MATTRESS ALARM

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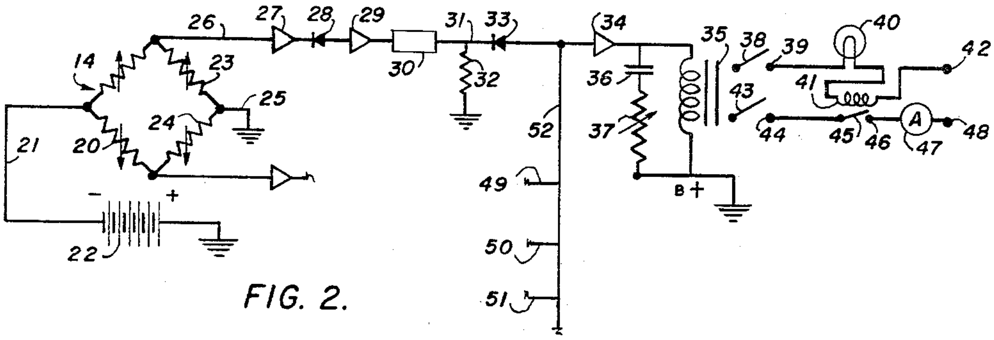

FIG. 2.

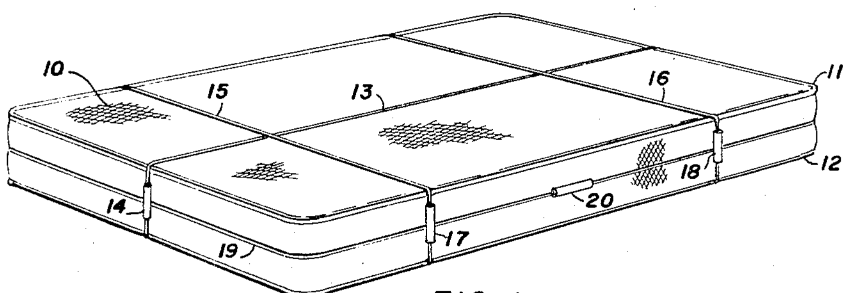

FIG. 1.

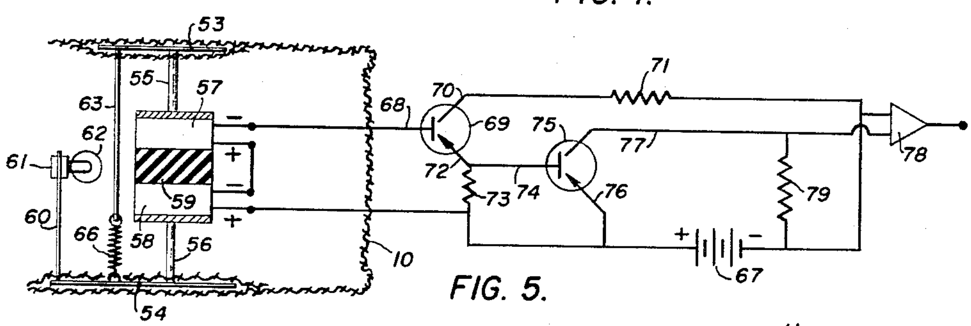

FIG. 5.

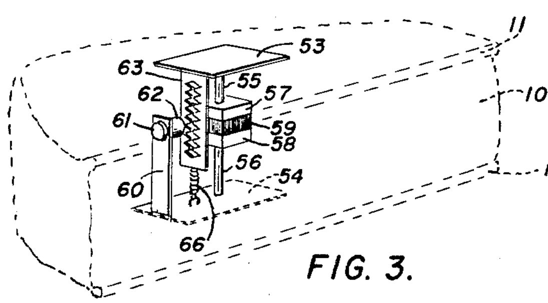

FIG. 3.

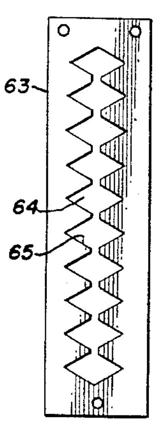

FIG. 4.

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MATTRESS ALARM

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This invention relates to alarm mechanisms and has reference to a mattress alarm for hospitals or the like.

