United States Patent [19]

Basham

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[45] Sept. 25, 1973

[54] RESPIRATION MONITORING APPARATUS AND METHOD

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[22] Filed: Sept. 1, 1971

[21] Appl. No.: 176,983

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 97,737, Dec. 14, 1970, abandoned.

[52] U.S. Cl. .... 128/2 R, 128/25, 317/261, 340/279

[51] Int. Cl. A61b 5/08

[58] Field of Search .... 128/25 R, 25 N, 2.08, 128/2.1 R, DIG. 17, 2.05 P; 73/398 C, 88.5 R; 340/279; 317/261

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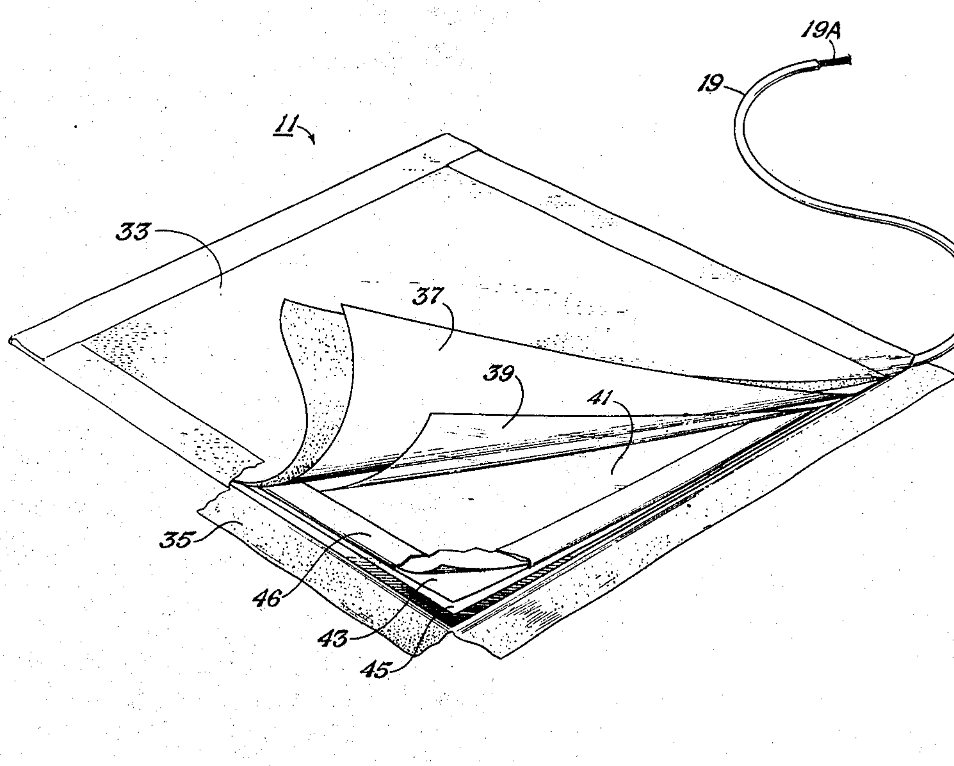
[57] ABSTRACT

Apparatus and method for monitoring the respiration of a patient through utilization of a force responsive transducer, which ideally is a capacitor transducer constructed from alternate layers of conductive and nonconductive materials that are flexible such that when placed beneath a patient or a resilient patient support, such as a mattress, the distance between the plates of the transducer changes for the purpose of producing electrical responses that upon amplification energize indicator means, such as a visual alarm or an audible alarm. The transducer is responsive to the vertical, reciprocating forces and motions caused by respiration and along with the associated circuitry, is sufficiently sensitive to energize an alarm upon sensing a cessation of respiration.

11 Claims, 9 Drawing Figures



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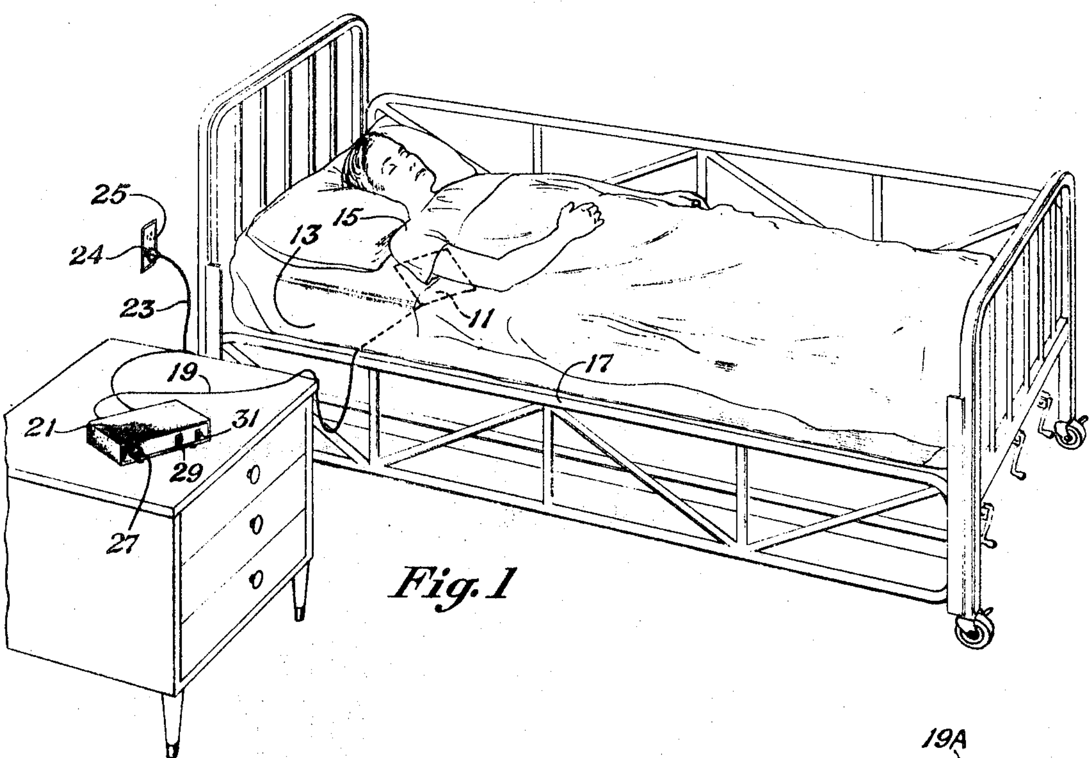

