Aug. 26, 1969 J. K. WHITNEY 3,462,778

INFLATABLE MATTRESS AND PRESSURE SYSTEM

Filed Feb. 25, 1966 3 Sheets-Sheet 1

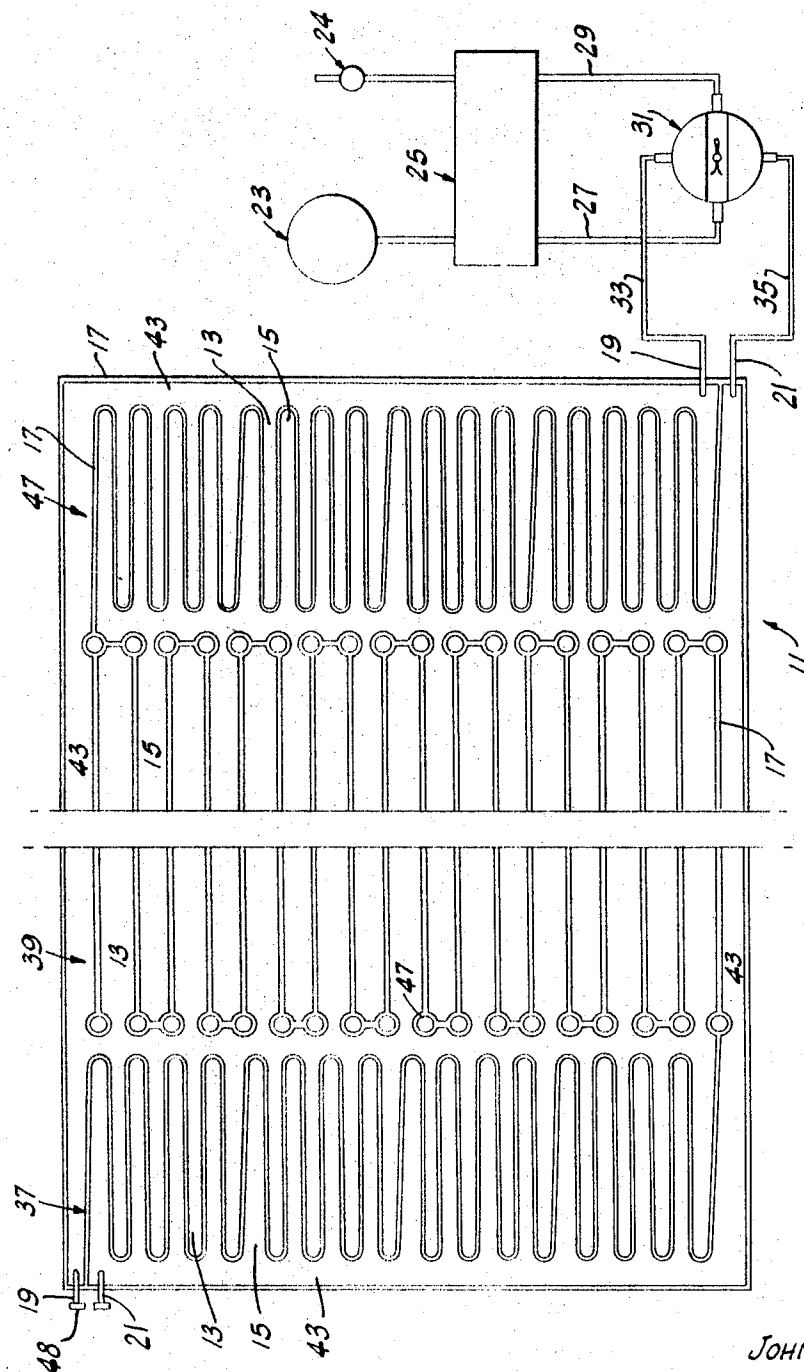


Fig. 1

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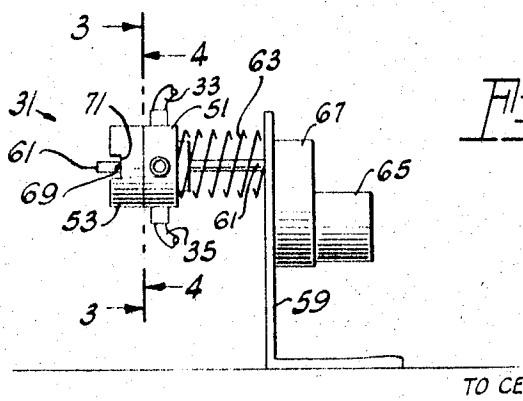