In nurseries, rest homes and hospitals patients or occupants not under individual surveillance or care are subject to the hazard of drug reactions or side effects, and can lapse into coma and may expire without detection for want of the ability to attract attention to their calamitous circumstances. Indeed, if a patient stops breathing and approaches death, the possibility of discovery in time for life-saving emergency treatment is quite remote in the absence of a special nurse or other attendant who might render or seek immediate aid.

In a normal respiration cycle a patient imports reactive forces to the mattress upon which he lies, and such forces, if kept under constant surveillance could be used as a clear indication of continuing life processes. Conversely, any alarm or indication brought about by the absence of such motion upon a mattress would indicate that the patient has discontinued processes necessary for continuation of life, or has left the bed; either even should be called to the immediate attention of attendants on duty since the latter could mean that the patient has fallen from the bed and may be grieviously injured.

It is the absence, rather than the presence, of reactive forces upon a hospital mattress which indicates a cause for alarm. It is the abnormal, rather than the normal, circumstance which gives rise to the need for continuous rather than periodic surveillance. If a nurse's attention can be called immediately to the abnormal status of a given patient, then the routine burden of maintaining periodic surveillance for a great number of patients can be greatly reduced and the probability of timely discovery of impairment or interruption of necessary life processes can be greatly enhanced.

Accordingly, an object of the present invention is to provide an alarm responsive to reactive forces upon a mattress.

Another object of the invention, an alarm which is operative upon the absence of, rather than the presence of, reactive forces upon a mattress.

A further object of the invention is to provide an alarm system capable of indicating the discontinuance of respiration of a patient, but which has no part of the alarm system actually attached to the body of the patient.

An important object of the invention is to provide an alarm adaptable to detect reactive forces upon a mattress as may be caused by the breathing of a patient without detecting lesser motions such as breeze ripples upon bed covers which might falsely indicate a situation of well being.

A particular object of the invention is to provide a hospital alarm capable of the detection of the absence of reactive forces upon a mattress corresponding in time intervals to normal respiration cycles.

A further object of the invention is to provide a hospital alarm which may continue to operate for an extended period of time in the event of a power failure.

An additional object of the invention is to provide a hospital alarm system which may be used simultaneously for a number of patients, indicating only abnormal circumstances, if any, of one or more of those patients.

These and other objects will become apparent from the following description and the accompanying drawing, wherein:

FIGURE 1 is a perspective view of a mattress having strain gauges and straps attached thereto in accordance with the present invention.

FIGURE 2 is a schematic diagram shown partially in block form of an electrical circuit of the present invention.

FIGURE 3 is a partially fragmentary perspective view of an alternate form of the invention.

FIGURE 4 is an enlarged front elevational view of a shutter illustrated as a component in FIGURE 3.

FIGURE 5 is a partially sectional side elevational view of the alternate form of the invention illustrated in FIGURE 3 and is shown with ancillary electrical components in schematic form.

In the drawing, a mattress 10, including the usual upper and lower bindings 11 and 12, in centrally and longitudinally encircled by a longitudinal strap 13 connected at its opposite ends to corresponding ends of a vertically strain gauge 14 positioned at the foot of the mattress. Transverse straps 15 and 16 are spaced from one another and transversely encircle the mattress 10 and are respectively connected at their opposite ends to corresponding ends of vertically disposed strain gauges 17 and 18 positioned at one side of the mattress. A circumferential strap 19 encircles the mattress 10 between the bindings 11 and 12 thereof and is connected at its opposite ends to corresponding ends of a horizontally disposed strain gauge 20, also positioned at one side of the mattress. The straps 13, 15, 16 and 19 are tightly fitted to the mattress and hold the same in compression so that the bulk of the mattress tends to extend the straps and hold the strain gauges 14, 17, 18 and 20 in a partially extended or stretched condition. Other straps and strain gauges (not shown) may be placed about the mattress at various positions and orientations with the strain gauges located at the sides or lower surface of the mattress.

For purposes of the present invention, a strain gauge may be defined as an electrical device having a resistance or output which varies in accordance with changes in applied extending or compressing forces. A particular construction for a strain gauge to be located within a mattress is described herein in connection with an alternate form of the invention, but it is to be understood that a variety of strain gauges including simple carbon compression devices as are well known in the art may be used with the present invention.