Fig. 1

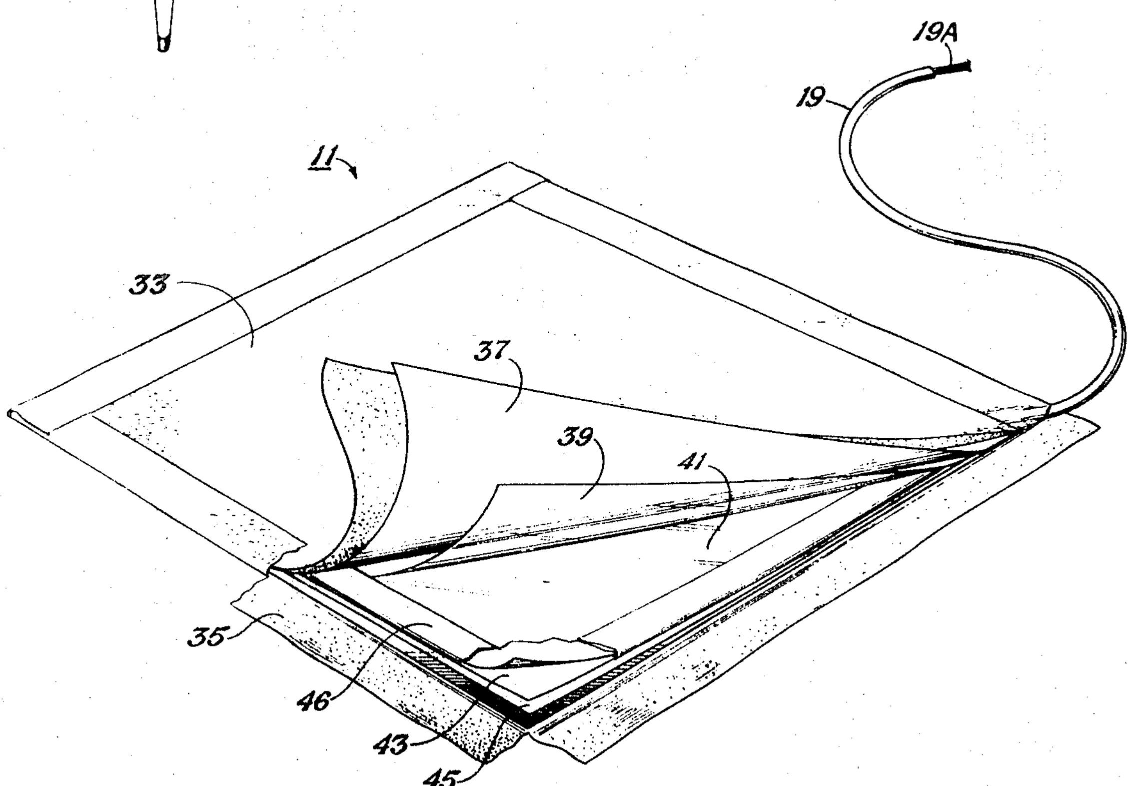

Fig. 2

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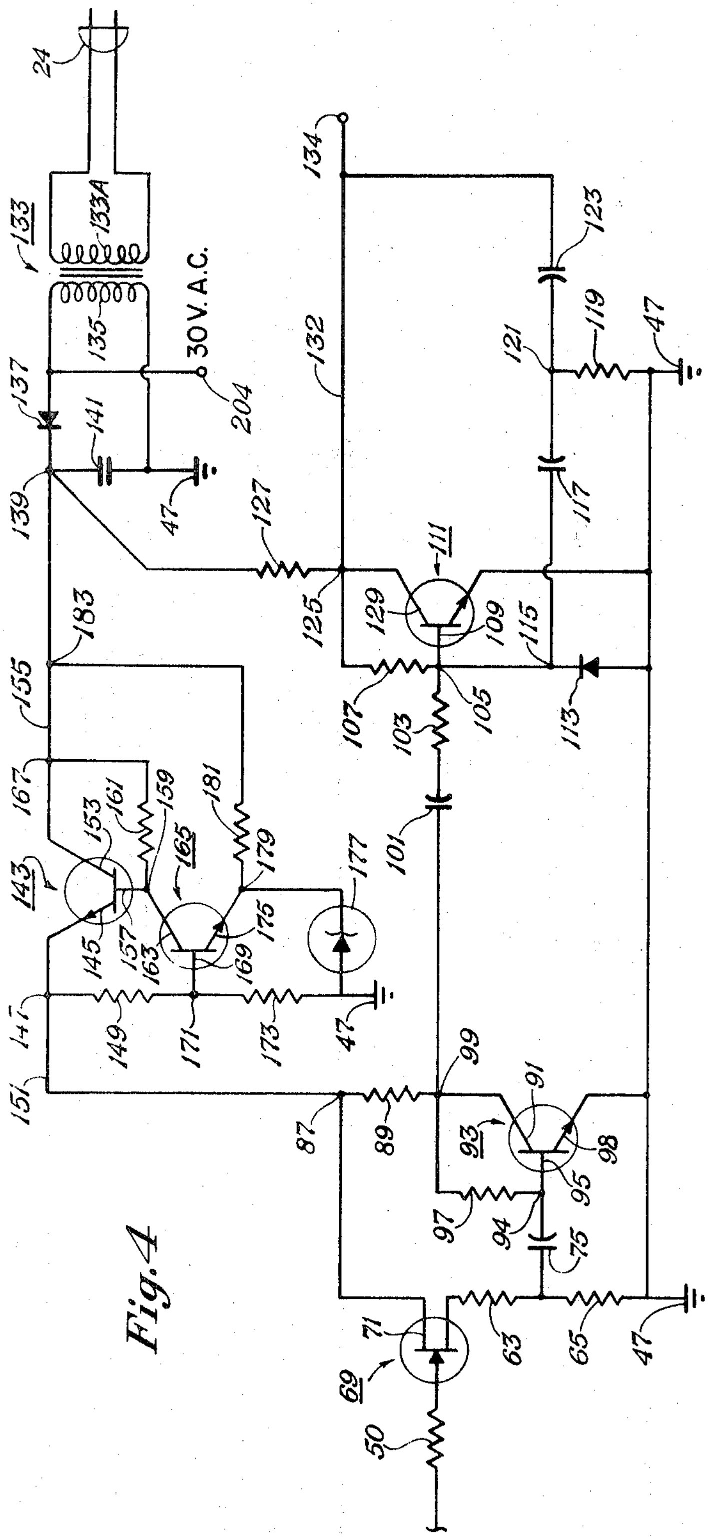

