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Support ApplianceBACKGROUND OF THE INVENTION

This invention relates to support appliances and is in particular concerned with the construction of an appliance in which a plurality of inflatable air sacs provide a support surface. In our British Patent Specification No. 1,474,018 there is described a bed of the above type which includes air operated bellows for raising and lowering the foot and/or head of the bed. The bed described in this British patent specification includes a sub-frame which is pivotably mounted on a carriage and includes means such as an electrically driven rack for altering the attitude of the sub-frame with respect to the carriage. The inflatable air sacs are mounted on support members which are pivotably connected to the sub-frame and bellows are provided for altering the angle of the support members with respect to the sub-frame.

While the bed described in our above mentioned patent specification has proved to be successful and effective in nursing seriously ill patients, there is a need for a support appliance which can be made more cheaply and can be fitted to a standard hospital bed frame.

DISCLOSURE OF THE INVENTION

According to the present invention there is provided a support appliance adapted to be supported on a bed

frame and comprising a plurality of elongated inflatable air sacs, mounted in groups, ^{extending} transversely of the appliance and providing a surface for supporting a person thereon, each group of sacs being connected to a respective supply header chamber and to a respective exhaust header chamber located at opposite sides of the appliance for passing pressurised air through said sacs, said supply header chambers being connected to air supply conduits passing through a common housing located at one end of the appliance and each exhaust header chamber being arranged to discharge to atmosphere through a respective flow control valve.

The appliance is constructed so that it can be contoured i.e. shaped to suit the person occupying it, without substantially impeding the air flow to the air sacs.

With this objective in mind the air sacs may be mounted on a base comprising a foamed plastics or rubber material which is shaped to provide passageways for receiving the conduits. In addition the conduits and header chambers are preferably sufficiently flexible so that the base can be contoured in use or even rolled up for easy transportation and storage.

In use, the appliance may be laid on the frame of a standard hospital bed such as the standard bed used in the British National Health Service and termed the "Kings Fund Bed". This is a rigid, tubular steel framed bed. Alternatively, the appliance may be supported on any

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other flat surface of convenient height.

The inflatable sacs are preferably connected to the header chambers by releasable connectors. Air may be passed into the header chamber on one side and exhausted from the air sac on the opposite side through the corresponding exhaust header chamber. A control valve is provided to control the flow of air which is allowed to escape from the exhaust header chambers. In this way, the pressure and rate of flow of air through each group of air sacs can be individually controlled.

The air sacs are divided into groups in a similar way to the sacs in our British Patent No.1,474,018 so that the sacs in each section can be raised to a pressure which is appropriate for the part of the patient's body which is to be supported at that point. As described in our British patent specification 1442944 and in the book "Bed Sore BioMechanics" edited by R.M. Kennedy, J.M.Cowden and J.T. Scales published by Macmillan, 1976, pages 259-299, adjustment of the pressure of the air sacs on which the patient is supported and of the throughflow of air through the sacs to maintain the skin of the patient at the optimum temperature, greatly reduces the incidence of bed sores.

The contour or overall shape of the patient support surface can be adjusted when it is placed on a standard hospital bed by providing air operated bellows similar to those described in our British Patent,

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1,474,018. The bellows are arranged to act at the head and to press on a baseboard placed on the bed frame of the bed or to press on a similar baseboard placed on the surface of the bed at its foot. A single or connected
5 baseboard may be employed. These bellows can be operated by air supplied through conduits which pass either through the interior of the appliance or are connected via external conduits. Conveniently the inlet ports for the air supply conduits and control valves therefor are
10 grouped together and contained in a common housing located at one end of the mattress.

The support appliance may include a control valve for contouring the surface formed by the inflatable sacs which valve is a remotely operated air valve
15 comprising a chamber having an inlet and an outlet, the outlet including a tube which projects into the chamber and the chamber being divided by a flexible diaphragm so that the inlet and outlet are in the same part of the chamber, the diaphragm being movable between two extreme
20 positions in one of which the diaphragm seals the end of the inlet tube and the other allows air to escape into the chamber through the tube, the other part of the chamber being pressurised and the position of the diaphragm being controllable by venting or not venting air from the second
25 part of the chamber.

