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(54) **VIBRATING PATIENT SUPPORT APPARATUS WITH A RESONANT REFERENCING PERCUSSION DEVICE**

(76) Inventors: **Jean-Paul Dionne**, Levis (CA); **Melanie Dostaler**, Quebec (CA)

Correspondence Address:
HOWARD & HOWARD ATTORNEYS, P.C.
THE PINEHURST OFFICE CENTER, SUITE #101
39400 WOODWARD AVENUE
BLOOMFIELD HILLS, MI 48304-5151 (US)

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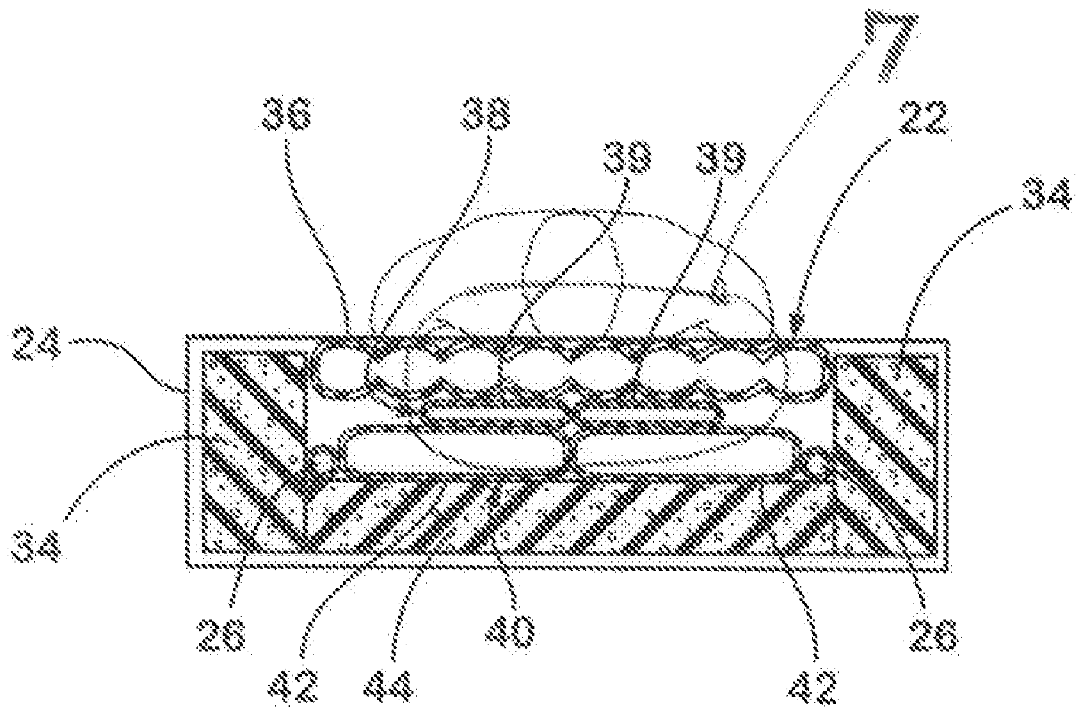
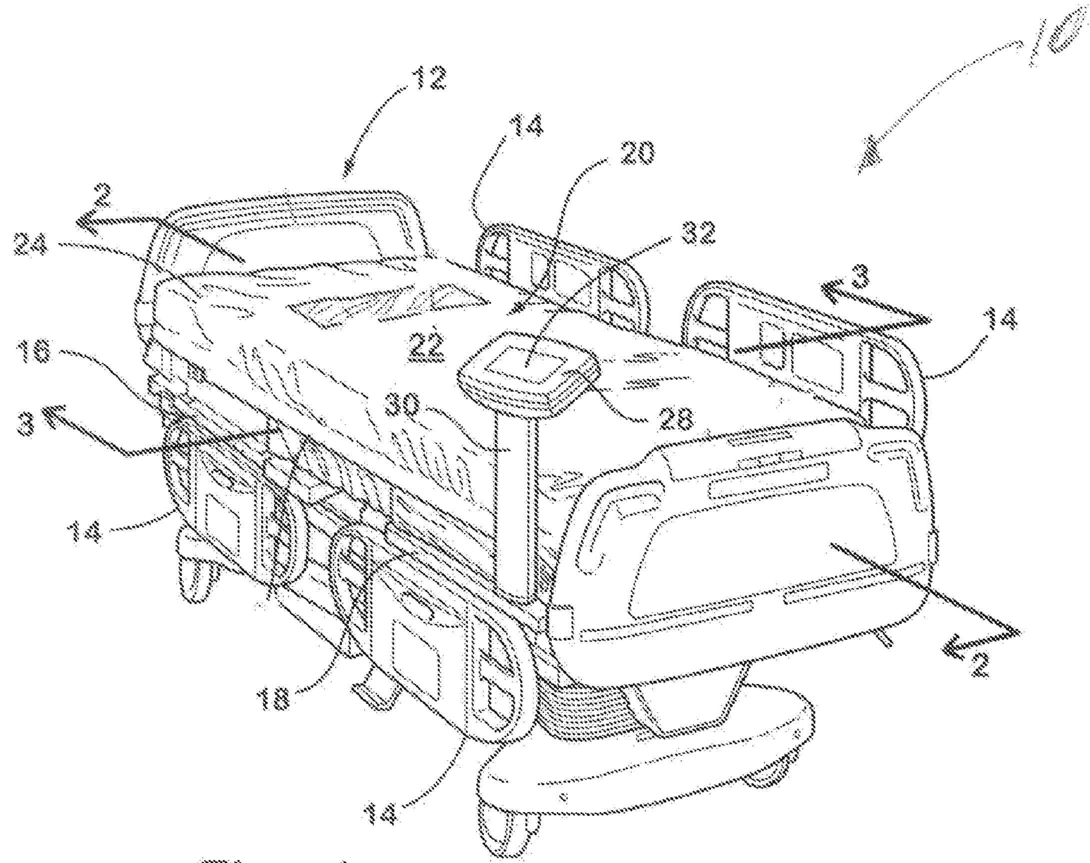
(57) **ABSTRACT**

A vibrating patient support apparatus has a resonant referencing percussion device preferably located internally to a cover of a mattress of the apparatus. The percussion device delivers a percussion or vibration at a controlled operating frequency that is preferably slightly less than a resonant frequency located internal to the mattress of the apparatus. With the various weight distributions of a patient, the device is capable of determining the ever shifting resonant frequency via control signals received by a controller from a pressure sensor or accelerometer of the device. Because the operating frequency is slightly less than the natural resonating frequency, energy of the system is conserved. Because the operating frequency is not the controller calculated resonant frequency, wear on the device and potential damage is minimized.

