

Sept. 15, 1964

J. K. WHITNEY  
SUPPORT DEVICE

3,148,391

Filed Nov. 24, 1961

4 Sheets-Sheet 1

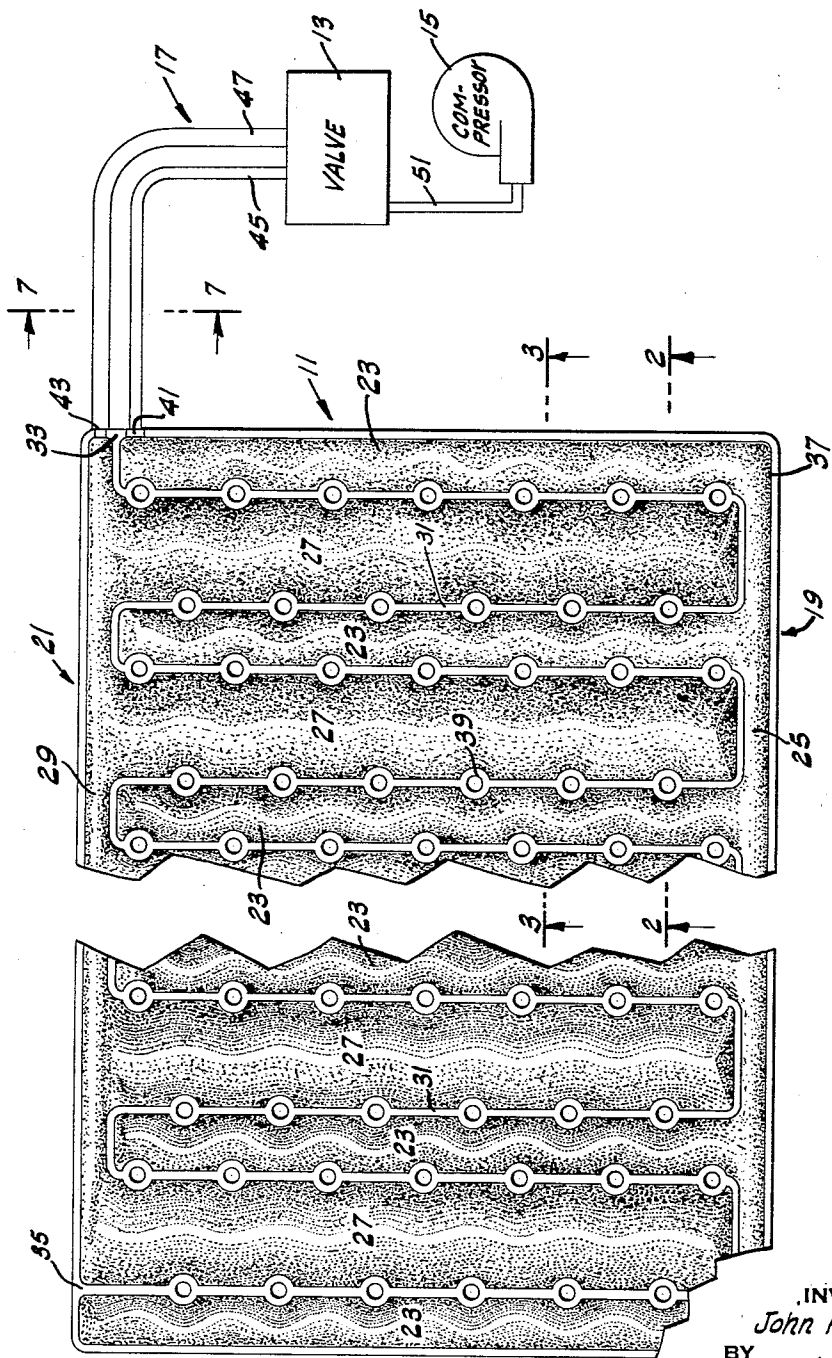


Fig. 1

INVENTOR  
John K. Whitney  
BY  
Robert E. Strauss  
ATTORNEY

Sept. 15, 1964

J. K. WHITNEY  
SUPPORT DEVICE

3,148,391

Filed Nov. 24, 1961

4 Sheets-Sheet 2

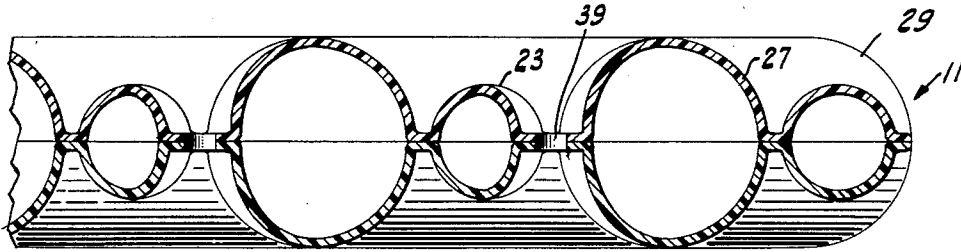


