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EP 0182412 A1
WO 2010/141960 A2
WO 2009/093020 A2
WO 2009/042240 A1
WO 2009/017762 A2
WO 2007/030609 A2

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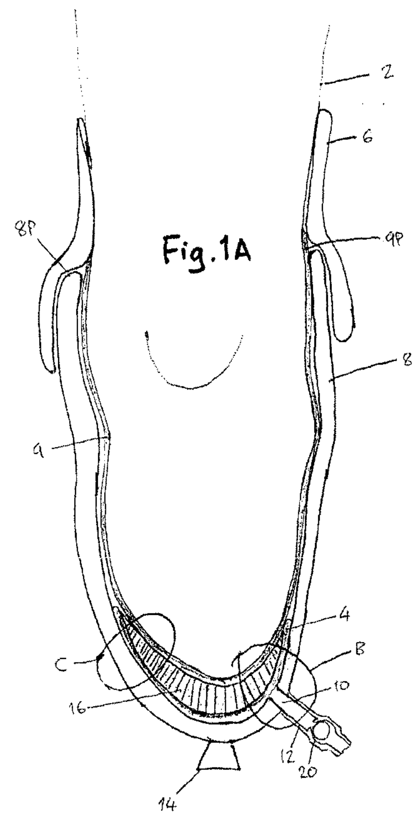
(54) Title of the Invention: **Vacuum-assisted suspension device**
Abstract Title: **Vacuum assisted suspension device**

(57) A vacuum assisted suspension device for a limb prosthesis or orthosis comprising an air impermeable outer wall member 8 shaped to receive a limb portion 2, the wall member 8 having a peripheral edge. An evacuation port 10, and a non-return valve 20 associated with the evacuation port 10 and arranged to maintain a vacuum between the wall member 8 and the limb portion 2 when the latter is received by the wall member. A resilient cushioning layer 4 shaped and dimensioned to be located between an inner surface of the wall member 8 and the limb portion 2, the cushioning layer 4 having an inner surface 20 and an outer surface 22. A porous distribution layer 6 located between an inner surface of the wall member 8 and the limb portion 2 when the latter is received by the wall member 8, and adapted to allow transmission of the air and moisture transversely through the distribution layer 6, the distribution layer extending over the outer surface 22 of the cushioning layer 4 and having a part which is in registry with the evacuation port. Means for forming a seal between the wall member 8 and the limb portion 2 in the region of the peripheral edge 4. Wherein the cushioning layer is made of an air impermeable material at least of which has perforations 18 which extend through the layer 4 from the inner surface 20 to the outer surface thereof, the apertures present to the limb portion 2 being less than 2mm across. In another aspect a cushioning member 4 with voids in communication with the non return valve 20 is described.



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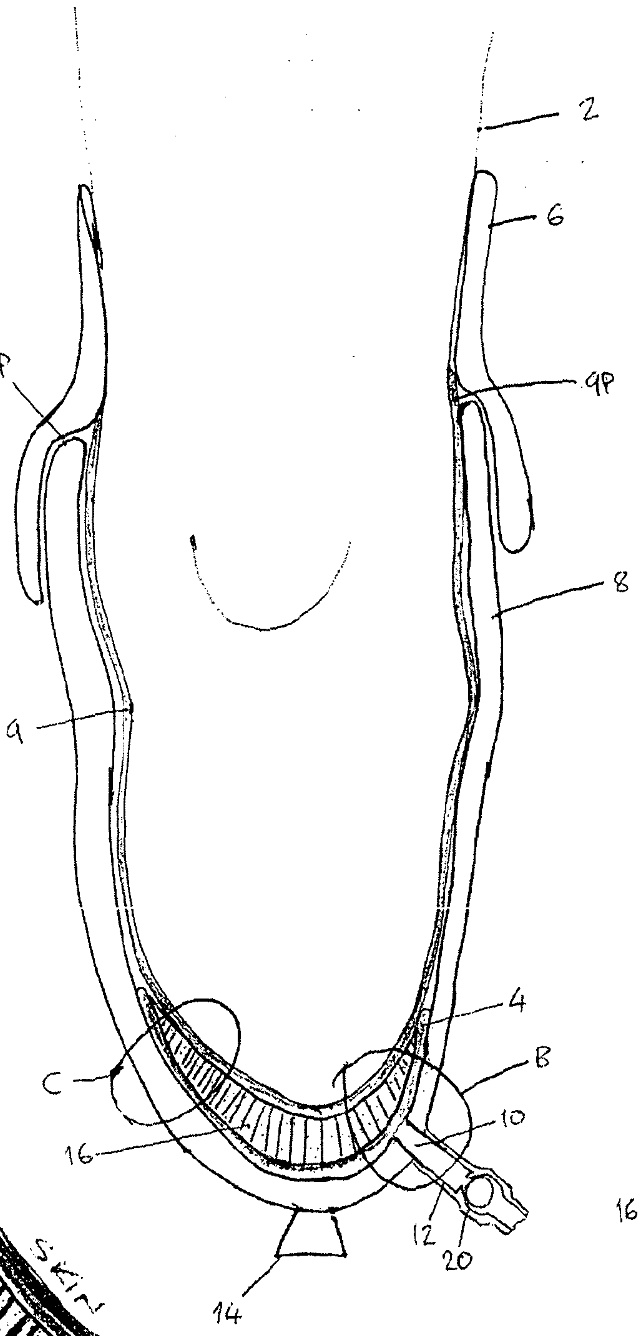