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14
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24
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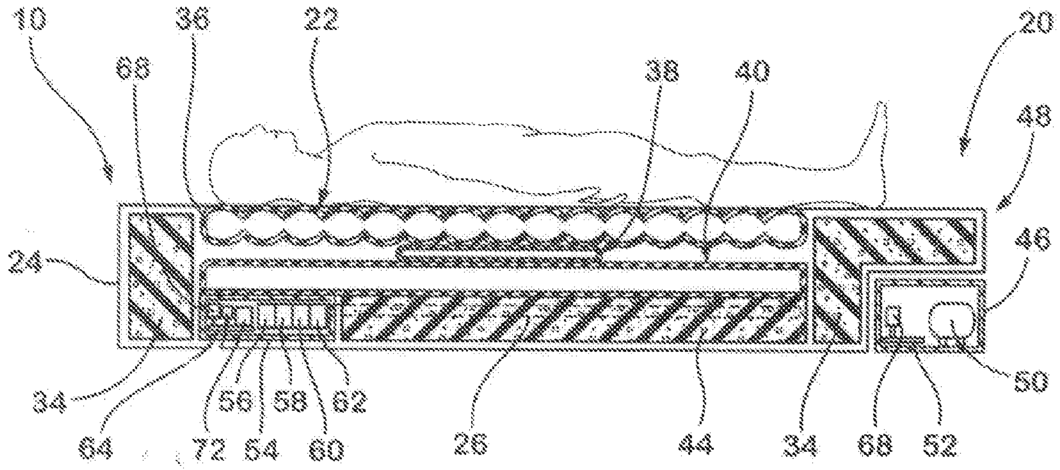
28
30
18

Fig. 1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36
22
20
68
38
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34
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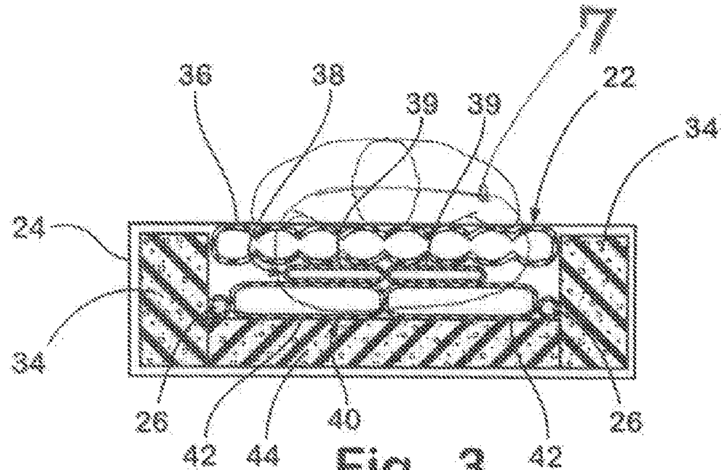
26
44
68
52
50

Fig. 2


36
38
39
39
7
22
34
24
34
26
42
44
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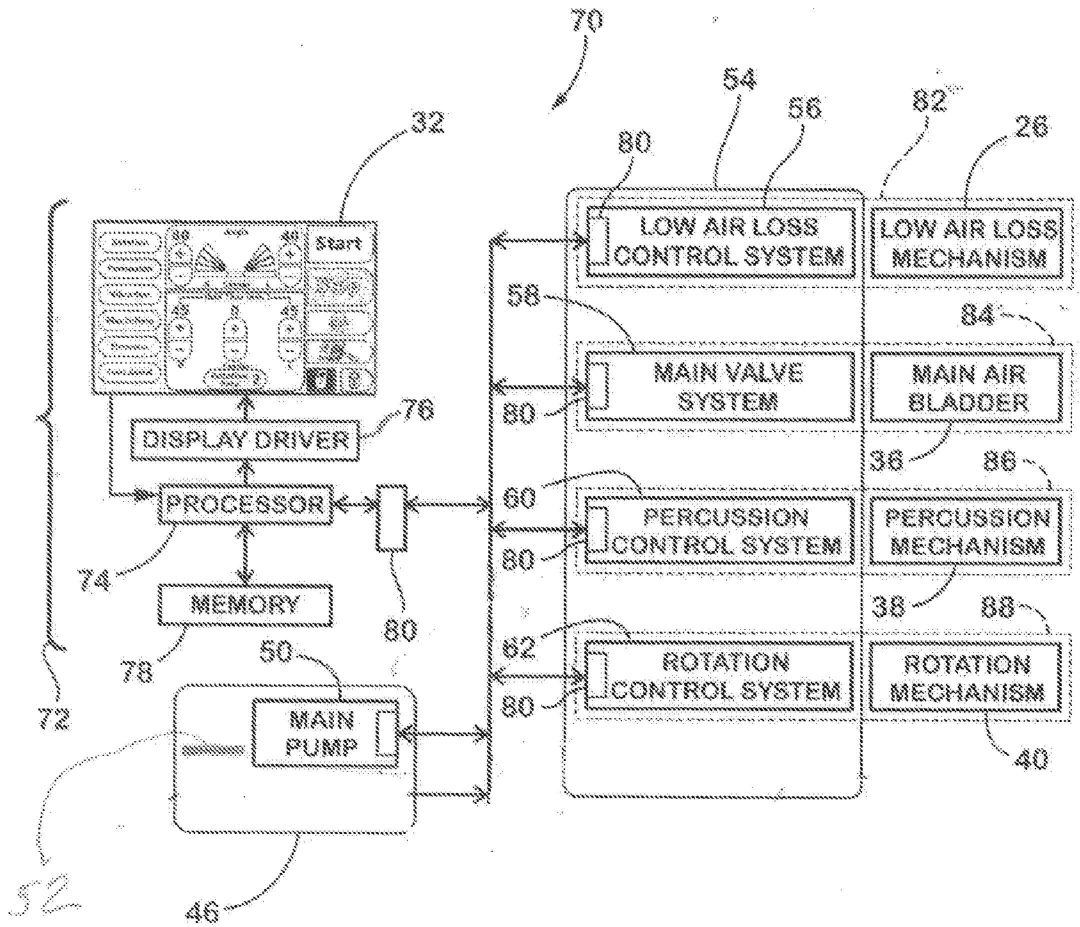
42
26

Fig. 3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32
Start
DISPLAY DRIVER
76
PROCESSOR
74
MEMORY
78
72
80
50
MAIN
PUMP
52
46
54
56
82
26
80
LOW AIR LOSS
CONTROL SYSTEM
LOW AIR LOSS
MECHANISM
58
84
MAIN VALVE
SYSTEM
80
MAIN AIR
BLADDER
36
86
60
PERCUSSION
CONTROL SYSTEM
80
PERCUSSION
MECHANISM
38
88
62
ROTATION
CONTROL SYSTEM
80
ROTATION
MECHANISM
40