Fig. 2

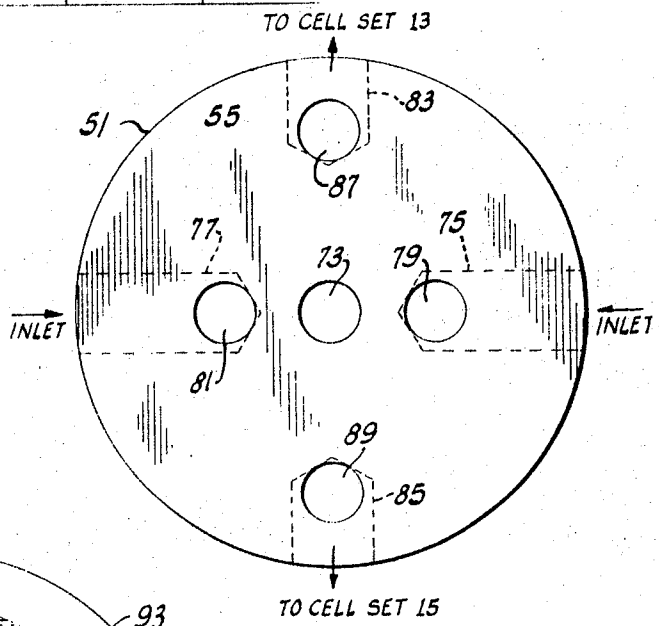


Fig. 3

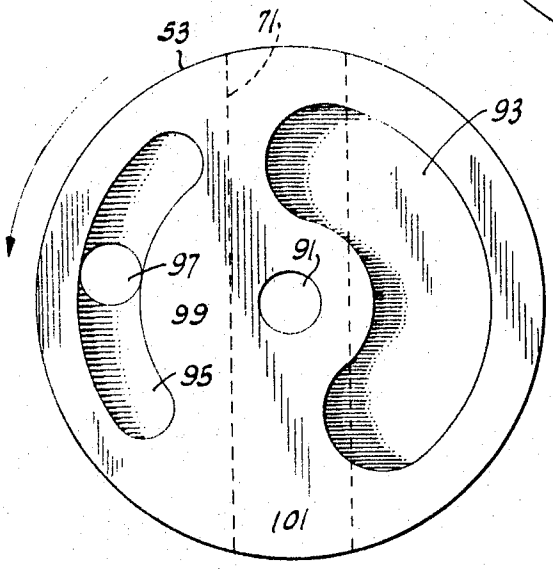


Fig. 4

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INFLATABLE MATTRESS AND PRESSURE SYSTEM

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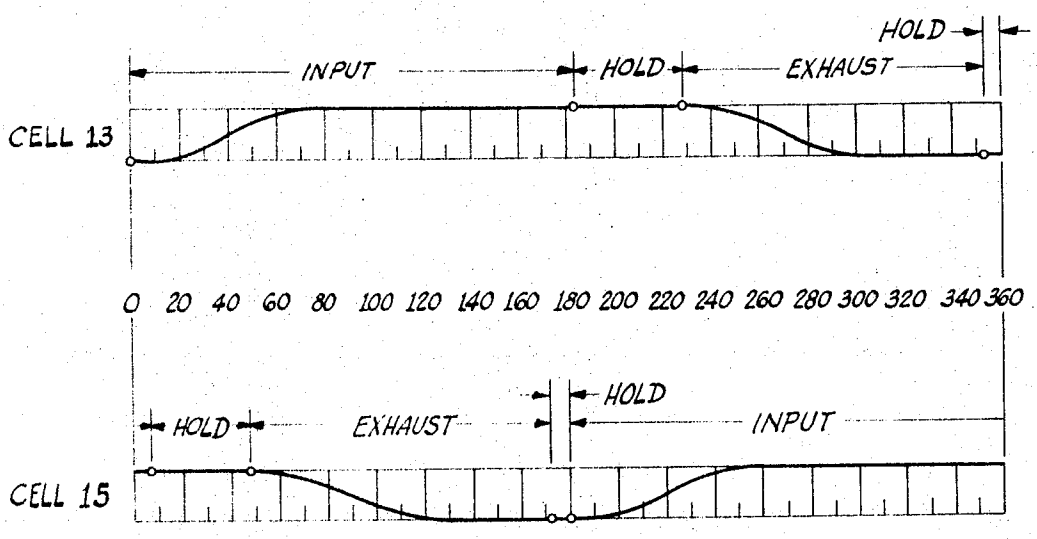


