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(54) **MATTRESS SYSTEM**

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• **EWART, Graham**  
**Lon-y-Llyn**  
**Caerphilly CF83 1BF (GB)**

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(74) Representative: **Abel & Imray LLP**  
**Westpoint Building**  
**James Street West**  
**Bath BA1 2DA (GB)**

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(56) References cited:  
**EP-A1- 2 050 425 EP-A1- 2 735 293**  
**WO-A1-97/48314 GB-A- 2 492 234**  
**US-A1- 2009 007 341**

(73) Proprietor: **Direct Healthcare Group Limited**  
**Lon-y-Llyn, Caerphilly CF83 1BF (GB)**

(72) Inventors:  
• **LEWIS, Jon**  
**Lon-y-Llyn**  
**Caerphilly CF83 1BF (GB)**

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## Description

### Field of the Invention

**[0001]** The present invention concerns mattresses and mattress systems. More particularly, but not exclusively, this invention concerns a mattress system for the reduction of pressure sores. The invention also concerns a mattress system with a control unit.

### Background of the Invention

**[0002]** Various mattresses and mattress systems exist which attempt to reduce the occurrence of pressure sores in long term users, such as hospital and care patients. Pressure sores can develop when a bed user lies in the same position for an extended period of time. Various systems exist depending on the level of risk of developing pressure sores for a bed user. For example, in a high-risk scenario, an active mattress system may be provided, where an air pump is used to cyclically vary the pressure inside numerous air chambers which make up a mattress.

**[0003]** The level of risk of someone developing pressure sores may be determined by use of a checklist or scale, which may be applied by a care giver to a patient. An example of such a scale is the Waterlow Scale. If a patient is determined to be at high risk of a pressure ulcer, they may be provided with an active mattress system as described above. However, some patients may find it difficult to sleep on an active mattress system, with the resulting sleep deprivation causing alternative health problems. There may also be patients which are at a boundary on the risk scale, where it is difficult to know whether an active mattress system should be used.

**[0004]** US2009/007341A1 discloses an alternating pad comprising a first set and a second set of alternately inflatable cells. Both sets of inflatable cells are supplied with air from a pump via a rotary valve. A sensor is positioned under the pad to receive pressure exerted by a patient upon movement and to be compressible relative to the applied pressure. Any change in patient position or movement will cause an alteration in the airflow in the sensor pad tube and will reduce or increase the differential pressure measured at the pressure transducer. Based on this feedback the microprocessor directly controls the power level to the pump and increases or decreases the air flow to the cells to alter the amplitude of the cells and also controls the timing of the rotary valve to change the timing of the inflation and deflation cycle.

**[0005]** WO97/48314A1 discloses a pneumatic mattress system including a plurality of rigid ribs positioned side-by-side and hingedly interconnected so as to form a continuous overlay basis which is flexible in one direction. A plurality of pneumatic cushions are attached to each rib so as to provide a cushioned surface. The pressure of the cushions is controlled by a main pressure control system which include a main supply conduit with

a pressurized inlet and an exhaust, both controlled by a control unit, and a pressure sensor. The cushions are connected through a number of tubes located within the ribs to a rib control system which selectively connects them to the main supply conduit. By synchronized control of the pressure of the main supply conduit and the rib control system, the pressure within each cushion can be measured and controlled independently.

**[0006]** US2009100604A1 discloses a method of inflating, in alternating manner, inflatable cells of a support device. The device is of the mattress type for supporting the body of a patient, said mattress having at least one zone made up of first and second series of inflatable cells referred to respectively as "first" cells and as "second" cells. Alternating deflation and re-inflation cycles are performed during which each series of cells is deflated and then re-inflated in alternation and in succession, said first cells being deflated and then re-inflated simultaneously with the re-inflation and with the deflation, respectively, of said second cells. The alternating deflation and re-inflation of said first and second cells of the support device takes place in a cycle controlled by said inflation means being switched on/off, wherein the switching on/off is controlled as a function of the values of the pressures of the fluid measured inside said cells and of comparison of said values with at least one reference pressure value determined as a function of the morphology of the patient.

**[0007]** EP2735293A1 discloses a system for supporting a patient comprising: an inflatable mattress comprising a first and second series of cells; detecting means to detect the air pressure; a compressor to inflate said inflatable mattress; and a control chamber placed under the patient. A method of operating the system involves calculating the supporting pressure of a patient on the mattress on the basis of parameters such as, for instance, weight and position.

**[0008]** The present invention seeks to mitigate the above-mentioned problems. Alternatively or additionally, the present invention seeks to provide an improved mattress system.

### Summary of the Invention

**[0009]** The present invention provides, according to a first aspect, a mattress system according to claim 1. The mattress system comprising:

- a mattress comprising a plurality of interconnected chambers;
- a control unit;
- the plurality of interconnected chambers connected to the control unit, whereby activation of the control unit may increase or decrease the pressure within the plurality of interconnected chambers;
- the control unit comprising one or more sensors arranged to detect pressure changes in the plurality of interconnected chambers, wherein the mattress sys-

tem is configured for use in an active mode, where the control unit is activated to increase or decrease the pressure within the plurality of interconnected chambers, and a passive mode where the control unit is arranged to monitor the pressure changes in the plurality of interconnected chambers.

**[0010]** The mattress system further comprises a calibration mode, wherein the control unit is arranged to increase the pressure within the plurality of interconnected chambers to a first pressure, then allow the deflation of the plurality of interconnected chambers to a second pressure, whereby the time taken to deflate from the first pressure to the second pressure is monitored and recorded. The time taken to deflate from the first pressure to the second pressure, which may from herein be referred to as the "deflation time" may indicate the approximate weight of a patient lying on the bed. For example, a heavier patient may have a shorter deflation time than a lighter patient. The control unit may have a memory unit including a correlation between the deflation time and the approximate weight of a patient. The first set of pressure changes is determined at least in part based on the detected deflation time.

**[0011]** The control unit may comprise a pump unit or compressor unit. The pump unit or compressor unit may be controlled by the control unit to increase or decrease the pressure within the interconnected chambers when the control unit is in the active mode.

**[0012]** The control unit may be arranged to monitor the pressure changes detected by the one or more sensors. The control unit may comprise a communications module. The communications module may be controlled by the control unit. The communications module may be arranged to send communications signals via wired or wireless communication channels. For example, the communications module may be arranged to send communications signals to a mobile phone device, or a remote monitoring call centre. The communications module may be arranged to receive communications signals via wired or wireless communication channels. The communications signals may include alert signals. The communications signals may include control signals, for example control signals which activate or deactivate the active mode of the control unit. The control signals may include one or more activation sequences, for example relating to the duration or activation frequency of the active mode of the control unit.

**[0013]** The control unit comprises a processor, the processor arranged to analyse the pressure changes detected by the one or more sensors of the control unit. The processor is arranged, in response to a first set of pressure changes, to send a first signal. The processor is arranged, in response to a second set of pressure changes, to send a second signal.

**[0014]** The first set of pressure changes may be chosen such that they indicate the patient is moving frequently enough, and in an appropriate manner, such that pres-

sure ulcers are unlikely. The first set of pressure changes may comprise a threshold pressure change, above which the movement of a patient is taken to be a useful movement, for example a rotational movement of the torso of a patient. Pressure changes below the threshold pressure change may be taken to be non-useful movement, for example an arm movement of the patient. An example threshold pressure change may be between 0.5mmHg and 10mmHg, or between 1mmHg and 5mmHg. The threshold pressure change may be 2mmHg. The threshold pressure change may be adjusted in dependence on the weight of the patient, for example the weight as detected by the use of the calibration mode of the mattress system. The first set of pressure changes may comprise between 1 and 10, or between 1 and 5, or for example 3, pressure changes above the threshold pressure in an hour long period.

**[0015]** The second set of pressure changes may be chosen such that they indicate the patient is not moving frequently enough, or in an appropriate manner, thereby indicating the risk of pressure ulcers is high. An example of inappropriate (non-useful) movement would be where the patient is only moving their arms; as this movement may be insufficient to prevent pressure ulcer development on their torso. The second set of pressure changes may comprise detection of little or no pressure changes over a set period of time. The second set of pressure changes may comprise detection of an insufficient number of pressure changes which exceed the threshold pressure change in a given time period. The insufficient number may be zero, one or two threshold pressure changes an hour, for example.

