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(54) INFLATABLE COMPRESSION GARMENT OR MATTRESS

**AUFBLASBARES KLEIDUNGSSTÜCK ZUM AUSÜBEN VON DRUCK ODER AUFBLASBARE
MATRAZE**

VETEMENT OU MATELAS DE COMPRESSION GONFLABLE

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Description

The present invention relates to an inflatable apparatus, in particular, a mattress or a compression garment for use in general therapeutic treatment and treatment of vascular disorders and edemas.

It is generally accepted that dynamic compression devices and systems which involve a compression pump and inflatable compression sleeves are more effective than static devices such as compression bandages and elastic compression stockings.

The greatest beneficial effect is achieved when the pressure exerted on the limb concerned is highest at the distal end and gradually reduces towards the heart at the proximal end.

The use of intermittent compression garments is well known in the medical field and, although the general purpose of such devices is similar, there are many variations in the way compression can be applied to the extremities of the body to be treated. The garments usually take the form of a single or multi-chamber garment and, where a plurality of chambers are utilised, they can provide either sequential and/or graduated compression. The manufacture of single chamber devices is technically the simplest and has the added advantage of lower costs. At higher compression pressures sequential devices are accepted generally as being more comfortable to the patient but the patient can suffer from a "ridging" effect. This occurs because of the "Dead" space between individual chambers where the skin is never contacted by the device. This can be overcome, however, by taking special precautions such as overlapping of adjacent chambers or by placing a membrane between adjacent chambers. Furthermore, on the whole sequential and/or graduated compression devices tend to be the most expensive to manufacture.

The medical field also makes use of mattresses which employ a similar principle for therapeutic treatment. The mattress can be static or dynamic depending on the specific treatment which is required.

It is thought that true graduated intermittent compression is therapeutically the most effective treatment and is preferred to true sequential compression. Therefore, devices which utilise either graduated intermittent compression or a combination of graduated intermittent compression and sequential compression are preferred.

US-A-4,029,087 describes a prior art extremity compression device which makes use of spring valves or passageways between adjoining chambers to maintain a pressure gradient between adjacent chambers.

Therefore, it is an object of at least a preferred embodiment of the present invention to provide an inflatable apparatus in the form of a mattress or compression garment which overcomes the problems previously encountered with known apparatus. In the description which follows, references to apparatus "of the type defined" should be understood as meaning mattresses and compression garments. Accordingly, there is provided an inflatable apparatus for therapeutic treatment

of patients such as a mattress or a compression garment, the apparatus including at least one series of inflatable chambers, means for connection to a first chamber of the series for supply of inflation fluid, and fluid flow restrictor means providing restricted fluid flow interconnection between adjacent chambers of the series, characterised in that a bleed valve open to the atmosphere is located in the last chamber of the series which maintains a pressure gradient between adjacent chambers.

Preferably, the fluid flow restrictor means is a tube of small bore.

Preferably, the tube of small bore is located in a membrane between the adjacent chambers.

Preferably, each chamber can be deflated simultaneously via an external tube connected to the supply of inflation fluid, the external tube being connected to each chamber and having non-return valves located between adjacent chambers which ensure that only the first chamber can be inflated directly by the supply of inflation fluid.

Preferably, the chambers can be deflated simultaneously via the supply of inflation fluid and through the fluid flow restrictor means between adjacent chambers.

Preferably, the bleed is adjustable to create varying pressure gradients.

Preferably, the apparatus is a mattress.

Preferably, the apparatus is a garment.

A preferred embodiment of the present invention will now be described in detail, by way of example only, with reference to the accompanying drawings, of which:

Figure 1 is a view from above of a compression garment according to a first preferred embodiment of the present invention;

Figure 2 is a perspective view of the garment in direction X in Figure 1;

Figure 3 is an enlarged view of one of the bleed orifices in Figure 1;

Figure 4 is an enlarged view of one of the non-return valves in Figure 1;

Figure 5 is a view in direction A-A of the membrane detail in Figure 1 with an alternative non-return valve to that shown in Figure 4;

Figure 6 is an enlarged view of the alternative non-return valve in Figure 5;

Figure 7 is a view from above of a compression garment according to a second preferred embodiment of the present invention.