Electrically, each strain gauge is part of a separate circuit adapted to give an alarm in the absence of a change of physical forces upon at least one strain gauge secured to a mattress. With particular reference to FIGURE 2, strain gauges 14 and 20 have been arbitrarily selected for purposes of illustration and are shown as variable resistances which are each connected at one end through a cable 21 to the negative terminal of the battery 22. Preferably, the battery 22 is a storage cell provided with a trickle charger (not shown) connected to a conventional AC outlet. The strain gauges 14 and 20 are respectively connected at their other ends to variable resistors 23 and 24 which are, in turn, connected to the positive terminal end of the battery 22 by a common conductor 25. Hence, one strain gauge 14 and its variable resistor 23 are connected in parallel with the other strain gauge 20 and its variable resistor 24 with respect to the terminals of the battery 22. Each strain gauge attached to, or constructed within a mattress is wired in series with a variable resistor and in parallel with all other paired strain gauges and variable resistors of that mattress.

Considering now only one strain gauge 14, the input line 26 of a DC amplifier 27 is wired to the electrical junction of that strain gauge and its corresponding variable resistor 23. The output of the DC amplifier is electrically connected to a diode 28 which is, in turn, connected to the input of a pulse shaper **29** which may be any square wave generating device having a positive output and an input responsive to positive pulses of extremely low frequency. The output of the pulse shaper **29** is fed to the input of a monostable multivibrator **30** which is well-known in the art and often termed a "one-shot." The output **31** of the monostable multivibrator **30** is electrically connected to the positive terminal of the battery **22** through a resistor **32**, and one terminal of a diode **33** is also connected to the output line **31** of the monostable multivibrator **30** and the other terminal of the diode is connected to the input of an amplifier (Class A) **34**. The output of the Class A amplifier **34** is connected to one terminal of the coil of a normally closed double pole single throw relay **35**; the other terminal of the coil of the relay **35** is connected to the positive terminal of the battery **22**. A condenser **36** has one of its terminals wired to the output of the Class A amplifier **34** and its other terminal electrically connected to the terminal of the battery **22** through a variable resistor **37**. A first armature **38** of the normally closed double pole single throw relay **35** is electrically connected to one terminal of an AC power source (not shown) and the contact point **39** of the first armature **38** is connected to one electrical terminal of a light bulb **40** or to any other visual or audible alarm device or signal. The other terminal of the light bulb **40** is connected to one end of the coil of a normally closed single pole single throw relay **41**, whereas the other end of the coil of the single pole single throw relay is connected to the other terminal of the previously described AC power source. The other armature **43** of the double pole single throw relay **35** is connected to an auxilliary battery (not shown) which may be provided with a trickle charger. The contact point **44** of the second armature **43** of the double pole single throw relay **35** is electrically connected to the armature **45** of the single pole single throw relay **41**. The contact point of the single pole single throw relay **41** is wired to an auxilliary alarm device **47** which is, in turn, wired to the other terminal **48** of the auxilliary battery previously described. The auxiliary alarm **47** may be any visual or audible alarm or signaling device or may be several such devices in combination and preferably includes an electrically triggered but spring wound bell-type alarm.

In operation, motion (including breathing) of a person upon a mattress **10** causes changes in the tension of the longitudinal strap **13**; these changes are imparted to the opposite ends of the strain gauge **14** as changes in tension which alter the electrical resistance of the strain gauge. The variable resistance **23** regulates the current which flows through the strain gauge within its range of operating resistances and can be adjusted to control the detection sensitivity of the invention. Any change in the resistance of the strain gauge **14** results in a change in the input line **26** of the DC amplifier **27**, but only the positive going portions of change cycles appearing at the output of the DC amplifier are passed by the diode **28** which serves as a pulse clipper. In the pulse shaper **29**, rectified waves, or other positive going pulses passed by the diode **28** are transformed to square wave pulses. It should be noted that the output of the pulse shaper **29** may occur as pulses of various amplitudes passing into the input of the monostable multivibrator **30**, but the output pulses of the monostable multivibrator are inherently constant in amplitude and time duration. The diode **33** passes only the positive going portions of the output of the monostable multivibrator **30** which are amplified by the Class A amplifier **34** and impressed upon the coil of the double pole single throw relay **35** and the condenser **36**. The Class A amplifier is biased to 0 output in the absence of a pulse from the monostable multivibrator **30**, so that output pulses of the Class A amplifier tend to charge the condenser **36** and to keep the normally closed double pole single throw relay **35** in its abnormal or open state. The variable condenser **37** controls the leakage and hence the

discharge of the condenser **36** and thus determines the frequency with which pulses must appear at the output of the Class A amplifier **34** in order to keep the normally closed double pole single throw relay **35** in its abnormal or open state. Negative going transient pulses which may appear at the output of the monostable multivibrator **30** are blocked by the diode **33** and are diverted to the positive terminal of the battery **22** through the resistor **32**.