Fig. 5

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INFLATABLE MATTRESS AND PRESSURE SYSTEM

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Int. Cl. A47c 27/08
U.S. Cl. 5—347 4 Claims

ABSTRACT OF THE DISCLOSURE

A multiple cell, fluid pressure system utilizing a valve which substantially fills one set of cells before exhausting the other set of cells whereby movement of a patient thereon is held to a minimum in a horizontal plane.

This invention relates to a therapeutic mattress and pressure system adapted to provide cycling alternate adjoining body support areas for the user.

Persons required to lie in bed for an extended period of time suffer the discomforts of general fatigue, muscular pains, and in some instances, decubitus ulcers or pressure sores. In order to relieve these conditions, it has been proposed that multiple cell fluid or air mattresses be employed with a pressure system to alternately shift the body support pressure areas from one location to another. Although such prior mattresses have reduced the discomforts of the user, they have not satisfied the prerequisites required to adequately insure against tissue degeneration nor have they provided efficient and relatively maintenance-free operation during an extended period of usage.

It is known that certain bony parts of the body such as heels and shoulders are more prone to become sore during convalescence than other parts of the body. Further, the area of these parts which contact the mattress is relatively small compared to the size of the mattress cells normally used. Consequently, even though the adjoining cells are alternately inflated and deflated, the small body areas often remain fixed in pressure point location upon one cell width.

Accordingly, an object of this invention is to reduce the mattress cell width in those sections of the mattress which normally support the small bony areas of the body to better assure a transfer of the support areas between adjoining cells.

It is also known that therapeutic mattresses employing cells having more than one width dimension have been proposed. For instance, one such mattress employs essentially bifurcated cell extensions of larger longitudinal cells located at the bottom of the mattress. It has been found that such mattresses fail to combat tissue degeneration at several of the small bony areas of the body mentioned above. Further, these known mattresses, because of their simplicity of cell layout and minimum seal joints, are relatively weak and therefore with not withstand extended usage. Also, such mattresses are not reversible, thereby hastening failure, and they additionally lack universality for positioning purposes.

Accordingly, a further object of this invention is to provide greater comfort for the user, and reversibility and universality of the mattress by employing smaller cells at prescribed locations on the mattress.

Another object of the invention is to make the mattress more rugged by fabricating the cells in at least three sections, the center section cells being larger in width than the outer section cells.

When a person is lying on an alternating pressure support mattress, some disturbance occurs when the supported height of the body is changed. This has been evident in some prior mattress designs which allowed the user

to move alternately from a relatively high position when one set of cells was fully inflated to a relatively low position whereat the adjoining cells were at an equal level and pressure. Such cyclic vertical movement is bothersome to the user.

Accordingly, a further object of the invention is to transfer the body support areas from one cell to the adjacent one at a time when both cells are substantially fully inflated to minimize vertical movement of the user.

A still further object of the invention is to provide an improved therapeutic mattress and fluid pressure system.

