United States Patent [19]

Wridge, Jr. et al.

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[54] **CONSTANT PRESSURE LOAD BEARING AIR CHAMBER**

[75] Inventors: **Wilbur S. Wridge, Jr.**, Portland, Oreg.; **Lloyd D. Everard**, Kent, Wash.

[73] Assignee: **Sustena, Inc.**, Kent, Wash.

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[22] Filed: **Oct. 20, 1988**

[51] **Int. Cl.**[5] **A47C 27/08**

[52] **U.S. Cl.** **5/450**; 5/453

[58] **Field of Search** 5/449, 453, 450, 455; 297/DIG. 3

[56] **References Cited**

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Primary Examiner—Gary L. Smith
Assistant Examiner—Michael J. Milano
Attorney, Agent, or Firm—Christensen, O'Connor, Johnson & Kindness

[57] **ABSTRACT**

The air chamber includes a control for manually selecting a desired pressure within the chamber. Means for sensing the air pressure within the chamber are provided as are pump means for adding air to the chamber and vent means for removing air from the chamber. Control circuitry adds or removes air from the chamber responsive to the sensed pressure to maintain the pressure within the chamber at the preset level. Structural means are provided within the chamber for supporting a portion of a load placed thereon and thus decreases air pressure within the chamber to avoid deflation.

25 Claims, 2 Drawing Sheets

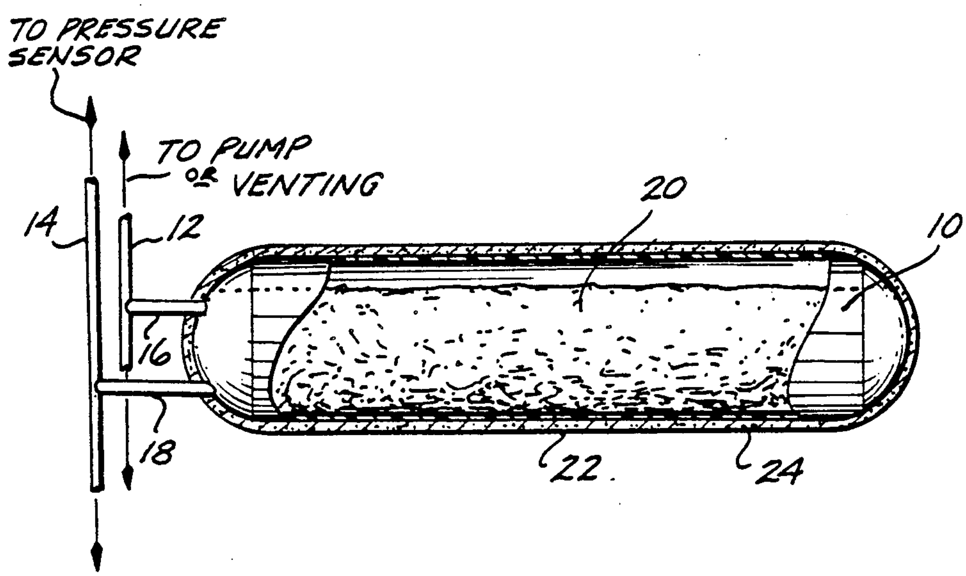
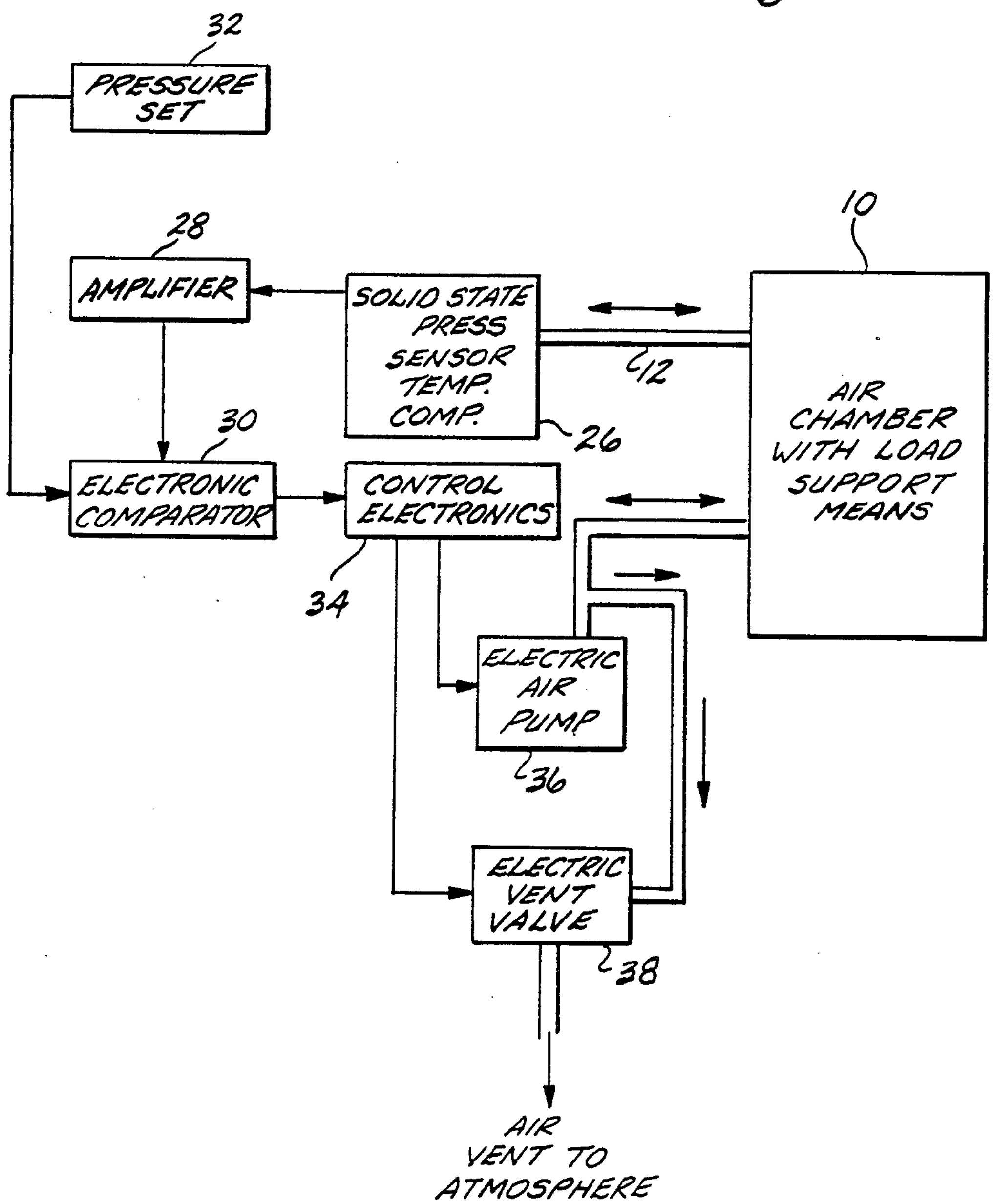