**[0016]** In response to the first signal sent from the processor, the mattress system is arranged to enter, or remain in, the passive mode. In response to the first signal, the control unit may be arranged such that the communications module sends an "OK" signal to a remote monitor, for example the phone of a nurse or a call centre.

**[0017]** In response to the second signal sent from the processor, the mattress system is arranged enter the active mode. The control unit may be arranged to enter the active mode automatically. Such an arrangement may be advantageous both in remote care scenarios, and in busy hospital environments. The risk of pressure ulcers developing may be reduced without requiring any input from a care provider.

**[0018]** In response to the second signal sent from the processing unit, the control unit may be arranged such that the communications module sends an alert signal to a remote monitor. The remote monitor may then send an activation signal which is received by the communications module, whereupon the active mode is activated. Such an arrangement may be advantageous in a home care environment, where a patient is not in regular contact with a care provider. The movement patterns of the patient may be monitored such that in the event of a risk of pressure ulcers developing, the active function of the mattress system may be activated remotely.

**[0019]** The control unit may comprise an alarm. The alarm may be an audible and/or visual alarm. The alarm may be arranged to be activated in response to the second signal being sent by the processing unit. The control unit may comprise a display screen, and the visual alarm may be shown on the display screen. Such an arrangement may be advantageous in a noisy and busy hospital environment, making it clear to a care provider that the patient is at risk of developing pressure ulcers.

**[0020]** Depending on the particular circumstances in which the mattress system is used, it may be preferable to require a care provider to choose whether or not the active mode of the control unit is activated. For example, the care provider may decide that leaving the control unit in the passive mode would result in better sleep for the patient, with the benefit of sleep outweighing the risk of pressure ulcers developing.

**[0021]** The control unit may comprise an input and an output, the input and output connected to the plurality of interconnected chambers. The input may be arranged to reduce pressure within the plurality of interconnected chambers. The output may be arranged to increase pressure within the plurality of interconnected chambers. The input and output may be a single physical connection to the control unit, and switch between being an input and output based on the operation of the control unit.

**[0022]** The mattress system may comprise a first set of interconnected chambers and a second set of interconnected chambers. The first set of interconnected chambers may be independent of the second set of interconnected chambers. In one embodiment, the first set of interconnected chambers may be independent of the second set of interconnected chambers when in the active mode, and the first set of interconnected chambers may be connected to (i.e. allowing fluid communication between) the second set of interconnected chambers when in the passive mode. The change between the independent operation and connection between the first set of interconnected chambers and second set of interconnected chambers may be controlled by a switch, for example a solenoid switch. The pressure within the first set of interconnected chambers and pressure within the second set of interconnected chambers may be independently controlled by the control unit.

**[0023]** In the active mode, the control unit may, for example, increase the pressure within the first set of interconnected chambers at the same time as decreasing the pressure within the second set of interconnected chambers, or vice versa. The first set of chambers may comprise a plurality of individual air chambers and the second set may comprise a plurality of individual air chambers. The chambers of the first set and the second set may be alternately laid out in the direction of the length of the mattress. The air pressure in the first set and the second set may alternately increase and decrease out of phase with each other; preferably 180 degrees out of phase, such that the pressure in the first set is always being increased as the pressure in the second set is being de-

creased.

**[0024]** In the active mode, the control unit may be arranged to increase and decrease the pressure within the chambers in a cyclical fashion. That is to say, the pressure in each air chamber may be periodically increased and decreased. Air chambers which are in fluid communication, or otherwise are a part of the same set, may increase and decrease in pressure with the same period.

**[0025]** The skilled person will appreciate that there are a number of possible patterns in which the air pressure in the chambers of the mattress may be increased and decreased. This will depend to some extent on the capabilities of the control unit and the specific arrangement of the air chambers. In some embodiments, three or more sets of chambers may be provided. It may also be the case that in the active mode the control unit causes a random inflation and deflation of the air chambers (to the extent that is possible if they are grouped into interconnected sets) such that the overall effect on the patient, in terms of allowing the pressure of the matters on a part of the body not to stay the same for longer than a threshold time, is similar to a regular (non-random) periodic inflation of the air chambers.

**[0026]** At least some of the air chambers may be substantially elongate. At least some of the air chambers may span more than 50%, 60%, or 70% the width of the bed.

**[0027]** There may be a sensor associated with one or both of the control unit input and control unit output. When the pumping function of the control unit is not activated, i.e. the control unit is in the passive mode, pressure changes within the plurality of interconnected chambers may be transmitted to one or both of the control unit input and control unit output. Such pressure changes may be referred to as "back pressure" changes. The sensors associated with the input and/or output may detect such back pressure changes and communicate those changes to the control unit. Such an arrangement may provide a self-contained, modular control unit which only requires connection to the plurality of interconnected chambers in order to provide a mattress system as claimed.

**[0028]** The one or more pressure sensors may be located underneath one or more of the plurality of interconnected chambers. The one or more pressure sensors may comprise a pressure sensor mat. The pressure sensor mat may be arranged to detect pressure changes as a user moves around on the plurality of one or more interconnected chambers. The one or more pressure sensors may be configured for wired or wireless communication with the control unit.

**[0029]** The control unit may comprise a memory unit. The memory unit may be arranged to record the pressure readings taken by the pressure sensors. Such information may be useful to provide patient history to a care provider. Additionally, such information may be useful for research purposes. For example, the pressure changes monitored may be compared with the occurrence of pressure ulcers on a given patient, for example to assist in

refining the series of pressure changes which is used to select whether the control unit is configured in the passive mode or active mode.

**[0030]** According to a second aspect of the invention there is also provided, according to claim 9, a method of controlling a mattress system, the method comprising the steps of:

providing a mattress system, the mattress system comprising a plurality of interconnected chambers and a control unit, the mattress system having an active mode in which the control unit is activated to increase and decrease the pressure within the plurality of interconnected chambers, and a passive mode in which the control unit does not increase or decrease the pressure within the plurality of interconnected chambers, the control unit further comprising one or more sensors arranged to detect pressure changes within the plurality of interconnected chambers when the control unit is in the passive mode,

configuring the mattress system into the passive mode,

monitoring the pressure changes in the plurality of interconnected chambers, and

if the detected pressure changes fall within a first set of pressure changes, the control unit generating a first signal commanding the control unit to remain in the passive mode, and if the detected pressure changes fall within a second set of pressure changes, the control unit generating a second signal different from the first signal.

**[0031]** The method further comprises a calibration step, wherein the mattress system has a calibration mode, optionally used when a patient first lies on a mattress, wherein when in the calibration mode the control unit is configured to increase the pressure within the interconnected chambers to a first pressure, and then allow deflation of the interconnected chambers to a second pressure, and the time taken to deflate from the first pressure to the second pressure is monitored. The control unit may use the deflation time to calculate an approximate weight of the patient.

**[0032]** The control unit may comprise a memory unit, where a database of deflation times is stored, and the control unit may further be configured to compare the detected deflation time to the database of deflation times in order to arrive at an approximation of the weight of a patient. The deflation time, or in alternative examples the approximate weight of the patient, is used to calibrate the mattress system, in particular with regards to the determination of the first set of pressure changes and second set of pressure changes. For example, the first set of pressure changes may comprise a series of pressure changes detected over a set time period, where the pressure changes exceed a threshold value. The threshold value may be adjusted based on the approximate weight

of a patient, for example reduced for lighter patients and increased for heavier patients. The calibration step may comprise determining the threshold pressure change value on the basis of the weight of the patient and/or deflation time.

**[0033]** The use of the calibration mode of the mattress advantageously allows the mattress system to be tailored to the patient lying on the mattress system without requiring any additional user or medical professional input. For example, there is no need to weigh the patient before they get on the bed, and there is no need to input any additional data into the control unit when the patient gets on the bed. The calibration mode allows for the automatic adjustment of the mattress system based on the weight of a patient.

**[0034]** The first set of pressure changes may be chosen to indicate that a patient is moving sufficiently to avoid pressure ulcers. The first signal may command the control unit to remain in the passive mode.

**[0035]** The second set of pressure changes may be chosen to indicate that the patient movement pattern is at risk of pressure ulcers developing. The second signal may command the control unit to enter the active mode, and begin changing the pressure within the plurality of interconnected chambers. The second signal may cause the control unit to emit an alarm signal or notification, for example an audible or visual alarm, or an alert notification to a care provider. The alert notification may query the care provider, requesting instructions on whether to move the control unit into the active mode. The care provider may send a response signal to the control unit, either having the effect of leaving the control unit in the passive mode, or causing the control unit to enter the active mode. In the event of a nonresponse to the alert notification in a given time period, the control unit may enter the active mode.