Fig. 4

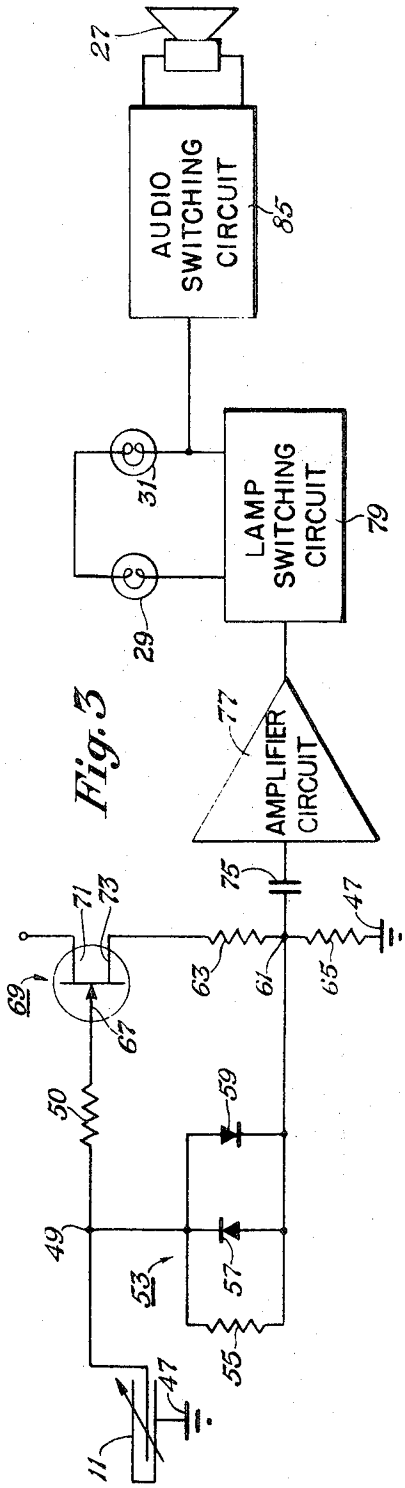

Fig. 3

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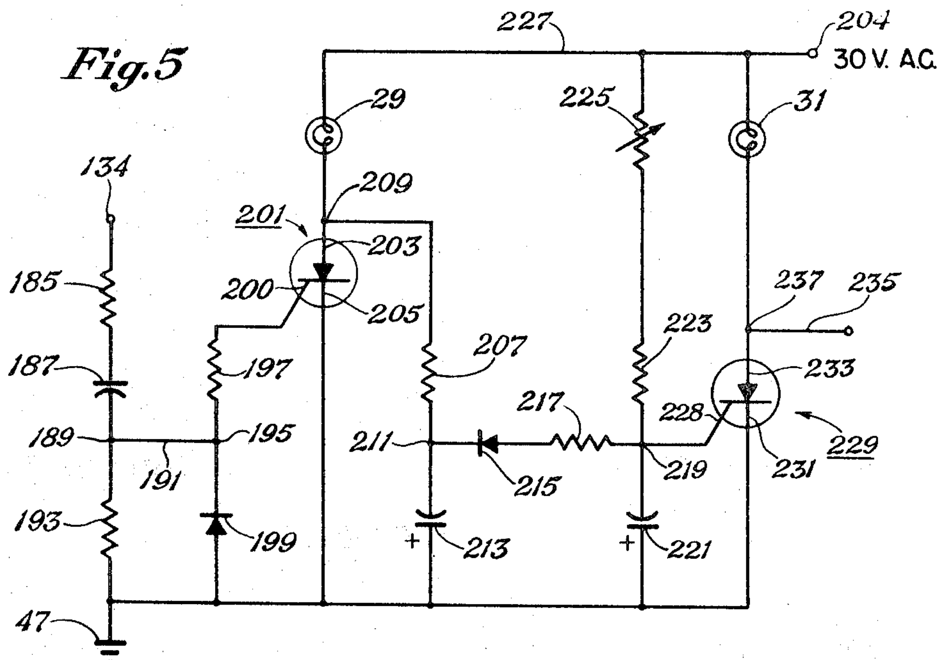

Fig. 5

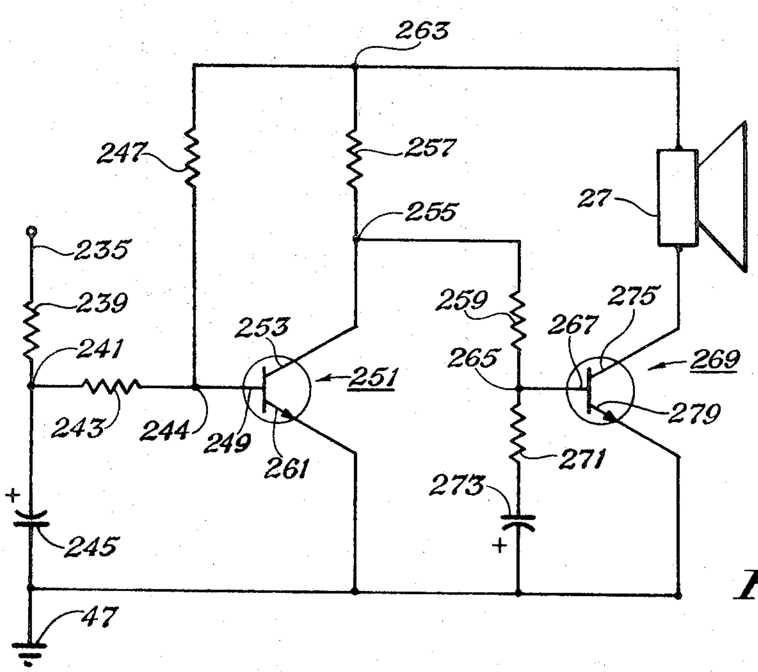

Fig. 6

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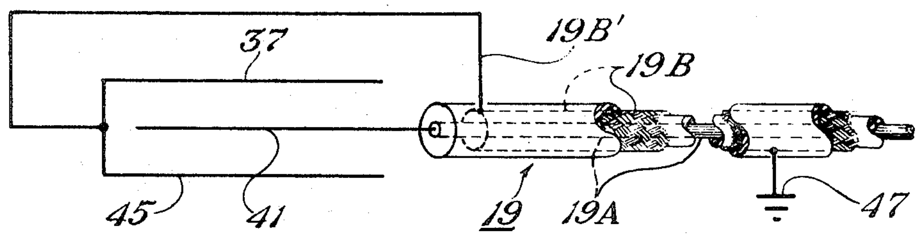