Figure 1 depicts an intermittent compression garment 1 suitable for location over the lower part of the leg and the foot, for example. The garment comprises three separate inflatable chambers 2a, 2b, and 2c. The chambers 2a, 2b, and 2c are connected via flow restrictor means in the form of bleed orifices 3 and 4 between adjacent chambers 2a and 2b, and 2b and 2c respectively. The orifices 3 and 4 consist of a tube of small bore and predetermined length. Chambers 2b and 2c are fed with air from chamber 2a which is connected to a pump or a piped air supply via an inlet tube 5. During an inflation

cycle, air will be fed into chamber 2a and will then pass through bleed orifice 3 to chamber 2b. In accordance with Bernoulli's Theorem there will be a pressure drop when the air passes through the bleed orifice 3. The air which passes into chamber 2b will then pass through bleed orifice 4 into chamber 2c and there will be a further pressure drop. Accordingly, the bleed orifices 3 and 4 act as fluid flow restrictors which enable the fluid pressures in chambers of a series of inflatable chambers to be increased successively from one chamber to the next.

There is an adjustable bleed 6 from chamber 2c which vents air to the atmosphere. The bleed 6 is preferably a needle valve and can be pre-set or adjustable and will determine the pressure drop which occurs between adjacent chambers by adjusting the flow of air from the garment. However, the bleed 6 could be dispensed with or shut-off completely if there was no need for a graduated pressure between chambers. The pressure drop can, however, only be maintained when fluid flow between adjacent chambers continues. Should the fluid flow stop, the pressure between chambers will eventually equalise.

Deflation of the garment is controlled by a valve, for example, within the pump, which is connected to inlet tube 5. When the pump valve is opened to the atmosphere, the chambers 2a, 2b, and 2c are able to exhaust simultaneously through an external tube 7 which is connected between the inlet tube 5 and bleed 6. The external tube 7 is provided with non-return valves 8,9 leading between chambers 2a and 2b, and 2b and 2c respectively. The valves 8,9 are arranged so that the chambers 2b and 2c cannot be inflated directly through the external tube 7 when the inlet tube 5 is inflating chamber 2a. There are T-piece connections 10,11, and 12 connecting the chambers 2a,2b and 2c to the external tube 7 and in the case of chamber 2a to the inlet tube 5 and in the case of chamber 2c to the bleed 6. The chambers 2a and 2b are separated by a membrane 13 and the chambers 2b and 2c are separated by a membrane 14 and it is within membranes 13 and 14 that the bleed orifices 3 and 4 are located. The bleed orifices 3 and 4 run substantially parallel to the join between adjacent chambers in order to avoid "kinking" of the orifices if the user bends the garment in that area.

Figure 2 is a perspective view of the leg garment in Figure 1 taken in direction X. The inlet tube 5 is visible and there is a zipper fastening 15 which allows the garment to be located around the leg and secured in position. Other forms of fasteners can be used for securing the garment in position such as Velcro^(TM) or a clinging plastic sheet, for example.

Figure 3 is an enlarged perspective view of the bleed orifice 3. This shows how the bleed orifice 3, which consists of a tube of small bore, passes from chamber 2a to the next chamber 2b. The bleed orifice 3 is located in membrane 13 between the chambers 2a and 2b.

The bleed orifice 3 is secured in position by a patch 16 which is welded over the tube on both sides of membrane 13.

Figure 4 is an enlarged view of one of the non-return valves 8 and 9 in Figure 1. It can be seen that only air which is exhausting from the chambers via the T-piece connections 11 and 12 will be allowed to flow through external tube 7. Any air which is pumped into the garment via inlet tube 5 will close the non-return valves 8 and 9 so that chambers 2b and 2c can only be inflated by air which passes from chamber 2a via bleed orifices 3 and 4.

Figure 5 is a view in direction A-A of the membrane detail in Figure 1. However, in this Figure the membrane 13 also includes an alternative non-return valve arrangement 17 which could replace non-return valves 8 and 9 in Figure 1.

Figure 6 is an enlarged view of the non-return valve 17 in Figure 5.

Figure 7 is a further embodiment of the compression garment described in connection with Figure 1. In this embodiment like reference numerals indicate like features but the non-return valves 8 and 9 and the external tube 7 have been dispensed with. In practice, it has been found that the non-return valves were ineffective in some orientations and resulted in leakages particularly if ball valves were used. Therefore, the non-return valves and external tube for deflation of the apparatus were removed such that deflation occurs through the bleed orifices 3 and 4 and out through the fluid supply 5. The advantage with this arrangement is that the bleed orifices ensure that some residual pressure remains (less than 5mm Hg) in the chambers furthest from the first chamber which allows a smaller compressor to be used thus reducing the overall size of the apparatus.