**[0036]** The mattress may further comprise a fall detection mode, wherein if the pressure detected by the pressure sensors suddenly drops, an alarm is activated. The fall detection mode may be an optional mode activated where a patient is bed-bound, as otherwise a more mobile patient may activate the alarm simply when getting out of bed.

**[0037]** According to a third aspect, the invention provides, according to claim 15, a control unit for a mattress system according to the first aspect of the invention, the control unit comprising an output, the output configured for connection to a plurality of interconnected chambers, the output further comprising a sensor, the sensor arranged to detect pressure changes in the plurality of interconnected chambers when the output is connected to the plurality of interconnected chambers.

**[0038]** The control unit may include any of the features as described in relation to the control unit of the first aspect of the invention. Advantageously, the control unit according to the third aspect of the invention may be retrofitted to existing mattresses to provide a mattress system according to the first aspect of the invention.

**[0039]** According to a fourth aspect (not claimed), there is disclosed a method for measuring the weight of patient lying on a mattress system, the mattress system comprising at least one air-holding chamber connected to a pump unit, the method comprising the steps of activating the pump unit to increase the pressure within the air-holding chamber to a first pressure, allowing the deflation of the air-holding chamber to a second pressure, and monitoring the deflation time between the first pressure and second pressure. The invention may also provide a mattress system, the mattress system comprising at least one air-holding chamber connected to a pump unit, the mattress system comprising a "weigh" mode, in which the mattress is arranged to perform the method as described according to the fourth aspect of the invention. The method may further comprise the step of comparing the deflation time to a calibration table of deflation times, thereby arriving at an approximate weight of the patient.

**[0040]** According to a fifth aspect (not claimed), there is disclosed a method for calibrating a mattress system, the mattress system comprising at least one air-holding chamber connected to a pump unit, the method comprising the steps of a first patient of a known weight lying on the mattress system, the pump unit inflating the air-holding chamber to a first pressure, allowing the air-holding chamber to deflate to a second pressure and monitoring the deflation time between the first pressure and second pressure, recording the weight of the patient and the associated deflation time, repeating the method steps with a second patient of a known weight, the weight of the second patient being different to that of the first patient. By such a method, and repeating the method steps any number of times, a database of deflation times and patient weights may be compiled.

**[0041]** It will of course be appreciated that features described in relation to one aspect of the present invention may be incorporated into other aspects of the present invention. For example, the method of the invention may incorporate any of the features described with reference to the apparatus of the invention and *vice versa*.

#### Description of the Drawings

**[0042]** Embodiments of the present invention will now be described by way of example only with reference to the accompanying schematic drawings of which:

Figure 1 shows a schematic view of a mattress system according to a first embodiment of the invention;

Figure 2 shows schematic view of a control unit forming part of the mattress system shown in figure 1;

Figure 3 shows a process diagram for a method of controlling a mattress system according to a second embodiment of the invention; and

Figure 4 shows a flow chart of a method of operating the mattress system.

#### Detailed Description

**[0043]** Figure 1 shows a mattress system 10 comprising a mattress 12 and a control unit 14. The mattress comprises a first set of interconnected chambers 16 and second set of interconnected chambers 18. The first set of interconnected chambers 16 is connected to the control unit 14 by a connection tube 20, such that the control unit 14 may increase or decrease the pressure within the first set of interconnected chambers 16. The second set of interconnected chambers 18 is also connected to the control unit 14 by a connection tube 22, such that the control unit 14 may increase or decrease the pressure within the second set of interconnected chambers 18. The first set of interconnected chambers 16 and second set of interconnected chambers 18 may be arranged to be independently adjustable by the control unit 14 in an active mode, and increase or decrease in pressure in one set of interconnected chambers has no effect on the pressure within the other set of interconnected chambers. The first set of interconnected chambers 16 and second set of interconnected chambers 18 may be arranged to be in fluid communication in a passive mode, where air may pass between the first set of interconnected chambers 16 and second set of interconnected chambers 18. The change between the independent operation and fluid communication may be controlled by a switch, for example a solenoid switch (not shown) in the control unit 14.

**[0044]** The connection tube 20 and connection tube 22 are each joined to the control unit 14 by a connector valve 24, 26. Each connector valve 24, 26, comprises a pressure sensor 28, 30, the pressure sensors arranged to monitor the backpressure in the interconnected chambers. The mattress system 10 has a first, passive, mode, in which the control unit 14 monitors pressure changes within the plurality of interconnected chambers 16, 18, and a second, active, mode, in which the control unit 14 is used to adjust the pressure levels within the plurality of interconnected chambers 16, 18.

**[0045]** The pressure sensor 28 is arranged such that when the mattress system is in the first, passive, mode, pressure changes within the first set of interconnected chambers are detected by the sensor 28. The pressure sensor 30 is arranged such that when the mattress system is in the first, passive, mode, pressure changes within the second set of interconnected chambers are detected by the sensor 30. Alternatively, there may be a single back pressure sensor when the first set of interconnected chambers and second set of interconnected chambers are in fluid communication with each other.

**[0046]** The control unit 14 further comprises a pump unit 32. The pump unit 32 is activated by the control unit 14 when in the active mode, in order to increase or decrease the pressure within the plurality of interconnected chambers 16, 18. The control unit 14 is arranged to receive the sensor data obtained by the sensors 28, 30. The control unit 14 further comprises a processor 34, to

which the control unit 14 sends the sensor data. The processor 34 analyses the sensor readings, and determines whether they fall within a first set of readings or second set of readings. The first set of readings are chosen such that they represent the patient moving a sufficient amount, both in frequency and type of movement, that the risk of pressure ulcers is low. For example the first set of readings may comprise the detection of three or more occurrences of pressure changes greater than 2mmHg over an hour long period. The second set of readings are chosen such that they represent the patient moving an insufficient amount, and the risk of pressure ulcers is high, for example the detection of two or fewer occurrences of pressure changes less than 2mmHg over an hour long period.

**[0047]** In response to the processor 34 categorising the sensor readings in the first set, the pumping function of the control unit 14 is either deactivated, or left inactive, thereby putting the mattress system in the first, passive, mode.

**[0048]** In response to the processor 34 categorising the sensor readings in the second set, two possible responses are available depending on how the control unit 14 has been configured. If the control unit 14 has been configured to "automatic" mode, the control unit 14 will automatically activate the pumping function of the pump unit 32, thereby putting the mattress system in the second, active mode. If the control unit 14 has been configured to "instruct" mode, the control unit 14 will activate an alarm signal via a communications module 36. The communications module 36 may be configured to emit an audible and/or visual alarm, or send a notification signal to a care provider, for example a mobile phone of a nurse, or to a centralised monitoring centre. In response to the alarm, the care provider may decide to initiate the second, active mode of the mattress system 10, for example by pressing a button on the control unit 14 if the care provider is present, or sending an activation signal to the communications module 36 should the care provider be in a remote location. Alternatively, the care provider may decide to override the alarm signal, and choose to leave the mattress system 10 in the first, passive, mode. Should the care provider fail to acknowledge the alarm signal, the control unit 14 may be configured to automatically put the mattress system 10 into the second, active, mode after a predetermined period of time, for example 30 minutes after sending the alarm signal.

**[0049]** The mattress system 10 further comprises a calibration mode, where the control unit 14 is configured to detect the approximate weight of a patient lying on the mattress 12. In the calibration mode, the control unit 14 may inflate the plurality of interconnected chambers to a first pressure, for example 30mmHg. The control unit 14 is then arranged to allow the deflation of the plurality of interconnected chambers to a second pressure, for example 6mmHg. The control unit is further arranged to monitor the deflation time from the first pressure to the second pressure. The deflation time is dependent on the

weight of a patient, and the control unit includes a calibration table with a series of deflation times and associated patient weights. By comparison of the deflation time with the calibration table, the approximate weight of the patient may be determined. Based on the detected deflation time (and associated approximate patient weight) the control unit may adjust the threshold values for the pressure changes which indicate useful movement of a patient. For example, for a particularly light patient, the threshold pressure value may be reduced, and for a particularly heavy patient, the threshold pressure value may be increased. Therefore, the system may be automatically configured to provide the optimum patient monitoring without requiring any additional input from a user or healthcare professional.

