and VBIAS-2. A voltage regulator **1760** is connected to filter capacitors **1740** and **1780**, each having exemplary capacitance values of 100 μF. The voltage regulator **1760** regulates the input voltage through voltage divider chain **1800**, which contains resistors **1820, 1840** and **1860**. Resistors **1820, 1840** and **1860** have exemplary resistance values of 10 kΩ, 3.3 kΩ and 10 kΩ, respectively. Capacitors **1890** and **1910** each have an exemplary capacitance value of 10 μF.

The main power supply circuit **1720** also includes the relay **2030**, driven by the push-pull circuit **1420**, which physically activates the lights **300, 320** on and off. LOAD2, indicated at **2080**, represents a lighting load connected to the circuit **8000**. LOAD2 is connected to the energy efficient load control switch **350**. A user presets the two position load control switch **350** to activate a portion, for example, half or all of the lighting loads connected to the light switch **150**. A first lighting load, LOAD1, indicated at **2070** is shown in the power supply board circuit **1920**. The three position bypass switch **370** is also preset by a user to set the light switch **150** in its automatic mode or to bypass the light switch **150** completely.

The power supply board circuit **1920** can be mounted to a separate circuit board within the ultrasonic switch **150**. The power supply board circuit **1920** contains two distinct power supply portions. Specifically, when the lights within the room have been activated, a first portion **1940** of the power supply board circuit **1920** provides power to the circuit **800**. The first portion incorporates step-up transformer **1980**, and a full wave rectifier **2000** comprising diodes each having exemplary part number 1N4005. Zener diode **2020**, having exemplary part number 1N4747, receives the rectified voltage from resistor **2050**, having an exemplary value of 100 Ω. The zener diode **2020** removes excess voltage from the rectified voltage output of rectifier **2000**. When the lights are not turned on, the power is generated through a second portion **1960** of the power supply board circuit **1920**, where the input voltage passes through resistor **1990**, having a value of 27 Ω at 2 watts, and capacitor **2010** having a capacitance value of 0.47 μF rated at 630 V. Half-wave rectification occurs when the voltage passes through diodes **2040** and **2060**, each having exemplary part number 1N4005. The zener diode **2020** again removes excess voltage from the voltage output of the half-wave rectifier.

While particular embodiments of the invention have been shown and described, it will be obvious to those skilled in the art that changes and modifications can be made without departing from the invention in its broader aspects and therefore the appended claims are intended to cover all such changes and modifications as allowed in the true spirit and scope of the invention.

What is claimed:

1. An energy efficient lighting control, comprising:

preselection means having at least three selectable settings, a first setting for activating all of at least two banks of lights within a bounded area, said banks of lights electrically connected thereto, a second setting for activating a portion only of said banks of lights and a third setting for not activating any of said banks of lights, said preselection means being changeably preset to selectively activate all, none or a portion only of said banks of lights; and

means for detecting an occupant within said bounded area, said detecting means coupled to said preselection means and said banks of lights and adapted to activate all, none or a portion of said banks of lights upon detecting an occupant within said bounded area, depending upon if said preselection means is preset to said first, said second or said third setting.

2. An energy efficient lighting control as defined in claim **1**, further comprising:

means for manually activating said lights, said manually activating means being electrically connected to said lights.

3. An energy efficient lighting control as defined in claim **2**, wherein said manually activating means comprises a touch sensitive switch.

4. An energy efficient lighting control as defined in claim **1**, further comprising:

means for automatically turning off said lights following a variable time delay if said detecting means does not detect occupants during said variable time delay.

5. An energy efficient lighting control as defined in claim **4**, wherein said variable time delay is less than 60 minutes.

6. An energy efficient lighting control as defined in claim **1**, wherein said detecting means is adapted to automatically switch from an initial sensitivity level for detecting an occupant within an initial range to a higher sensitivity level for detecting an occupant within an expanded range.