DESCRIPTION OF THE DRAWINGS

Various aspects and features of the present invention will now be described with reference to the

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accompanying drawings in which

Figure 1 is a perspective view of an appliance in accordance with the invention, partly broken away to show the interior and with only 2 air sacs shown.

5 Figure 2 is a section taken on the line A-A in Figure 1 and showing an inflatable air sac in position, and

Figure 3 is a sectional view of a control valve for supplying air to the appliance,

10 Figure 4 is a diagrammatic sectional view of a remotely operated air valve.

DETAILED DESCRIPTION OF THE INVENTION

15 Referring to the drawings, Figure 1 shows a perspective view of the appliance which can be supported on the base frame of a bed. The appliance comprises a base 1 formed by a tough, flexible, plastics outer cover which is filled with a foamed plastics or foamed rubber
20 interior. A semi-rigid polyurethane or polyether foam is preferred since a firm base is desirable. However, the base should be flexible enough to be contoured into the configuration shown in Figure 1 and to recover to take up a generally flat configuration. The foamed interior of
25 the base 1 is shaped to form passageways to receive air supply and exhaust conduits which will be described in detail later.

A baseboard, 2a and 2b, conveniently formed from plywood, is joined by a suitable connector for ease of transportation and provides a base for a pair of bellows 3 and 4. As can be seen in Figure 1, the bellows each consist of two interconnected air bags and their internal construction and method of operation is very similar to that of the bellows described in our British Patent No.1,474,018. The bellows act between the baseboards 2a and 2b and support boards 5 and 6. Boards 5 and 6 are hinged at one end to the baseboard and board 6 is articulated at 7 so that the foot part of the appliance can be raised to form a plateau. Guide struts 8 and 9 connect the upper boards with the baseboards and also prevent distortion or slipping of the bellows from between the boards. It is not essential to provide bellows at both the foot and head of the appliance.

A support surface for the occupant of the support appliance is provided by a plurality of inflatable air sacs or bags 10. For clarity only 2 bags are shown in Figure 1 but in a typical appliance there will be about 20 air sacs which are grouped in 5 groups of 4 sacs each. The arrangement of the air sacs is similar to that shown in our British Patent 1,474,018. Each group of air sacs is supplied with air at an individually controlled temperature and pressure. In this way the different parts of the patient's body is effectively supported with uniform pressure over the area of the body and the support surface corresponds to the precise shape of the

patient's body. This reduces formation of bed sores and accelerates healing of damaged skin. Air is arranged to pass through the air sacs in the direction shown by the arrows in the broken-away air sac 10 in Figure 1 and this is important for maintaining the comfort of the patient by control of body temperature and evaporation of body sweat and fluids exuded from wounds. Air is supplied to the inflatable sacs 10 by means of conduits 11 extending internally of the mattress and connected in a housing 12 to conduits 13 which is supplied with air from a blower unit (not shown). The blower unit can be as illustrated in Figure 6 in our prior British Patent No. 1, 474, 018.

Figures 1 and 2 show the internal construction of the base 1. The base 1 comprises a stout, flexible reinforced plastics outer case, the interior of which is filled with plastics or rubber foam, the foam being in the form of slabs 14 and 15 which are shaped to define passageways for reception of air supply and exhaust conduits and also the conduits

for supplying air to the bellows 3 and 4. The foam 14 and 15 is bonded together with a suitable adhesive. Housed in longitudinal pockets 16 and 17 on opposite sides of the appliance are a series of header chambers 19 and 20. In the arrangement illustrated, chambers 19 are designated the supply headers and chambers 20 the exhaust header chambers. Chambers 19 are supplied with air through conduits 11, the conduits 11 being arranged to enter the appliance at one end through a common housing 12 attached 10 to the foot of the appliance.

Inflatable air sacs 10 are mounted transversely of the appliance and are connected to oppositely aligned connectors 21 and 22 in chambers 19 and 20. In use air is supplied from a blower unit (not shown) which contains 15 pressure control valves for each supply conduit and thermostatically controlled heaters. Air then passes through connectors 21 into the air sacs 10 and then out through a corresponding exhaust header chamber 20. Air is exhausted from chambers 20 via conduits 23 and the rate 20 of exhaust of air from each conduit is controlled by a flow control valve 25 located in a common housing 24. The chambers 19 and 20 are arranged transversely in pairs and are individually supplied and exhausted with air via separate control valves so that pressure in each group of 25 sacs can be individually controlled. Figure 1 provides for five groups of 4 inflatable sacs but it would be

appreciated that the number can be varied according to the sophistication required.