Fig. 7

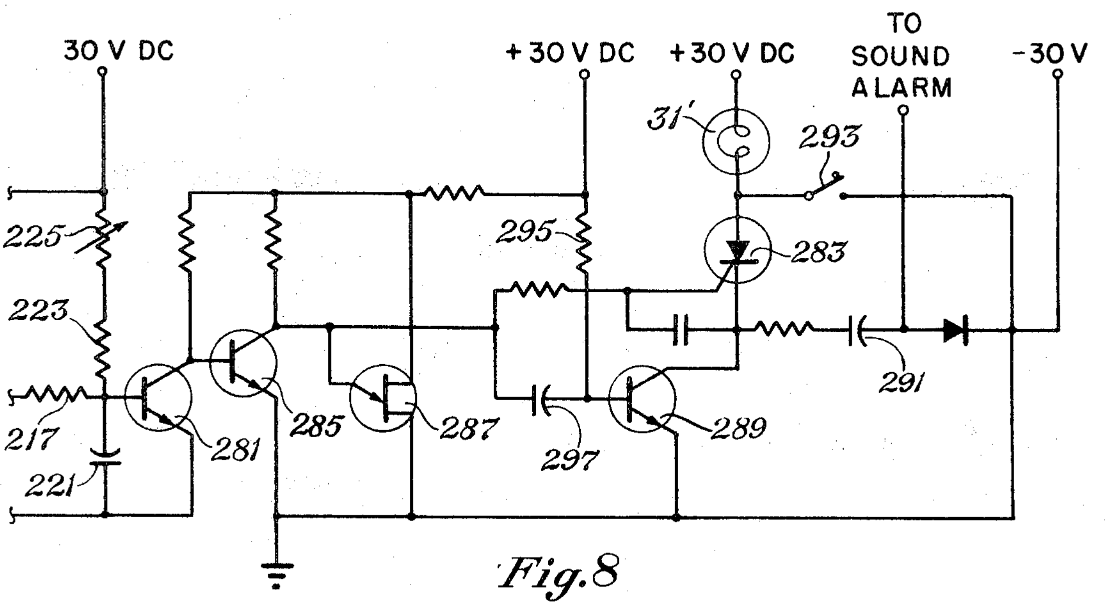

Fig. 8

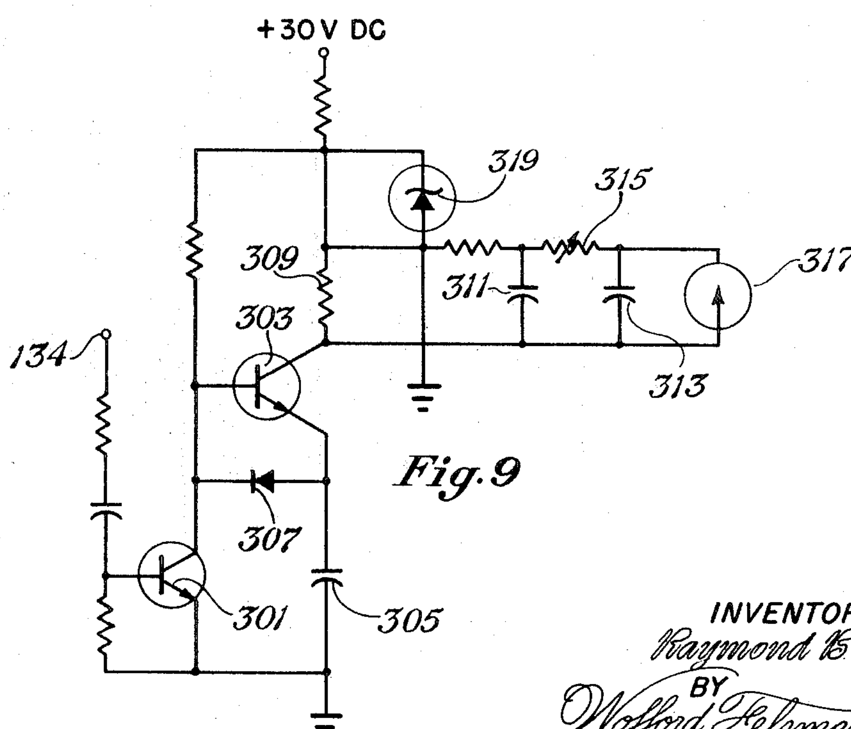

Fig. 9

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RESPIRATION MONITORING APPARATUS AND METHOD

This application is a continuation-in-part of U.S. Pat. application Ser. No. 97,737 filed Dec. 14, 1970, now abandoned.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates in general to patient monitoring apparatus, particularly to apparatus adapted to monitor respiration for the purpose of providing an alarm upon cessation of respiration.

2. Description of the Prior Art

A number of different types of methods and apparatus have been proposed in the past for the purpose of monitoring respiration. However, the previously known apparatus and methods have not yet received widespread acceptance due to a number of severely limiting disadvantages. One previously known method utilizes the connection of electrodes directly to the skin of a patient to sense electrical resistance changes during respiration in the skin surrounding the expanding and retracting chest cavity. Connecting electrodes directly to the patient is often irritating to the patient, whose skin frequently rejects the saline solution commonly used to produce satisfactory contact between the electrode and the patient. And in addition, such method can be dangerous if a large voltage is applied inadvertently or accidentally across electrodes secured to a patient. A number of accidents of this type have been reported. In addition, devices have been proposed for sensing force of motion cessation that include the use of a photoelectric cell, but such devices lack that degree of sensitivity leading to successful operation.

SUMMARY OF THE INVENTION

It is the general object of the invention to provide improved respiration monitoring apparatus and methods that accurately sense respiration and cessation of respiration without need for direct attachment to the body.

Another object of the invention is to provide respiration monitoring apparatus that utilizes a capacitor transducer for accurately sensing respiration and cessation of respiration.

Another object of the invention is to provide an apparatus and method for respiration monitoring that utilizes electrical responses from a capacitor transducer, that amplifies such responses, and that transmits the responses to either an audible or visual indicator and circuit means to notify a patient's attendant that respiration has ceased.

The invention comprises respiration monitoring apparatus and method, the apparatus including a force responsive transducer, which ideally is a capacitor transducer with movable plates, adapted for placement beneath a patient or a patient support such as a mattress. The transducer senses changes in the forces and movements caused by patient respiration. By suitably amplifying the electrical responses generated with the transducer, these responses may be fed to indicator means that provide either a visual or an audible warning that signifies when the electrical responses cease due to cessation of respiration. The indicator means are ideally a lamp, for visual warning and an audible device such as a speaker, for audible warning, to signify the cessation of electrical response. Such apparatus and method are sufficiently sensitive and accurate to sense cessation in the generally vertical, reciprocating forces generated by patient breathing. Hence, should this bodily function cease, the visual and audible alarms are energized.