Thus, it can be seen that the garment is able to compress the limb sequentially at a variable rate of pressure rise and can provide a graduated pressure from chamber to chamber. In addition, the pressure difference between adjacent chambers can be adjusted by adjusting the air bleed 6 to the atmosphere. If graduated pressure is not required the bleed 6 can be closed and the multi-chamber garment will behave like a single chamber garment with equal pressure in all chambers. Although only three chambers have been described it will be appreciated that any number of chambers can be used by employing such an arrangement. The bleed 6 provides a built-in pressure control which ensures that once the steady state pressure gradient is reached, it is held by exhausting any excess flow through a valve in the pump and at a controlled rate through the bleed valve.

It is also envisaged that the bleed 6 could be used to provide ventilation and cooling in the bed of the patient which will make the treatment process far more pleasant, particularly during lengthy treatment sessions.

It will be appreciated that the intermittent compression garment described and depicted in Figures 1 to 7 can be adapted such that it can simply provide a sequential compression by omitting (or shutting off) the bleed 6. In this way, one can obtain a successive pressure rise from chamber to chamber with each chamber eventually reaching the same pressure. Alternatively, if a graduated compression is required, the bleed 6 will be adjusted to

provide the required drop in pressure between adjacent chambers. This is however, only a single example of how successive and graduated pressure is used for treatment.

For example, a static mattress will not usually require sequential compression since all chambers will be required to reach the same final pressure immediately. However, in a dynamic mattress a sequential compression would be useful for therapy. In some situations there may be a demand for a graduated pressure in a static or dynamic mattress, for example, where parts of the mattress require a higher support pressure than other parts.

Claims

1. An inflatable apparatus for therapeutic treatment of patients such as a mattress or a compression garment, the apparatus including at least one series of inflatable chambers (2a,2b,2c), means (5) for connection to a first chamber (2a) of the series for supply of inflation fluid, and fluid flow restrictor means (3,4) providing restricted fluid flow interconnection between adjacent chambers of the series, characterised in that a bleed valve (6) open to the atmosphere is located in the last chamber (2c) of the series which maintains pressure gradient during fluid flow between adjacent chambers.
2. An apparatus as claimed in Claim 1, wherein the fluid flow restrictor means (3,4) is a tube of small bore.
3. An apparatus as claimed in Claim 2, wherein the tube of small bore (3,4) is located in a membrane (13,14) between adjacent chambers.
4. An apparatus as claimed in any preceding claim, wherein each chamber (2a,2b,2c) can be deflated simultaneously via an external tube (7) connected to the supply of inflation fluid, the external tube (7) being connected to each chamber and having non-return valves (8,9) located between adjacent chambers which ensure that only the first chamber (2a) can be inflated by the supply of inflation fluid.
5. An apparatus as claimed in any of Claim 1 to 3, wherein the chambers (2a,2b,2c) can be simultaneously deflated via the supply of inflation fluid and through the fluid flow restrictor means (3,4) between adjacent chambers.
6. An apparatus as claimed in any preceding claim, wherein the bleed (6) is adjustable to create varying pressure gradients.
7. An apparatus as claimed in any preceding claim in the form of a mattress.

8. An apparatus as claimed in any of Claims 1 to 6 in the form of a garment.

Patentansprüche

1. Aufpumpbares Gerät wie eine Matraze oder ein Kompressions-Kleidungsstück für die therapeutische Behandlung von Patienten, wobei das Gerät zumindest eine Reihe von aufpumpbaren Kammern (2a, 2b, 2c) aufweist, Mittel (5) zur Verbindung mit einer ersten Kammer (2a) der Reihe zur Zuführung eines Aufpumpfluids und Fluidfluß-Beschränkungsmittel (3, 4), die eine Verbindung für beschränkten Fluidfluß zwischen angrenzenden Kammern der Reihe schaffen, dadurch **gekennzeichnet**, daß ein Ablassventil (6), das zur Umgebung hin offen ist, in der letzten Kammer (2c) der Reihe angeordnet ist, das einen Druckgradienten während eines Fluidflusses zwischen angrenzenden Kammern aufrechterhält.
2. Gerät nach Anspruch 1, wobei das Beschränkungsmittel (3, 4) für den Fluidfluß eine Rohrleitung mit kleiner Bohrung ist.
3. Gerät nach Anspruch 2, wobei die Rohrleitung mit kleiner Bohrung (3, 4) in einer Membran (13, 14) zwischen angrenzenden Kammern angeordnet ist.
4. Gerät nach einem der vorstehenden Ansprüche, wobei jede Kammer (2a, 2b, 2c) gleichzeitig über eine externe Rohrleitung (7), die mit der Zufuhr des Aufpumpfluides verbunden ist, entleert werden kann, wobei die externe Rohrleitung (7) mit jeder Kammer verbunden ist und Rückschlagventile (8, 9) aufweist, die zwischen aneinandergrenzenden Kammern angeordnet sind und sicherstellen, daß durch die Zufuhr von Aufpumpfluid nur die erste Kammer (2a) aufgepumpt werden kann.
5. Gerät nach einem der Ansprüche 1 bis 3, wobei die Kammern (2a, 2b, 2c) gleichzeitig über die Zufuhr von Aufpumpfluid und durch das Fluidfluß-Beschränkungsmittel (3, 4) zwischen aneinandergrenzenden Kammern entleert werden können.
6. Gerät nach einem der vorstehenden Ansprüche, wobei das Ablassventil (6) einstellbar ist, um unterschiedliche Gradienten zu erzeugen.
7. Gerät nach einem der vorstehenden Ansprüche in Form einer Matraze.
8. Gerät nach einem der Ansprüche 1 bis 6 in Form eines Kleidungsstücks.