The foregoing objects are achieved in one aspect of the invention by the provision of an inflatable mattress having at least three sections, each of which includes two sets of interdigitated cells. The outer section cell sets utilize cells having a width substantially less than the central section cells. A fluid pressure system is connected to the mattress to provide alternate inflation and deflation movements of the adjoining interdigitated cells. This system operates in a manner to maintain one set of cells in an inflated position while the other set of cells is deflated and then substantially inflated again. Accordingly, although the user's pressure points on the mattress change position from one cell to the adjoining cell during each cycle of operation, the actual transfer of the support areas occur without substantially altering the support height of the user.

For a better understanding of the invention, reference is made to the following description and accompanying drawings in which:

FIG. 1 is a plan view of the inflatable mattress coupled to the pressure system;

FIG. 2 shows the manner in which the pressure system valve is mounted;

FIG. 3 is a view taken along line 3—3 of FIG. 2 of the stationary member of the valve;

FIG. 4 is a view taken along line 4—4 of FIG. 2 showing the rotating valve member; and

FIG. 5 is a chart illustrating the operation of the valve in the pressure system as well as the inflation and deflation movements of the adjoining mattress cells.

Referring generally to FIG. 1, mattress **11** is provided with two sets of interdigitated cells **13** and **15** formed by seal ribbons **17**. Access connections **19** and **21** are attached to cell sets **13** and **15**, respectively. Fluid pressure is supplied to mattress **11** from pump **23** through chamber **25**, conduits **27** and **29** and valve **31**. The fluid pressure from the valve is transferred to the mattress by conduits **33** and **35**. An adjustable pressure relief valve **24** is also connected to chamber **25** to insure maintenance of proper pressure in the system.

More specifically, mattress **11** may be formed from two rectangular vinyl chloride sheets of .020 inch thick plastic matterial having a peripheral contour similar to a typical hospital bed mattress. The sheets are attached to one another by seal joints indicated by ribbons **17** around the periphery. Similar seal ribbons form the separating fluid impervious joints between cell sets **13** and **15**.

As indicated in FIG. 1, the mattress is formed with at least three distinct sections **37**, **39**, and **41**. The peripheral channels **43** and intermediate channels **45** serve to interconnect the respective cell sets **13** and **15** so that a given cell set in each mattress section inflates and deflates along with its counterpart in the other sections.

It is to be noted that access connections **19** and **21** may be disposed at both ends of mattress **11**. Also, the configurations of outer sections **37** and **41** substantially conform to one another. Accordingly, such a layout of cells and access connections provides reversibility for the mattress. Suitable plugs **48**, clamps or other means may be employed to seal off the connections **19** and **21** which are not being used at the time.

The mattress is more rugged than previous ones for several reasons. For instance, the three mattress sections **37**, **39** and **41** individually have a large number of seal joints along ribbon **17** with few interconnecting ribbon lines. Further, in areas where terminations or relatively sharp corners would be encountered such as at the corners of the cell sets **13** and **15** in central section **39**, circular seal ribbons **47** are provided for strength.

Central section **39** uses relatively wide cell widths for interdigitated cell sets **13** and **15**. Normally, such cells are arranged longitudinally to contact the trunk portion of the patient. It has been found that cell widths of about 1.75 inches are quite satisfactory for the central section cells.

The cells of sets **13** and **15** in the outer sections **37** and **41** generally are positioned longitudinally of the mattress to reside where the rather small bony areas of the body rest. Two such areas are the heels and certain parts of the shoulder. Due to the relatively small size of these bony areas, it has been found beneficial to make the cells in outer sections **37** and **41** substantially smaller than those in central section **39**. For example, cell widths for sets **13** and **15** in these outer sections may have a width of about 1.00 inch. Accordingly, the adjoining interdigitated cells are sufficiently small to transfer the pressure support point from one cell to the other even for the small bony parts of the body that they contact.

With respect to the fluid pressure system, pump **23** may be any conventional air pump, preferably of the continuously operating diaphragm type capable of delivering about .75 p.s.i. Chamber **25**, which may be made of plastic, serves as a pressure pulse damper and a noise suppressor. The pressure relief valve preferably comprises a variable control bleeder type valve.