Fig. 4

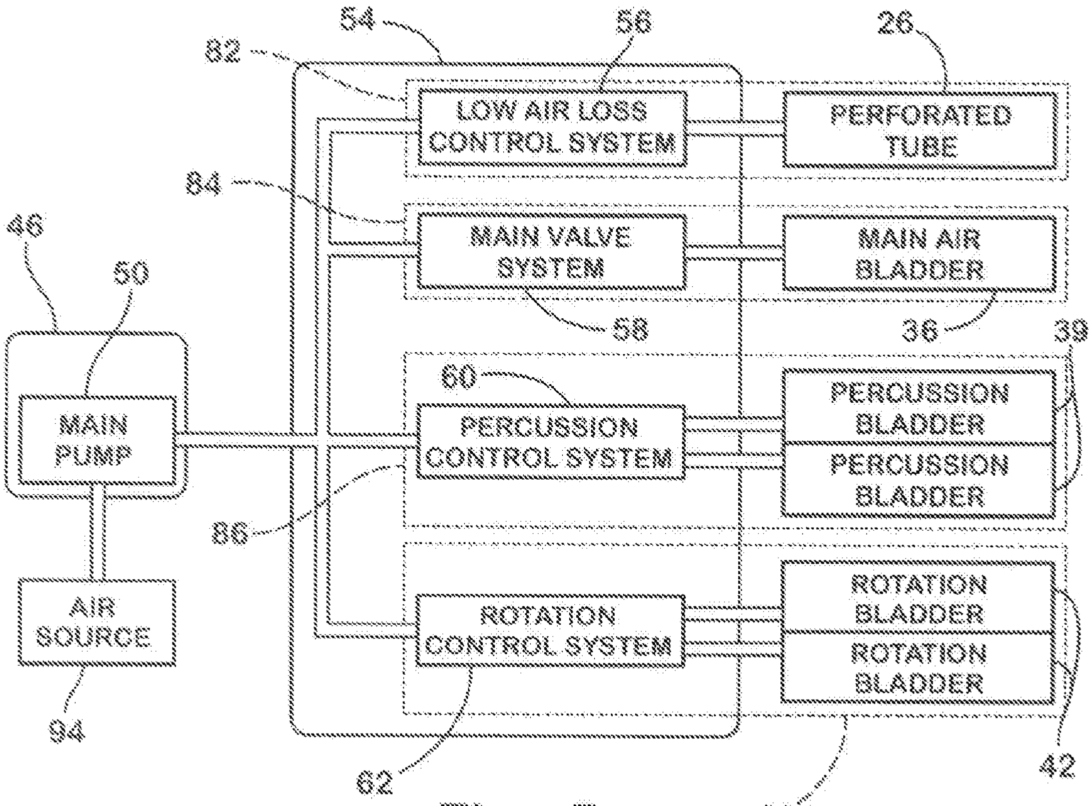
54
56
26
82
LOW AIR LOSS CONTROL SYSTEM
PERFORATED TUBE
84
MAIN VALVE SYSTEM
MAIN AIR BLADDER
46
50
58
36
39
60
MAIN PUMP
PERCUSSION CONTROL SYSTEM
PERCUSSION BLADDER
PERCUSSION BLADDER
86
ROTATION CONTROL SYSTEM
ROTATION BLADDER
ROTATION BLADDER
AIR SOURCE
94
62
42
88