**[0050]** Figure 3 shows various processes the mattress system 10 may be configured to undertake. Initially, the sensors 28, 30 in the control unit 14 are arranged such that they monitor the pressure changes in the mattress 100. The processor 34 then analyses the pressure sensor readings 102. If the pressure sensor readings fall within a first set of readings 104, indicating that no action is required, the mattress system 10 remains in the passive mode 106. The process then returns to the monitoring stage 100.

**[0051]** If the pressure sensor readings fall within a second set of readings 108, indicating that the patient is at risk of pressure ulcers, two possible modes may be chosen. If configured for automatic operation, the mattress system is automatically switched to the active mode 110. If configured for "alert" operation, a notification is sent to a care provider, or an alarm is triggered at the pump unit 112. On receipt of the notification, or on noticing the alarm, the care provider may decide to leave the mattress system in passive mode 114, and the process returns to the monitoring stage 110. Alternatively, the care provider may decide to initiate the active mode of the mattress 116. If no response is received from the care provider within a certain time frame, the control unit 14 may assume that the care provider is unavailable and activate the active mode of the mattress system 116.

**[0052]** Figure 4 is an alternative flow diagram demonstrating how the mattress system may operate. The method is similar, with the addition of a calibration step at the beginning. Initially, in step 200 a patient lies on a mattress, and the mattress system 10 enters the configuration mode 202. Then the control unit 14 of the mattress system 10 inflates the plurality of chambers 16, 18, to a first pressure, in this case 30mmHg, in step 204. The control unit 14 then allows the plurality of chambers 16, 18, to deflate to a second pressure, in this case 6mmHg, in step 206. The deflation time from the first pressure to the second pressure is monitored, and compared to a table of results stored in the control unit 14. As such, in step 208, the weight of the patient may be obtained. Using the weight of the patient, the method may further comprise calibrating the threshold pressure value which indicates a useful movement, in step 210. The method may

then proceed to step 100, as described with reference to figure 3, and carry on as described with reference to figure 3.

**[0053]** Whilst the present invention has been described and illustrated with reference to particular embodiments, it will be appreciated by those of ordinary skill in the art that the invention lends itself to many different variations not specifically illustrated herein. By way of example only, certain possible variations will now be described.

**[0054]** The invention may comprise one or more pressure sensor mats located underneath the mattress, and more particularly under one or more of the plurality of interconnected chambers. An example position of a pressure sensor mat 40 is shown in figure 1. The one or more pressure mats may be configured to communicate sensor readings to the control unit via wired or wireless communication. The invention may comprise pressure sensors associated, and mechanically coupled, to the pump unit and pressure sensor pads located underneath the mattress. The processing unit may analyse the pressure sensor readings of both types of pressure sensor when determining whether to activate the active mattress mode.

**[0055]** The invention may also comprise a control unit being retrofitted to an existing mattress, where the existing mattress comprises a plurality of interconnecting chambers. The control unit may comprise one or more fixing elements, for fixing the control unit in position relative to the mattress. For example, the fixing elements may comprise one or more hooks which may be used to secure the control unit to a bed frame. Therefore, the control unit may be used to convert a conventional mattress to an active/passive mattress system as described above.

**[0056]** The control unit is preferably electrically powered, and via a mains power connection. However, in an alternative embodiment the control unit may be battery powered.

**[0057]** The control unit may be programmable via a wired or wireless connection to a computer device. The control unit may be configured to send communications to a smart device, such as a mobile phone or tablet via a pairing process, for example Bluetooth communication. Alternatively, the control unit may comprise an input panel, for example a keyboard or touchscreen, into which a care provider may input information such as a mobile phone number. The input panel may be configured to present a care provider with a number of options relating to the set up of the control unit, for example whether the control unit was arranged to send an alert signal or enter the active mode automatically.

**[0058]** The plurality of interconnecting chambers may comprise an air-retaining material, for example a foam section. The foam section may comprise cross-sectional profile. Foam present in different chambers of the plurality of interconnecting chambers may have different cross-sectional profiles.

**[0059]** The skilled person will appreciate that whilst the term "mattress" is used, and this will usually be interpreted to mean a mattress on a bed, the invention is equally applicable to a cushion, seat pad, or seat backrest.

5 **[0060]** It will be appreciated by the reader that integers or features of the invention that are described as preferable, advantageous, convenient or the like are optional and do not limit the scope of the independent claims. Moreover, it is to be understood that such optional integers or features, whilst of possible benefit in some embodiments of the invention, may not be desirable, and may therefore be absent, in other embodiments.

## 15 Claims

1. A mattress system (10) comprising:

a mattress (12) comprising a plurality of interconnected chambers (16, 18);

a control unit (14);

the plurality of interconnected chambers (16, 18) connected to the control unit (14), whereby activation of the control unit (14) may increase or decrease the pressure within the plurality of interconnected chambers (16, 18);

the control unit (14) comprising one or more sensors (28, 30) arranged to detect pressure changes in the plurality of interconnected chambers (16, 18) and a processor (34) arranged to analyse the pressure changes detected by the one or more sensors (28, 30),

wherein the mattress system (10) is configured for use in:

an active mode, where the control unit (14) is activated to increase or decrease the pressure within the plurality of interconnected chambers (16, 18), and

a passive mode, where the control unit (14) is arranged to monitor pressure changes within the plurality of interconnected chambers (16, 18);

wherein the mattress system (10) further comprises:

a calibration mode, wherein the control unit (14) is arranged to increase the pressure within the plurality of interconnected chambers (16, 18) to a first pressure, then allow a deflation of the plurality of interconnected chambers (16, 18) to a second pressure, whereby the time taken to deflate from the first pressure to the second pressure is monitored and recorded;

**characterised in that:**

the processor (34) is arranged to send, in response to a first set of pressure changes, a first signal in response to which the mattress system (10) is arranged to enter or remain in the passive mode, and is arranged to send, in response to a second set of pressure changes different from the first set of pressure changes, a second signal in response to which the mattress system (10) is arranged to enter the active mode; and the first set of pressure changes is determined at least in part based on the time taken to deflate from the first pressure to the second pressure obtained when the mattress system (10) is in the calibration mode.

2. A mattress system as claimed in claim 1, wherein the first set of pressure changes comprises one or more pressure changes which exceeds a threshold value a set number of times in a given time period.
3. A mattress system as claimed in claim 2, wherein the second set of pressure changes comprises pressure changes which do not exceed the threshold value the set number of times in the given time period.
4. A mattress system as claimed in any preceding claim, wherein the control unit (14) comprises an input and an output, the input and output connected to the plurality of interconnected chambers (16, 18), wherein a pressure sensor (28, 30) is associated with one or both of the control unit (14) input and output.
5. A mattress system as claimed in any preceding claim, wherein one or more pressure sensors are located underneath one or more of the plurality of interconnected chambers (16, 18).
6. A mattress system as claimed in claim 5, wherein the pressure sensor comprises a pressure sensor mat.
7. A mattress system as claimed in any preceding claim, wherein the mattress (12) comprises a first set of interconnected chambers (16) and a second set of interconnected chambers (18), the pressure in the first set of interconnected chambers (16) being adjustable independently of the pressure in the second set of interconnected chambers (18).
8. A mattress system as claimed in any of claims 1 to 6, wherein the mattress comprises a first set of interconnected chambers (16) and a second set of in-

terconnected chambers (18), the first set of interconnected chambers (16) being switchable between being independent of the second set of interconnected chambers (18) and in fluid communication with the second set of interconnected chambers (18), wherein the pressure in the first set of interconnected chambers (16) is adjustable independently of the pressure in the second set of interconnected chambers (18) when the mattress system (10) is in the active mode, and the first set of interconnected chambers (16) is in fluid communication with the second set of interconnected chambers (18) when in the passive mode.