Upon failure of a pulse to appear at the output of the Class A amplifier within a preset time internal, current sufficient to maintain the double pole single throw relay **35** in its abnormal state will cease to flow through the coil of that relay and its armatures **38** and **43** will return to their normal condition in electrical contact with their respective contact points **39** and **44**. AC current flowing through the first described armature **38** and its contact point **39** lights the filament of the bulb **40** which is wired in series with the coil of the single pole single throw relay **41**; through the single pole single throw relay **41** the AC current which operates the alarm light **40** also interrupts the auxilliary DC circuit which would otherwise flow through the second armature **43** of the double pole single throw relay and its contact point **44** to operate the auxilliary alarm **47**. Variable condensers **14** and **37** respectively control the sensitivity of detection of motion of the invention and the time domain of pulses necessary to keep an alarm from operating.

The horizontally disposed strain gauge **20** is connected in the same manner as described vertical strain gauge **14** to a DC amplifier, clipper, pulse shaper, monostable multivibrator, and diode as previously described for a vertically disposed strain gauge **14**. In the same manner, each strain gauge is electrically connected to an identical set of components as previously described for the vertically disposed strain gauge **14**, but the output for the diodes corresponding to the diode **33** previously described are connected in common to the input of the Class A amplifier **34** with their respective terminals **49** through **51** and a common conductor **52** as indicated in FIGURE 2. Hence, a change in physical forces upon any strain gauge, results in the appearance of a positive pulse at the input of the Class A amplifier and of an output pulse therefrom which charges a condenser **36** and maintains the double pole single throw relay in its abnormal or open condition.

An alternate form of the invention in illustrated FIGURES 3, 4 and 5, compression type strain gauges are interiorly located within the mattress **10** and extend between an upper and lower surface thereof. Generally, the strain gauge illustrated consists of a frame extending between upper and lower surfaces of the mattress and having the resilient portion integrally constructed as part of the frame so that motion anti-compression of the mattress is detected as a corresponding compression of the frame. A light bulb is supported by the lower portion of the frame and a relative motion between the shutter and the light bulb causes variations in the resistance of photo conductive cells carried by the frame.

For this particular reference to FIGURE 3, an upper plate **53** and a lower plate **54** are horizontally disposed, one above the other, and are positioned interiorly of the mattress **10** in contact with the upper and lower surfaces thereof. An upper compression post **55** of tubular construction is affixed to the lower surface of the upper compression plate **53** and projects perpendicularly downwardly therefrom. In like manner, the lower compression post **56** is affixed to the upper surface of the lower compression plate **54** and projects upwardly therefrom in coaxial alignment with the upper compression post **55**. An upper photo conductive cell **57** is affixed to the lower end of the upper compression post **55**, and a lower photo conductive cell **58** is affixed to the upper end of the lower compression post **56**. The photo conductive cells **57** and **58** are spaced from one another and each is oriented so that its light sensitive parts face horizontally and rearwardly. The resilient spacer **59** is respectively attached at its upper and lower surfaces to the upper and lower photo conductive cells **57** and **58**; preferably, the resilient spacer **59** is constructed as a block of rubber. A lamp bracket **60** projects upwardly from the lower compression plate **54** at a position thereon spaced rearwardly from the lower compression plate **56**. A light socket **61** projects forwardly from the lamp **60** at the level of the resilient spacer **59** and a light bulb **52** is received by the socket **61**. A shutter **63** comprising an elongated metal plate having an aperture **64** consisting of notched or saw-toothed lateral edges **65** is attached to and depends downwardly from the upper compression plate **53** between a light bulb **62** and the photo conductive cells **57** and **58**. The lower end of the shutter **63** is spaced from but connected to the lower compression plate **54** by a coil spring at **66** having a spring tension which is very small when compared to the force required to achieve significant compression of the resilient spacer **59**.