Fig. 5

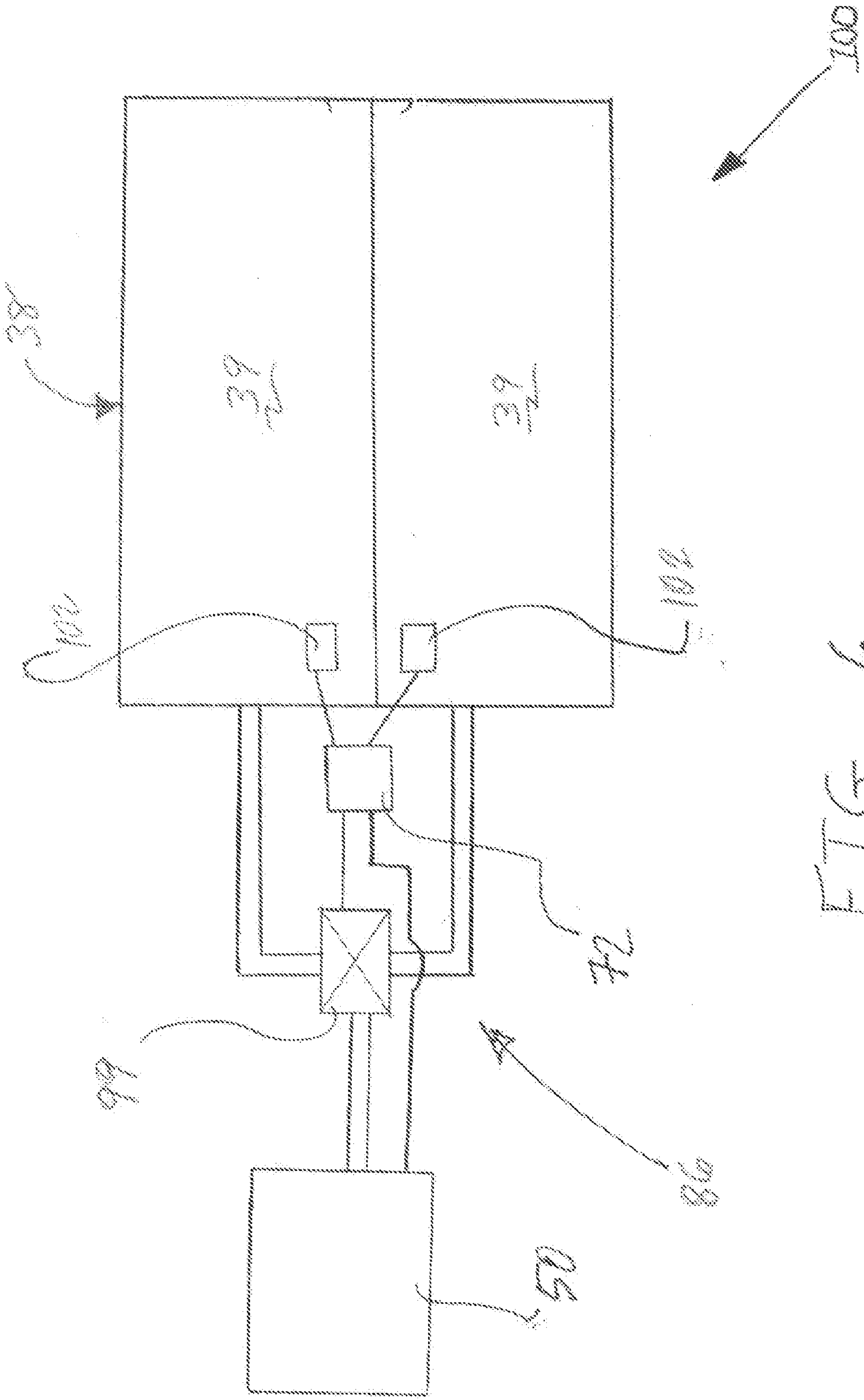

FIG. 6

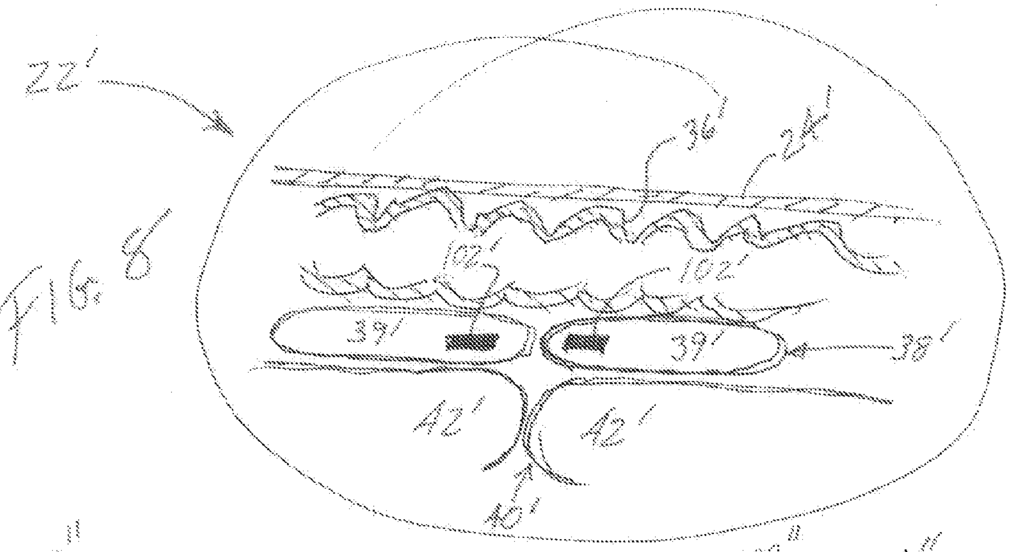

FIG. 8

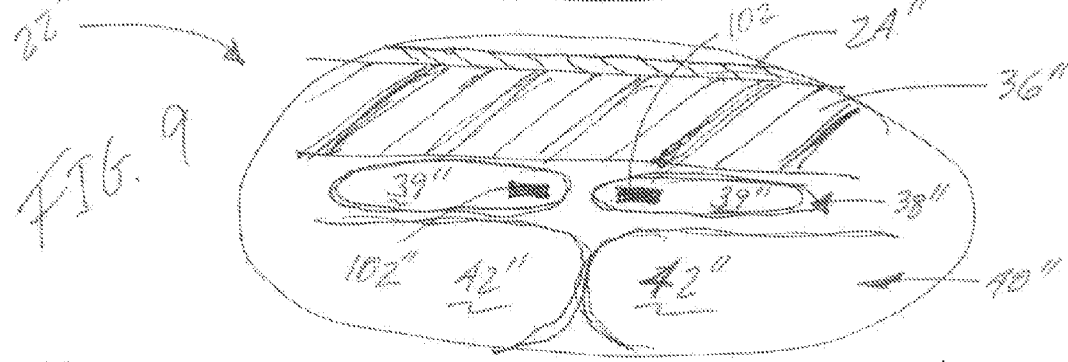

FIG. 9

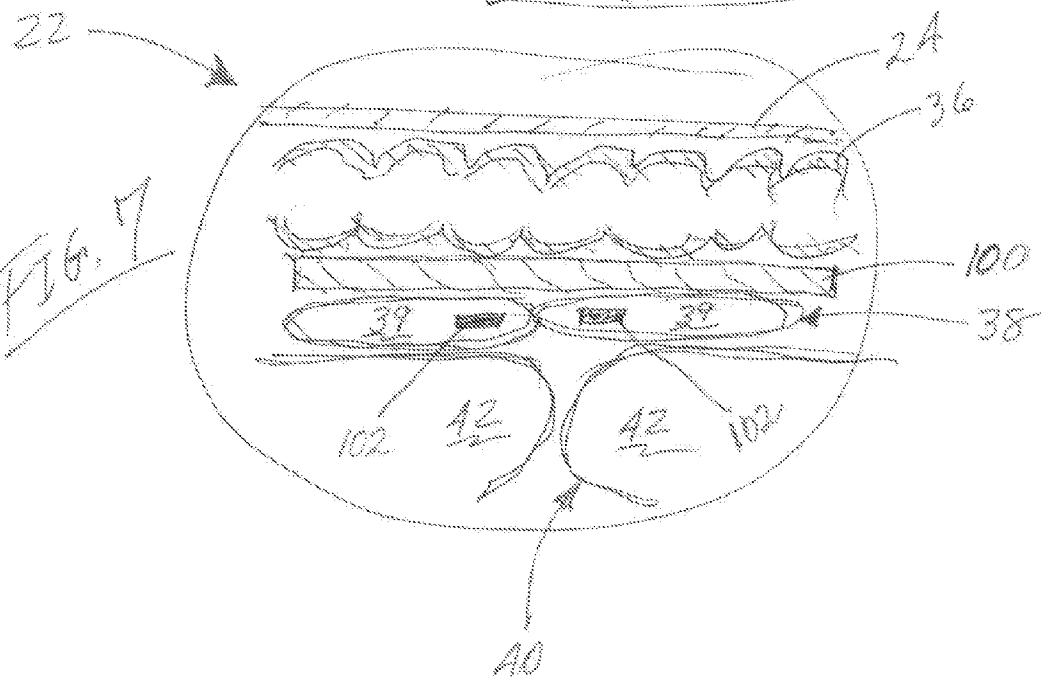

FIG. 7

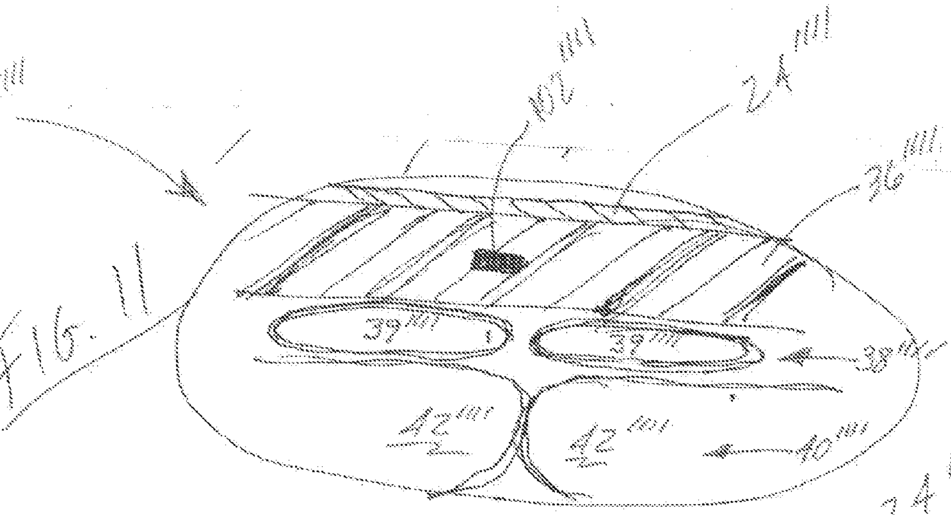

FIG. 11

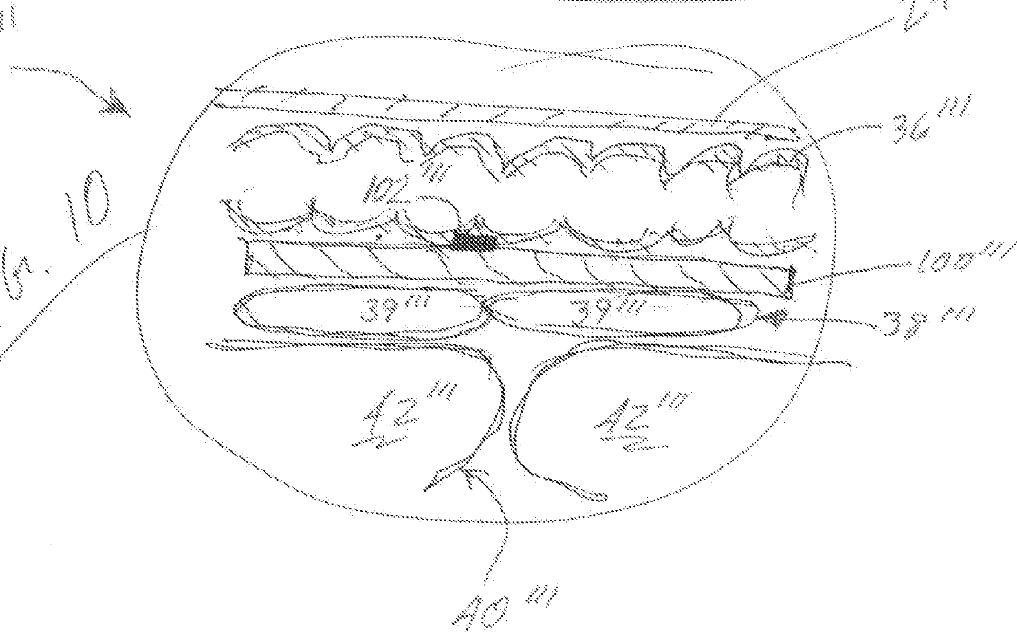

FIG. 10

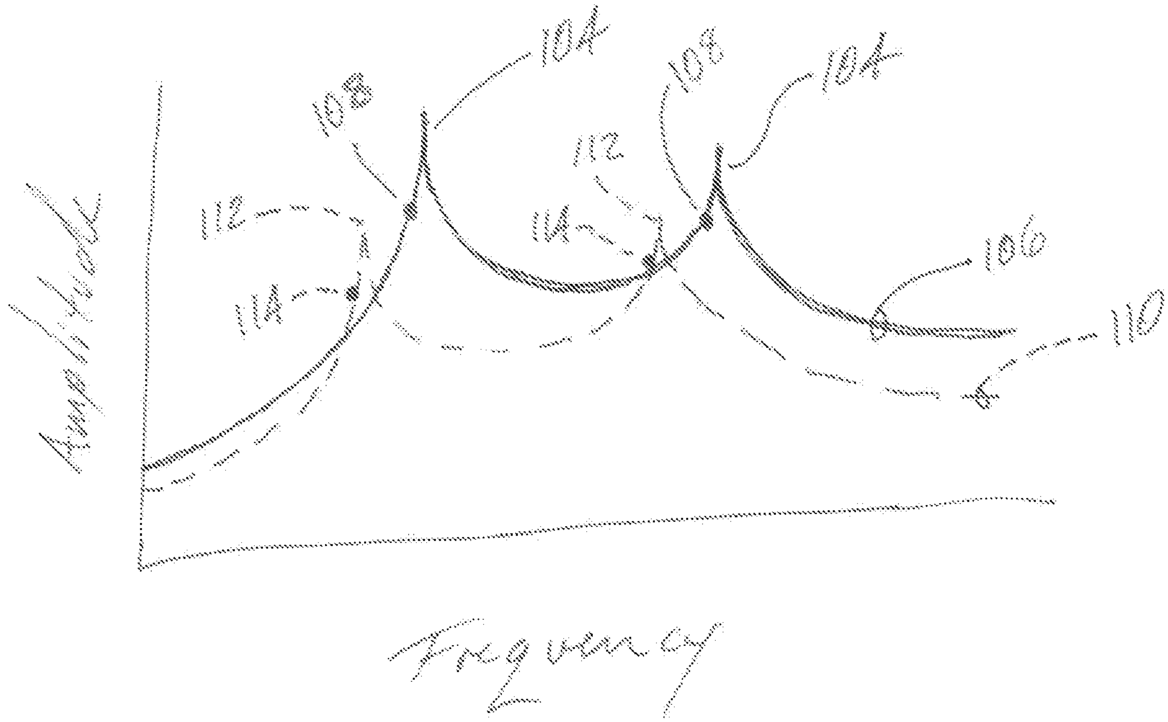

FIG. 12

VIBRATING PATIENT SUPPORT APPARATUS WITH A RESONANT REFERENCING PERCUSSION DEVICE

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of U.S. provisional patent application Ser. No. 60/677,728, filed May 4, 2005, the advantages and disclosure of this application is hereby incorporated by reference.

FIELD OF THE INVENTION

[0002] The present invention relates generally to a patient support apparatus and more particularly to a resonant frequency referencing percussion device of a vibrating patient support apparatus.

BACKGROUND OF THE INVENTION

[0003] Patient support systems are well known in the art for providing therapy to a patient. A typical patient support apparatus comprises a mattress having a plurality of air bladders for supporting the patient against the bias of gravitational forces, a percussion device that alternates inflation and deflation of air bladders to provide percussion and vibration therapy to the patient, and a rotation device, usually positioned beneath the mattress, to rotate the patient from side to side. Percussion, vibration, and rotation therapy assist in reducing pulmonary problems and bed sores, respectively.

[0004] One example of a rotation device in a mattress is shown in U.S. Pat. No. 5,611,096 to Bartlett et al. and incorporated herein by reference in its entirety. The rotation device of Bartlett et al. has two selectively inflatable and deflatable air bladders lying longitudinally beneath the mattress to provide rotation therapy to the patient for reducing bed sores. A controller including an operator input panel and display is used to control the rotation device. The input panel includes a plurality of raised buttons for advancing through and adjusting parameters associated with rotation functions.