Fig. 2

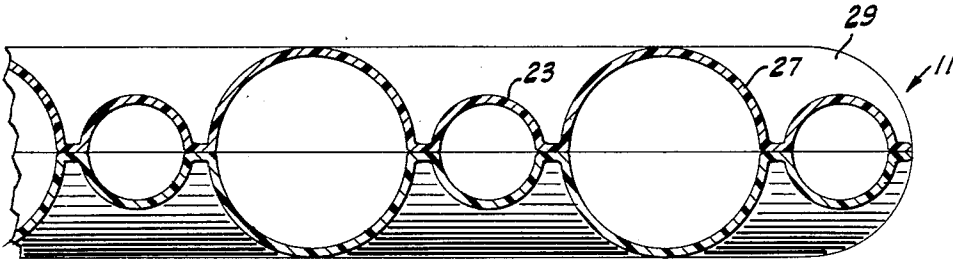


Fig. 3

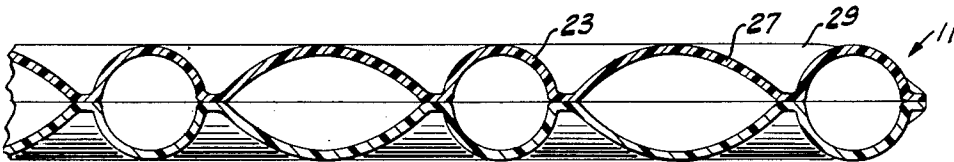


Fig. 4

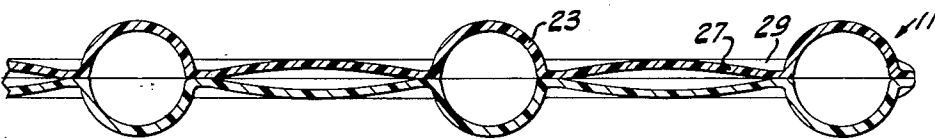


Fig. 5

INVENTOR  
John K. Whitney  
BY  
*Robert C. Strasser*  
ATTORNEY

Sept. 15, 1964

J. K. WHITNEY  
SUPPORT DEVICE

3,148,391

Filed Nov. 24, 1961

4 Sheets-Sheet 3