In one embodiment a memory device is provided that continuously indicates that temporary cessation had occurred in the event that the patient recovers and begins breathing again.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a perspective view of respiration monitoring apparatus positioned relative to a patient lying in a conventional hospital bed in accordance with the principles of my invention.

FIG. 2 is a perspective view of a force responsive transducer, with portions thereof separated to show the construction thereof.

FIG. 3 is an electrical schematic diagram showing a preferred circuit for energizing both a visual and an audible alarm to indicate cessation of respiration.

FIG. 4 is an electrical schematic diagram of an amplifier circuit shown in block form in FIG. 3.

FIG. 5 is an electrical schematic diagram of a lamp switching circuit shown in block form in FIG. 3.

FIG. 6 is an electrical schematic diagram of an audio switching circuit shown in block form in FIG. 3.

FIG. 7 illustrates in more detail the manner in which electrical connections are made to the transducer.

FIG. 8 is an electrical schematic diagram of an alternative warning system incorporating a memory device.

FIG. 9 is an electrical schematic diagram of a rate meter for indicating the rate of respiration of a patient.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring initially to FIG. 1 of the drawing, the numeral 11 designates a force responsive transducer inserted between the mattress 13 and springs (not shown), generally under the shoulder region of a patient 15 in a reposed position in a conventional hospital bed 17. The force responsive transducer 11 is connected by a coaxial cable 19 with a console 21, which is in turn connected by multi-line conductor 23 and plug 24 with a wall socket 25 associated with a 110 volt alternating current source. As shown in FIG. 1 the console 21 has exposed on its exterior an audible alarm 27 and two visual alarms 29, 31, the operation and function of which will be explained subsequently.

Referring to FIG. 2, the force responsive transducer 11 is preferably a capacitor transducer comprised of layers of flexible, alternately conductive and nonconductive material as follows. The exterior of the capacitor 33 is of a nonconductive material such as an acrylic or cellulose, the lower side of such covering material having a flap 35 adapted to fold over and bond to the upper cover. As shown in FIG. 2 the next material from the top is preferably a flexible conductive sheet 37 of suitable material such as sheet steel that is adjacent a nonconductive sheet of material 39 that in turn lies adjacent a conductive sheet 41 on top of a nonmetallic sheet 43 adjacent an exterior conductive sheet 45 that is covered by material 33, as previously explained. The sheets 39, 41 and 43 are secured in this instance with a nonconductive strip 46. The outer conductive sheets 37 and 45 not only provide the reference plates to establish capacitance with respect to the inner plate 41 but also shield the inner plate from stray electric fields.

The coaxial cable 19 leading from the transducer to the console 21 has its center conductor 19A connected to the conductive sheet 41 as illustrated in FIG. 7. The shield 19B of cable 19 is connected to the two outer conductive sheets 37 and 45 as illustrated by connection 19B'. At the console the shield 19B is grounded as illustrated at 47. An example of a satisfactory conductive material is sheet steel metal of about 0.003 inch thickness, while a satisfactory nonconductive material is acrylic having a thickness of approximately 0.003 of an inch. The alternate layers of conductive and nonconductive material may be approximately 6 inches square. Hence, the composite transducer has the characteristics of flexibility and pliability for the purpose of accurately sensing force changes upon the mattress 13.

Referring initially to FIG. 3, which is a schematic diagram of a preferred circuit means, the numeral 11 designates the variable capacitor transducer illustrated in FIGS. 2 and 7. The cable conductor 19A is connected with the juncture 49 of a resistor 50 and a protective network 53 that comprises in this instance a biasing resistor 55 connected in parallel with diodes 57, 59, which are in turn connected with the juncture 61 of two source resistors 63 and 65, 65 being connected with ground 47 as shown.

Resistor 50 is connected with the gate 67 of a field effect transistor 60 having its drain 71 connected with a 25 volt source received from a 110 volt AC source, as will be explained in connection with FIG. 4. The source 73 of the transistor 69 is connected in series with the source resistor 63.

The juncture 61 between source resistors 63 and 65 is connected with a capacitor 75, in turn connected in series with an amplifier circuit means 77 that feeds first a lamp switching circuit 79 for selective activation of two lamps 29, 31 (see also FIG. 1) or other suitable visual indicators, and second an audio switching circuit 85 that drives a speaker 27 (see also FIG. 1).

Describing the FIG. 3 circuit operationally, the field effector transistor 69 is connected in a source follower configuration with the resistors 63 and 65, which are connected with the source, in this instance the variable capacitor 11. The resisotr 63 supplies the bias to regulate the gate cut-off point on the field effect transistor. The voltage developed across resistor 65 is supplied back to the capacitor 11 through resistor 55, and polarizes the capacitor transducer in such a way that it will act upon this voltage but will produce a variable voltage that is inversely proportional to the change in the capacitance of the transducer. This variable voltage is then sensed through resistor 50 by the gate 67 of the field effect source follower. The output of the field effect source follower is transmitted to the juncture 61 of resistors 63, 65, which are connected through capacitor 75 to the amplifier. In operation each time pressure is applied to the capacitor transducer 11, a signal appears at the output of the amplifier circuit 77. The resulting amplified signal is applied to the lamp switching circuit 79. The respiration lamp 29 responds to cyclic breathing pressure applied through the mattress 13 to the transducer. This lamp is adapted to flash each time there is breathing motion applied to the capacitance transducer by the mattress. So long as the cyclic mattress motion caused by patient breathing continues, the respiration lamp 29 will continue to light cyclically.

In the event of respiration failure of the patient, the respiration lamp will extinguish and after a period of time determined by the setting of adjustable resistor 225, the alarm lamp 31 will switch on. This in turn applies an AC signal into the audio swtiching circuit 85, which in turn closes the switching circuit in order to excite an audible alert device that can be a buzzer, but preferably is a solid state transistor signalling device that gives an audible alarm simultaneous with the emergency lamp.

Referring to FIG. 4 for an explanation of a preferred amplifier circuit, the drain 71 of the field effect transistor 69 is connected at the juncture 87 of a resistor 89 which is connected in series with the collector 91 of a transistor 93. The base 95 of the transistor 93 is connected with the juncture 94 between the output of capacitor 75 and a resistor 97, the collector 91 being connected with the juncture 99 between resistors 89 and 97. The emitter 98 of transistor 93 is connected to ground. The juncture 99 is connected with a capacitor 101 connected in series with a resistance 103, which in turn is connected at the juncture 105 of a resistor 107 and the base 109 of a transistor 111.