9. A method of controlling a mattress system (10), the method comprising the steps of: providing a mattress system (10), the mattress system (10) comprising a plurality of interconnected chambers (16, 18) and a control unit (14), the mattress system (10) having:

an active mode in which the control unit (14) is activated to increase and decrease the pressure within the plurality of interconnected chambers (16, 18),

a passive mode in which the control unit (14) does not increase or decrease the pressure within the plurality of interconnected chambers (16, 18), the control unit (14) further comprising one or more sensors (28, 30) arranged to detect pressure changes within the plurality of interconnected chambers (16, 18) when the control unit (14) is in the passive mode, and

a calibration mode in which the control unit (14) is configured to increase the pressure within the plurality of interconnected chambers (16, 18) to a first pressure, and then allow deflation of the plurality of interconnected chambers (16, 18) to a second pressure, and a time taken to deflate from the first pressure to the second pressure is monitored;

configuring the mattress system (10) into the calibration mode and obtaining the time taken to deflate from the first pressure to the second pressure;

based on the time taken to deflate from the first pressure to the second pressure, determining a first set of pressure changes and a second, different, set of pressure changes;

configuring the mattress system (10) into the passive mode,

monitoring the pressure changes in the plurality of interconnected chambers (16, 18) using the one or more sensors (28, 30), and

if the detected pressure changes fall within the first set of pressure changes, the control unit (14) generating a first signal commanding the control unit (14) to remain in the passive mode, and if

the detected pressure changes fall within the second set of pressure changes, the control unit (14) generating a second signal different from the first signal.

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10. A method as claimed in claim 9, wherein the control unit (14) uses the deflation time to calculate an approximate weight of a patient.
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11. A method as claimed in claim 9 or 10, wherein the second set of pressure changes is chosen to indicate that a patient movement pattern is at risk of pressure ulcers developing.
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12. A method as claimed in claim 11, wherein the second signal commands the control unit (14) to enter the active mode, and begin changing the pressure within the plurality of interconnected chambers (16, 18).
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13. A method as claimed in claim 11, wherein the second signal causes the control unit (14) to emit an alert notification that is sent to a care provider, the alert notification requesting instructions on whether to move the mattress system (10) into the active mode.
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14. A method as claimed in claim 13, where in response to instructions from the care provider, the mattress system (10) is moved into the active mode or remains in the passive mode.
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15. A control unit (14) for a mattress system (10) according to claim 1, the control unit (14) comprising:

an output, the output configured for connection to a plurality of interconnected chambers (16, 18), the output further comprising a sensor (28, 30) arranged to detect pressure changes in the plurality of interconnected chambers (16, 18) when the output is connected to the plurality of interconnected chambers (16, 18), and

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a processor (34) arranged to analyse the pressure changes detected by the sensor (28, 30); wherein the control unit (14) is configured to operate the mattress system (10) in:

an active mode, where the control unit (14) is activated to increase or decrease the pressure within the plurality of interconnected chambers (16, 18),

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a passive mode, where the control unit (14) is arranged to monitor pressure changes within the plurality of interconnected chambers (16, 18), and

wherein the control unit (14) is further configured to operate the mattress system (10) in:

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a calibration mode, wherein the control

unit (14) is arranged to increase the pressure within the plurality of interconnected chambers (16, 18) to a first pressure, then allow a deflation of the plurality of interconnected chambers (16, 18) to a second pressure, whereby the time taken to deflate from the first pressure to the second pressure is monitored and recorded;

**characterised in that:**

the processor (34) is arranged to send, in response to a first set of pressure changes, a first signal in response to which the mattress system (10) is arranged to enter or remain in the passive mode, and is arranged to send, in response to a second set of pressure changes different from the first set of pressure changes, a second signal in response to which the mattress system (10) is arranged to enter the active mode; and

the first set of pressure changes is determined at least in part based on the time taken to deflate from the first pressure to the second pressure obtained when the mattress system (10) is in the calibration mode.

## Patentansprüche

### 1. Matratzensystem (10), umfassend:

eine Matratze (12), die mehrere miteinander verbundene Kammern (16, 18) umfasst;

eine Steuereinheit (14);

wobei die mehreren miteinander verbundenen Kammern (16, 18) mit der Steuereinheit (14) verbunden sind, wobei die Aktivierung der Steuereinheit (14) den Druck innerhalb der mehreren miteinander verbundenen Kammern (16, 18) erhöhen oder verringern kann;

wobei die Steuereinheit (14) ein oder mehrere Sensoren (28, 30) umfasst, die so eingestellt sind, dass sie Druckänderungen innerhalb der mehreren miteinander verbundenen Kammern (16, 18) erfasst, und einen Prozessor (34), der so eingestellt ist, dass er die Druckänderungen analysiert, die durch den einen oder die mehreren Sensoren (28, 30) erfasst werden,

wobei das Matratzensystem (10) konfiguriert ist für die Verwendung in:

einem aktiven Modus, in dem die Steuer-

einheit (14) aktiviert ist, um den Druck innerhalb der mehreren miteinander verbundenen Kammern (16, 18) zu erhöhen oder zu verringern, und einem passiven Modus, in dem die Steuereinheit (14) so eingestellt ist, dass sie Druckänderungen innerhalb der mehreren miteinander verbundenen Kammern (16, 18) überwacht; wobei das Matratzensystem (10) ferner umfasst:

einen Kalibriermodus, in dem die Steuereinheit (14) so eingestellt ist, dass sie den Druck innerhalb der mehreren miteinander verbundenen Kammern (16, 18) auf einen ersten Druck erhöht, dann einen Luftverlust in den mehreren miteinander verbundenen Kammern (16, 18) auf einen zweiten Druck zulässt, wobei die Zeit, die für den Luftverlust vom ersten Druck zum zweiten Druck benötigt wird, überwacht und aufgezeichnet wird;

**dadurch gekennzeichnet, dass:**

der Prozessor (34) so eingestellt ist, dass er als Antwort auf einen ersten Satz Druckänderungen ein erstes Signal sendet, auf das hin das Matratzensystem (10) so eingestellt wird, dass es in den passiven Modus schaltet oder in diesem verbleibt, und so eingestellt ist, dass er als Antwort auf einen zweiten Satz Druckänderungen, der sich vom ersten Satz Druckänderungen unterscheidet, ein zweites Signal sendet, auf das hin das Matratzensystem (10) so eingestellt wird, dass es in den aktiven Modus schaltet; und

der erste Satz Druckänderungen wenigstens teilweise basierend auf der Zeit ermittelt wird, die für den Luftverlust vom ersten Druck zum zweiten Druck benötigt wird und die ermittelt wird, wenn das Matratzensystem (10) sich im Kalibriermodus befindet.

2. Matratzensystem wie in Anspruch 1 beansprucht, wobei der erste Satz Druckänderungen ein oder mehrere Druckänderungen umfasst, die einen Schwellenwert eine bestimmte Anzahl von Malen innerhalb eines bestimmten Zeitraums überschreiten.
3. Matratzensystem wie in Anspruch 2 beansprucht,

wobei der zweite Satz Druckänderungen Druckänderungen umfasst, die den Schwellenwert die bestimmte Anzahl von Malen innerhalb des bestimmten Zeitraums nicht überschreiten.

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4. Matratzensystem wie in einem vorhergehenden Anspruch beansprucht, wobei die Steuereinheit (14) einen Eingang und einen Ausgang umfasst, wobei der Eingang und der Ausgang mit den mehreren miteinander verbundenen Kammern (16, 18) verbunden sind, wobei ein Drucksensor (28, 30) mit einem oder mit beiden der Ein- und Ausgänge der Steuereinheit (14) verbunden ist.
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5. Matratzensystem wie in einem vorhergehenden Anspruch beansprucht, wobei ein oder mehrere Drucksensoren sich unter einer oder mehreren der mehreren miteinander verbundenen Kammern (16, 18) befinden.
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6. Matratzensystem wie in Anspruch 5 beansprucht, wobei der Drucksensor eine Drucksensormatte umfasst.
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7. Matratzensystem wie in einem vorhergehenden Anspruch beansprucht, wobei die Matratze (12) einen ersten Satz von miteinander verbundenen Kammern (16) und einen zweiten Satz von miteinander verbundenen Kammern (18) umfasst, wobei der Druck im ersten Satz von miteinander verbundenen Kammern (16) unabhängig vom Druck im zweiten Satz von miteinander verbundenen Kammern (18) einstellbar ist.
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8. Matratzensystem wie in einem der Ansprüche 1 bis 6 beansprucht, wobei die Matratze einen ersten Satz von miteinander verbundenen Kammern (16) und einen zweiten Satz von miteinander verbundenen Kammern (18) umfasst, wobei der erste Satz von miteinander verbundenen Kammern (16) umschaltbar ist zwischen unabhängig vom zweiten Satz von miteinander verbundenen Kammern (18) und in Fluidverbindung mit dem zweiten Satz von miteinander verbundenen Kammern (18), wobei der Druck im ersten Satz von miteinander verbundenen Kammern (16) unabhängig vom Druck im zweiten Satz von miteinander verbundenen Kammern (18) einstellbar ist, wenn das Matratzensystem (10) sich im aktiven Modus befindet, und der erste Satz von miteinander verbundenen Kammern (16) sich in Fluidverbindung mit dem zweiten Satz von miteinander verbundenen Kammern (18) befindet, wenn es sich im passiven Modus befindet.
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9. Verfahren zur Steuerung eines Matratzensystems (10), wobei das Verfahren die folgenden Schritte umfasst: Bereitstellen eines Matratzensystems (10), wobei