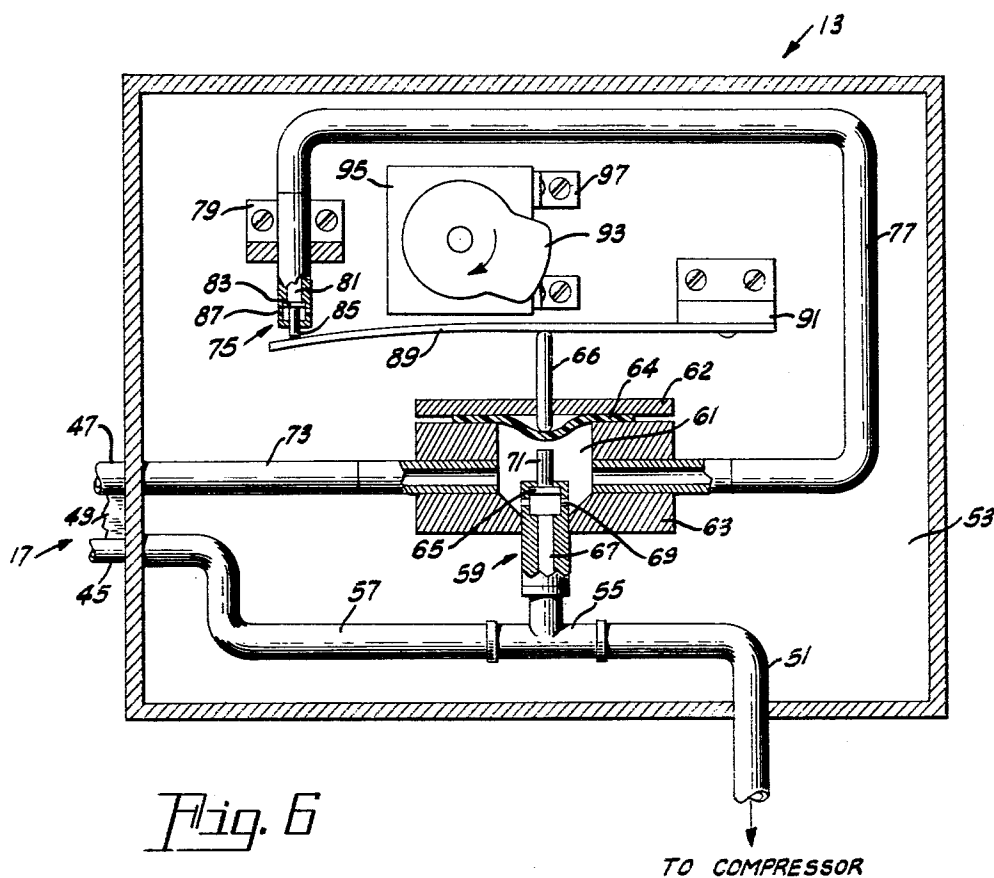


*Fig. 6*

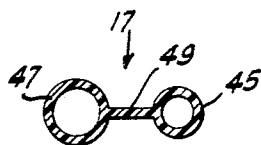


*Fig. 7*

INVENTOR  
John K. Whitney  
BY  
*Robert C. Strauss*  
ATTORNEY

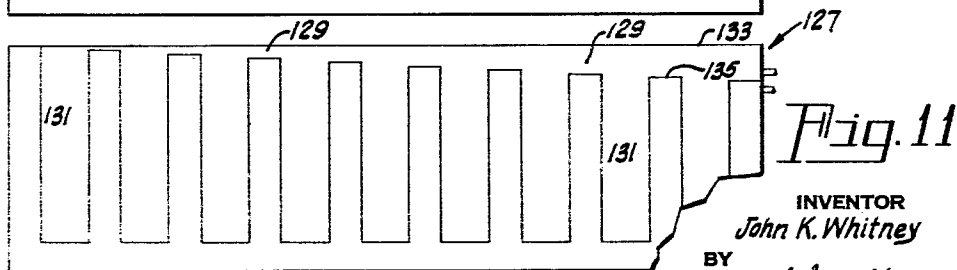
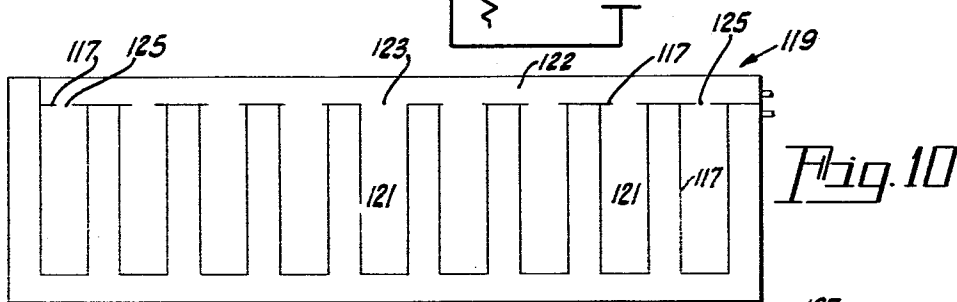
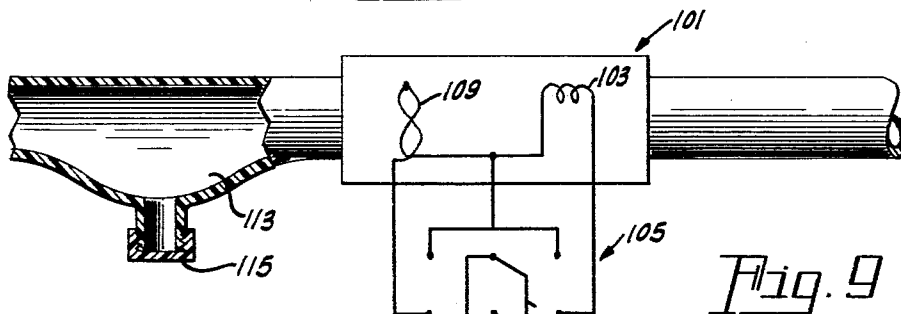
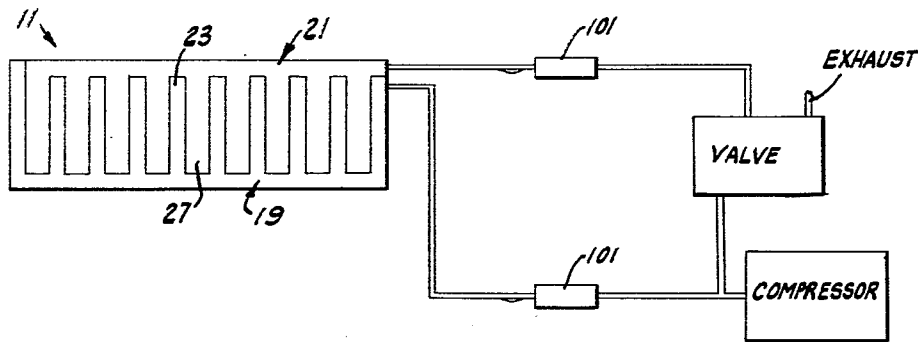
Sept. 15, 1964

