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Remote sensor for monitoring departure from bed.

A bed monitoring system for sensing and remotely signalling the presence or absence of a person in bed in a hospital, nursing home, or home care environment includes a sensing pad positioned above the mattress and under the person. The sensing pad has a tape switch responsive to bend or distortion of the upper surface of the mattress resulting from the weight of the person. The remote signalling of the presence or absence of the person in bed uses power line carrier transmission interfaces to send and receive "bed occupied" and "bed unoccupied" signals over the standard AC power distribution wiring. The received signals are used to provide visual and audible indications and to activate lights in the monitored room as the person arises from bed.

Field of the Invention

This invention relates to systems for sensing and indicating the presence or absence of a person in bed and, more particularly, to an improved sensor responsive to bend of the upper surface of a mattress and remote signalling and indicating apparatus.

Background of the Invention

A common problem encountered in hospitals, nursing homes, and home care settings is that of patients who get out of bed when their condition, because of medication, disorientation, dizziness, disease, age, or some other reason, requires assistance to avoid risk of injury to that patient. Furthermore, a patient's movement while in bed may indicate a change in physical condition or may jeopardize medical treatment or medical monitoring attachments to the patient. These and related problems concerning bed-restricted patients create a need to monitor the activity of such patients and to be forewarned when a patient is about to or is attempting to leave the bed. That need is particularly acute in situations involving institutional staff reductions or in home care settings where continuous care may be a family responsibility. The need for monitoring the presence of young children or babies in bed can also arise when kidnapping or injury from movement is a concern.

Various types of bed monitoring sensors and systems have been proposed. One group of such sensors uses force-activated or pressure-activated switch devices mounted beneath the mattress. Examples of such devices are disclosed in United States Patents Number 2,818,477 (Gollhofer); 3,961,201 (Rosenthal); 4,020,482 (Feldl); 4,263,586 (Nicholas); 4,242,672 (Gault); 4,539,560 (Fleck et al.); and 4,907,845 (Wood). The application of such devices is generally restricted to specific types of bed or mattress construction.

In order to overcome that shortcoming, a number of devices positioned above the mattress have been proposed. Examples of these devices are disclosed in United States Patents Number 4,175,263 (Triplet); 4,228,426 (Roberts); 4,264,904 (McCoy et al.); 4,484,043 (Musick et al.); 4,565,910 (Musick et al.); 4,633,237 (Tucknott et al.); 4,638,307 (Swartout); and 4,845,323 (Beggs). Disclosed in these patents are both pneumatic pressure sensing pads and weight-activated or pressure-activated electrical switch devices. A disadvantage of the weight-activated or pressure-activated electrical switch devices is that the operation of such devices depends on both the weight of the person and the ability of the mattress to distribute that weight. Because the function of a mattress is to distribute weight and to reduce points of high pressure, the device must sense low pressures. There are difficulties in constructing a device which reliably

senses these low pressures. Therefore, a device responsive to bend of the upper surface of the mattress instead of weight or pressure is desirable.

Of the devices disclosed in the above-mentioned patents designed to be positioned above the mattress, only the devices disclosed by Musick et al. (United States Patents Number 4,484,043 and 4,565,910) are constructed specifically to respond to bending or twisting distortion. These devices are designed, however, for use in hospitals where a new sensing pad is used with each new patient. The construction of these disposable devices requires that they be replaced every month to ensure reliable operation.

McCoy et al. (United States Patent Number 4,264,904) discloses an above-mattress sensing pad which uses tape switches. The tape switches used in the device disclosed by McCoy et al. are constructed to respond to pressure, however, not to bend.

It is common in hospitals and nursing homes to provide a nurse call button adjacent to the bed so that a patient may operate the call button to signal a nursing station that assistance is required. In order to minimize additional wiring and installation cost, most electronic monitoring systems associated with bed departure sensing devices connect to this existing nurse call system when remote indication is required. Systems using such remote indication are disclosed in United States Patents Number 4,228,426 (Roberts); 4,264,904 (McCoy et al.); 4,539,560 (Fleck et al.); 4,633,237 (Tucknott et al.); and 4,638,307 (Swartout).

Means of distinguishing between a patient nurse call and a bed departure indication are proposed by McCoy et al. and Tucknott et al. McCoy et al. disclose a flashing circuit which provides pulsed activation of an indicator at the nurse call station. Many conventional nurse call systems have latching type indicators, however, and, therefore, are unable to display this alternative indication for bed departure. Consequently, alternative embodiments are disclosed by Swartout and McCoy et al. which have separate remote signalling and indicating means using radio transmitters and receivers.

Summary of the Invention

The present invention relates to bed departure monitoring systems and, more particularly, to relatively inexpensive bed departure monitoring systems having above-mattress sensing pads and remote signalling and indicating means. It eliminates many of the disadvantages of the prior art and provides additional features and advantages not previously available in bed departure monitoring systems.

One embodiment of the remote sensor for monitoring departure from bed of the present invention includes a sensing pad positioned above the mattress and under the person. The sensing pad includes a

tape switch responsive to bend or distortion of the upper surface of the mattress resulting from the weight of the person. The sensing pad is durable and designed to provide a reliable indication of bed departure for many years of regular use.

Electronics connected to the sensing pad monitor the electrical signals from the sensing pad and produce a signal indicative of the absence or presence of a person in bed. The present invention further includes power line carrier transmission interfaces which receive the absence and presence signals and transmit them to a remote location over the standard AC power distribution wiring. The received signals are used to provide visual and audible indications and to activate lights in the monitored room as the person arises from bed. Neither an existing nurse call system nor additional wiring to the remote indicating station is required in the present invention.

It is to be understood that both the foregoing general description and the following detailed description are exemplary, but are not restrictive, of the invention.

Brief Description of the Drawing

The invention is best understood from the following detailed description when read in connection with the accompanying drawing, in which:

Figure 1 illustrates a typical bed having a sensing pad, connected sensing electronics, a signal transmitting module, signal receiving modules, and remote indicating apparatus according to the present invention;

Figure 2 is a plan view of the sensing pad illustrated in Figure 1;

Figure 3 is an enlarged, cross-sectional view of the sensing pad of Figure 2 taken along the line 3-3 of Figure 2 showing details of the construction of the sensing pad of the present invention; Figure 3A shows a side view of the sensing pad shown in Figure 3 with its insulating jacket removed, illustrating the pad as closed after a flexing snap action;

Figure 4 is an enlarged, exploded view of the tape switch assembly illustrated in Figure 3;

Figure 5 is a plan view of an alternative example of a sensing pad of the present invention;

Figure 6 is a circuit diagram of one embodiment of the sensing electronics illustrated in Figure 1; and

Figure 7 is a schematic view indicating the overall component relationship of another example of the remote indicating apparatus of the present invention.