[0005] An example of a percussion or vibrating device in a mattress is shown in U.S. Patent Application Publication No. 2004/0193078 A1, to Flick et al. and incorporated herein by reference in its entirety. The percussion device of Flick et al. discloses a vibrating pad having a plurality of bladders that fill and deflate with the flow of air or fluid at a prescribed frequency controlled by a controller causing the above mattress or mattress cushion to vibrate. This vibration therapy is capable of reducing pulmonary problems such as the accumulation of secretions in the lungs.

[0006] Unfortunately, controllers of known percussion devices do not sense or process displacement amplitude with displacement frequency of the vibrating media of the bladders. Hence, known percussion devices are not capable of detecting and/or utilizing natural resonant frequencies of the vibrating media. If the operating vibration frequency of known percussion devices is too distant from the natural resonant frequency, energy is wasted. If the operating vibration frequency is unintentionally at the natural resonant frequency, then damage or accelerated wear of the patient support apparatus may occur.

SUMMARY OF THE INVENTION

[0007] A vibrating patient support apparatus has a resonant referencing percussion device preferably located internally to a cover of a mattress of the apparatus. The percussion device delivers a percussion or vibration at a controlled operating frequency that is preferably slightly less than a resonant frequency located internal to the mattress of the apparatus. With the various weight distributions of a patient, the device is capable of determining the ever shifting resonant frequency via signals received by the controller from a pressure sensor or accelerometer of the device. Because the operating frequency is slightly less than the natural resonating frequency, energy of the system is conserved. Because the operating frequency is not the controller calculated resonant frequency, wear on the device and potential damage is minimized.