J. K. WHITNEY  
SUPPORT DEVICE

3,148,391

Filed Nov. 24, 1961

4 Sheets-Sheet 4



INVENTOR  
John K. Whitney  
BY *Robert C. Strasser*  
ATTORNEY

1

3,148,391

## SUPPORT DEVICE

John K. Whitney, 298 Glenhurst Road,  
Tonawanda, N.Y.

Filed Nov. 24, 1961, Ser. No. 154,463  
8 Claims. (Cl. 5—348)

This invention relates to devices employing support pads or mattresses for the body which cyclically alter the primary body support pressure areas in order to provide comfort for the user.

Persons required to spend a considerable amount of time either in a sitting or lying position suffer the discomforts of general fatigue, muscular pains, and in some instances, decubitus ulcers or pressure sores. In order to relieve these discomforts, it has been proposed that air mattresses and valving arrangements be used which alternately expand and exhaust adjoining mattress segments in an out-of-phase relationship in order to shift the body support pressure areas. Such a system is inefficient, expensive to produce, cumbersome to use, and it lacks the refinements necessary to provide an adequate and realistic solution which satisfies each of the various aspects of the problems confronting a person suffering from fatigue or tissue degeneration.

Accordingly, an object of this invention is to overcome the aforementioned disadvantages by the provision of a pressurized body support device which is compact, economical, dependable in operation, and has greatly enhanced capabilities regarding comfort and/or therapeutic treatment for the user.

A further object of this invention is to provide a support device employing a pad which cyclically alters the areas of primary body support in an improved manner.

Another object is the provision of a ventilated as well as a more comfortable support pad form.

Still another object of this invention is to provide a body support device which generates undulations simulating a massage.

Another object is the utilization of support pad cells for contacting the body which are temperature controlled to provide the comfort or treatment necessary to meet the various requirements of individual users.

The foregoing objects are achieved in one aspect of the invention by the provision of a cycling differential body pressure area support device using fluid pressure cells which are cyclically expanded or contracted relative to one another in a manner to alter the primary body support pressure areas. One bank of common pressure cells in the pad are made larger than adjoining cells so that the expansion and exhaust of these larger cells relative to the continuously expanded smaller cells provide the desired cell height differential to effect the body pressure position cycling. This pad or mattress may be provided with ventilating openings for additional comfort and the fluid pressure operating on the cells may be temperature controlled by heating or cooling units. The cells can employ various sized orifices leading from a common pressure chamber to provide automatic sequential expansion if desired. Such a wave movement or undulation simulates a massage.