Detailed Description of the Invention

Referring now to the drawing, wherein like refer-

ence numerals refer to like elements throughout, Figure 1 illustrates a system for monitoring the presence or absence of a person in bed in accordance with the present invention. The Figure shows a bed 1 with a mattress 2 on which is positioned a sensing pad 5 responsive to bend or distortion of the upper surface 7 of mattress 2 which results from the weight of a person in bed 1. Bed 1 and mattress 2 may have any common type of construction and may be in a hospital, nursing home, or home care environment.

Sensing pad 5 is positioned on the upper surface 7 of mattress 2 in an area which is subject to maximum distortion. Sensing pad 5 may extend, for example, across the width of bed 1 and under the hips of the person when in bed 1 -- as illustrated in Figure 1. In the preferred embodiment of the present invention, sensing pad 5 is fixed in position with commercially available hook and loop tape such as, for example, the tape commonly sold under the trademark "Velcro".

In Figure 1, two pieces of adhesive-backed hook tapes 9 and 11, permanently bonded to sensing pad 5, engage with one piece of adhesive-backed loop tape 13, permanently bonded to the upper surface 7 of mattress 2. Engagement of hook tapes 9 and 11 with loop tape 13 when sensing pad 5 is placed on upper surface 7 of mattress 2 fixes the position of sensing pad 5 relative to mattress 2, preventing undesirable relocation of sensing pad 5 when the person moves in bed 1. The hook and loop engagement provides for the removal and replacement of sensing pad 5 in the same position relative to mattress 2 should sensing pad 5 have to be removed for any reason. Easy removal and replacement of sensing pad 5 is desirable because sensing pad 5 is designed to be durable, washable, sterilizable, and to have a long operating life.

It will be appreciated by those skilled in the art that numerous alternative configurations and positions of hook and loop tape may be used to temporarily locate sensing pad 5 relative to mattress 2. Alternatively, adhesive tape may be used for this purpose.

Sensing pad 5 includes a tape switch assembly (not shown in Figure 1) with two conductive strips forming electrical contacts which are open when bed 1 is unoccupied. When bed 1 is occupied, surface 7 of mattress 2 bends and distorts to distribute the weight of the person in bed 1. The two conductive strips of sensing pad 5 close when subjected to the bending of the mattress surface 7 when bed 1 is occupied. With continued reference to Figure 1, the construction of sensing pad 5 will be described in greater detail in connection with Figures 2, 3, 3A, and 4.

Conventional tape switches generally close in reaction to a concentrated force, not a bend or flex moment. Consequently, such switches are not well adapted for mounting on soft surfaces such as mat-

tresses because the force generated by the weight of a person lying or sitting on the mattress is not concentrated. Rather, the person's weight is distributed over a considerable area. To react to the concentrated force, therefore, the switch must be sensitive to the extremely small force per unit area applied by the person's weight--a difficult and often impractical requirement.

Conventional tape switches which close in reaction to a concentrated force also face another problem. Typically, the conductive strips of such switches are supported along their edges by an insulator to assure separation when the switch is open. Moreover, any curvature, transverse or otherwise, of the strips functions to separate the strips rather than to urge snap-action contact between the strips. Consequently, conventional tape switches respond only to relatively large, concentrated forces.

The tape switch of sensing pad 5 overcomes both related problems, namely, responding only to a large, concentrated force and requiring extreme sensitivity, inherent in the conventional tape switches.

Figure 2 is a plan view of the sensing pad 5 illustrated in Figure 1 showing tape switch assembly 15. Leads 17 and 19 of cable 21 are electrically connected to two normally open conductive strips of tape switch assembly 15. Cable 21 has a connector 23 at the end remote from tape switch assembly 15.

Figure 3 is an enlarged, cross-sectional view of the sensing pad 5 taken along the line 3-3 of Figure 2, showing details of the construction of the sensing pad 5 of the present invention. Tape switch assembly 15 comprises first and second conductive strips 25 and 27, respectively. Conductive strips 25 and 27 each have a transverse curvature and are separated by a plurality of insulating members 29 and 31 (indicated in the enlarged, exploded view of tape switch 15 in Figure 4) sandwiched between them.

Insulating members 29 and 31 are spaced to hold conductive strips 25 and 27 separated unless conductive strips 25 and 27 are flexed or bowed. In the preferred embodiment, tape switch assembly 15 further includes an enclosing flexible insulating jacket 35. Conductive strips 25 and 27 are shown separated in Figure 3; a person is neither sitting nor lying on sensing pad 5.

The spacing of the insulating members is chosen so that, after a predetermined amount of flexing, conductive strips 25 and 27 will snap together. Tape switch assembly 15 is designed to flex to conform to the shape of the person's body sitting or lying on mattress 2. Figure 3A shows a side view of Figure 3 with insulating jacket 35 removed. Figure 3A illustrates the flexing snap action of conductive strips 25 and 27. After tape switch assembly 15 has been flexed by a predetermined amount of force, conductive strips 25 and 27 will snap together into a closed position at point 30 forming a good electrical contact.

A third strip 33 is a stabilizing member, which may be flat or have a transverse curvature opposite to that of first and second conductive strips 25 and 27, and functions to assist the snap action. Strips 25, 27, and 33 are manufactured from a springy, conductive material such as, for example, beryllium copper or spring steel.

Examples of a tape switch assembly responsive to bend which may be used in constructing the sensing pad of the present invention are fully disclosed by Koenig in United States Patent Number 3,694,600 (issued September 26, 1972), the entire disclosure of which is accordingly incorporated by reference herein. Such a tape switch is commercially available from Tapeswitch Corporation of America of Farmingdale, New York, and is identified as the product "Flex Action Ribbon Switch 180".