[0008] Preferably, the patient support apparatus includes a number of other devices for patient comfort and therapeutic treatment substantially located in a manageable and light weight mattress. All the devices are generally light weight with moving parts generally being bladders, thus relatively quiet when operating. For ease of manufacturing and cost, a substantial portion or all of the devices operate off of a common pump for preferably flowing pressurized air to an assortment of bladders. For instance, the percussion device preferably has bladders. Moreover, the apparatus preferably has a bladder operated rotation device for rotating a patient to minimize bed sores, a bladder operated firmness setting device for providing patient comfort, and an air loss control system for flowing air through the mattress to control temperature.

[0009] Objects, features and advantages of the present invention include a patient support apparatus that has a relatively lightweight and manageable mattress having numerous devices for therapeutic treatment. Other advantages of the apparatus include a relatively simple and robust design that is inexpensive to manufacture, reduces wear and warranty costs and reduces energy consumption.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0010] Advantages of the present invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

[0011] **FIG. 1** is a perspective view of a patient support apparatus of the present invention positioned on a hospital bed frame;

[0012] **FIG. 2** is a cross-sectional view of the patient support apparatus taken along the line **2-2** in **FIG. 1**;

[0013] **FIG. 3** is a cross-sectional view of the patient support apparatus taken along the line **3-3** in **FIG. 1**;

[0014] **FIG. 4** is a schematic view of a control system of the patient support apparatus;

[0015] **FIG. 5** is a schematic view of an air flow system of the present invention;

[0016] **FIG. 6** is a schematic view of a resonant percussion device of the present invention;

[0017] **FIG. 7** is a partial enlarged cross section taken from the circle **7** of **FIG. 3**;

[0018] **FIG. 8** is a cross section similar in perspective to **FIG. 7** and of a second embodiment of the patient support apparatus;

[0019] **FIG. 9** is a cross section similar in perspective to **FIG. 7** and of a third embodiment of the patient support apparatus;

[0020] **FIG. 10** is a cross section similar in perspective to **FIG. 7** and of a fourth embodiment of the patient support apparatus;

[0021] **FIG. 11** is a cross section similar in perspective to **FIG. 7** and of a fifth embodiment of the patient support apparatus; and

[0022] **FIG. 12** is an amplitude versus frequency graph.

DETAILED DESCRIPTION OF THE INVENTION

[0023] Referring to the Figures, wherein like numerals indicate like or corresponding parts throughout the several views, a vibrating patient support apparatus of the present invention is generally shown at **10**.

[0024] Referring to **FIG. 1**, the patient support apparatus **10** of the present invention is shown in combination with a mobile hospital bed frame **12**. As illustrated, the hospital bed frame **12** typically includes a plurality of side rails **14** that can be lowered for patient transfer and raised to confine a patient. The hospital bed frame **12** can also include a plurality of adjustable sections including an adjustable head section **16** that is pivotally adjustable relative to a main body section **18** of the bed frame **12** to allow the patient to sit up while eating or visiting with family.

[0025] Still referring to **FIG. 1**, the patient support apparatus **10** preferably comprises a generally self-contained mattress or pad assembly **20** having a patient support surface **22**. The mattress **20** is referred to as being self-contained since a substantial portion of the working components of the mattress **20** that are used to carry out multiple functions, including a plurality of therapeutic functions, are enclosed by a cover **24** of the mattress **20**. The cover **24** can be any conventional material including, but not limited to natural fibers, polymeric materials, or combinations thereof. The cover **24** is preferably a vapor permeable material to be used in conjunction with a low air loss mechanism **26** of the mattress **20** described below.

[0026] Referring to **FIG. 4**, a controller **72** of the patient support apparatus **10** controls operation of a main pump **50** preferably located externally of the mattress **20**. The main pump **50** supplies a controlled amount of pressurized air to multiple systems or devices of the mattress **20** that are generally located internally to the cover **24** of the mattress **20**. These systems include; a low air loss device **82** having a low air loss control system **56** and the low air loss mechanism or perforated tubing **26**, a firmness setting device **84** having a main valve system **58** and a main air bladder **36** (see **FIG. 3**), a percussion device **86** having a percussion control system **60** and a percussion mechanism **38**, and a rotation device **88** having a rotation control system **62** and a rotation mechanism **40**. The rotation mechanism **40** is preferably two air bladders **42** located beneath the percussion mechanism **38**. The percussion mechanism **38** is preferably a plurality of air bladders **39** located beneath the main air bladder **36** of the mattress **20**. The main air bladder **36**, percussion mechanism **38**, and rotation mechanism **40** are supported within the cover **24** of the mattress **20** by a base cushion **44** positioned within a perimeter of the frame **34**. The base cushion **44** can be rigid or flexible and comprise an air bladder, or simply be constructed of conventional bedding materials such as foam, and the like.

[0027] Preferably, a pendant **28** of the controller **72** is supported by a tower **30** coupled electrically to the mattress **20** and preferably supported structurally by the bed frame **12**. The pendant **28** includes user interface **32** of the patient support apparatus **10** used to operate at least a portion of the functions of the mattress **20**. The user interface **32** is preferably of a touch-screen display type that is well known to those skilled in the art for operator input, as well as output, based upon the particular software used to configure the user interface or touch-screen display **32**. Here, the touch-screen display **32** has input and output capabilities. These features are shown in application Ser. No. 11/260,452, filed Oct. 27, 2005, hereby incorporated by reference.

[0028] Referring to **FIGS. 2-4**, the mattress **20** has a generally peripheral frame **34** of a conventional bedding frame material. Such material can include, but is not limited to foam, polymeric materials, metal, gels, or combinations thereof. Generally disposed internally to the cover **24** of the mattress **20** is the main air bladder **36** of the firmness setting device **84**, which is positioned within the perimeter of the frame **34** and immediately below an upper portion of the cover **24**. The main air bladder **36** acts as the primary support for the patient and with a controlled flow of air into and out of the bladder **36** can be useful in controlling the temperature of the bedding material exposed to the patient.

[0029] The percussion-vibration mechanism **38** of the percussion device **86** is positioned below the main air bladder **36**, hereinafter referred to as the percussion mechanism **38**. The percussion mechanism **38** provides both percussion and vibration therapy to the patient. The particular therapy being employed is dependent on the frequency or the number of beats per second generated by the percussion mechanism **38**. For example, and not to be limited to these examples, the percussion therapy usually employs 1-7 beats per second (i.e. 1-7 hertz) and the vibration therapy employs 7 to 25 beats per second (i.e. 7-25 hertz). The percussion mechanism **38** may employ mechanical fingers or rollers to impart the percussion motion, but preferably comprises a pair of inflatable percussion bladders **39**, best shown in **FIG. 3**, having fingerlike cells that oscillate between inflated and deflated states to provide the percussive movement required. Such a mechanism is illustrated in U.S. Patent Application Publication No. 2004/0193078 to Flick et al., previously referenced.