The juncture 105 and the base 109 of transistor 111 is connected with a diode 113 through a juncture 115 leading to a capacitor 117. A resistor 119 is connected with ground and with the juncture 121 between capacitor 117 and a capacitor 123, which is in turn connected with the juncture 125 between resistance 127 and the collector 129 of transistor 111, such juncture also connecting resistors 107 and 127 as shown. Resistor 127 is connected at a terminal 139 and thus across an unregulated 35 volts (DC). The conductor 132 and terminal 134 define the output of the amplifier circuit.

The 35 volt source is derived typically from a plug 24 of a 110 volt AC source that is connected across the primary 133A of a transformer 133, the secondary 135 that in turn is connected through a rectifier, which in this instance is a diode 137 connected between the juncture 139 between resistor 127 and capacitor 141 connected to ground as shown.

A regulator circuit comprises a transistor 143 having its emitter 145 connected at a juncture 147 between resistor 149 and a conductor 151 leading to the juncture 87 between resistor 89 and the field effect transistor 69. The collector 153 of transisotr 143 is connected with the 35 volt unregulated supply via conductor 155, and its base 157 is connected with the juncture 159 of a resistor 161 and the collector 163 of a transistor 165. The opposite terminal 167 of resistor 161 is connected with the conductor 155 and thus the 35 volt unregulated source. The base 169 of transistor 165 is connected to the juncture 171 between resistors 149 and 173. The emitter 175 of transistor 165 is connected with the cathode of a Zener diode 177, the anode of such diode being connected to ground and to resistor 173 as shown. In addition, the cathode of the Zener diode 177 is connected with the juncture 179 between a resistor 181 and the emitter 175 of transistor 165. The resistor 181 is connected at terminal 183 with the conductor 155 leading to the 35 volt source.

The regulator circuit shown is of conventional form, using a 15 volt Zener diode as a reference and a voltage divider device transistor 165 which in turn controls the base of the transistor 143, the output of the regulator then being the reference voltage difference in the voltage divider defined by resistors 149 and 173 for setting the bias operation point for transistor 165, which would be the 25 volt point plus the forward voltage drop across transistor **165.**

Operationally, the above described amplifier circuit consists of two stages, that include respectively transistor **93** and transistor **111,** having their capacitance coupled. Transistor **111** has a low pass filter of the negative feed-back type connected between the collector and the base of transistor **111.** This filter consists of capacitors **117, 123** and resistor **119.** This network provides a necessary frequency feed-back in order to give the amplifier relatively low frequency roll off so that any signals above and higher than the frequency of normal respiration signals are rejected, and the gain of the amplifier is thus extreme for such signals.

A preferred lamp switching circuit is illustrated in FIG. **5** with the output **134** of the amplifier circuit being connected in series with a resistor **185** and a capacitor **187,** which is connected at the juncture **189** between a conductor **191** and a resistor **193** leading to ground **47.** Conductor **191** leads to the juncture **195** between a resistor **197** and a diode **199,** also connected with ground. The output of resistor **197** is connected with the gate **200** of a silicon controlled rectifier **201** having its anode **203** connected in series with the lamp **29,** which is connected with the 30 volt source **204** as shown, the cathode **205** of the rectifier being connected with ground.

The anode **203** of rectifier **201** is connected through a juncture **209** with a resistor **207** in turn connected through a juncture **211** between a capacitor **213** that is grounded as shown. The diode **215** is connected in series with a resistor **217,** which is connected with the juncture **219** between a capacitor **221,** connected with ground, and a resistor **223** connected in series with a variable resistor **225** connected to the 30 volt AC source applied to the conductor **227.**

The gate **228** of a silicon controlled rectifier **229** is connected with the juncture **219** between capacitor **221** and resistors **217, 223,** while the cathode **231** is connected to ground and the anode **233** is connected with the lamp **31** and with a lamp **29** through conductor **227.** An output conductor **235** leads from the juncture **237** between lamp **31** and the anode **233** of the rectifier **229.**

Operationally, the respiration lamp switching circuit **79** comprises the silicon controlled rectifier **201** that switches the lamp **29** on each time there is a respiration signal from the transducer **11.** The anode **203** of the rectifier **201** is connected to the capacitor **213** in order to maintain a charge on this capacitor so that the emergency lamp **31** will remain off during the time that the charge is maintained. Each time rectifier **201** is energized and the respiration lamp **29** is turned on there is a negative voltage appearing at the anode **203** of the rectifier **201,** and this in turn maintains a negative charge on capacitor **213.**

With respect to rectifier **229,** the emergency lamp switching rectifier, would normally keeo the emergency light **31** energized if it were not for the negative charge maintained on the capacitor **213.** Failure of patient respiration or a failure of the respiration lamp **29** would no longer maintain a negative charge on capacitor **213,** and thus, the emergency lamp **31** would be excited. As a consequence, that in the event of failure of the respiration light **29,** the instrument will give alarm. Such a malfunction energizes the energency lamp **31** and the audible alarm (as explained subsequently) so that the patient attendant whould know that there was either an emergency or there had been a failure of the instrument. Any failure in the circuitry described thusfar will energize lamp **31;** this in turn tends to make the whole instrument essenatially fail safe.

A preferred audio switching circuit is illustrated in FIG. **6,** in which a resistor **239** is connected with the output **235** of the lamp switching circuit and with a juncture **241** between resistor **239** and a capacitor **245** connected to ground. The resistor **243** is connected with the juncture **244** between a resistor **247** and the base **249** of a transistor **251,** having its collector **253** connected with the juncture **255** between a resistor **257** and a resistor **259,** and its emitter **261** connected to ground as shown. Resistor **247** and resistor **257** are connected with a juncture **263** leading to the **35** volt DC source.

Resistor **259** is connected with the juncture **265** between a base **267** of a transistor **269** and a resistor **271** connected in series with a capacitor **273** connected with ground. The collector **275** of transistor **269** is connected to the speaker **27** connected with the 35 volt DC source at junction **263,** while the emitter **279** of the transistor is connected to ground.

Operationally, the output of the emergency switch devices (transistor) **229** of FIG. **5** charges capacitor **245** through lamp **31.** When the lamp **31** is switched on, it produces a negative charge on capacitor **245** that biases the transistor **251** in the cut-off condition so that its collector is at its maximum voltage. Under these conditions a positive bias is supplied to the base of transistor **269,** which switches on the transistor and in turn causes current to flow through an audible alert device such as speaker **27.** When the emergency lamp **31** is in the off condition, there is no charge applied to the capacitor **245,** such that transistor **251** is biased in the forward direction through resistor **247.** This in turn drops the base current to zero in transistor **269,** which in turn cuts off this transistor to prevent current flow to the audio alert device.