Tape switch assembly 15 is sandwiched between two sheets of flexible material 37 and 39, as shown in Figure 3. In the preferred embodiment, sheets 37 and 39 are 0.020 inch thick soft vinyl. Adhesive layer 41 bonds and laminates sheets 37 and 39, fixedly locating and sealing tape switch assembly 15 between sheets 37 and 39. In addition to sealing tape switch assembly 15, sheets 37 and 39 support and maintain the orientation of tape switch 15 and further provide for attachment of hook and loop tapes 9 and 11 used to fix the position of sensing pad 15 relative to upper surface 7 of mattress 2, as shown in Figure 1. It will be appreciated by those skilled in the art that sheets 37 and 39 may be manufactured from alternative flexible materials including, for example, soft plastic and rubber materials. It will also be appreciated by those skilled in the art that alternative processes such as, for example, heat sealing, may be used to laminate and bond sheets 37 and 39 and seal tape switch assembly 15.

Sensing pad 5 of the preferred embodiment of the present invention has dimensions of approximately 32 inches by 3 inches. It will be appreciated by those skilled in the art that the sensing pad of the present invention may be constructed to alternative dimensions. Alternative dimensions might be required, for example, for different sizes of bed.

It will further be appreciated by those skilled in the art that, although in the preferred embodiment of the sensing pad of the present invention only one tape switch assembly 15 is sandwiched between sheets 37 and 39, a plurality of tape switch assemblies, electrically connected in parallel, could be used to provide a larger sensing area. A larger area may be advantageous, for example, in larger beds where the lying position of the person is less restricted. Figure 5 shows an alternative embodiment of the sensing pad. Sensing pad 43 in Figure 5 includes a plurality of tape switch assemblies 45, 47, and 49 electrically interconnected in parallel by wires 51, 53, 55, and 57.

McCoy et al. disclose in United States Patent

Number 4,264,904 an above-mattress sensing pad incorporating tape switch assemblies responsive to pressure. A disadvantage of pressure-responsive tape switch assemblies in this application is that their operation depends on both the weight of the person and the ability of the mattress to distribute that weight. Because the function of a mattress is to distribute weight and to reduce points of high pressure, the sensing pad must detect low pressures. Construction of a device which reliably senses such low pressures is difficult. The present invention eliminates that disadvantage by using a tape switch assembly responsive to bend. Consequently, the sensing pad of the present invention will sense reliably on beds of different constructions, including those with soft mattresses, those with firm mattresses, and waterbeds. In addition, the sensing pad of the present invention will reliably sense both heavy people and light people such as, for example, children or babies.

When installed, as shown in Figure 1, sensing pad 5 is electrically connected to sensing electronic unit 59 by a cable 21 and a connector 23. Sensing electronic unit 59 monitors the conductive strips of tape switch assembly 15 (see Figure 2) of sensing pad 5 for contact closure and produces, as its output, an electrical signal indicating the presence or absence of a person in bed 1. The electronic circuitry of sensing electronic unit 59 functions to eliminate false "bed unoccupied" signals. Such signals may arise when the person moves in bed 1 and causes the electrical contacts of sensing pad 5 to open. The electronic circuitry of sensing electronic unit 59 will be described in greater detail below in connection with Figure 6.

Figure 6 is a circuit diagram of the electronics of sensing electronic unit 59. Sensing pad 5 is represented by an electrical equivalent, switch 111, which is connected to input terminals 113 and 115. The output of sensing electronic unit 59 is produced at output terminals 117 and 119. The circuitry shown in Figure 6 produces a "bed occupied" signal (a logic high at terminal 119) after the sensing pad electrical contacts, represented by switch 111, have remained closed for approximately 20 seconds and produces a "bed unoccupied" signal (a logic low at terminal 119) after the sensing pad electrical contacts, represented by switch 111, have remained open for approximately 3 seconds.

Logic gates 121 and 123 are 2-input Schmitt trigger NAND gates connected as inverting buffers. Resistor 127 pulls both inputs of gate 121 to a logic high when switch 111 is open. When switch 111 is closed, the inputs of gate 121 are pulled to a logic low (to ground). The output of gate 121 is connected to both inputs of gate 123. Consequently, the output of gate 123 is the complement of the output of gate 121.

Capacitor 125 reduces noise at the input of gate 121 when switch 111 is open. Diode 129 and resistor

131, connected to the output of gate 123, and capacitor 133 cooperate to produce a signal at input 145 of gate 141 which goes low approximately 20 seconds after the output of gate 123 has remained low. Similarly, diode 135 and resistor 137, connected to the output of gate 121, and capacitor 139 cooperate to produce a signal at input 151 of gate 143 which goes low approximately 3 seconds after the output of gate 121 has remained low.

Gates 141 and 143, which are also 2-input Schmitt trigger NAND gates, are connected to form an RS latch circuit, as will be recognized by those skilled in the art. Consequently, the output of gate 143 will go low when switch 111 has remained closed for approximately 20 seconds, indicating a "bed occupied" condition, and will go high when switch 111 has remained open for approximately 3 seconds, indicating a "bed unoccupied" condition. The output of gate 143 is connected to the base of transistor 153 through resistor 155, such that transistor 153 pulls terminal 119 low through resistor 157 in response to a logic high at the output of gate 143.

The circuitry of Figure 6 is powered by lithium battery 161. Capacitor 163 is a decoupling capacitor. Gates 121, 123, 141, and 143 are provided by a CMOS logic part number 4093. Transistor 153 is a Darlington transistor part number MPSA12KS.

Sensing electronic unit 59 may also have a sense status indicator 61 (see Figure 1) electrically connected to its output. Indicator 61 will inform whether the sensing electronic unit 59 is producing a "bed occupied" or a "bed unoccupied" signal and will allow verification that the sensing pad 5 and sensing electronic unit 59 are functioning correctly during either installation or periodic checks by nursing or attending personnel.

The electrical signal indicative of the presence or absence of a person in bed 1, the signal output from sensing electronic unit 59, is connected to the input of power line carrier signalling transmitter module 63 by a cable 65. Power line carrier signalling modules are known to those skilled in the art and are generally used to remotely turn on and off appliances and lights. Typically, one or more standard transmitter modules, plugged into a standard AC power outlet, communicates with one or more receiver modules, similarly plugged into another standard AC power outlet, by superimposing low voltage high frequency control signals on the 110V AC or 220V AC, 50Hz or 60Hz power distribution wiring. Thus, the bed monitoring system of the present invention is easy and inexpensive to install and does not require additional wiring to points of remote indication.