Revendications

1. Appareil gonflable pour le traitement thérapeutique de patients, tel qu'un matelas ou un vêtement de compression, l'appareil comprenant au moins une série de chambres gonflables (2a, 2b, 2c), un moyen (5) de raccordement à une première chambre (2a) de la série, pour la fourniture d'un fluide de gonflage, et des moyens de restriction de l'écoulement du fluide (3, 4) fournissant une liaison d'écoulement restreint de fluide entre des chambres adjacentes de la série, caractérisé en ce que dans la dernière chambre (2c) de la série est située une soupape de purge (6) ouverte dans l'atmosphère, qui maintient un gradient de pression pendant l'écoulement de fluide entre les chambres adjacentes. 5 10 15
2. Appareil selon la revendication 1, dans lequel le moyen de restriction d'écoulement de fluide (3, 4) est un tube de petit diamètre interne. 20
3. Appareil selon la revendication 2, dans lequel le tube de petit diamètre interne (3, 4) est situé dans une membrane (13, 14) entre des chambres adjacentes. 25
4. Appareil selon l'une quelconque des revendications précédentes, dans lequel toutes les chambres (2a, 2b, 2c) peuvent être dégonflées simultanément par l'intermédiaire d'un tube externe (7) relié à l'alimentation en fluide de gonflage, le tube externe (7) étant relié à chaque chambre et présentant des clapets anti-retour (8, 9) situés entre des chambres adjacentes, qui assurent que seule la première chambre (2a) peut être gonflée par l'alimentation en fluide de gonflage. 30 35
5. Appareil selon l'une quelconque des revendications 1 à 3, dans lequel les chambres (2a, 2b, 2c) peuvent être dégonflées simultanément par l'intermédiaire de la fourniture de fluide de gonflage et par l'intermédiaire des moyens de restriction d'écoulement de fluide (3, 4) situés entre des chambres adjacentes. 40
6. Appareil selon l'une quelconque des revendications précédentes, dans lequel la purge (6) peut être réglée pour créer des gradients de pression variables. 45
7. Appareil selon l'une quelconque des revendications précédentes, présentant la forme d'un matelas. 50
8. Appareil selon l'une quelconque des revendications 1 à 6, présentant la forme d'un vêtement. 55