[0030] Preferably, a rotation mechanism **40** of the rotation device **88** for rotation therapy is positioned below the percussion mechanism **38**. The rotation mechanism **40** provides rotation therapy to the patient by rotating the patient from side to side. Along with percussion and percussion-vibration therapy, rotation therapy assists in reducing bed sores and pulmonary problems of the patient. The rotation mechanism **40** is preferably a pair of longitudinally positioned rotation bladders **42**, shown in **FIG. 3** and described in the '078 publication to Flick et al. The rotation bladders **42** are independently inflated and deflated to raise one side of the patient, lower the patient, and then raise the other side of the patient such that the patient experiences a side-to-side rotation that shifts pressures between the patient and the bladder **36** of the firmness setting device **84** of the mattress **20**.

[0031] Referring to **FIGS. 3 and 4**, the low air loss mechanism **26** of the mattress **20** used in conjunction with the encapsulating yet permeable cover **24** is preferably positioned inward of the cover **24**. In operation, air is pumped from the low air loss mechanism **26** through the permeable cover **24** to reduce the temperature below the patient support surface **22** and decrease the chance of skin maceration that lowers the risk of bed sores. Preferably, the main pump **50** delivers pressurized air to the perforated tubing of the mechanism **26** disposed within the frame **34** and under the cover **24**. The tubing is external to the main air bladder **36**, the percussion mechanism **38**, and the rotation mechanism **40**.

[0032] Referring specifically to **FIG. 2**, a first control unit **46** of a main control system **70** in the form of a rigid box and preferably not of the mattress **20** is shown adjacent to a foot end **48** of the mattress **20**. The first control unit **46** encloses the main pump **50** and a power circuit board **52** of a main control system **70** for operating the main pump **50** and transferring power to the rest of the mattress components generally located in a second control unit **54**. As shown, the first control unit **46** fits neatly below the foot end **48** of the mattress **20**, but is not incorporated within the cover **24** of the mattress **20**. Of course, other configurations with the first control unit **46** inside the cover **24** are also possible. Such configurations are illustrated in the '078 publication to Flick et al. In a preferred embodiment, the main pump **50** is used to inflate the main air bladder **36**, the percussion bladders **39**, and the rotation bladders **42**, and to convey air to the perforated tube **26**.

[0033] The second control unit **54** of the main control system **70** in the form of a rigid box is shown beneath the cover **24** of the mattress **20** within the perimeter of the frame **34** (see **FIG. 2**). The second control unit **54** encloses the low air loss control system **56** for controlling the low air loss mechanism **26**, the main valve system **58** for inflating and deflating the main air bladder **36**, the percussion control system **60** for controlling the percussion mechanism **38**, the rotation control system **62** for controlling the rotation mechanism **40**, and a main circuit board **64** in operative communication with these systems and the power circuit board **52** of the first control unit **46**. The second control unit **54** also preferably encloses a processor **74** and memory **78** of the controller **72** for controlling operation of these systems **56**, **58**, **60**, **62** and the main pump **50**. These systems **56**, **58**, **60**, **62** may comprise motors, solenoid valves, and/or motor-controlled valves, as disclosed in the '078 publication. It should be appreciated that each of these separate control systems **56**, **58**, **60**, **62** may also represent portions of a larger system. Those skilled in the art will now recognize that the systems employed for controlling operation of the loss air loss mechanism **26**, main air bladder **36**, percussion mechanism **38**, and rotation mechanism **40** may assume a variety of configurations.

[0034] Referring to **FIG. 4**, the main control system **70** of the patient support apparatus **10** is schematically illustrated. The main control system **70** includes the controller **72** which comprises the processor **74**, the touch-screen display **32**, a display driver **76** for driving the touch-screen display **32**, the memory **78**, and a communication interface **80**. The controller **72**, via communication interfaces **80**, is also in operative communication with the low air loss control system **56**, main valve system **58**, percussion control system **60**, rotation control system **62**, and the main pump **50**.

[0035] Referring to **FIG. 5**, an air flow schematic of the patient support apparatus **10** is shown. The air flow schematic generally shows the movement of air through conduits from an air source **94** (preferably outside air at atmospheric pressure) via the main pump **50** to the second control unit **54** and more specifically, to the low air loss control system **56**, the main valve system **58**, the percussion control system **60**, and the rotation control system **62**. Each of these systems **56**, **58**, **60**, **62** preferably comprises valve controls for operating their respective mechanisms, i.e., the perforated tube **26**, the main air bladder **36**, the percussion bladders **39**, and the rotation bladders **42**. Such valve controls are described in more detail in the previously referenced '078 publication to Flick et al. herein incorporated by reference. It should be appreciated that each of the separate control systems **56**, **58**, **60**, **62** may be portions of a larger valve system, or the control systems **56**, **58**, **60**, **62** may represent direct connections between the main pump **50** and the respective perforated tube **26** or bladders **36**, **39**, **42**.

[0036] With further regards to the percussion device **86** and more specific to the present invention, **FIG. 6** illustrates the percussion device **86** having the previously described percussion control system **60** and the percussion mechanism **38**. Referring to **FIG. 7**, the percussion mechanism **38** also has a resonating pad **100** located between the main bladder **36** and the percussion bladders **39**, and a sensor **102** preferably being a pressure transducer located in preferably each percussion bladder **39** for sensing air pressure. Referring to **FIG. 12**, the resonating pad **100** is made of a resiliently flexible material having at least one known natural resonant frequency **104** that theoretically has a corresponding amplitude (displacement) that extends to infinity. The natural resonant frequency **104** is of the pad **100** when in an unloaded state (i.e. no patient weight) and as best illustrated by the solid amplitude vs. frequency curve **106** of **FIG. 12**.

[0037] In operation, and assuming no patient load is placed upon the resonating pad **100** of mechanism **38**, (see **FIG. 12**), the percussion device **68** inflates and deflates the plurality of bladders **39** at a baseline operating frequency **108** for optimal energy efficiency. In order to substantially reduce wear and potential damage of the device **86** via excessive vibration amplitude or displacement, the baseline operating frequency **108** is close to but is not at the resonant frequency **104** of the pad **100**. Generally, the baseline operating frequency **108** of the percussion device **86** is slightly less than any chosen one of the at least one resonant frequencies **104**. To optimize percussion therapy, the material and size of the resonating pad **100** is chosen with consideration made to the range of weight distributions of the patient that will tend to shift the amplitude vs. frequency curve **106**. This shift or addition of compressive weight on the resonating pad **100** generally alters the resonating frequencies of the pad **100** and is best illustrated as the shifted curve **110** having shifted resonating frequencies **112** in **FIG. 12**.

[0038] For ease of explanation, each bladder **39** has a pressure transducer **102**, thus each bladder **39** can react to weight changes of the respective overhead portion of the patient. However, one skilled in the art would now know that a plurality of bladders **39** could be controlled by one pressure transducer **102**. If, for instance possibly due to manufacturing cost, only one pressure transducer **102** is utilized, its optimal location would be toward the center of the mattress **22** or under the lungs of the patient since percussion therapy is primarily used for treatment of the lungs.