Standard transmitter and receiver modules generally transmit and respond to preset address codes and control commands such as on, off, and light dim. Such power line carrier signalling transmitter and receiver modules are commercially available from X-10

(USA) Inc. of Northvale, New Jersey. The operating principles of such modules are described in detail in "Technical Note: The X-10 POWERHOUSE Power Line Interface Model # PL513 and Two-Way Power Line Interface Model # TW523", published by X-10 (USA) Inc.

In the preferred embodiment of the present invention, power line carrier signalling transmitter module 63 is a Model BA284 interface manufactured by X-10 (USA) Inc. Transmitter module 63, plugged directly into a wall-mounted power outlet 71 and electrically connected to power distribution wiring 103, has address code select switches 73 and input screw terminals 67 and 69 to which cable 65 is connected. Consequently, the bed occupied/unoccupied signal from sensing electronic unit 63 is the turn off/turn on control signal for transmitter module 63.

Receiver module 75, with similar address code selection switches 77, is similarly plugged into a power outlet 79 in another room of the house or building and is electrically connected to power distribution wiring 103. In the preferred embodiment of the present invention, receiver module 75 is a Model LM465 lamp control module manufactured by X-10 (USA) Inc. Such a module can turn on or turn off any light or lamp plugged into socket 81 of receiver module 75 in response to command signals received over the power distribution wiring.

In the preferred embodiment, the address code selection switches 77 on receiver module 75 are set to correspond to the address code selection switches 73 on transmitter module 63. Consequently, lamp 83 plugged into socket 81 of receiver module 75 is turned off when bed 1 is occupied and turned on when bed 1 is unoccupied, thus providing a remote indication of the presence or absence of a person in bed 1.

It will be appreciated by those skilled in the art that more than one receiver module can be used to receive control signals from, and to respond to, transmitter module 63. In Figure 1, receiver module 85, plugged into power outlet 87 near bed 1 and electrically connected to power distribution wiring 103, is identical to receiver module 75. Therefore, lamp 89 plugged into socket 91 of receiver module 85 is also turned off when bed 1 is occupied and turned on when bed 1 is unoccupied. Consequently, lamp 89 illuminates the monitored room as the person arises from bed 1, eliminating the need for the person to locate and operate a light or lamp switch.

Also shown in Figure 1 is yet another receiver module 93 plugged into yet another power outlet 95 and electrically connected to power distribution wiring 103. In the preferred embodiment, receiver module 93 is a Model UM506 manufactured by X-10 (USA) Inc. which incorporates a buzzer 97 with selectable momentary or continuous operation. Receiver module 93 can function, therefore, as an audible alarm to indicate the departure of the person from bed 1.

Power line carrier signalling transmitter module 63 further includes a manual "on" switch 99 and a manual "off" switch 101. Switches 99 and 101 can be used for verification of the correct connection, address switch selection, and operation of the power line carrier signalling transmitter module 63 and remote indicating devices during installation or periodically during checks by nursing or attending personnel.

In the preferred embodiment of the present invention, power line carrier signalling transmitter module 63 can be set so that a lamp or indicator connected to a receiver module is turned on when the bed becomes unoccupied and remains on after the bed is occupied again. This latching mode is desirable when nursing attention is always required in response to a bed departure. The "bed unoccupied" indication can be turned off by the nurse or attending person with manual "off" switch 101 on transmitter module 63.

In the preferred embodiment of the present invention, as illustrated in Figure 1, sensing electronic unit 59 and transmitter module 63 are separate units. As will be appreciated by those skilled in the art, however, the electronics of sensing electronic unit 59 could, alternatively, be incorporated into transmitter module 63. Similarly, the functionality of receiver module 75, controlling lamp 83, and receiver module 93, with buzzer 97, could be combined into one module to control both a lamp and a buzzer.

It will also be appreciated by those skilled in the art that, in a hospital or nursing home where there is a need to monitor the beds of a number of patients, a sensing pad, sensing electronic unit, and power line carrier signalling transmitter module can be fitted to each bed to be monitored. Each transmitter module can be set to have a different address code. Consequently, a receiver module plugged into an AC power line outlet can monitor control signals from all modules and can display which beds are occupied and which beds are unoccupied. It will also be appreciated that the bed monitoring system of the present invention can operate independently of a nurse call system or in a home which has no existing nurse call system.

Figure 7 is a schematic view indicating the component relationship of one such remote indicating device for monitoring the status of multiple beds in a hospital or nursing home. Power line carrier transmitter-receiver module 171, plugged into power outlet 173 and electrically connected to the power distribution wiring, is connected to microcontroller 177 of remote indicating device 175. Power line carrier transmitter-receiver module 171 of Figure 7 is suitably a Model TW523 manufactured by X-10 (USA) Inc. Module 171 provides the necessary signal lines 179 for microcontroller 177 to receive "bed occupied" and "bed unoccupied" signals from up to 256 beds. Microcontroller 177 is connected to a display driver 181. Display driver 181 is connected to display 183 which

has visual indicators of "bed occupied" and "bed unoccupied" status for multiple beds. Also connected to microcontroller 177 is an audible indicator 185 which is used to alert nursing or attending personnel of a departure from bed.

In the preferred embodiment of the remote indicating device of the present invention, audible alarm 185 is activated for approximately 5 seconds and a visual indicator of the number of the unoccupied beds is pulsed on and off for approximately 30 seconds immediately upon bed departure. After that period, the visual indicator remains on until the bed becomes occupied.

Power line carrier transmitter-receiver module 171, in addition to receiving signals from other transmitters, can transmit signal acknowledgements back to other similar transmitter-receiver modules. As will be recognized by those skilled in the art, "handshaking" of this type can improve the reliability of communication when multiple transmitters are used by incorporating methods known in the art such as, for example, polling, collision detection, and retransmission. Consequently, it is advantageous to replace transmitter-only modules, such as transmitter module 63 in Figure 1, with transmitter-receiver modules including associated acknowledgement circuitry in hospitals or nursing homes where multiple beds are to be monitored.

Although described above with respect to its particular embodiments, the present invention is nevertheless not intended to be limited to the details shown. Rather, various modifications may be made in the details within the scope and range of equivalents of the claims and without departing from the spirit of the invention.