das Matratzensystem (10) mehrere miteinander verbundene Kammern (16, 18) und eine Steuereinheit (14) umfasst, wobei das Matratzensystem (10) besitzt:

einen aktiven Modus, in dem die Steuereinheit (14) aktiviert ist, um den Druck innerhalb der mehreren miteinander verbundenen Kammern (16, 18) zu erhöhen oder zu verringern, einen passiven Modus, in dem die Steuereinheit (14) den Druck innerhalb der mehreren miteinander verbundenen Kammern (16, 18) nicht erhöht oder verringert, wobei die Steuereinheit (14) ferner ein oder mehrere Sensoren (28, 30) umfasst, die so eingestellt sind, dass sie Druckänderungen innerhalb der mehreren miteinander verbundenen Kammern (16, 18) erfasst, wenn die Steuereinheit (14) sich im passiven Modus befindet, und

einen Kalibriermodus, in dem die Steuereinheit (14) so konfiguriert ist, dass sie den Druck innerhalb der mehreren miteinander verbundenen Kammern (16, 18) auf einen ersten Druck erhöht und dann den Luftverlust in den mehreren miteinander verbundenen Kammern (16, 18) auf einen zweiten Druck zulässt, und eine Zeit überwacht, die für den Luftverlust vom ersten Druck zum zweiten Druck benötigt wird; Konfigurieren des Matratzensystems (10) in den Kalibriermodus und ermitteln der Zeit, die für den Luftverlust vom ersten Druck zum zweiten Druck benötigt wird;

Ermitteln eines ersten Satzes Druckänderungen und eines zweiten, unterschiedlichen Satzes von Druckänderungen, basierend auf der Zeit, die für den Luftverlust vom ersten Druck zum zweiten Druck benötigt wird; Konfigurieren des Matratzensystems (10) in den passiven Modus,

Überwachen der Druckänderungen in den mehreren miteinander verbundenen Kammern (16, 18) unter Verwendung der ein oder mehreren Sensoren (28, 30), und,

wenn die ermittelten Druckänderungen in den ersten Satz Druckänderungen fallen, Erzeugen eines ersten Signals durch die Steuereinheit (14), welches die Steuereinheit (14) anweist, im passiven Modus zu verbleiben, und, wenn die ermittelten Druckänderungen in den zweiten Satz Druckänderungen fallen, Erzeugen eines zweiten Signals durch die Steuereinheit (14), welches sich vom ersten Signal unterscheidet.

10. Verfahren wie in Anspruch 9 beansprucht, wobei die Steuereinheit (14) die Luftverlustzeit zur Berechnung eines ungefähren Gewichts eines Patienten heranzieht.

11. Verfahren wie in Anspruch 9 oder 10 beansprucht, wobei der zweite Satz Druckänderungen ausgewählt wird, um anzuzeigen, dass ein Bewegungsmuster eines Patienten ein Risiko für die Ausbildung von Dekubitalgeschwüren darstellt.

12. Verfahren wie in Anspruch 11 beansprucht, wobei das zweite Signal die Steuereinheit (14) anweist, in den aktiven Modus zu schalten und damit zu beginnen, den Druck innerhalb der mehreren miteinander verbundenen Kammern (16, 18) zu ändern.

13. Verfahren wie in Anspruch 11 beansprucht, wobei das zweite Signal bewirkt, dass die Steuereinheit (14) eine Warnmeldung ausgibt, die an einen Pflegedienstleister gesendet wird, wobei die Warnmeldung Anweisungen anfordert, ob das Matratzensystem (10) in den aktiven Modus schalten soll.

14. Verfahren wie in Anspruch 13 beansprucht, wobei als Reaktion auf die Anweisungen vom Pflegedienstleister das Matratzensystem (10) in den aktiven Modus schaltet oder im passiven Modus verbleibt.

15. Steuereinheit (14) für ein Matratzensystem (10) gemäß Anspruch 1, wobei die Steuereinheit (14) umfasst:

einen Ausgang, wobei der Ausgang konfiguriert ist zur Verbindung mit mehreren miteinander verbundenen Kammern (16, 18), wobei der Ausgang ferner einen Sensor (28, 30) umfasst, der eingestellt ist, um Druckänderungen in den mehreren miteinander verbundenen Kammern (16, 18) zu erfassen, wenn der Ausgang mit den mehreren miteinander verbundenen Kammern (16, 18) verbunden ist, und einen Prozessor (34), der so eingestellt ist, dass er die vom Sensor (28, 30) erfassten Druckänderungen analysiert; wobei die Steuereinheit (14) so konfiguriert ist, dass sie das Matratzensystem (10) betreibt in:

einem aktiven Modus, in dem die Steuereinheit (14) aktiviert ist, um den Druck innerhalb der mehreren miteinander verbundenen Kammern (16, 18) zu erhöhen oder zu verringern,

einem passiven Modus, in dem die Steuereinheit (14) so eingestellt ist, dass sie Druckänderungen innerhalb der mehreren miteinander verbundenen Kammern (16, 18) überwacht, und

wobei die Steuereinheit (14) ferner so konfiguriert ist, dass sie das Matratzensystem (10) betreibt in:

einem Kalibriermodus, in dem die Steu-

ereinheit (14) so eingestellt ist, dass sie den Druck innerhalb der mehreren miteinander verbundenen Kammern (16, 18) auf einen ersten Druck erhöht, dann einen Luftverlust in den mehreren miteinander verbundenen Kammern (16, 18) auf einen zweiten Druck zulässt, wobei die Zeit, die für den Luftverlust vom ersten Druck zum zweiten Druck benötigt wird, überwacht und aufgezeichnet wird;

**dadurch gekennzeichnet, dass:**

der Prozessor (34) so eingestellt ist, dass er als Antwort auf einen ersten Satz Druckänderungen ein erstes Signal sendet, auf das hin das Matratzensystem (10) so eingestellt wird, dass es in den passiven Modus schaltet oder in diesem verbleibt, und so eingestellt ist, dass er als Antwort auf einen zweiten Satz Druckänderungen, der sich vom ersten Satz Druckänderungen unterscheidet, ein zweites Signal sendet, auf das hin das Matratzensystem (10) so eingestellt wird, dass es in den aktiven Modus schaltet; und  
der erste Satz Druckänderungen wenigstens teilweise basierend auf der Zeit ermittelt wird, die für den Luftverlust vom ersten Druck zum zweiten Druck benötigt wird und die ermittelt wird, wenn das Matratzensystem (10) sich im Kalibriermodus befindet.

## Revendications

### 1. Système de matelas, comprenant :

un matelas (12) comprenant une pluralité de chambres connectées mutuellement (16, 18) ;  
une unité de commande (14) ;  
la pluralité de chambres connectées mutuellement (16, 18) étant connectées à l'unité de commande (14), moyennant quoi l'activation de l'unité de commande (14) peut augmenter ou diminuer la pression à l'intérieur de la pluralité de chambres connectées mutuellement (16, 18) ;  
l'unité de commande (14) comprenant un ou plusieurs capteurs (28, 30) agencés pour détecter des changements de pression dans la pluralité de chambres connectées mutuellement (16, 18) et un processeur (34) agencé pour analyser les

changements de pression détectés par les un ou plusieurs capteurs (28, 30), dans lequel le système de matelas (10) est configuré pour être utilisé dans :

un mode actif, dans lequel l'unité de commande (14) est activée pour augmenter ou diminuer la pression à l'intérieur de la pluralité de chambres connectées mutuellement (16, 18), et  
un mode passif, dans lequel l'unité de commande (14) est agencée pour surveiller des changements de pression à l'intérieur de la pluralité de chambres connectées mutuellement (16, 18) ;  
dans lequel le système de matelas (10) comprend en outre :

un mode d'étalonnage, dans lequel l'unité de commande (14) est agencée pour augmenter la pression à l'intérieur de la pluralité de chambres connectées mutuellement (16, 18) à une première pression, puis permettre un dégonflage de la pluralité de chambres connectées mutuellement (16, 18) à une seconde pression, moyennant que le temps pris pour le dégonflage de la première pression à la seconde pression est surveillé et enregistré ;

**caractérisé en ce que :**

le processeur (34) est agencé pour envoyer, en réponse à un premier ensemble de changements de pression, un premier signal en réponse auquel le système de matelas (10) est agencé pour entrer ou rester dans le mode passif, et est agencé pour envoyer, en réponse à un second ensemble de changements de pression différent du premier ensemble de changements de pression, un second signal en réponse auquel le système de matelas (10) est agencé pour entrer dans le mode actif ; et  
le premier ensemble de changements de pression est déterminé au moins en partie sur la base du temps pris pour le dégonflage de la première pression à la seconde pression obtenu lorsque le système de matelas (10) est dans le mode d'étalonnage.