7. An energy efficient lighting control, comprising:

preselection means having three settings, a first setting for activating all of at least two banks of lights within a bounded area, said banks of lights electrically connected thereto, a second setting for activating a portion only of said banks of lights and a third setting for not activating any of said banks of lights, said preselection means preset to selectively activate all, none or a portion only of said banks of lights; and

means for detecting occupants within said bounded area, said detecting means being adapted to switch from an initial sensitivity level for detecting occupants within an initial range to a higher sensitivity level for detecting occupants within an expanded range, said detecting means coupled to said preselection means and said banks of lights and adapted to activate all, none or a portion of said banks of lights upon detecting occupants within said bounded area, depending upon if said preselection means is preset to said first, said second or said third setting; and

means for automatically resetting said detecting means to said initial sensitivity level from said higher sensitivity level following a predetermined grace period after said lights are turned off, said detecting means continuing to detect motion within said expanded range during said predetermined grace period.

8. An energy efficient lighting control as defined in claim **7**, wherein said detecting means automatically turn on said lights upon detecting motion during said predetermined grace period if said lights are inadvertently turned off.

9. An energy efficient lighting control as defined in claim **8**, wherein said predetermined grace period is less than 12 seconds.

10. An energy efficient lighting control as defined in claim **1**, further comprising:

means for selecting between an automatic mode wherein said lights are automatically activated and a manual mode for allowing manual activation of said lights; and

means for turning said lights off.

11. An energy efficient lighting control, comprising:

preselection means having three settings, a first setting for activating all of at least two banks of lights within a

bounded area, said banks of lights electrically connected thereto, a second setting for activating a portion only of said banks of lights and a third setting for not activating any of said banks of lights, said preselection means preset to selectively activate all, none or a portion only of said banks of lights;

means for detecting occupants within said bounded area, detecting means coupled to said preselection means and said banks of lights and adapted to activate all, none or a portion of said banks of lights upon detecting occupants within said bounded area, depending upon if said preselection means is preset to said first, said second or said third setting;

means for selecting between an automatic mode wherein said lights are automatically activated and a manual mode for allowing manual activation of said lights;

means for turning said lights off;

means effective in said automatic mode for turing off said lights manually, said detecting means maintaining said higher sensitivity level upon detecting motion, and resetting to said initial sensitivity level after no motion is detected during a variable time delay, after which said lights are automatically turned off;

means for defining a predetermined grace period immediately following said variable time delay during which said detecting means continues to detect motion within said expanded range; and

means for resetting said detecting means to an automatic on state wherein said detecting means automatically turns on said lights upon detecting motion within said initial detecting range.

12. An energy efficient lighting control, comprising:

preselection means having three settings, a first setting for activating all of at least two banks of lights within a bounded area, said banks of lights electrically connected thereto, a second setting for activating a portion only of said banks of lights and a third setting for not activating any of said banks of lights, said preselection means preset to selectively activate all, none or a portion only of said banks of lights;

means for detecting occupants within said bounded area, detecting means coupled to said preselection means and said banks of lights and adapted to activate all, none or a portion of said banks of lights upon detecting occupants within said bounded area, depending upon if said preselection means is preset to said first, said second or said third setting;

means for selecting between an automatic mode wherein said lights are automatically activated and a manual mode for allowing manual activation of said lights;

means for turning said lights off;

means effective in said manual mode for turing off said lights automatically, after no motion is detected during a variable time delay after which said lights are automatically turned off;

means for defining a predetermined grace period immediately following said variable time delay during which said detecting means detects motion within said expanded range; and

means for resetting said detecting means to a manual on state requiring manual activation of said lights.

13. An energy efficient lighting control as defined in claim **1**, further comprising:

means for selectively activating all of said lights.

14. An energy efficient lighting control as defined in claim **1**, further comprising:

means for selectively activating substantially half of said lights.