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

FIG. 1 is a plan view of the body support pad and the fluid pressure system;

2

FIG. 2 is a partially sectioned view of the pad shown in FIG. 1 taken along line 2—2 when the cells are expanded;

FIG. 3 is a partially sectioned view of the pad shown in FIG. 1 taken along line 3—3;

FIG. 4 is a partially sectioned view of the pad illustrating the relative cell sizes at one period of the cyclic operation;

FIG. 5 is a partially sectioned view of the pad illustrating the cell sizes during another period of the operation;

FIG. 6 illustrates a valve mechanism of the type employed in the system shown in FIG. 1;

FIG. 7 is a cross section of the twin tube conduit used with the system taken along 7—7 of FIG. 1;

FIG. 8 illustrates the body support pad and fluid pressure system using temperature controlling devices;

FIG. 9 is a schematic of the temperature controlling device illustrated in FIG. 8;

FIG. 10 is a plan view of a pad capable of producing undulations; and

FIG. 11 is another embodiment of a pad capable of producing undulations.

Referring to the drawings, the cycling differential body pressure area support device is shown comprising a pad or mattress 11 coupled to a valve 13 and compressor 15 through a twin tube conduit 17.

The pad 11 may have an outside contour formed to provide a mattress capable of supporting the full length of a person's body as shown, or it may be formed as a seat pad, back support, etc. The pad is made of elastic or expandable material such as plastic or rubber. A rugged pad has been made from 20 gauge calendered vinyl sheeting, electronically welded.

Pad 11 has two banks 19 and 21 of spaced expandable serially arrayed cells interdigitated with respect to one another. The smaller cells 23 are all connected to a common peripheral chamber 25 whereas larger cells 27 are connected to their respective common chamber 29. Referring to FIG. 1, it can be seen that interdigitated cells 23 and 27 are formed by a continuous seal ribbon 31 which terminates at positions 33 and 35 at the periphery of the pad. Ribbon 31 and edge seal 37 form the sealed cells and their common chambers.

Ventilating openings 29 are formed in seal ribbon 31 in order to provide more comfort for the user. These openings are staggered relative to one another between adjacent cells, thereby producing a serpentine configuration for each of the cells 23 and 27. It has been found that this form of cell markedly reduces degeneration of body tissues when a person is required to spend a considerable period of time in a lying or sitting position. Two ports 41 and 43 are provided in pad 11 for connection with the fluid pressure system to be hereinafter described. Pad 11 may be formed by superposing two sheets of the vinyl material and then electronically producing seal ribbon 31 and edge seal 37. The surfaces defining ventilating openings 39 may be tear sealed if desired.

Pad 11 is connected to valve 13 and compressor 15 by means of the twin tube conduit 17 which employs a small flexible tube 45 and a larger flexible tube 47. The smaller tube is connected to port 41 whereas tube 47 is attached to port 43. Accordingly, the larger cell 27 in the pad is coupled to the larger tube. FIG. 7 illustrates the rela-

tive sizes of the tubes. In order to form conduit 17 as a flexible, compact integral lead, the tubes 45 and 47 are connected by a flexible web 49. This twin tube conduit has the advantage of providing a simple single connection with pad 11.

Air compressor 15 may be any conventional type which is constructed for continuous operation and may supply from about 2 to 4 p.s.i. A diaphragm type compressor has been found to be well adapted to supply about 1.5 p.s.i. for bed mattresses since it is economical, quiet, dependable, and produces minimum vibration. Compressor 15 is connected to valve 13 by tube 51.

Referring to FIG. 6, valve 13 is shown comprising a housing 53 through which compressor tube 51 and twin tubes 45 and 47 pass. A T-connection 55 allows the air from the compressor to pass directly through sleeve 57 to tube 45 to maintain pressure in cell bank 19. The other leg of T-connection 55 leads to valve 59 and chamber 61 formed in block 63. When valve head 65 is in the upper position shown, air from the compressor passes through opening 67 and holes 69 into chamber 61. When valve rod 71 is pressed downwardly as will be hereafter described, head 65 seals the openings 69, thereby preventing air from entering chamber 61. Valve head 65 may be spring loaded in the upper position if desired although the air pressure normally urges the head in that direction. Chamber 61 is sealed by a cover plate 62 and a flexible diaphragm 64. Ram 66 is mounted in plate 62 for axial reciprocating movement.