Referring to FIGS. 2, 3, and 4, valve **31** employs a stationary member **51** and a rotating member **53**. These members have flat faces **55** and **57** which are formed to mate in a substantially air tight manner. Members **51** and **53** are molded from graphite so that there is little friction and a good hermetic seal between faces **55** and **57**.

The valve **31** is mounted on bracket **59** attached to the pressure system chassis, not shown, by means of motor shaft **61** and spring **63**. The shaft is driven by an electric clock motor **65** through a gear reduction mechanism **67**. Rotating member **53** is affixed to shaft **61** by means of a cotter pin **69** nesting in slot **71**. Spring **63** presses against stationary member **51** to assure that the flat faces **55** and **57** remain in intimate contact. The shaft passes through member **51**, which is held against rotation by the conduit lines **27**, **29**, **33** and **35**. It is to be noted that very little turning force is exerted on stationary member **51** during rotation of member **53** because of the low friction.

During operation, the clock motor **65** runs continuously to drive shaft **61** and rotating member **53**, while stationary member **51** remains in fixed position pressing against member **53** by action of spring **63**. It has been found that **15** revolutions per hour of member **53** is satisfactory. This gives a cycle time of four minutes during which the cell sets **13** and **15** in mattress **11** proceed through one alternation of inflation and deflation by virtue of the full revolution of rotating member **53**.

FIGURES 3 and 4 illustrate the details of valve **31**. Stationary member **51** has a central opening **73** through which the rotating shaft **61** passes. Oppositely disposed inlet ports **75** and **77** extend into the body of member **57** and terminate in openings **79** and **81** respectively on the flat face **55**. These inlet ports are preferably located with centers lying on an inner concentric circle. Discharge ports **83** and **85**, which are connected to cell sets **13** and **15** through couplings **33** and **35**, also extend into the body of member **51** and terminate at openings **87** and **89** respectively on face **55**. The discharge ports terminate at positions lying on an outer concentric circle.

Accordingly, air is supplied to stationary member **55** through inlet ports **75** and **77** and discharged to the mattress through ports **83** and **85**.

The rotating member **53** of the valve has a central opening **91** for shaft **61**. This member is affixed to the shaft and rotates therewith by virtue of the nesting relationship of cotter pin **61** in slot **71**.

The flat face **57** of rotating member **53** is provided with an arcuate air transfer groove **93** and an arcuate air exhaust groove **95** which has an opening **97** to the atmosphere. The arcuate length of groove **93** is less than 180° of rotation by approximately the diameter of openings **87** and **89**. The radial width encompasses both of these openings. The width and length has to be sufficient to straddle an inlet port opening and a discharge port opening to transfer the air to the mattress cells. However, the arcuate length preferably is less than that required to straddle both discharge port openings **87** and **89** since there is no desire to connect the cell sets **13** and **15** to a common pressure source for a period of time sufficient to cause the pressure in both cell sets to equalize. When this occurs, both cell heights drop and then one of them will rise again to a fully inflated position. This up and down movement is disturbing to the patient.

Arcuate discharge groove **95** has a location and radial width such that it only intercepts discharge port openings **87** and **89** in member **55** during rotation. The length of groove **95** is sufficient to straddle one discharge port at a time. When the groove is over one of the discharge ports, the mattress cell set connected at that port is deflated by exhausting to the atmosphere through opening **97**.

Face **57** of member **53** is provided with lands **99** and **101** lying between grooves **93** and **95**. During rotation, the arcuate lengths of these lands determine the hold period between the inflation and deflation cycles of the apparatus. Also, land **101**, in conjunction with the speed of rotation and the pressure in the system, determines the length of time needed to hold an inflated cell set in that condition so that the other cell set can be substantially inflated before the first set is exhausted. As mentioned previously, this condition is desirable so that the patient does not sense any appreciable vertical movement on the mattress while the pressure support points on his body are being transferred between adjoining cells.