In hospitals, where a plurality of the devices of the present invention may be employed simultaneously to monitor the breathing of a plurality of newborn babies respectively, means is needed to allow an attendant nurse to know if a given baby has experienced temporary cessation of breathing but has subsequently recovered. For example, while the nurse is attending to one baby, a baby behind her may experience temporary cessation of breathing causing the lamp **31** of its associated monitor to be energized and its alarm **27** to sound. By the time the nurse turns around, breathing may be restored causing the monitor lamp **31** to turn off and the alarm **27** to terminate its sounding. Thus the nurse will not be able to know which baby had temporary problems from observing the monitors employed.

Referring to FIG. **8,** there will be described a circuit arrangement incorporating a memory device which will retain evidence of cessation of breathing if it occurs by the baby being monitored by a given monitor. This circuitry is a modification of that of FIG. **5** with additional components employed. In this respect, transistor **281** is substituted for silicon controlled rectifier **229** and the lamp **31** removed from the position shown in FIG. **5.** The lamp is connected as shown at **31'** in FIG. **8** to a silicon controlled rectifier **283** which is employed for memory purposes. The remainder of the circuitry of FIG. **8** comprises a transistor **285,** a unijunction transistor 287, a transistor 289 and a capacitor 297. Transistor 287 and capacitor 297 form an oscillator. Normally when a patient is breathing, transistor 281 is in a nonconductive state, transistor 285 is conducting, unijunction transistor 287 is off or in a nonconducting state, silicon controlled rectifier 283 is off or in a nonconducting state and transistor 289 is conducting. Thus lamp 31′ is off and the sound or audible alarm 27 coupled between the silicon controlled rectifier 283 and transistor 289 also is off. When transistor 281 is off, a positive bias is applied to the base of transistor 285 maintaining it in a conductive state. The resulting low potential from the collector of transistor 285 maintains the transistor 287 in a nonconducting state. The transistor 289 is biased to a conducting state through resistor 295.

When a patient stops breathing, transistor 281 becomes conductive thereby causing transistor 285 to become nonconductive. This causes the oscillator to begin oscillating for the production of positive pulses which are applied to the gate of silicon controlled rectifier 283 and negative pules which are applied to the base of transistor 289. The first positive pulse applied to the gate of silicon controlled rectifier 283 renders it in a continuous conductive state while each negative pulse applied to the base of transistor 289 renders it temporarily nonconducting. Thus since silicon controlled rectifier 283 is on and transistor 289 is turned on and off, lamp 31′ periodically is energized to flash on and off. As the lamp 31′ flashes on and off a negative pulse periodically is applied to the sound alarm 27 by way of capacitor 291 to periodically turn the sound alarm on and off also. If the patient begins to breath again transistor 281 is turned off, transistor 285 turned on which terminates oscillation of oscillator 287. Thus transistor 289 becomes conductive continuously again. Silicon controlled rectifier 283 also remains in a conductive condition thereby continuously energizing the lamp 31′ providing a memory or continuous record to allow the attendant to know from an inspection of the lamp 31′ that the patient had a temporary cessation of breathing. In order to return the lamp 31′ and silicon controlled rectifier 283 to their normal conditions, the attendant merely has to temporarily close switch 293 to ground the anode circuit of the silicon controlled rectifier 283 in order to place the rectifier in its normal nonconducting state.

Referring to FIG. 9, there is disclosed circuitry and a device which may be employed as a visual indicator of breathing in addition to the lamp 29. This circuitry comprises a rate meter and may be coupled to the amplifier of FIG. 4 at terminal 134. In the circuitry of FIG. 9, transistor 301 normally is off but is turned on each time respiration occurs. Transistor 303 normally is on when there is no respiration but becomes nonconductive when transistor 301 becomes conducting. A capacitor 305 is charged through transistor 303 when it is conducting and transistor 301 is off. When transistor 301 conducts, the capacitor 305 is discharged through diode 307 and transistor 301. When this occurs, transistor 303 is cut off by the fact that its base is more negative than its emitter. When transistor 301 turns off, transistor 303 simultaneously turns on in order to charge the capacitor 305 and the charging current is measured across resistor 309 by way of an integrator comprising capacitors 311 and 313 and variable resistor 315, the latter of which is adjusted or calibrated whereby the respiration rate of the patient may be measured. The Zener diode 319 is provided in order to regulate the voltage that is supplied to the capacitor 305 in order that the voltage supplied to it is a very accurate reference voltage.

From the above apparatus and operational descriptions, it should be apparent taht I have provided an invention having significant advantages. By placing the force responsive transducer beneath the patient as shown in FIG. 1, the respiration of the patient may be sensitively monitored. The transducer is sensitive to the generally vertical, reciprocating motions transmitted to the mattress 13 by the patient's respiration. As a consequence, should the patient's respiration be interrupted, the visual and audible alarms associated with the console will be energized for the purpose of alerting the patient's attendant. For the first time an apparatus has been provided that possesses sufficient sensitivity to monitor accurately respiration without requiring direct attachment to the patient.

While the invention has been shown in only one of its forms, it should be apparent to those skilled in the art that it is not so limited but is susceptible to various changes and modifications without departing from the spirit thereof. The specific form of force responsive transducer is not limited specifically to the capacitor transducer shown and described, and the configuration of the capacitor transducer itself may be varied widely within the broad scope of the invention. In addition, the invention is not limited in its broadest sense to the specific form of circuitry shown by way of preferred embodiment, since there are alternate circuit configurations capable of producing the intended, satisfactory result.

I claim:

1. A system for monitoring the respiration of a patient comprising:

a flexible force responsive capacitor means for placement beneath a patient or patient support for sensing the respiration of a patient,

said capacitor comprising:

three layers of flexible sheets of electrically conductive material,

a flexible sheet of electrically non-conductive material located between adjacent sheets of conductive material to form alternate layers of conductive and non-conductive sheets of material,

the outer conductive sheets being larger than the center sheet and having their peripherical edges substantially contiguous to each other so as to provide effective electrostatic shielding for the center conductive sheet,

said flexible layers of conductive material being sensitive to changes in forces applied thereto and caused by the respiration of a patient,

an electrical conductor connected to the center sheet of conductive material,

an electrical conductor connected to the outer sheets of conductive material, and

flexible non-conductive material surrounding and covering said outer layers of flexible sheets of conductive material,

means connected to said conductors for applying a substantially constant voltage across said capacitor, and monitor means coupled to said capacitor means for monitoring the respiration of a patient.