Chamber 61 opens into a sleeve 73 which is connected to the larger twin tube 47 as well as to an exhaust valve 75 through exhaust tube 77. A bracket 79 holds valve 75 on housing 53. Valve 75 employs an opening 81 which is normally sealed by valve head 83 as shown. When valve rod 85 is allowed to lower, valve head 83 drops below exhaust holes 87, thereby opening chamber 61 to atmospheric pressure. Valve head 83 may be spring loaded downwardly if desired although the pressure normally urges the head in this direction.

A leaf spring 89 is mounted upon housing 53 by bracket 91. This spring contacts the upper end of ram 66 and the lower end of exhaust valve rod 85. Spring 89 is forced to flex upon engagement by cam 93 of timing device 95, which is also mounted upon the housing by brackets 97. The rotation of cam 93 may be produced by any conventional means such as a geared electric motor.

Referring specifically to FIGS. 1 and 6, it can be seen that pressure is maintained in pad cells 23 at all times during operation of compressor 15 due to the direct coupling through T-connection 55. However, cells 27 are cyclically expanded and contracted by operation of valve 13 in accordance with the speed of rotation of cam 93. When the cam is not touching leaf spring 89, the inlet valve head 65 and exhaust valve head 83 are in the position shown in FIG. 6. During this period, air pressure is supplied to bank 21 of cells 27 through holes 69, chamber 71, sleeve 73, tube 47, port 43, and common chamber 29. The air cannot pass to the atmosphere through tube 77 since exhaust valve head 83 is in the closed or upper position.

During rotation, when timing cam 93 contacts spring 89, ram 66 is forced downwardly against flexible seal diaphragm 64. This diaphragm stretches with continued ram movement until it pushes rod 71 downwardly a sufficient amount to have inlet valve head 65 seal holes 69. This action prevents pressure from entering chamber 61. At the same time as spring 89 is acting upon ram 66, the end thereof is also dropping away from exhaust valve rod 85, thereby allowing valve head 83 to move downwardly. When head 83 moves below holes 87, the large cells 27 in bank 21 are exhausted to the atmosphere through chamber 29, port 43, tube 47, sleeve 73, chamber 61, tube 77, and the holes 87 of valve 75. The speed of rotation of cam 93 and the circumferential distance of the

active cam surface determines the expansion and contraction rate of cells 27. The contour of the cam determines the rate of change of pressure in these cells.

The timed valving arrangement operating in conjunction with pad 11 produces a cycling differential primary body pressure area support device which has produced excellent results regarding the retardation of human body tissue degeneration and muscular fatigue of the type normally associated with prolonged pressure on a given area of the body. Referring to FIGS. 1 through 5, it can be seen that the larger diameter cells 27, when inflated, present an upper surface somewhat higher than the upper surface of continuously inflated cells 23. FIGS. 2 and 3 illustrate the relative cell sizes when cells 27 are fully expanded; FIG. 4 when cells 27 are partially deflated; and FIG. 5 when cells 27 are almost completely deflated or exhausted. Accordingly, when employing a mattress or pad formed in accordance with this invention, the primary support for a body would be first at those body areas touching cells 27, FIGS. 2 and 3; then substantially at those body areas touching both cells 23 and 27, FIG. 4; then primarily upon body areas touching cells 23. This cycle would be subsequently reversed as cells 27 were again inflated. The effects of the cyclic body pressure area alternation is enhanced by the serpentine form of the cells as well as by the ventilating openings 39.

Briefly summarizing the operation of the device, smaller cells 23 are maintained at a constant pressurized expanded dimension whereas the larger cells 27 are inflated and exhausted at a given rate. When the valve spring lever 89 is in the upward position, compressor 15 is connected to cells 27 through inlet valve 59, chamber 61, sleeve 73, and twin tube 47. Exhaust valve 75 is closed during this period. When spring 89 is forced downwardly by cam 93, inlet valve 59 is closed, thereby closing chamber 61 to the compressor. At this time, exhaust valve 75 is open to the atmosphere, thereby effecting exhaust of cells 27 through twin tube 47, sleeve 73, chamber 61, tube 77, and valve 75.