As shown in FIGURE 5, the photo conductive cells **57** and **59** are wired in series and are directly connected to the positive terminal of a D.C. power source **67**. The other terminal of the series wired photo conductive cells **57** and **59** is connected to the base **68** of a transistor **69** having its collector **70** connected to the negative terminal of the D.C. power source **67** through a resistor at **71**. The emitter **72** of the transmitter **69** is connected to the positive terminal of the D.C. power source **67** through a biasing resistor **73** and the emitter **72** is also connected to the base **74** of a second transistor **75** having its emitter **76** electrically connected to the positive terminal of the D.C. power source **67** and having its collector electrically connected to the input of a D.C. amplifier like the D.C. amplifier **27** previously described, and also having its collector connected to the negative terminal of the D.C. power source **67** through a transistor **79**.

In operation of the alternate form of the invention, displacement of the compression plates **53** and **54** relative to one another, displaces the shutter **63** relative to the bulb **62** and also, to a certain extent, displaces the photo conductive cells **57** and **58** relative to one another. Linear displacement of the shutter **63** may be substantially identical with the linear displacement of an upper photo cell **57**, but proximity of the shutter to the bulb **62** effects a difference in the angular displacement of these two elements with respect to the bulb so that a change in the amount of illumination passing through the shutter to the upper photo conductive cell is accomplished. It should be noted that characteristics of the illustrated strain gauge can be altered merely by changing the configuration of the edges of the aperture so that within a given range the electrical characteristics of the strain gauge can be made linear with respect to applied pressure, or can be given exponential or logarithmic characteristics, if desired. On the other hand, caution should be exercised to make certain that an edge **65** of the aperture **64** is not such that displacement of the compression plates **53** and **54** relative to one another does not bring about complementary effects in the photo conductive cells **57** and **58**. Because the two cells are wired in series with one another, the net effect of displacement of the shutter is the sum of the resistances of the two photo conductive cells **57** and **58**; if the edge **65** of the aperture **64** of the shutter **63** is such that increase in illumination on one photo conductive cell leads at the same time to a decrease in illumination of the other photo conductive cell, then the two will tend to compensate for one another and the total electrical resistance will remain unaltered. Simple geometric considerations may be used to avoid this result when its avoidance is desired.

It should also be noted that aperture configuration of the shutter **63**, as illustrated, can provide gain control characteristics for the output of the strain gauge in that respiratory motion of a heavy person may yield substantially the same result as that of a much lighter person, the only difference being that different saw tooth edges are

interposed between the lamp **62** and the photo conductive cells **57** and **58**.

The invention is not limited to the exemplary construction herein shown and described, but may be made in various ways within the scope of the intended claims.

What is claimed is:

1. In an alarm including a mattress,

a strap exteriorly encompassing said mattress and having opposite ends terminating at a side of said mattress,

an electrical resistance type strain gauge having its operative opposite ends respectively attached to said opposite ends of said strap,

means providing an electrical potential across the resistive component of said strain gauge,

electrical pulsing means for producing a pulse for substantially each change in electrical current flowing through said resistive component of said strain gauge,

and alarm means connected to said pulsing means and responsive to the prolonged absence of electrical pulses of said pulsing means.

2. The invention as defined in claim **1** and wherein said alarm means includes a normally closed single throw relay,

a signal device wired in series with the armature of said relay and the normally closed contact point thereof,

a diode wired in series with the coil of said relay,

a condenser wired in parallel with said coil of said relay and in series with said diode,

a resistor wired in series with said condenser and in parallel with said coil of said relay,

and means electrically connecting said diode to said pulsing means.

3. In a mattress,

an alarm including an electrical strain gauge for producing a series of current changes having a given rate of occurrence in response to a series of strains placed upon said strain gauge,

means operatively connecting said strain gauge to exterior surfaces of said mattress,

pulsing means electrically connected to said strain gauge and responsive to changes in electrical current in said strain gauge,

means providing an electrical potential across said strain gauge,

and alarm means for providing a perceptable indication in response to a rate of occurrence of said pulses below said given rate.

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