2. A system for monitoring the respiration of a patient comprising:

a capacitor transducer means capable of sensing force changes applied thereto and caused by the respiration of a patient,

said transducer being a thin, flexible, pad-like member, comprising:

a plurality of thin flexible layers of electrically conductive material including two outer layers,

a thin flexible layer electrically nonconductive material located between adjacent layers of conductive material to form alternate layers of conductive and nonconductive material,

two electrical conductors connected to certain ones of said conductive layers to form a capacitor having two plate means, one of which includes the outer conductive layers of material electrically connected together,

the other plate means being located between said outer conductive layers of material,

the outer layers of said conductive material having their peripherical edges extending beyond said other plate means and substantially contiguous to each other so as to provide effective electrostatic shielding for said other plate means, and

flexible electrically nonconducting material surrounding and covering said outer conductive layers

said flexible layers of conductive material being sensitive to changes in forces applied thereto and caused by the respiration of a patient,

means connected to said conductors for applying a substantially constant voltage across said capacitor transducer, and

monitor means coupled to said capacitor transducer means for monitoring the respiration of a patient.

3. The system of claim 2 wherein said means for applying a substantially constant voltage across said capacitor supplies a substantially constant voltage of less than 25 volts D.C.

4. The system of claim 2 wherein said plurality of layers of electrically conductive material comprise an odd number of layers.

5. The system of claim 2 including the combination therwith of a memory system comprising:

a lamp indicator means,

circuitry means coupled to said capacitor transducer for periodically energinzing said lamp indicator means to cause said lamp indicator means to flash on and off when respiration ceases,

said circuitry including means for continuously energizing said lamp indicator means if respiration begins following cessation thereof.

6. The apparatus of claim 5 wherein said circuitry comprises:

normally electrically nonconducting means coupled to said lamp indicator means and which is rendered electrically conductive by the application of a signal thereto and which remains in a conductive state following termination of said signal,

a normally conducting means coupled to said normally nonconducting means for providing a flow path of energy from said normally nonconducting means, and

oscillator means coupled to said normally nonconducting means and to said normally conducting means and responsive to cessation of respiration for producing periodic signals for rendering conductive said normally nonconducting means and for periodically rendering said normally conducting means nonconductive to periodically cuase said lamp indicator means to flash on and off.

7. A system for monitoring the respiration of a person comprising:

a capacitor transducer means capable of sensing force changes imparted to a mattress or the like due to the respiration of a person while supported by the mattress,

said transducer being a thin, flexible, pad-like member comprising:

alternate layers of thin flexible sheets of electrically conductive and nonconductive material forming a thin and flexible capacitor having a ratio of surface area in the plane of said pad-like member relative to its thickness through said sheets of greater than 500 to one,

the number of layers of conductive material being greater than two,

two electrical conductors connected to certain ones of said conductive sheets of material to form a capacitor having two plate means, one of which includes the outer conductive sheets of material electrically connected together,

the other plate means being located between said outer conductive sheets of material,

the outer layers of said conductive sheets of amterial have their peripherical edges extending beyond said other plate means and substantially contiguous to each other so as to provide effective electrostatic shielding for said other plate means, and

thin flexible electrically nonconductive material surrounding and covering said outer layers of electrically conductive sheets of material,

said flexible sheets of conductive material being sensitive to changes in forces applied thereto and caused by the respiration of a patient,

means connected to said conductors for applying a substantially constant voltage across said capacitor transducer, and

monitor means coupled to said capacitor transducer means for monitoring the respiration of a patient.

8. The system of claim 7 wherein the number of layers of conductive material comprise an odd number of layers.

9. A system for monitoring the respiration of a patient comprising the combination of:

a capacitor transducer means capable of sensing force changes applied thereto and caused by the respiration of a patient,

said capacitor transducer comprising a thin, flexible pad-like member including alternate layers of thin flexible sheets of electrically conductive and nonconductive material forming a thin and flexible capacitor having a number of layers of conductive material greater than two,

two electrical conductor means connected to certain ones of said conductive sheets of material to form a capacitor having two plate means, one of which includes the outer sheets of conductive material electrically connected together and to one of said conductor means,

circuitry means connected to said electrical conductor means and to be supplied with energy from a supply of electrical energy for producing a substantially constant voltage for application to said capacitor transducer,

said circuitry comprising:

regulator means for producing a regulated supply of voltage from said supply of electrical energy, and

a field effect transistor connected in a source follower configuration and having its drain connected to the output of said regulator means; its gate connected to the other of said conductor means and hence to said other plate means of said capacitor transducer; its source connected to said one conductor means by way of a source biasing resistor and a load resistor; and a gate return resistor having one terminal connected to said gate and the other terminal connected to the juncture between said source biasing resistor and said load resistor and

monitor means coupled to the source of said field effect transitor for monitoring the respiration of a patient.

10. The system of claim **9** wherein said capacitor transducer means includes three conductive layers of material, the outer layers of conductive material being larger than the center layer and having their peripherical edges substantially contiguous to each other to provide effective electrostatic shielding for the center layer.

11. A method of monitoring the respiration of a person supported on a mattress or the like comprising the steps of:

locating a capacitor transducer at a position sufficient to sense force changes imparted to the mattress caused by the respiration of the person while supported by the mattress,

said capacitor transducer comprising:

three layers of flexible sheets of conductive material,

a flexible layer of non-conductive material located on opposite sides of the center sheet of conductive material,

the flexible layers of non-conductive material on opposite sides of said center sheet of conductive material having their edges connected together forming an inner member having a covering of non-conductive material surrounding said center sheet of conductive material,

an exterior flexible non-conductive layer of material covering the outward facing side of each of the outer sheets of conductive material,

the exterior flexible non-conductive layers of material having their edges connected together forming an exterior covering of non-conductive material surrounding said outer sheets of conductive material with said inner member located between said outer sheets of conductive material,

said outer sheets of conductive material being larger in their planes than said center sheet of conductive material and having their peripherical edges extending beyond the peripherical edges of said center sheet of conductive material so as to provide effective electrostatic shielding for said center sheet of conductive material,

said flexible layers of conductive material being sensitive to changes in forces applied thereto and caused by the respiration of a patient,

an electrical conductor connected to said center sheet of conductive material, and

an electrical conductor connected to said outer sheets of conductive material,

applying a substantially constant voltage to said two conductors and hence across said capacitor transducer,

sensing capacitive changes between said layers of flexible sheets of conductive material due to force changes applied thereto due to the respiration of said person,

converting said sensed capacitive changes into electrical responses,

amplifying said electrical responses, and

applying said electrical responses to a monitor means.

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