15. An energy efficient lighting control as defined in claim **1**, further comprising:

a three position bypass switch having an off setting for deactivating said lighting control, an automatic setting for normal use and an on setting for electrically bypassing said lighting control and leaving said lights on.

16. An energy efficient lighting control as defined in claim **1**, wherein said lighting control replaces a wall mounted single or dual toggle switch.

[17. An energy efficient light switch, comprising:

means for detecting motion within an initial range, said detecting means preset to an initial sensitivity level;

means for automatically switching said detecting means to a preset higher sensitivity level from said initial sensitivity level upon detecting motion within said initial range, said detecting means detecting motion at said higher sensitivity level within an expanded range; and

means for automatically activating at least one bank of lights upon detecting motion within either said initial range or said expanded range.**]**

[18. An energy efficient light switch as defined in claim **17**, further comprising:

means for manually activating said lights, said manually activating means being electrically connected to said lights.**]**

[19. An energy efficient light switch as defined in claim **17**, further comprising:

means for receiving a reflected ultrasonic wave from the room, said activating means activating said lights when said reflected ultrasonic wave is a doppler-shift of said ultrasonic wave emitted into the room.**]**

[20. An energy efficient light switch as defined in claim **19**, further comprising

means for resetting said detecting means to said initial sensitivity level when said reflected ultrasonic wave is not the doppler-shift of said ultrasonic wave emitted into the room.**]**

[21. An energy efficient light switch as defined in claim **17**, further comprising:

means for automatically turning off said lights following a variable time delay if said detecting means does not detect any motion during said variable time delay.**]**

[22. An energy efficient light switch as defined in claim **21**, wherein said variable time delay is in a range between 30 seconds to 15 minutes.**]**

[23. An energy efficient light switch as defined in claim **17**, further comprising:

means for automatically resetting said detecting means to said initial sensitivity level from said higher sensitivity level following a predetermined grace period after said lights are turned off, said detecting means continuing to detect motion within said expanded range during said predetermined grace period.**]**

[24. An energy efficient light switch, comprising:

means for emitting an ultrasonic wave at a predetermined frequency into a room;

means for detecting motion within an initial range, said detecting means preset to an initial sensitivity level;

means for switching said detecting means to a preset higher sensitivity level from said initial sensitivity level upon detecting motion within said initial range, said detecting means detecting motion at said higher sensitivity level within an expanded range;

means for automatically activity at least one bank of lights upon detecting motion within either said initial range or said expanded range; and

means for automatically resetting said detecting means to said initial sensitivity level from said higher sensitivity level following a predetermined grace period after said lights are turned off, said detecting means continuing to detect motion within said expanded range during said predetermined grace period;

wherein said detecting means automatically turns on said lights upon detecting motion during said predetermined grace period if said lights are inadvertently turned off.**]**

25. An energy efficient light switch as defined in claim **[23]** *9*, wherein said predetermined grace period is 5 seconds.

[26. An energy efficient light switch as defined in claim **17**, further comprising:

means for selecting between an automatic mode wherein said lights are automatically activated and a manual mode for allowing manual activation of said lights; and

means for turning said lights off.**]**

[27. An energy efficient light switch, comprising:

means for emitting an ultrasonic wave at a predetermined frequency into a room;

means for detecting motion within an initial range, said detecting means preset to an initial sensitivity level;

means for switching said detecting means to a preset higher sensitivity level from said initial sensitivity level upon detecting motion within said initial range, said detecting means detecting motion at said higher sensitivity level within an expanded range;

means for automatically activating at least one bank of lights upon detecting motion within either said initial range or said expanded range;

means for selecting between an automatic mode wherein said lights are automatically activated and a manual mode for allowing manual activation of said lights;

means for turning said lights off;

means effective in said automatic mode for turning off said lights manually, said detecting means maintaining said higher sensitivity level upon detecting motion after no motion is detected during a variable time delay after which said lights are automatically turned off;

means for defining a predetermined grace period immediately following said variable time delay during which said detecting means continues to detect motion within said expanded range; and

means for resetting said detecting means to an automatic on state wherein said detecting means automatically turns on said lights upon detecting motion within said initial detection range.**]**