FIG. 5 will aid in an understanding of the operation of the inflation and deflation cycle of the mattress cells as well as the pressure system valve sequence. Presume that cell set **13** is deflated and cell set **15** is inflated and holding at the beginning of a cycle, and that rotating member **53** is moving counter clockwise approximately from the position shown in FIG. 4. Arcuate groove **93** will first encounter opening **87** of discharge **83** and connect it with inlet port **75**. This causes the air to be supplied to cell set **13** in the mattress **11**. The cells of set **13** proceed to inflate, and, approximately at the time they reach full inflation, discharge arcuate groove **95** intercepts opening **89** of port **85**. This causes cell set **15** to deflate by exhausting to atmosphere through opening **97**. During continued rotation of member **53**, port **83** remains connected to the source of air pressure first through port **79** and then port **77**. At the same time, cell set **15** is being exhausted through groove **95** and is finally held in that condition by land **99**. At this point, member **53** has rotated about member **51** about 180° from the initial assumed starting position. The alternate inflation-deflation sequence of the mattress cells then begin. Grove **93** now moves over port **85** leading to the deflated cell set **15** and begins to inflate these cells. At the same time, land **101** is positioned over opening **87**, thereby holding cell set **13** in the inflated condition. This hold period may last for about 50 degrees of rotation, after which exhaust groove **95** encounters port opening **87** to cell set **13** to begin exhausting. Here again, the timing between exhausting of cell set **13** and full inflation of cell set **15** is such

that the patient senses no up and down movement during transfer upon the support cells. Some overlap of the inflated hold period on one cell set with the full inflation period of the other set can be tolerated by the patient. However, it is not desirable to shorten the inflated hold position to the extent that the other set is not near full inflation since it will cause patient movement as pointed out above.

During the final rotational movement to complete the 360° cycle, groove **93** remains in contact first with port **77** and then **75** to maintain cell set **15** inflated. During this same period, groove **95** is straddling port **83** and land **99** to maintain cell set **13** in a deflated condition.

It can be readily understood from the above description that this invention provides an improved fluid pressure system and therapeutic mattress formed to produce cycling alternate adjoining body support areas for the user. The mattress is rugged and formed for comfort, therapeutic value, reversibility and universality. Further, the pressure system is unique and efficient, and it relieves the patient from the discomfort of vertical movement experienced with prior mattresses.

What is claimed is:

1. In a fluid pressure system, the combination of an inflatable mattress formed to provide cycling alternate adjoining body support areas for the user having at least first and second sets of sealed fluid impervious interdigitated cells with an access connection for each cell set, a continuously operating pump formed to provide fluid pressure, and a valve interconnecting said pump and said access connections for inflating said cell sets, the valve comprising a stationary member and a rotating member, the stationary member having inlet ports coupled to the pump and spaced discharge ports coupled to the access connections of said mattress, each of said ports having an opening into a flat face formed on said stationary member, the rotating member having a flat face formed to mate in a substantially fluid-tight relationship with the face of said stationary member, said rotating member face being formed to provide spaced arcuate grooves separated by lands, the arcuate grooves and lands being arranged to continuously block communication through the valve ports between said first and second cell sets, the first of said grooves having an arcuate length sufficient to straddle an inlet and discharge port, the second of said grooves having an exhaust opening to atmospheric pressure, the grooves and lands further being arranged relative to the stationary member ports during rotation to sequentially maintain each set of cells inflated while the other set is deflated and then substantially inflated to provide alternating support on adjoining areas of the mattress without substantially altering the support height of the user.

2. A system in accordance with claim **1** wherein the fluid pressure is sufficient to inflate a set of said cells through the valve in less than half the degrees of movement of said rotating member during the period when the first of said arcuate grooves is in communication with an inlet and discharge port.

3. A system in accordance with claim **1** wherein a land separating the first and second grooves is of sufficient arcuate length to maintain fluid pressure in one of said cell sets until the second of said cell sets is substantially inflated.

4. A system in accordance with claim **3** wherein the stationary valve member has two oppositely disposed discharge ports terminating on an outer concentric circle and two oppositely disposed inlet ports terminating at positions arcuately positioned between said discharge ports on an inner concentric circle, the first groove of said rotating member having a radial width sufficient to encompass both said inlet and discharge ports and the second of said grooves having a radial width sufficient to encompass only said discharge ports.

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128—33