### 2. Système de matelas selon la revendication 1, dans lequel le premier ensemble de changements de

pression comprend un ou plusieurs changements de pression qui dépassent une valeur de seuil un nombre de fois fixé dans une période de temps donnée.

3. Système de matelas selon la revendication 2, dans lequel le second ensemble de changements de pression comprend des changements de pression qui ne dépassent pas la valeur de seuil le nombre de fois fixé dans la période de temps donnée. 5
4. Système de matelas selon l'une quelconque des revendications précédentes, dans lequel l'unité de commande (14) comprend une entrée et une sortie, l'entrée et la sortie étant connectées à la pluralité de chambres connectées mutuellement (16, 18), dans lequel un capteur de pression (28, 30) est associé à l'une de l'entrée et de la sortie de l'unité de commande (14), ou aux deux. 10
5. Système de matelas selon l'une quelconque des revendications précédentes, dans lequel un ou plusieurs capteurs de pression sont situés sous une ou plusieurs de la pluralité de chambres connectées mutuellement (16, 18). 15
6. Système de matelas selon la revendication 5, dans lequel le capteur de pression comprend un tapis de capteur de pression. 20
7. Système de matelas selon l'une quelconque des revendications précédentes, dans lequel le matelas (12) comprend un premier ensemble de chambres connectées mutuellement (16) et un second ensemble de chambres connectées mutuellement (18), la pression dans le premier ensemble de chambres connectées mutuellement (16) étant ajustable indépendamment de la pression dans le second ensemble de chambres connectées mutuellement (18). 25
8. Système de matelas selon l'une quelconque des revendications 1 à 6, dans lequel le matelas comprend un premier ensemble de chambres connectées mutuellement (16) et un second ensemble de chambres connectées mutuellement (18), le premier ensemble de chambres connectées mutuellement (16) pouvant être commuté entre être indépendant du second ensemble de chambres connectées mutuellement (18) et être en communication fluïdique avec le second ensemble de chambres connectées mutuellement (18), dans lequel la pression dans le premier ensemble de chambres connectées mutuellement (16) est ajustable indépendamment de la pression dans le second ensemble de chambres connectées mutuellement (18) lorsque le système de matelas (10) est dans le mode actif, et le premier ensemble de chambres connectées mutuellement (16) est en communication fluïdique avec le second ensemble de cham-

bres connectées mutuellement (18) lorsqu'il est dans le mode passif.

9. Procédé de commande d'un système de matelas (10), le procédé comprenant les étapes consistant à : 5  
fournir un système de matelas (10), le système de matelas (10) comprenant une pluralité de chambres connectées mutuellement (16, 18) et une unité de commande (14), le système de matelas (10) présentant : 10

un mode actif dans lequel l'unité de commande (14) est activée pour augmenter ou diminuer la pression à l'intérieur de la pluralité de chambres connectées mutuellement (16, 18),

un mode passif dans lequel l'unité de commande (14) n'augmente ni ne diminue la pression à l'intérieur de la pluralité de chambres connectées mutuellement (16, 18), l'unité de commande (14) comprenant en outre un ou plusieurs capteurs (28, 30) agencés pour détecter des changements de pression à l'intérieur de la pluralité de chambres connectées mutuellement (16, 18) lorsque l'unité de commande (14) est dans le mode passif, et

un mode d'étalonnage dans lequel l'unité de commande (14) est configurée pour augmenter la pression à l'intérieur de la pluralité de chambres connectées mutuellement (16, 18) à une première pression, puis permettre le dégonflage de la pluralité de chambres connectées mutuellement (16, 18) à une seconde pression, et un temps pris pour le dégonflage de la première pression à la seconde pression est surveillé ; configurer le système de matelas (10) dans le mode d'étalonnage et obtenir le temps nécessaire pour le dégonflage de la première pression à la seconde pression ;

sur la base du temps pris pour le dégonflage de la première pression à la seconde pression, déterminer un premier ensemble de changements de pression et un second ensemble de changements de pression différent ;

configurer le système de matelas (10) dans le mode passif,

surveiller les changements de pression dans la pluralité de chambres connectées mutuellement (16, 18) en utilisant les un ou plusieurs capteurs (28, 30), et

si les changements de pression détectés tombent dans le premier ensemble de changements de pression, l'unité de commande (14) génère un premier signal donnant comme instruction à l'unité de commande (14) de rester dans le mode passif, et si les changements de pression détectés tombent dans le second ensemble de changements de pression, l'unité de commande

- (14) génère un second signal différent du premier signal.
10. Procédé selon la revendication 9, dans lequel l'unité de commande (14) utilise le temps de dégonflage pour calculer un poids approximatif d'un patient. 5
11. Procédé selon la revendication 9 ou 10, dans lequel le second ensemble de changements de pression est choisi pour indiquer qu'un modèle de mouvement de patient est à risque de développement de plaies de pression. 10
12. Procédé selon la revendication 11, dans lequel le second signal donne comme instruction à l'unité de commande (14) d'entrer dans le mode actif, et de commencer à changer la pression à l'intérieur de la pluralité de chambres connectées mutuellement (16, 18). 15
13. Procédé selon la revendication 11, dans lequel le second signal amène l'unité de commande (14) à émettre une notification d'alerte qui est envoyée à un prestataire de soins, la notification d'alerte demandant des instructions pour déplacer ou non le système de matelas (10) dans le mode actif. 20
14. Procédé selon la revendication 13, dans lequel, en réponse à des instructions du prestataire de soins, le système de matelas (10) est déplacé dans le mode actif ou reste dans le mode passif. 25
15. Unité de commande (14) pour un système de matelas (10) selon la revendication 1, l'unité de commande (14) comprenant : 30
- une sortie, la sortie étant configurée pour être connectée à une pluralité de chambres connectées mutuellement (16, 18), la sortie comprenant en outre un capteur (28, 30) agencé pour détecter des changements de pression dans la pluralité de chambres connectées mutuellement (16, 18) lorsque la sortie est connectée à la pluralité de chambres connectées mutuellement (16, 18), et 35
- un processeur (34) agencé pour analyser les changements de pression détectés par le capteur (28, 30) ; 40
- dans lequel l'unité de commande (14) est configurée pour faire fonctionner le système de matelas (10) dans : 45
- un mode actif, dans lequel l'unité de commande (14) est activée pour augmenter ou diminuer la pression à l'intérieur de la pluralité de chambres connectées mutuellement (16, 18), 50
- un mode passif, dans lequel l'unité de commande (14) est activée pour maintenir la pression à l'intérieur de la pluralité de chambres connectées mutuellement (16, 18). 55

mande (14) est agencée pour surveiller des changements de pression à l'intérieur de la pluralité de chambres connectées mutuellement (16, 18) ; et

dans lequel l'unité de commande (14) est configurée en outre pour faire fonctionner le système de matelas (10) dans :

un mode d'étalonnage, dans lequel l'unité de commande (14) est agencée pour augmenter la pression à l'intérieur de la pluralité de chambres connectées mutuellement (16, 18) à une première pression, puis permettre un dégonflage de la pluralité de chambres connectées mutuellement (16, 18) à une seconde pression, moyennant quoi le temps pris pour le dégonflage de la première pression à la seconde pression est surveillé et enregistré ;

**caractérisé en ce que :**

le processeur (34) est agencé pour envoyer, en réponse à un premier ensemble de changements de pression, un premier signal en réponse auquel le système de matelas (10) est agencé pour entrer ou rester dans le mode passif, et est agencé pour envoyer, en réponse à un second ensemble de changements de pression différent du premier ensemble de changements de pression, un second signal en réponse auquel le système de matelas (10) est agencé pour entrer dans le mode actif ; et

le premier ensemble de changements de pression est déterminé au moins en partie sur la base du temps pris pour le dégonflage de la première pression à la seconde pression obtenu lorsque le système de matelas (10) est dans le mode d'étalonnage.