28. An energy efficient lighting control, comprising:

means for emitting an ultrasonic wave at a predetermined frequency into a room;

means for detecting motion within an initial range, said detecting means preset to an initial sensitivity level;

means for switching said detecting means to a preset higher sensitivity level from said initial sensitivity level upon detecting motion within said initial range, said detecting means detecting motion at said higher sensitivity level within an expanded range;

means for automatically activating at least one bank of lights upon detecting motion within either said initial range or said expanded range;

means for selecting between an automatic mode wherein said lights are automatically activated and a manual mode for allowing manual activation of said lights;

means for turning said lights off;

means effective in said manual mode for turning off said lights automatically, after no motion is detected during a variable time delay after which said lights are automatically turned off;

means for defining a predetermined grace period immediately following said variable time delay during which said detecting means detects motion within said expanded range; and

means for resetting said detecting means to a manual on state requiring manual activation of said lights after automatically turning off said lights.

[**29**. An energy efficient light switch as defined in claim **17**, further comprising:

a three position bypass switch having an off setting for deactivating said light switch, an automatic setting for normal use and an on setting for electrically bypassing light switch and leaving said lights on.]

30. A method for automatically activating at least a portion of the lighting within a room, comprising the steps of:

presetting a preselection means in one of three settings, a first setting for activating all of at least two banks of lights within said room, a second setting for activating a portion only of said banks of lights and a third setting for not activating any of said banks of lights;

detecting motion within an initial range by a detector preset to an initial sensitivity level;

automatically switching said detector to a preset higher sensitivity level from said initial sensitivity level upon detecting motion within said initial range, said detector detecting motion within an expanded range at said higher sensitivity level; and

automatically activating all, none or a portion of said lights upon detecting motion within said initial range and said expanded range.

31. A method for automatically activating at least a portion of the lighting within a room as defined in claim **30**, further comprising the step of:

manually activating said lights.

32. A method for automatically activating at least a portion of the lighting within a room as defined in claim **30**, further comprising the step of:

automatically turning off said lights following a variable time delay if said detector does not sense any motion during said variable time delay.

33. A method for automatically activating on and off at least a portion of the lighting within a room as defined in claim **30**, further comprising the step of:

automatically resetting said detector to said initial sensitivity level from said higher sensitivity level following a predetermined grace period after said lights are turned off, said predetermined grace period allowing said detector to continue detecting motion within said expanded range.

34. A method for automatically activating at least a portion of the lighting within a room as defined in claim **30**, further comprising the step of:

selecting between an automatic mode wherein said lights are automatically turned on and a manual mode for allowing manual activation of said lights.

35. A method for automatically activating at least a portion of the lighting within a room, comprising the steps of:

presetting a preselection means in one of three settings, a first setting for activating all of at least two banks of lights within said room, a second setting for activating a portion only of said banks of lights and a third setting for not activating any of said banks of lights;

detecting motion within an initial range by a detector preset to an initial sensitivity level;

automatically switching said detector to a preset higher sensitivity level from said initial sensitivity level upon detecting motion within said initial range, said detector detecting motion within an expanded range at said higher sensitivity level;

automatically activating all, none or a portion of said lights upon detecting motion within said initial range and said expanded range;

turning off said lights manually in said automatic mode, said detecting means maintaining said higher sensitivity level upon detecting motion after no motion is detected during a variable time delay, after which said lights are automatically turned off;

defining a predetermined grace period immediately following said variable time delay during which said detecting means continues to detect motion within said expanded range; and

resetting said detecting means to an automatic on state wherein said detecting means automatically turns on said lights upon detecting motion within said initial detection range.