Excellent results have been achieved with the above-described device operating on a three or four minute cycle, using about 1.5 p.s.i. pressure and a mattress employing a serpentine shaped serial array of interdigitated cells having approximately 1½ inch and 2 inch expanded cell diameters for the smaller and larger cells respectively together with 1 inch diameter staggered ventilating openings.

Heating and/or cooling units 101 for the air, or perhaps other fluid which may be used in the device, are shown in FIGS. 8 and 9. Therefore, a person or patient using the pad 11 may receive therapeutic temperature treatment as desired. Units 101 may be provided for either or both cell banks. These units are preferably mounted in the system either near to or within pad 11. FIG. 8 illustrates units 101 in the twin tube line leading to the pad.

Referring to FIG. 9, the heating unit may comprise a heating coil 103 connected through a D.P.D.T. switch 105 to a source of potential 107. The cooling effect may be obtained by a thermoelectric refrigerator element 109 normally made from a junction of dissimilar metals operating in accordance with the Peltier effect. Element 109 may also be connected to the source of potential 107 through switch 105. The current through both the coil 103 and element 109 can be controlled by a rheostat 111. When a cooling unit is employed, it is preferable to use a sink 113 provided with a removable plug 115 to drain condensation.

Therapeutic treatment simulating a massage may be achieved by pad structures of the type shown in FIGS. 10 and 11. It can be seen that the seal ribbon 117 of pad 119 is formed to extend laterally of the cells 121 for varied distances along the array. In the pad shown in FIG. 10, the largest orifice 123 leading from common chamber 122 into a cell 121 is near the center of the pad

5

while each succeeding orifice extending away from the middle in both directions gets progressively smaller. The end orifices 125 are the smallest. Accordingly, when timing cam 93 is rotated sufficiently fast, the air entering or leaving common chamber 122 at spaced intervals of time will first expand and contract the cells 121 having the largest orifices and will expand and contract the cells 121 having the smallest orifices last. Therefore, it can be seen that pad 119 is capable of producing undulations outwardly starting at the center of the pad at least twice for each cycle if desired. These undulations simulate a massage.

In FIG. 11, a pad 127 is illustrated which produces undulations in the form of a unidirectional wave traversing the length of the pad. This is achieved by systematically making each succeeding orifice 129 for cells 131 correspondingly smaller by limiting the distance between the seal edge 133 and the end legs of seal ribbon 135. It is to be understood that pad forms other than those shown in FIGS. 10 and 11 employing graduated orifice sizes may be used to produce the desired undulations.

Pad 11 may also be provided with the features shown in pads 119 and 127 in order to produce undulations of any type and to any extent. For instance, with a variable speed controlled cam 93, the pad 11 can be made universal for operation both as a slow cyclic differential body pressure area support and as a therapeutic massage mattress. During slow operation, the pressure in the common chamber 29 is continuously substantially equalized in each cell. During faster operation, the cells expand and contract sequentially in accordance with their orifice size.

The body support device described herein is compact, efficient, and dependable in operation. The cyclic alternations of the cell support pressure areas, greatly reduce tissue degeneration and the ventilating openings provide comfort for the user. Additional therapeutic value may be achieved by employing the heating or cooling units provided. Undulations simulating a massage can also be produced if desired.

Although several embodiments of the invention have been shown and described, it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the scope of the invention as defined by the appended claims.

What is claimed is:

1. A cycling differential body pressure area support device comprising a body support pad having at least a first expandable cell of a given expanded size and a spaced second expandable cell having a larger expanded size, said cells being sealed from one another, a fluid pressure compressor connected to said first cell to maintain continuous pressure therein, a valve interconnecting said second cell and the compressor formed to operate between a closed position whereat said compressor is coupled to the second cell and an exhaust position whereat the second cell is coupled to the atmosphere, and a timing device coupled to said valve to provide operation thereof for cyclic pressurizing and exhausting of said second cell to change the primary body support pressure areas between said second expanded cell and said first expanded cell.