Claims

1. A sensing pad for detecting the presence of a person on the upper surface of a mattress on a bed, said sensing pad comprising:
 - first and second sheets of flexible material bonded together along selected lengths of said sheets;
 - a tape switch disposed between said first and second sheets of flexible material at a location at which said sheets are not bonded together, said tape switch having:
 - (a) first and second flexible conducting strips spaced apart and having transverse curvature, said flexible conducting strips adapted to flex in response to a predetermined bend of said upper surface of said mattress when said person is present in said bed and to snap together into electrical contact after a predetermined amount of flexing, and
 - (b) a plurality of insulating members disposed

between said first and second flexible conducting strips and maintaining said first and second flexible conducting strips in a non-contacting separated position absent said predetermined bend of said upper surface of said mattress;

means for electrically connecting said first and second flexible conducting strips to a remote unit for indicating when said first and second flexible conducting strips are in electrical contact; and

means for securing one of said sheets of flexible material to said upper surface of said mattress.

2. A sensing pad as claimed in claim 1 wherein said tape switch further has a flexible insulating jacket enclosing said first and second flexible conducting strips and said plurality of insulating members.
3. A sensing pad as claimed in claim 1 wherein said first and second sheets of flexible material are bonded together by an adhesive layer.
4. A sensing pad as claimed in claim 1 further comprising a stabilizing third strip disposed parallel and adjacent to one of said first and second flexible conducting strips to assist forming electrical contact between said first and second flexible conducting strips.
5. A sensing pad as claimed in claim 4 wherein said stabilizing third strip has a transverse curvature opposite that of said first and second flexible conducting strips.
6. A sensing pad as claimed in claim 1 wherein said first and said second sheets of flexible material are soft plastic.
7. A sensing pad as claimed in claim 1 wherein said first and said second sheets of flexible material are rubber.
8. A sensing pad as claimed in claim 1 wherein said electrical connecting means includes:
 - a first lead electrically connected to said first flexible conducting strip of said tape switch;
 - a second lead electrically connected to said second flexible conducting strip of said tape switch; and
 - a cable electrically connected to said first and second leads for carrying the electrical signal of said tape switch to said remote unit.
9. A sensing pad as claimed in claim 1 wherein said securing means includes:

a piece of hook and loop tape attached to said upper surface of said mattress; and
 a corresponding piece of hook and loop tape attached to said first sheet of flexible material.

10. A sensing pad as claimed in claim 1 wherein said first and said second sheets of flexible material are about 0.020 inches thick and said sensing pad has dimensions of approximately 32 inches by 3 inches.

11. A sensing pad as claimed in claim 1 wherein a plurality of tape switches are electrically interconnected to provide a larger sensing area.

12. A remote sensor for detecting the presence of a person on a member located in a building with power distribution wiring, said sensor comprising:
 at least one sensing pad for producing an electrical signal responsive to the presence of said person on said member;
 means for securing said sensing pad to said member;

a sensing electronic unit for receiving said electrical signal from said sensing pad and producing an output signal;

means for electrically connecting said sensing pad to said sensing electronic unit;

a power line carrier signalling transmitter module electrically connected to said sensing electronic unit and to said power distribution wiring for transmitting said output signal from said sensing electronic unit over said power distribution wiring using power line carrier transmission;
 at least one power line carrier signalling receiver module electrically connected to said power distribution wiring for receiving said signal transmitted by said transmitter module; and

means for remotely indicating the presence of said person on said member, said indicating means electrically connected to said receiver module and activated by said signal received by said receiver module.

13. A remote sensor as claimed in claim 12 wherein said sensing pad has:

first and second sheets of flexible material bonded together along selected lengths of said sheets; and

at least one tape switch disposed between said first and second sheets of flexible material at a location at which said sheets are not bonded together.

14. A remote sensor as claimed in claim 13 wherein said member is the upper surface of a mattress on a bed and said sensing pad responds to the

bend of said upper surface of said mattress when said person is present in said bed.

15. A remote sensor as claimed in claim 14 wherein said at least one tape switch has:

first and second flexible conducting strips spaced apart and having transverse curvature, said flexible conducting strips adapted to flex in response to a predetermined bend of said upper surface of said mattress when said person is present in said bed and to snap together into electrical contact after a predetermined amount of flexing;

a plurality of insulating members disposed between said first and second flexible conducting strips and maintaining said first and second flexible conducting strips in a non-contacting separated position absent said predetermined bend of said upper surface of said mattress; and

a flexible insulating jacket enclosing said first and second flexible conducting strips and said plurality of insulating members.

16. A remote sensor as claimed in claim 13 wherein said first and second sheets of flexible material are bonded together by an adhesive layer.

17. A remote sensor as claimed in claim 15 further comprising a stabilizing third strip disposed parallel and adjacent to one of said first and second flexible conducting strips to assist forming electrical contact between said first and second flexible conducting strips.

18. A remote sensor as claimed in claim 17 wherein said stabilizing third strip has a transverse curvature opposite that of said first and second flexible conducting strips.

19. A remote sensor as claimed in claim 13 wherein said first and second sheets of flexible material are soft plastic.

20. A remote sensor as claimed in claim 13 wherein said first and second sheets of flexible material are rubber.

21. A remote sensor as claimed in claim 15 wherein said electrical connecting means includes:

a first lead electrically connected to said first flexible conducting strip of said tape switch;

a second lead electrically connected to said second flexible conducting strip of said tape switch;

a cable electrically connected to said first and second leads for carrying the electrical signal of said tape switch away from said tape switch;

an electrical connector attached to the end of said cable opposite said leads for engaging said sensing electronic unit.

- 22.** A remote sensor as claimed in claim 12 wherein said securing means includes:
 a piece of hook and loop tape attached to said member; and
 a corresponding piece of hook and loop tape attached to said sensing pad. 5 10
- 23.** A remote sensor as claimed in claim 13 wherein said first and said second sheets of flexible material are about 0.020 inches thick and said sensing pad has dimensions of approximately 32 inches by 3 inches. 15
- 24.** A remote sensor as claimed in claim 13 wherein a plurality of tape switches are electrically interconnected to provide a larger sensing area. 20
- 25.** A remote sensor as claimed in claim 12 wherein said indicating means is a light.
- 26.** A remote sensor as claimed in claim 12 wherein said indicating means is a buzzer. 25
- 27.** A remote sensor as claimed in claim 12 wherein said sensing electronic unit and said power line carrier signalling transmitter module are combined into a single electronic unit. 30
- 28.** A remote sensor as claimed in claim 12 wherein:
 said power line carrier signalling transmitter module has address code select switches;
 said power line carrier signalling receiver module has address code select switches; and
 said address code select switches of said transmitter module are set to correspond to said address code select switches of said receiver module. 35 40
- 29.** A remote system for individually sensing the presence of a plurality of people on a corresponding plurality of members located in a building with power distribution wiring, said system comprising:
 a sensing pad for producing an electrical signal responsive to the presence of a person on each said member;
 means for securing at least one said sensing pad to each said member;
 a sensing electronic unit for receiving said electrical signal from each said sensing pad and producing an output signal;
 means for electrically connecting each said sensing pad to a corresponding said sensing electronic unit; 45 50 55