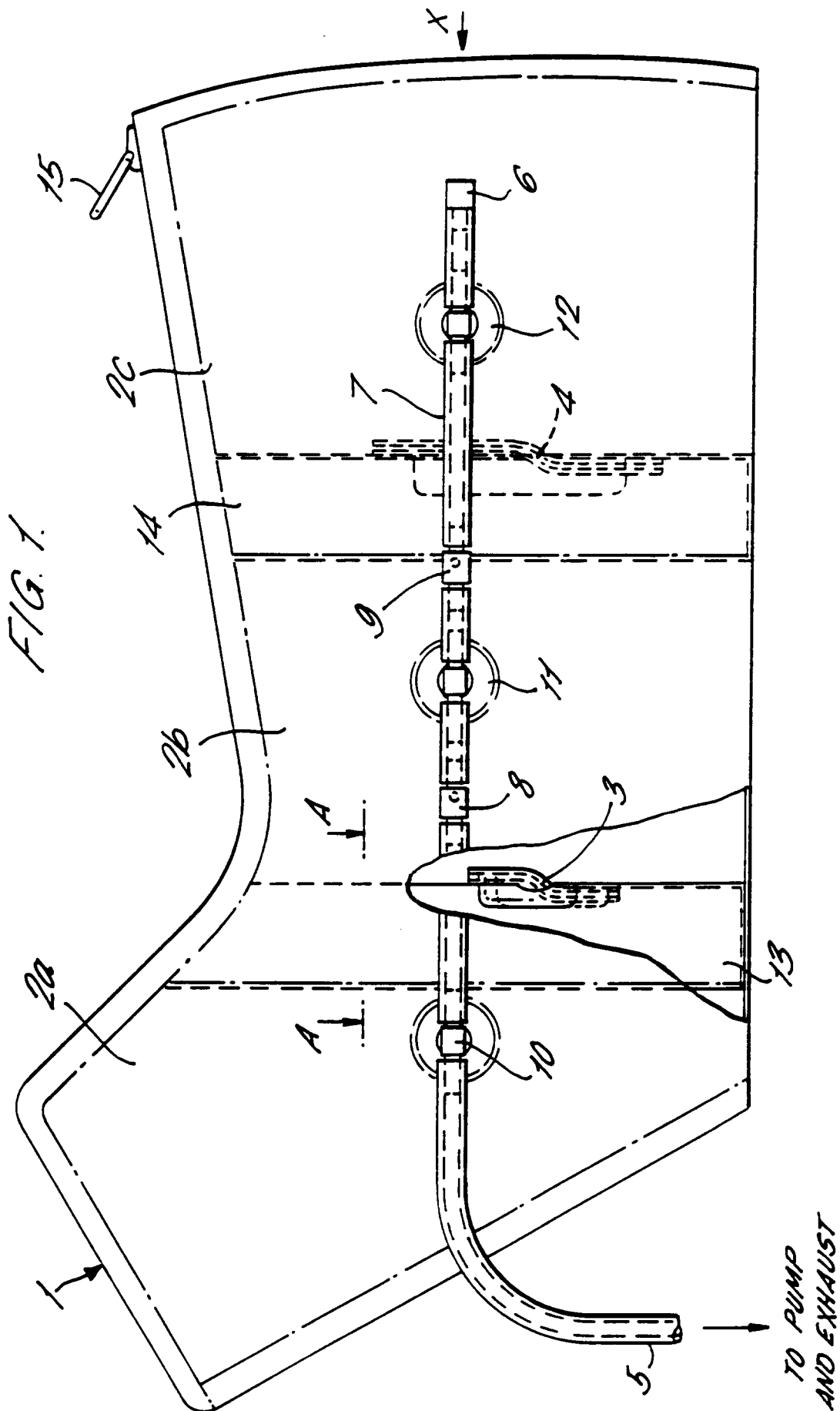


FIG. 2.

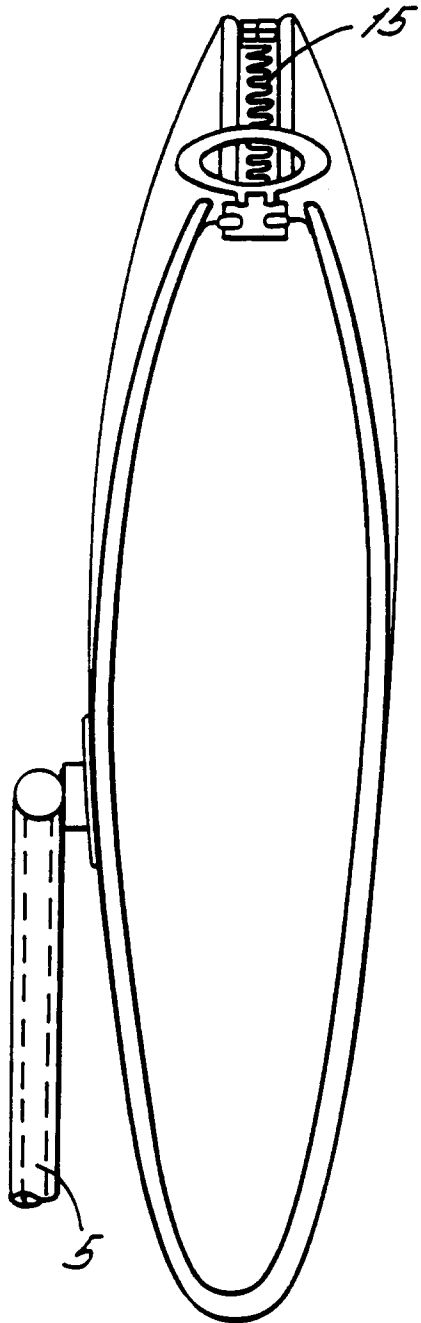


FIG. 3.