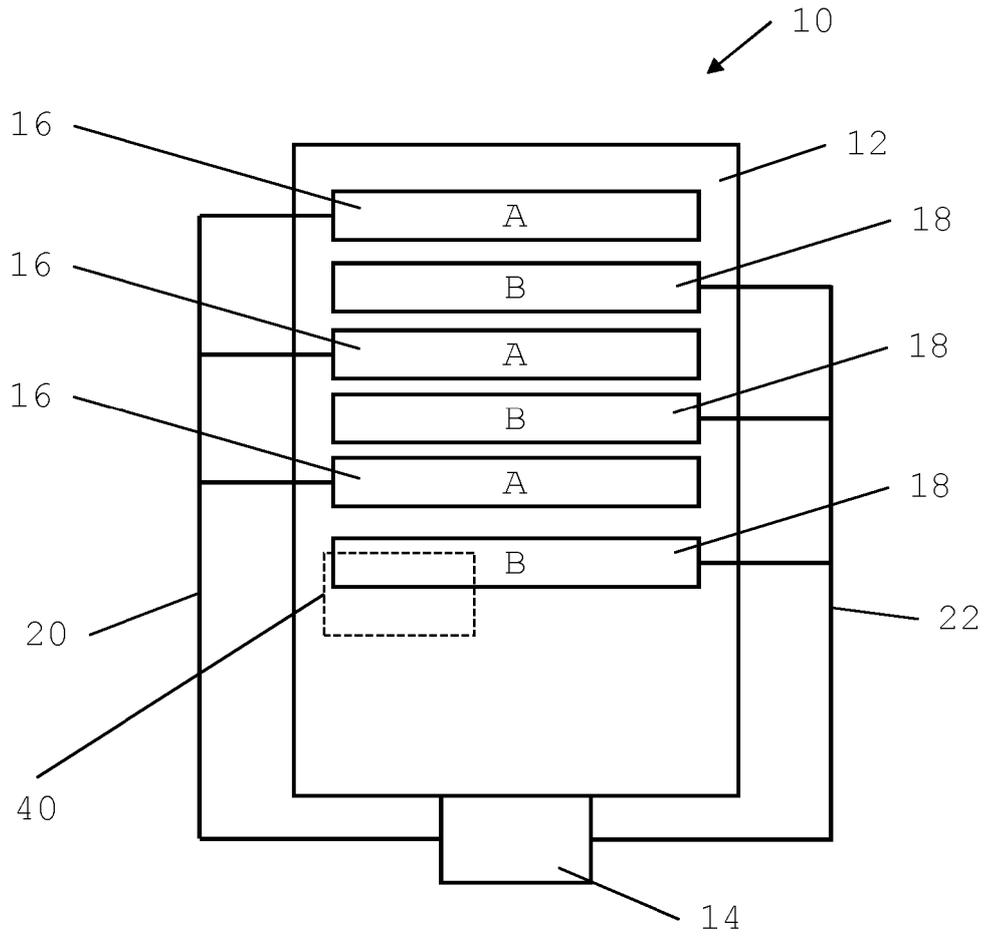


Fig. 1

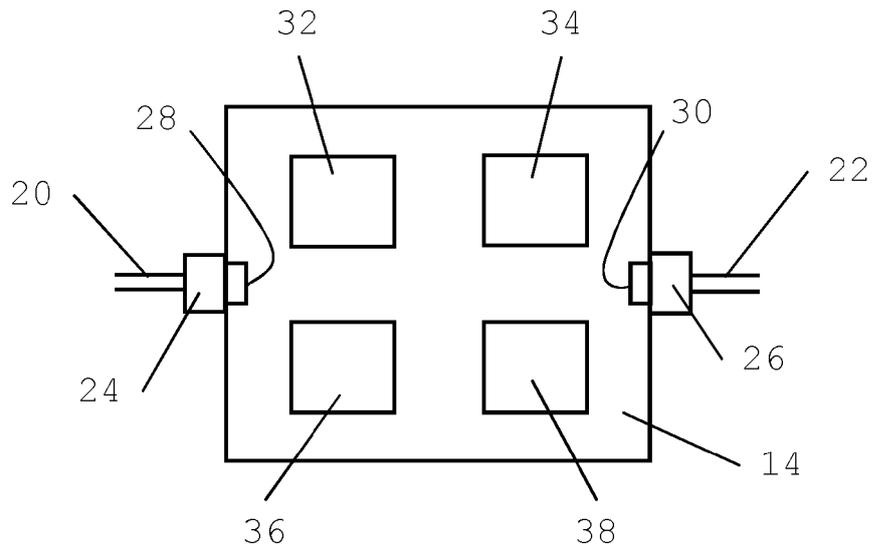


Fig. 2

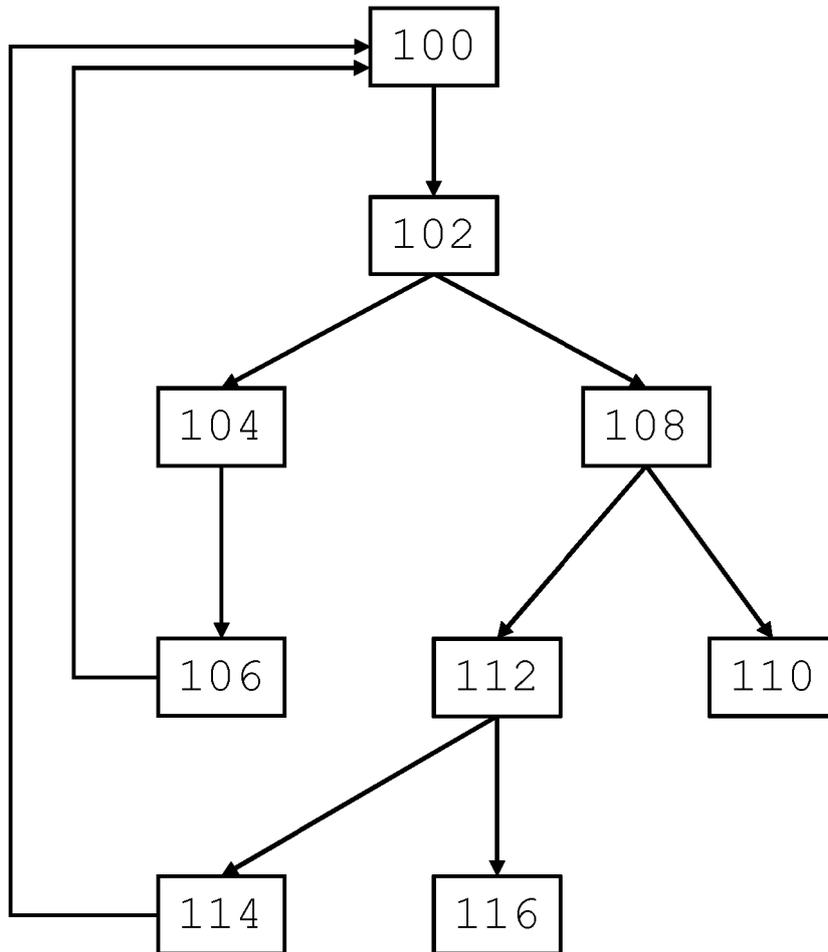


Fig. 3

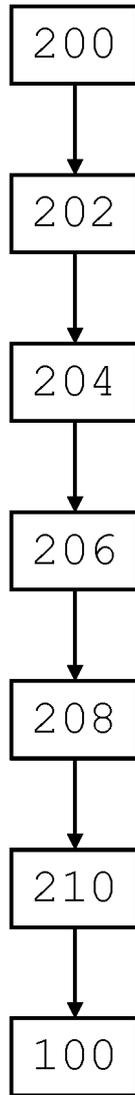


Fig. 4

**REFERENCES CITED IN THE DESCRIPTION**

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**Patent documents cited in the description**

- US 2009007341 A1 [0004]
- WO 9748314 A1 [0005]
- US 2009100604 A1 [0006]
- EP 2735293 A1 [0007]