Each exhaust header chamber 20 is provided with a flow control valve 25 whose construction is shown diagrammatically in Figure 3. Each control valve 5 25 is linked to the corresponding supply conduit so that air flow through each group of air sacs can be maintained constant as described below. As can be seen, the valve 31 comprises a chamber 32 which is divided by a flexible diaphragm 34 into chambers 40 and 41. A tube 35 enters 10 the chamber from one side and the end 36 of tube 35 is connected to an exhaust conduit 23 from a header 20. Accordingly air will exhaust from chamber 20 in the direction of arrow X in Figure 3. Tube 37 is connected at one end 38 to supply conduit 11 of the chamber 19 15 which is paired with the chamber 20 to which tube 35 is connected. The other end 39 is connected to the source of pressurised air via a pressure control valve in the blower supply unit. Tube 37 is linked to the chamber 40 by a small bore flexible tube 43. Air is supplied to 20 tube 37 in the direction indicated by arrow Y in Figure 3.

The valve 31 operates in the following manner:- Air is supplied in direction Y into the air sacs 10 and flows out through chamber 20 and the conduit 23 into tube 35 in the direction indicated by arrow X. In its 25 steady state there is a small clearance between the inner

end of the tube 35 and the diaphragm 34. Thus, in normal use there is a slow leak of air between the end of tube 35 and diaphragm 34 and out of the valve through port 42. If an air leak should develop in the circuit, for example, 5 owing to the development of greater porosity in the fabric forming the air sac 10 after washing, there would be a loss of air from the system and the air flow through the sac would otherwise reduce. This effect is compensated by the valve 31 automatically in the following manner:-

10 Greater leakage of air in the system will cause the pressure differential between air in tube 37 and that in tube 35 to increase. Since tube 37 is linked to chamber 40 by tube 43 this will cause the diaphragm 34 to be pressed more tightly against the end of tube 35. As a 15 consequence, less air will escape from port 42 and the total air flow to the air sac 10 will be maintained. Thus, it is no longer necessary to juggle with both a pressure supply valve and an exhaust valve when leakage characteristics of the air sacs change since the 20 compensator valve automatically takes account of such variations. Chamber 40 also has an outlet tube 44 and tubes 43 and 44 are fitted with adjustable throttle valves 45 and 46. Valves 45 and 46 are adjusted when installing the appliance so as to balance the pressure acting on the 25 diaphragm and provide a regulated escape of exhaust air due to any changes in air sac flow rate.

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The exhaust air passes through the ports 42 and escapes to atmosphere through holes in the cover of housing 24. Figure 4 illustrates a remotely operated air valve suitable for controlling air supply and exhaust to bellows at the head and foot of the appliance. Referring to Figure 4, a first chamber 51 is divided into two parts 52 and 53 by a diaphragm 54. An inlet tube 55 is connected to an air supply conduit to supply air in the direction of the arrow C to chamber 53. A tube 56 enters chamber 53 so that its end 57 is in close proximity to diaphragm 54. Tube 55 and chamber 52 are connected by a small bore tube 58 and chamber 52 can be exhausted through a small bore flexible tube 59, the exhaust of air through which can be controlled by a hand-operated valve 60.

Tube 56 is fitted with a branch tube 61 and tube 61 enters a second chamber 62 which is also divided into two halves, 63 and 64 by a flexible diaphragm 65. Chamber 64 is connected to supply tube 55 by a small bore flexible tube 66 and chamber 63 is provided with ports 67 to allow air to escape to atmosphere. Chamber 64 in addition is provided with a flexible tube 68 through which air may be vented to atmosphere under the control of a manually operated valve 69.

Tubes 58 and 66 are fitted with flow control valves 70 and 71 so that the air flow there along can

be controlled by adjustment of these valves.