a power line carrier signalling transmitter module electrically connected to each said sensing electronic unit and to said power distribution wiring for transmitting each said output signal from each said sensing electronic unit over said power distribution wiring using power line carrier transmission;

a power line carrier signalling receiver module electrically connected to said power distribution wiring for receiving each said signal transmitted by each said transmitter module;

a microcontroller for monitoring each said signal received by each said receiver module; and

means for remotely indicating the presence of each said person on each said member, said indicating means electrically connected to said microcontroller and activated by said signal monitored by said microcontroller.

- 30.** A remote system as claimed in claim 29 wherein said indicating means is an audible indicator.

- 31.** A remote system as claimed in claim 29 wherein said indicating means includes a display driver and a display, said display having visual indicators of member-occupied and member-unoccupied status for said plurality of members.

- 32.** A remote system as claimed in claim 29 wherein each said member is the upper surface of a mattress on a bed and said sensing pads respond to the bend of said upper surfaces of said mattresses when said people are present in said beds.

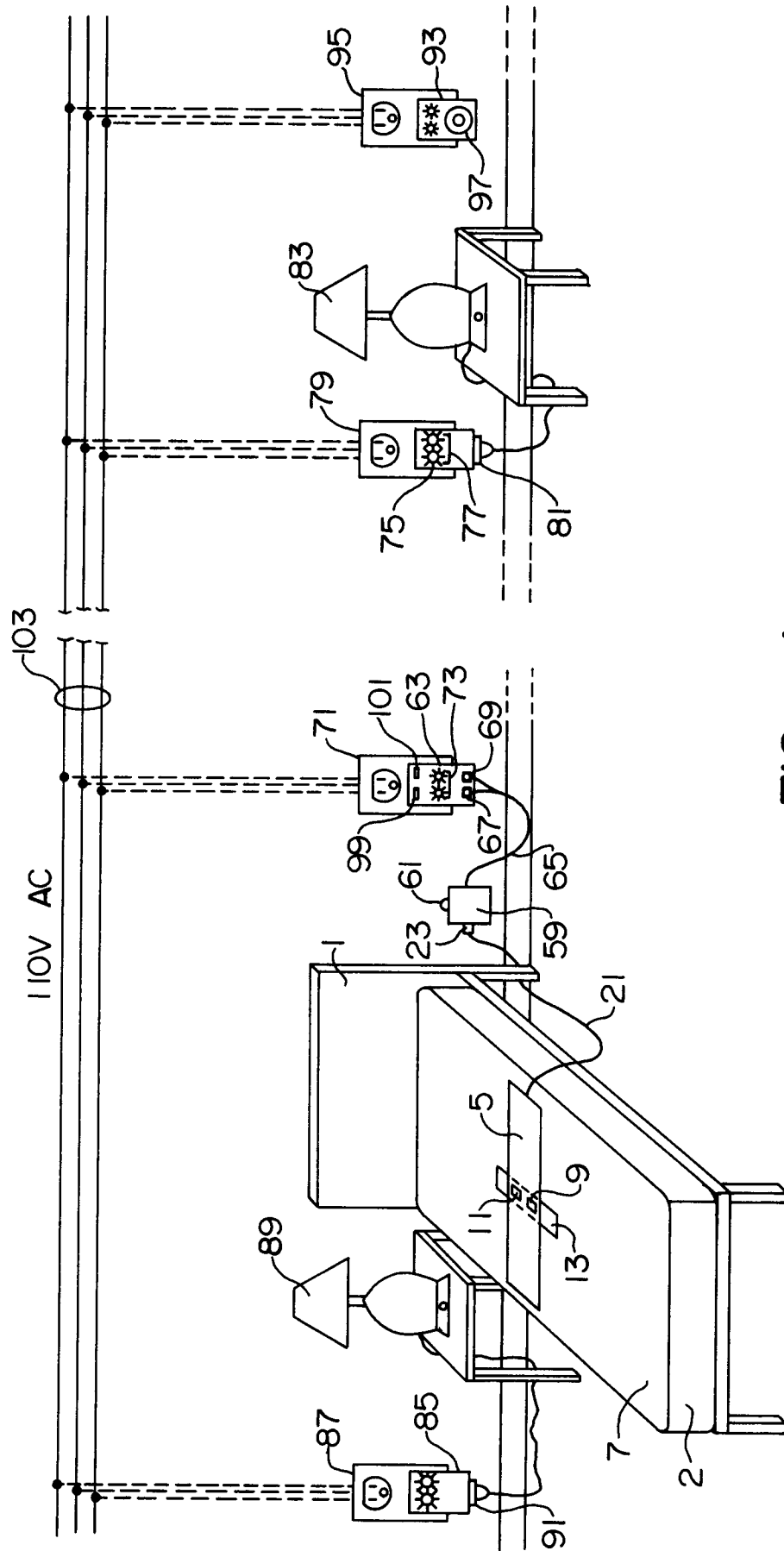


FIG. 1

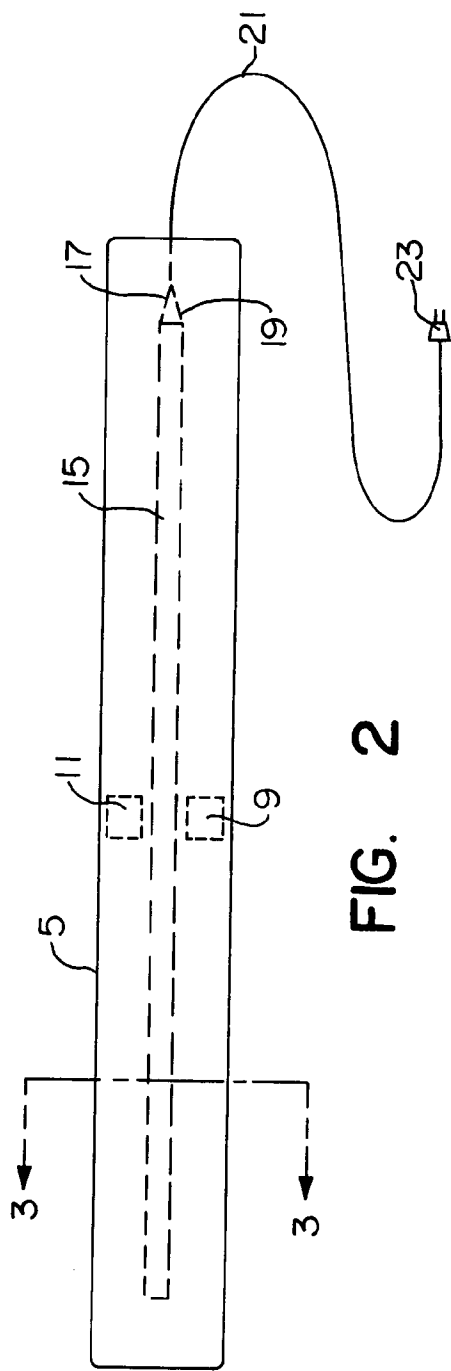


FIG. 2

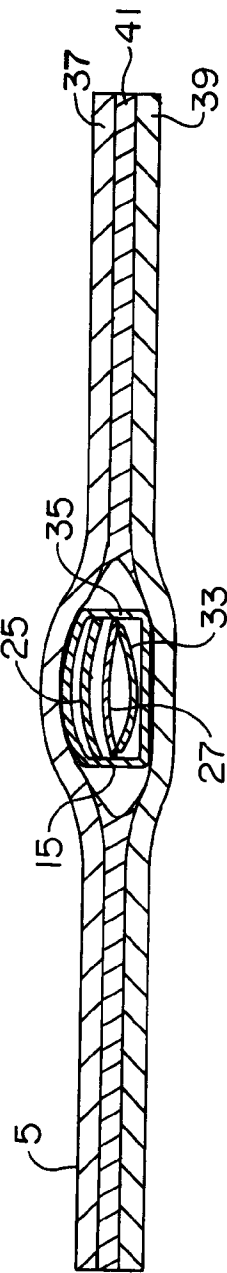


FIG. 3

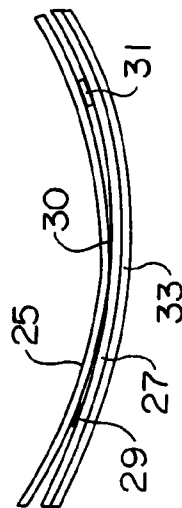


FIG. 3A

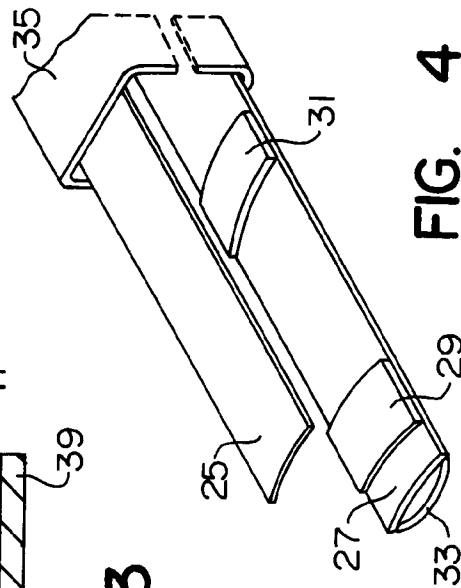
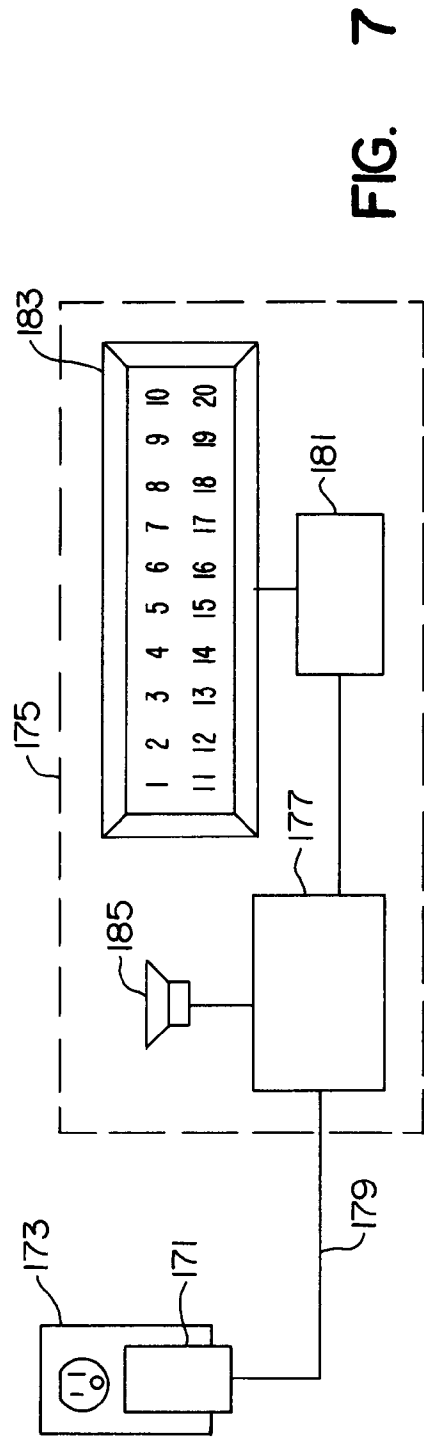
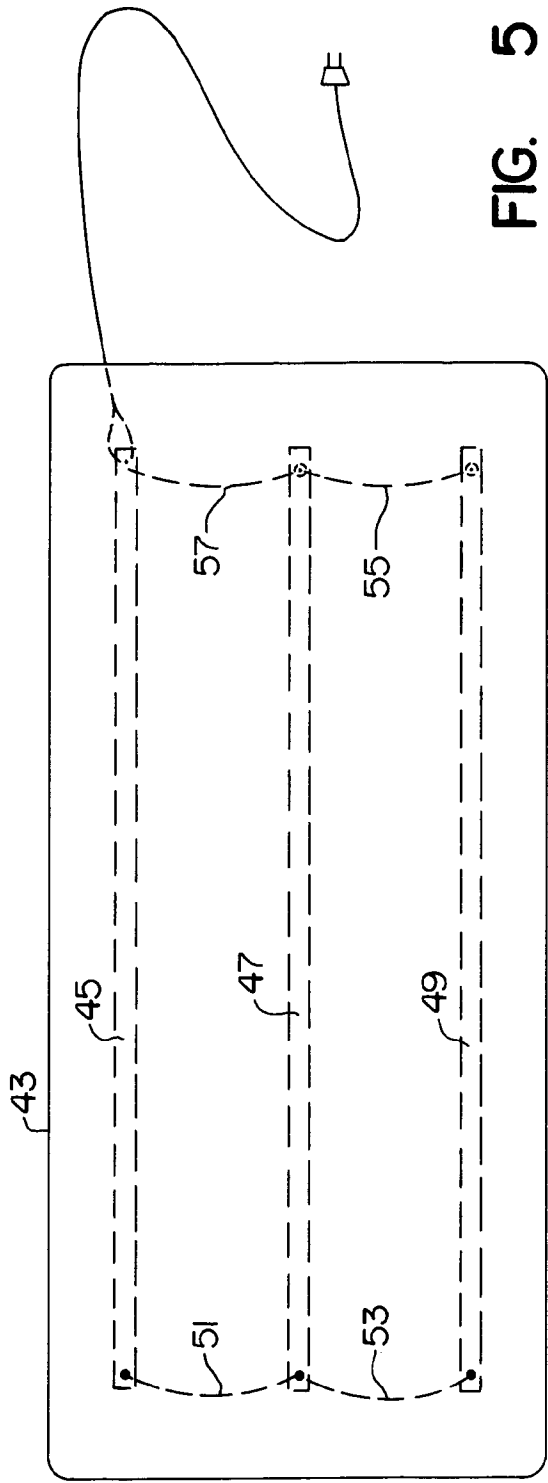