2. A cycling differential body pressure area support device comprising a body support pad having a first expandable cell of a given expanded size and a spaced second expandable cell having a larger expanded size, said cells being sealed from one another and connected to closely spaced first and second cell ports respectively, a twin tube flexible conduit having first and second tubes provided with smaller and larger diameters for connection with said first and second cell ports respectively and a flexible web bridging said tubes, a fluid pressure compressor connected to said first tube to maintain continuous pressure in said first cell, a valve interconnecting said second cell tube and the compressor formed to operate

6

between a closed position whereat said compressor is coupled to the second cell and an exhaust position whereat the second cell is coupled to the atmosphere, and a timing device coupled to said valve to provide operation thereof for cyclic pressurizing and exhausting of said second cell to change the primary body support pressure areas between said second expanded cell and said first expanded cell.

3. A cycling differential body pressure area support comprising a body support pad having at least first and second spaced sealed expandable cells and spaced ventilating openings passing therethrough intermediate the cells, a compressor for supplying fluid pressure to said cells, a valve for alternately connecting at least said second cell with the compressor and then with the atmosphere to change the primary body support pressure area between the second expanded cell and the first expanded cell, a timing device for controlling the operation of said valve, an electrical heating unit and a thermoelectric cooling unit coupled at least to one of said cells for controlling the temperature of the fluid supplied thereto, and variable power supply means connected to said heating and cooling units.

4. An undulating body support device comprising a body support pad having a plurality of spaced sealed expandable cells each connected to a common chamber through associated cell orifices, the size of said orifices varying in a systematic manner, a compressor for supplying fluid pressure to said cells through the common chamber, a valve for alternately connecting said cell with the compressor and then with the atmosphere, and a timing device for controlling the operation of said valve whereby the introduction into and release of pressure from said chamber causes expansion and contraction of said cells sequentially in accordance with their associated orifice size to produce the undulations.

5. An undulating body support device comprising a body support pad having a plurality of spaced sealed expandable cells each connected to a common chamber through associated cell orifices, the size of said orifices varying in a systematic manner, a compressor for supplying fluid pressure to said cells through the common chambers, a valve for alternately connecting said cell with the compressor and then with the atmosphere, a timing device for controlling the operation of said valve whereby the introduction into and release of pressure from said chamber causes expansion and contraction of said cells sequentially in accordance with their associated orifice size to produce the undulations, and a heating unit coupled to said cells for controlling the temperature of the fluid supplied thereto.

6. An undulating body support device comprising a body support pad having a plurality of spaced sealed expandable cells each connected to a common chamber through associated cell orifices, the size of said orifices varying in a systematic manner, a compressor for supplying fluid pressure to said cells through the common chamber, a valve for alternately connecting said chamber with the compressor and then with the atmosphere, a timing device for controlling the operation of said valve whereby the introduction into and release of pressure from said chamber causes expansion and contraction of said cells sequentially in accordance with their associated orifice size to produce the undulations, and a cooling unit coupled to said cells for controlling the temperature of the fluid supplied thereto.

7. An inflatable body support pad comprising two banks of sealed interdigitated serially arrayed spaced expandable serpentine-shaped cells, each bank being connected to an associated sealed common chamber, said cells and chambers being formed by a seal ribbon, and a plurality of ventilating openings passing through said pad provided in said seal ribbon between cells, each of said openings being staggered from the next adjacent opening lying between the serially arrayed cells.

8. A fluid pressure inflatable body support pad comprising a first bank of serpentine-shaped spaced serially arrayed expandable sealed cells of a given size connected to a first common chamber, a second bank of serpentine-shaped spaced serially arrayed expandable sealed cells having a size greater than said given size connected to a second common chamber, said first and second cell banks being interdigitated and formed by a seal ribbon, a plurality of ventilating openings passing through said pad provided in said seal ribbon, and closely spaced in-

5

10

dividual fluid pressure entrance ports for said first and second common chambers.

References Cited in the file of this patent

UNITED STATES PATENTS

|           |                 |               |
|-----------|-----------------|---------------|
| 2,719,986 | Rand -----      | Oct. 11, 1955 |
| 2,728,926 | Emery -----     | Jan. 3, 1956  |
| 2,998,817 | Armstrong ----- | Sept. 5, 1961 |
| 3,008,465 | Gal -----       | Nov. 14, 1961 |