Fig. 3.


32
PRESSURE SET
28
AMPLIFIER
SOLID STATE PRESS SENSOR TEMP. COMP.
10
12
AIR CHAMBER WITH LOAD SUPPORT MEANS
30
26
ELECTRONIC COMPARATOR
CONTROL ELECTRONICS
34
ELECTRIC AIR PUMP
36
ELECTRIC VENT VALVE
38
AIR VENT TO ATMOSPHERE

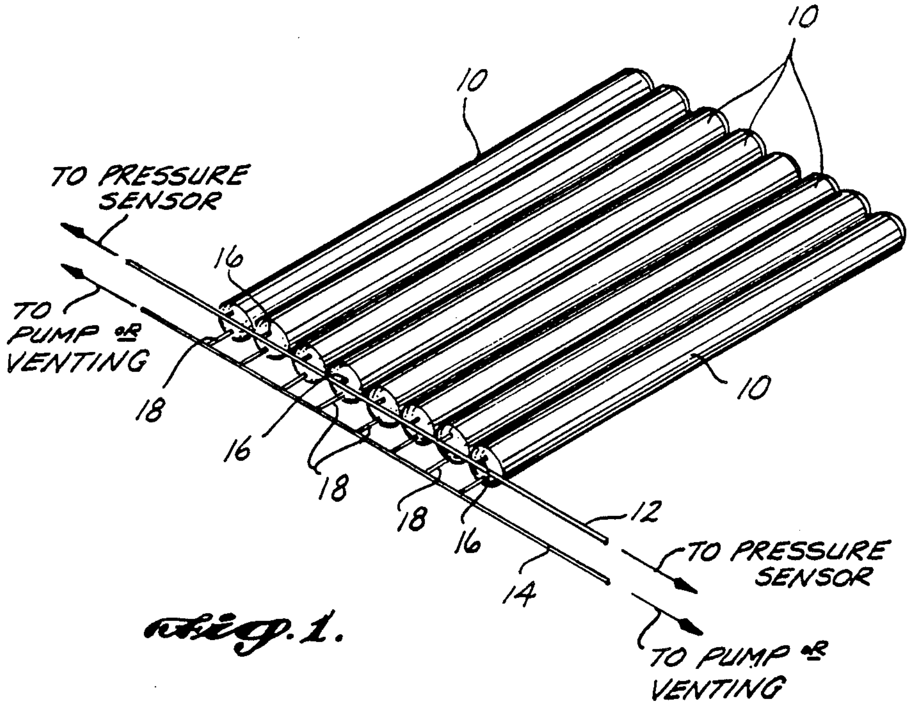

10
10
TO PRESSURE SENSOR
16
TO PUMP OR VENTING
18
16
18
10
18
16
12
TO PRESSURE SENSOR
14
TO PUMP OR VENTING

Fig. 1.

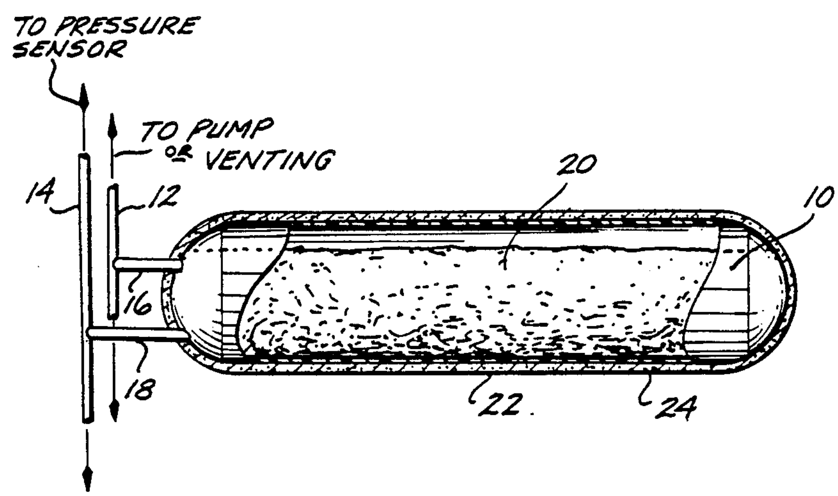

TO PRESSURE SENSOR
TO PUMP OR VENTING
14
12
20
10
16
18
22
24

Fig. 2.

CONSTANT PRESSURE LOAD BEARING AIR CHAMBER

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates broadly to air chambers adapted to support an external load and an apparatus for maintaining the air pressure within the chamber at a relatively constant preset level when the load is applied thereto. In particular, the invention relates to a constant pressure chamber suitable for use as an air mattress, seat cushion or other load bearing device.

2. Description of Prior Art

A long-standing problem in air mattress design involves the ability to maintain constant pressure within the air mattress in spite of varying loads on the mattress as one or more users sit or lie on the bed, toss and turn during sleep or arise and return to bed. The "feel" of the mattress to the user is directly related to the amount of air pressure within the mattress. Thus, in an air mattress into which air is drawn to a certain pressure and then sealed, such as those shown in U.S. Pat. Nos. 3,872,525 and 3,877,092, the internal pressure increases when a user lies thereon and the mattress thus "feels" harder as the load thereon increases.

U.S. Pat. Nos. 4,224,706 and 4,306,322 disclose air mattress systems which allow the firmness of the mattress to be controlled when a person is lying thereon through the use of a separate bladder which contains a quantity of air adapted to be transferred between the air mattress and the bladder responsive to changes in the volume of the bladder.

Also known are manually operated systems, such as that shown in U.S. Pat. No. 4,394,784, where air is supplied to a mattress by a blower or vented from the mattress through valves, both the blower and the valves being electronically controlled by hand-held control units. U.S. Pat. No. 4,078,842 discloses an inflatable auto seat wherein pressurized air is supplied by a manually operated compressor. U.S. Pat. No. 3,303,518 discloses an inflatable mattress wherein air is supplied to compartments therein by hoses connected to a remotely located compressor/pump controlled by the user.

U.S. Pat. No. 4,686,722 discloses a mattress formed from a plurality of individual cushions interconnected by ducting to an air pressure source. The pressure in selected cushions may be controlled by computer.