FIG. 4



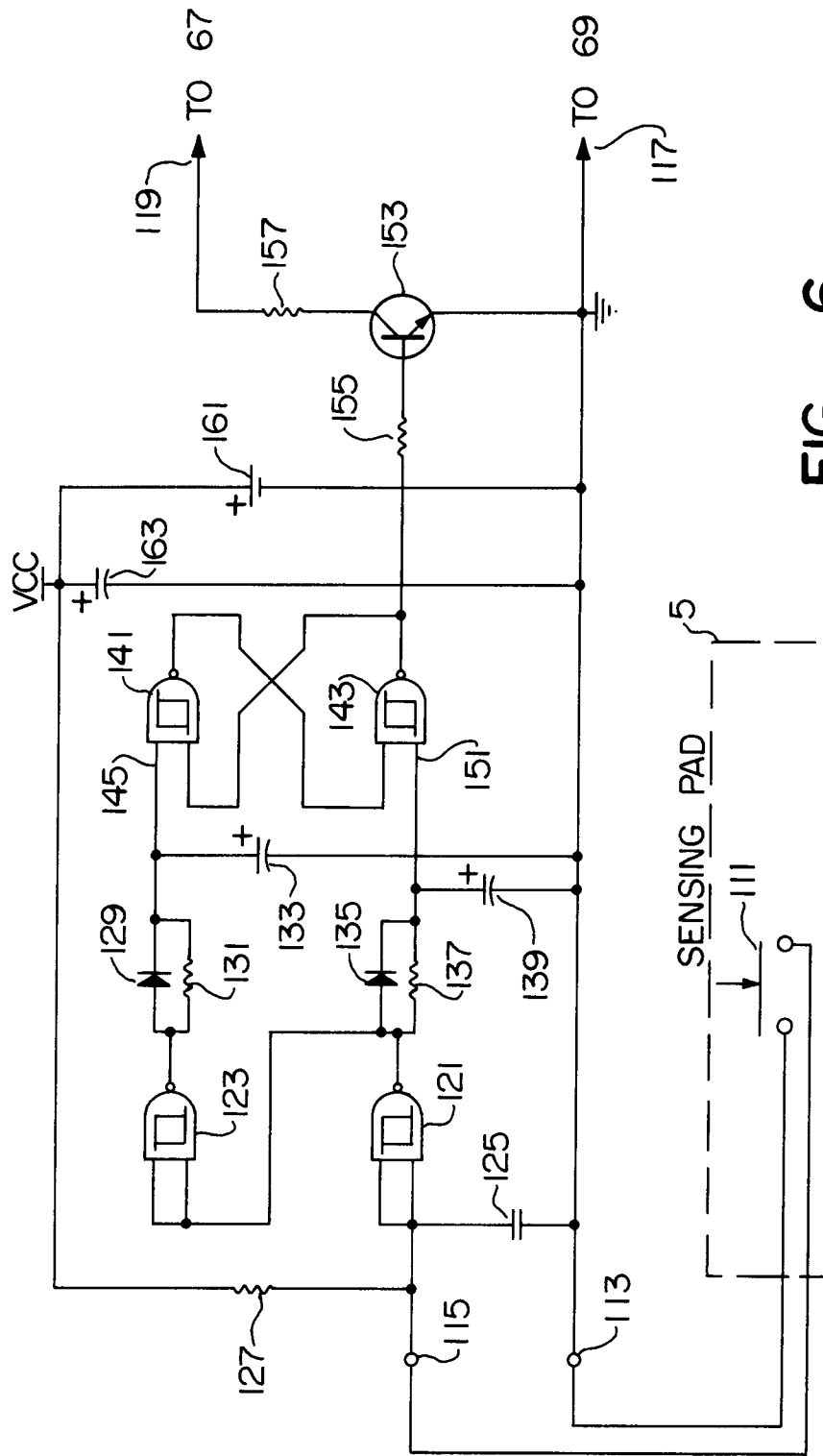


FIG. 6



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number

EP 92 30 7561

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
Y	US-A-4 295 133 (D. VANCE) * abstract; figures 3-8 * * column 6, line 18 - column 7, line 22 * * column 8, line 43 - column 9, line 41 * ---	1-32	G08B21/00
Y	WO-A-9 010 281 (RUDEKE J.) * abstract; figures 1-4 * * page 3, line 10 - page 4, line 26 * ---	1-32	
Y,D	US-A-3 694 600 (R. KOENIG) * the whole document * ---	1-32	
A	EP-A-0 107 058 (BED-CHECK CORP.) * abstract * -----	1	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			G08B H01H
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 10 NOVEMBER 1992	Examiner SGURA S.
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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