[0039] In operation of the percussion device **86** with the weight of a patient on the mattress **22**, the variable speed air pump **50** operates through the percussion control system **60** that preferably includes a double diaphragm valve system **99** for controlled inflation and deflation of the percussion bladders **39**. The inflation of the percussion bladders **39** by the pump **50** is oscillated such that the pressure in the percussion bladders **39** is increased and decreased, thereby lifting and dropping the patient. The weight of the patient not only shifts the resonating frequency to curve **110** but also adds a biasing force against the percussion bladders **39** preferably distributed through the pad **100**. This force correlates with a pressure increase in the percussion bladders **39**. The pressure inside the percussion bladders **39** is continuously monitored by the pressure transducers **102** and communicated to the controller **72**. As the speed of the pump **50** is changed, the pressure inside the percussion bladders **39** created by patient's potentially changing weight is monitored by the controller **72** to continually adjust for an optimal operating frequency **114** that correlates to a maximum pressure (pressure correlates to force divided by area, and area correlates to amplitude). The controller **72** then operates the pump **50** to achieve the optimal frequency **114** for percussion therapy for that particular patient.

[0040] Referring to **FIG. 8**, a second embodiment of a mattress **22'** is illustrated. In the second embodiment, the resonating pad **100** of the first embodiment is generally omitted. The percussion device **84'** of the second embodiment operates similarly to the first embodiment except that the main air bladder **36'** also functions as the resonating pad of the first embodiment, hence, it is the resonating frequency of the bladder **36'** that is generally monitored indirectly by the pressure sensors **102'**. As best illustrated in **FIG. 9**, a third embodiment of a mattress **22"** is illustrated that is similar to the second embodiment except that a main cushioning member **36"** of the mattress **22"** is not a bladder but a generally homogeneous and passive cushion preferably having a known natural resonating frequency.

[0041] Referring to **FIG. 10**, a fourth embodiment of a mattress **22'"** is illustrated wherein the sensors **102** of the first embodiment are generally replaced with accelerometers **102'"** of the fourth embodiment. The accelerometers **102'"** are positioned to measure displacement of a resonating pad **100'"** that directly corresponds to amplitude of vibration and/or percussion. Referring to **FIG. 11**, a fifth embodiment of a mattress **22""** is illustrated that is similar to the fourth embodiment except that a main cushioning member **36""** of the mattress **22""** is not a bladder but is a generally homogeneous and passive cushioning member **36""** preferably having a known natural resonating frequency. In the fifth embodiment, the accelerometer **102""** is preferably located in the cushioning member **36""**.

[0042] While the forms of the invention herein disclosed constitute presently preferred embodiments, many others are possible. It is not intended herein to mention all the possible equivalent forms or ramifications of the invention. It is understood that the terms used herein are merely descriptive rather than limiting, and that various changes may be made without departing from the spirit or scope of the invention. For instance, the term mattress as applied to mattress **20** is not meant to be limited to a patient's bed, but may apply to any pad assembly that supports all or any portion of a patient against the bias of gravitational forces and whether or not the patient is intended to actual sleep upon the mattress or pad assembly.

[0043] In light of the present invention, one skilled in the art would now realize that the bladder **36** may be a passive cushioning member thus generally eliminating the firmness setting device **84** altogether. Such a the cushioning member **36** could be a soft pad and/or made of a homogeneous material similar to the foam or gel of the frame **34**. Moreover, the air pump **50** and associated conduits could be replaced with a temperature controlled fluid pump system or a central pump system capable of handling a plurality of beds.

What is claimed is:

1. A patient support apparatus for providing therapeutic treatment to a patient, the patient support apparatus comprising:

a loaded state wherein at least a portion of the patient is supported by the patient support apparatus;

an unloaded state wherein the patient is not being supported by the patient support apparatus;

a percussion device for producing a variable oscillating displacement at an operating frequency;

a resonating pad having at least one natural resonant frequency when in the unloaded state and at least one shifted resonant frequency when in the loaded state and wherein each one of the at least one shifted resonant frequency corresponds to a respective one of the natural resonant frequency;

a controller for electrically operating the percussion device; and

a sensor for communicating a control signal that corresponds to an amplitude of vibration processed by the controller.

2. The patient support apparatus set forth in claim 1 further comprising at least one shifted operating frequency wherein each one of the shifted operating frequency is slightly less than a respective one of the at least one shifted resonant frequency.

3. The patient support apparatus set forth in claim 1 wherein the sensor is an accelerometer.

4. The patient support apparatus set forth in claim 3 wherein the accelerometer is in contact with the resonating pad.

5. The patient support apparatus set forth in claim 1 further comprising the percussion device having at least one bladder constructed and arranged to inflate and deflate at the shifted operating frequency.

6. The patient support apparatus set forth in claim 1 wherein the sensor is at least one pressure sensor located in at least one of the at least one bladder.

7. The patient support apparatus set forth in claim 6 further comprising a variable speed pump controlled by the controller for inflating and deflating the at least one bladder.

8. The patient support apparatus set forth in claim 7 wherein the variable speed pump is an air pump.

9. The patient support apparatus set forth in claim 7 wherein the variable speed pump is a fluid pump.

10. The patient support apparatus set forth in claim 1 further comprising a percussion mode wherein the shifted operating frequency is between one beat per second and seven beats per second.

11. The patient support apparatus set forth in claim 10 further comprising a vibration mode wherein the operating frequency is between seven beats per second and twenty five beats per second.

12. A patient support apparatus for providing therapeutic treatment to a patient, the patient support apparatus comprising:

a cushioning member;

a percussion device having a plurality of bladders located below the cushioning member and a sensor;

a variable speed pump for flowing a pressurized medium into the plurality of bladders;

a valve system for controlling flow to and from the bladders for inflation and deflation at a controlled operating frequency;

a controller for controlling the valve system and the variable speed pump based in-part on a signal received from the sensor.

13. The patient support apparatus set forth in claim 12 wherein the cushioning member is a main bladder inflated by the variable speed pump at a pressure controlled by the controller.

14. The patient support apparatus set forth in claim 13 further comprising a resonating pad of the percussion device located vertically between the main bladder and the plurality of bladders.

15. The patient support apparatus set forth in claim 14 wherein the resonating pad has at least one known natural resonating frequency located within a range producible by the controller, variable speed pump and valve system.

16. The patient support apparatus set forth in claim 14 wherein the sensor is an accelerometer being in contact with the resonating pad.

17. The patient support apparatus set forth in claim 12 wherein the sensor is an accelerometer being in contact with the cushioning member.

18. The patient support apparatus set forth in claim 12 wherein the sensor is at least one pressure sensor located in at least one of the plurality of bladders of the percussion device.

19. The patient support apparatus set forth in claim 12 further comprising:

the flow medium of the pump being pressurized air; and

the cushioning member being a main bladder of a firmness setting device that receives controlled pressurized air from the pump.

20. The patient support apparatus set forth in claim 19 further comprising a rotation device having two rotation bladders located below the plurality of bladders of the percussion device, and wherein the two rotation bladders are independently inflated and deflated by the controller and receive pressurized air from the pump.

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