36. A method for automatically activating at least a portion of the lighting within a room, comprising the steps of:

presetting a preselection means in one of three settings, a first setting for activating all of at least two banks of lights within said room, a second setting for activating a portion only of said banks of lights and a third setting for not activating any of said banks of lights;

detecting motion within an initial range by a detector preset to an initial sensitivity level;

automatically switching said detector to a preset higher sensitivity level from said initial sensitivity level upon detecting motion within said initial range, said detector detecting motion within an expanded range at said higher sensitivity level;

automatically activating all, none or a portion of said lights upon detecting motion within said initial range and said expanded range;

turning off said lights automatically in said manual mode after no motion is detected during a variable time delay, after which said lights are automatically turned off;

defining a predetermined grace period immediately following said variable time delay, during which said detecting means detects motion within said expanded range; and

resetting said detecting means to a manual on state requiring manual activation of said lights after automatically turning off said lights.

[**37**. An automatic lighting device, comprising:

means for detecting an occupant within a bounded area, said detecting means being adapted to switch from an initial sensitivity level for detecting an occupant within an initial range to a higher sensitively level for detecting an occupant within an expanded range; and

means for automatically resetting said detecting means to said initial sensitivity level from said high sensitivity level following a predetermined grace period after said lights are turned off, said detecting means continuing to detect motion within said expanded range during said predetermined grace period.]

38. An energy efficient lighting control, comprising:

means for activating at least one bank of lights within a predetermined area;

means for detecting an occupant within said predetermined area;

means for selecting between an automatic mode wherein said bank of lights is automatically activated upon detecting said occupant, and a manual mode wherein said bank of lights is activated manually; and

means effective in either said automatic mode or in said manual mode for automatically maintaining said bank of lights on while an occupant is detected within said predetermined area and turning said bank of lights off after no occupant is detected within said predetermined area.

39. An energy efficient lighting control, as defined in claim 38 comprising:

means for defining a grace period of time that starts immediately after said bank of lights is turned off and means for automatically turning on said bank of lights during said grace period upon detecting an occupant within said predetermined area.

40. An energy efficient lighting control as defined in claim 38, further comprising:

preselection means having three settings, a first setting for activating all of at least two banks of lights within said predetermined area, a second setting for activating a portion only of said banks of lights, and a third setting for not activating any of said banks of lights, said preselection means being preset to selectively activate all, none or a portion only of said banks of light.

41. An energy efficient lighting control as described in claim 38, further comprising:

means for switching said detecting means to a preset higher sensitivity level from said initial sensitivity level upon detecting an occupant within said initial range, said detecting means detecting an occupant at said higher sensitivity level within said expanded range.

42. An energy efficient lighting control, comprising:

means for activating at least one bank of lights within a predetermined area;

means capable of detecting an occupant within said predetermined area;

means for selecting between an automatic activating mode wherein said bank of lights is automatically activated upon detecting said occupant, and a manual activating mode wherein said bank of lights is activated manually; and

means effective in either said automatic activating mode or in said manual activating mode for permitting manual turnoff of said bank of lights or occupancy sensitive turn off;

said occupancy sensitive turn off mode comprising means for automatically maintaining said bank of lights on while an occupant is detected within said predetermined area and turning said bank of lights off after no occupant is detected within said predetermined area.

43. A method for activating at least a portion of the lighting within a predetermined area, comprising the steps of:

detecting an occupant within said predetermined area;

presenting selection means to either automatically activate a bank of lights within said predetermined area upon detecting said occupant, or to manually activate said bank of lights;

automatically maintaining said bank of lights on while an occupant is detected within said predetermined area and turning said bank of lights off after no occupant is detected within said predetermined area; and

preselecting selection means in one of three settings for activating all of at least two banks of lights within said predetermined area, a second setting for activating a portion only of said banks of lights, a third setting for not activating any of said banks of lights, said preselection means being preset to selectively activate all, none or a portion only of said banks of lights.

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