U.S. Pat. No. 4,694,520 discloses an air mattress which includes a sensor 170 positioned within the mattress which turns on an air compressor when the mattress deflates to a point where a patient comes in contact therewith.

U.S. Pat. No. 4,711,275 discloses a mattress including a rather complex system having a plurality of air compressors and pressure sensors to inflate and deflate portions of the mattress in cycle to prevent bedsores on a bedridden patient.

U.S. Pat. No. 4,679,264 discloses a self-regulating air mattress including a reservoir and means for adding or removing air from the system. A sensing device is disclosed which is adapted to sense the pressure in the mattress and add or remove air therefrom to maintain a constant pressure. Experimentation has shown, however, that such a system, supposedly designed to maintain pressure within a mattress at a predetermined level by sensing pressure and adding or removing air from the mattress in response to a change in pressure, simply do not work. The problem of such systems is that, assuming a preset pressure to be sensed and maintained, the pressure within the mattress is increased when a load is placed thereon. This increased pressure is sensed and air is vented from the mattress in response thereto. However, venting of air from the mattress does not decrease pressure within the mattress so long as the load remains thereon until the mattress is almost totally deflated.

The present invention provides an air mattress or the like which can be maintained at a constant pressure even under load without deflating.

SUMMARY OF THE INVENTION

It is known that pressure is generated in the air chambers of an air mattress by the force of the semielastic walls of the chambers upon the air captured therewithin. When a load, such as a person, is placed upon the mattress, the pressure within the mattress is produced both by the downward force exerted by the weight of the person and the forces generated by the semielastic mattress chamber walls. It has been found that if the size of the load placed on the mattress is relatively small, the increase in pressure normally caused by the load can be compensated for by the elasticity of the air chamber walls. As the load increases, however, the ability of the chamber walls to absorb the increasing pressure load diminishes and the air pressure within the chamber increases. As a result, the firmness of the mattress is also increased. In known active sensing mattress systems, the pressure sensor would, at this time, begin venting air from the mattress chambers to the atmosphere in an attempt to lower the pressure within the chambers. However, since the weight upon the mattress remains constant, and thus the pressure within the chambers remains at a constant high level, the venting of air to atmosphere does not reduce pressure but rather merely deflates the mattress.

In the present invention, applicants have solved this problem by providing a structure within the mattress chamber itself which is adapted to support a portion of a load placed upon the mattress to thereby reduce the air pressure within the mattress to a desired preset pressure level such that the sensor stops venting air to the atmosphere and the mattress does not deflate. In a preferred form, a resilient open-cell foam cushion is placed within the mattress which, while typically not resilient enough to constitute a comfortable mattress by itself, has the ability to support a sufficient amount of the weight of a person to allow the pressure within the mattress to be reduced. The reduced pressure is sensed and venting of air to the atmosphere is stopped. In practice, it has been found that due to the lightweight nature of the foam cushion, the "feel" of the air mattress does not change even when a person's body bears upon the foam through the upper surface of the mattress.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be described more fully with reference to the preferred embodiment shown in the drawings wherein:

FIG. 1 is a schematic perspective view of a plurality of tubes suitable for use as the air support chambers of an air mattress, including conduit means interconnecting the tubes, connecting them to both a pressure sensor and pumping or venting means.

FIGS. 2*a*–2*c* are schematic side elevational views of the embodiments of the air chambers of FIG. **1** with portions of the sides broken away to show the positioning of the support elements therein.

FIG. **3** is a block diagram illustrating the movement of air into and out of a chamber of the present invention, including the electronic controls therefor.

DETAILED DESCRIPTION OF THE INVENTION

Referring initially to FIG. **1**, a plurality of air chambers **10** are disclosed positioned side by side in the general form of a tube-shaped mattress core. In a preferred embodiment, the chambers are defined by membranes **11** formed of polyvinyl chloride in a known manner although polyurethane or other suitable materials may also be used. In use as a mattress, the membranes **11** are typically covered on at least their top and bottom by a light foam pad **22** and the entire unit encased within a fabric cover **24** for sleeping comfort.

It has been found that in a preferred embodiment, the membrane **11** may be sized so that four membranes placed side by side define a single bed of so-called "twin bed" size, while eight membranes provide a satisfactory double bed.