The valve operates as follows:-

With manual controlled valve 60 open air will flow along tube 55 into chamber 53 and press diaphragm 54 away from the end 57 of tube 56. This will allow
5 air to pass along tube 56 in the direction of arrow D into the bellows for the head of the bed. While manual control valve 69 remains closed, diaphragm 65 in chamber 62 will remain pressed against the end of tube 61 and no air will pass there along.

10 When it is desired to exhaust the bellows, valve 60 is closed and valve 69 is opened. Closing of valve 60 will cause the pressure to rise in chamber 52 to a level which is at least equal to the pressure in chamber 53. Because the area of the diaphragm
15 subjected to pressure in chamber 52 is greater than the area in chamber 53, diaphragm valve 54 will close over the end of tube 57 and prevent further air entering tube 56. At the same time, pressure in chamber 64 will fall as valve 69 is opened and this will cause diaphragm
20 65 to move away from the end of tube 61. Consequently air will flow out of the bellows and escape from the system via tube 61, chamber 63 and ports 67.

25 One remotely operated air valve is normally provided to control the head raising bellows 3 and a second similar valve to control the foot bellows 4. The valves

can be located at any convenient location, for example, within the housing 12 or in the blower unit. Valves 60 and 69 can be located in a hand control unit so that the patient or a nurse may operate the bellows. It will be appreciated that the use of remotely operated air valves and bellows and low pressure air to power the raising and lowering of the head and foot sections of the appliance is a very safe system and in particular avoids the need for any electrical connections to the bed or controls operated by the nurse or or patient.

As can be seen from Figures 1 and 2 the conduit 72 for feeding and exhausting air to and from the head bellows 3 extends through the appliance. Although not specifically shown, the conduit from the foot bellows also passes through the appliance. Thus, all connections for supplying and exhausting air from the air sacs and the bellows pass through the housings 24 and 12 mounted at the foot of the appliance.

Preferably the air sacs 10 (or the upper surface thereof) is made from a microporous fabric which is non-permeable to air but is permeable to water vapour. One such material is a microporous polyurethane-coated nylon manufactured by Carrington and Dewhurst under the trademark Permatex.

The air sacs 10 are connected to the chambers 19 and 20 by connectors of the kind described in our Patent Application No. 8006375 (2,070,174).

CLAIMS

1. A support appliance adapted to be supported on a bed frame and comprising a plurality of elongated inflatable air sacs, mounted in groups, extending transversely of the appliance and providing a surface for
5 supporting a person thereon, each group of sacs being connected to a respective supply header chamber and to a respective exhaust header chamber located at opposite sides of the appliance for passing pressurised air through said sacs, said supply header chambers being connected to
10 air supply conduits passing through a common housing located at one end of the appliance and each exhaust header chamber being arranged to discharge to atmosphere through a respective flow control valve.

2. An appliance according to claim 1, wherein the
15 air sacs are mounted on a base comprising a foamed plastics or foamed rubber material which is shaped to provide passageways for receiving said conduits.

3. An appliance according to claim 1 or claim 2, wherein the inflatable sacs are releasably connected to
20 ports in the header chambers.

4. An appliance according to any one of the preceding claims which also includes a baseboard and at



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least one inflatable bellows disposed between the baseboard and the air sacs, the bellows being connected to a source of pressurised air via a control valve so that the supporting surface formed by the inflatable sacs can be contoured by admission of air to the bellows.

5. An appliance according to claim 4, wherein the bellows is arranged to be supplied with air by means of a conduit passing through said common housing.

6. An appliance according to claim 4 or claim 5, wherein the baseboard comprises two parts joined by a connector in order to facilitate transportation.

7. An appliance according to claim 4 in which the control valve for controlling the contouring of the surface formed by the inflatable sacs is a remotely operated air valve which comprises a chamber having an inlet and an outlet, the outlet including a tube which projects into the chamber and the chamber being divided by a flexible diaphragm so that the outlet and inlet are in the same part of the chamber, the diaphragm being movable between two extreme positions in one of which the diaphragm seals the end of the inlet tube and the other allows air to escape into the chamber through the tube, the other part of the chamber being pressurised and the position of the diaphragm being controllable by venting or not venting air from the second part of the chamber.



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8. A support appliance substantially as described
with reference to the accompanying drawings.



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