As illustrated in FIG. **1**, manifold means **12** interconnect all of the chambers **10** so that a uniform pressure is maintained in all of the chambers which, as indicated, may be sensed by a pressure sensor to which manifold **12** is connected. Likewise, manifold **14** interconnects all of the tubes and is in turn connected to air pump or air vent means in a manner which will be described in greater detail hereafter. Tubes **16** and **18** are shown connecting the individual chambers to the manifolds **12** and **14** respectively, but it will be understood that the particular shape of the tubes, manifolds, and the connections therebetween may be varied, and FIG. **1** is meant to be illustrative only.

In particular, it has been found that a double bed mattress is preferably provided with dual sensing, pumping and venting means so that persons lying side by side are able to separately control the air pressure within the chambers on their side of the mattress and the consequent firmness or "feel" of the mattress.

Referring additionally to FIG. 2*a*, a support element **20** is shown positioned within the chamber **10** to act as load support in a manner to be described in greater detail hereafter. Element **20** is preferably formed of a lightweight, open cell foam and it will be understood that element **20** is positioned within chamber **10** during construction of the chamber and that the foam element may be of any suitable shape and may be affixed to or allowed to move loosely within chamber **10**. The foam material **20** need not have a great crushing strength since the foam itself does not act as the major weight supporting element of the air mattress and, thus, in and of itself, need not be of a strength sufficient to be used as a satisfactory mattress. As depicted, the support element **20** is dimensioned so that the top of the support element is spaced away from the top portion of the inflatable membrane **11** when the membrane is fully inflated.

Besides the described foam material, a lightweight fibrous material or any other resilient material including a metal spring may be satisfactorily used to accomplish the function of supporting a portion of the user's weight to prevent total deflation of the mattress in the manner described hereafter. FIG. 2*b* depicts a version of the chamber **10'** wherein lightweight fibrous material **25** is provided as the fill material and FIG. 2*c* depicts a version of still another alternative embodiment of the invention wherein the metal springs **27** are disposed within the chamber **10"** to serve as the support element.

While softness and resiliency are desired for comfort in a mattress, it will be understood that a nonresilient weight support means might be satisfactorily used to again accomplish the goal of decreasing air pressure to the extent necessary to cause the sensor to stop venting air to the atmosphere when a load is placed upon the inflated chamber.

FIG. 2*a* also discloses the chamber covering foam pad **22** described above, as well as conventional fabric cover **24** surrounding and overlying the air chambers.

Referring now to the block diagram shown in FIG. **3**, the operation of the present invention will be described in detail. As illustrated, chamber **10** is shown to be connected by means of conduit **12** to pressure sensor **26**. In a preferred form, the pressure sensor is a conventional solid state device which is electronically compensated for change in ambient air. It has been found that satisfactory pressures within chamber **10** range from between two inches to ten inches of gage water pressure, which is approximately one-thirtieth of atmospheric pressure. These small pressures place little stress upon the seams of the chamber **10**, and thus the unit made according to the present invention has been found to be long-lived.

The output signal of pressure sensor **26** is led through a conventional amplifier means **28** to an electronic comparator **30** wherein the signal from the amplifier is compared to a signal generated by pressure select control **32**. Elements **30** and **32** are conventional, off-the-shelf items, element **32** typically being of a type which allows a user to select the degree of mattress firmness, i.e., pressure within the air chamber, by simply turning a dial to an indicated setting. Air pressure within the chamber may be changed by simply turning the dial to a different setting. Electronic comparator **30** compares the selected pressure with the actual pressure within chamber **10** as transmitted through amplifier **28**. Comparator **30** produces an output signal that is forwarded to control electronics **34** that controls an air pump **36** and a selectively open vent valve **38**. The control electronics **34**, in response to the comparator signal, either turns on electric air pump **36** or opens electric vent valve **38** to add or remove air from chamber **10**. In a preferred embodiment, pump **36** is a diaphragm pump. Control electronics **34** are conventional as are air pump **36** and vent valve **38**.

In typical operation, a user selects a desired air pressure within chamber **10** by adjusting the dial on the pressure select control **32**. Assuming an initially deflated chamber, electric air pump **36** is activated to pump air into chamber **10** until pressure sensor **26** senses the pressure within the chamber is substantially equal to the desired selected pressure. If the air pressure within chamber **10** should increase or decrease due, for example, to a change in temperature or atmospheric pressure of the ambient air within the room where the mattress is placed, the change in pressure will be sensed and either air pump **36** turned on to force air into chamber **10** or vent valve **38** opened to bleed air from the chamber. In this manner the preselected pressure is maintained.

When a person lies upon the mattress, the pressure within chamber **10** is increased substantially. This increase in pressure is sensed by sensor **26**, thus causing

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