Fig.1A

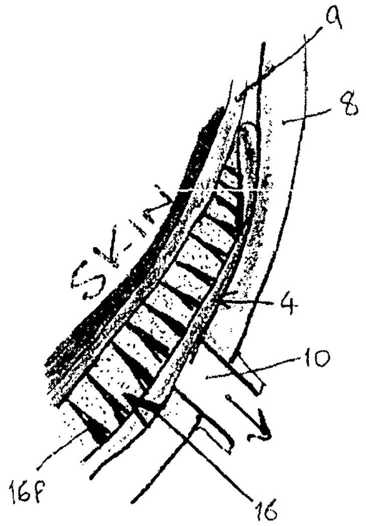

Fig.1B

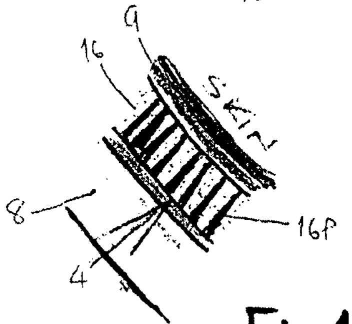

Fig.1C

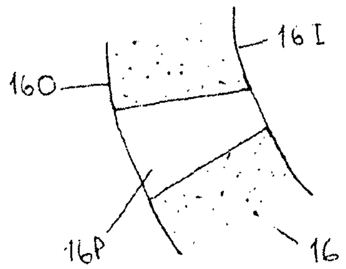

Fig. 2A

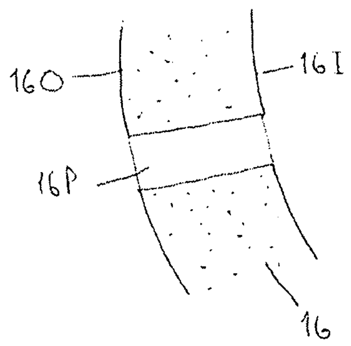

Fig. 2B

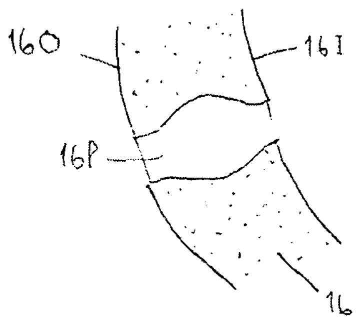

Fig. 2C

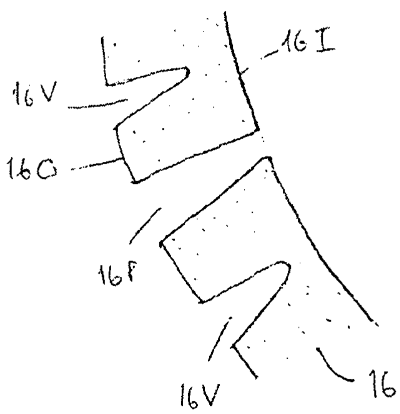

Fig. 2D

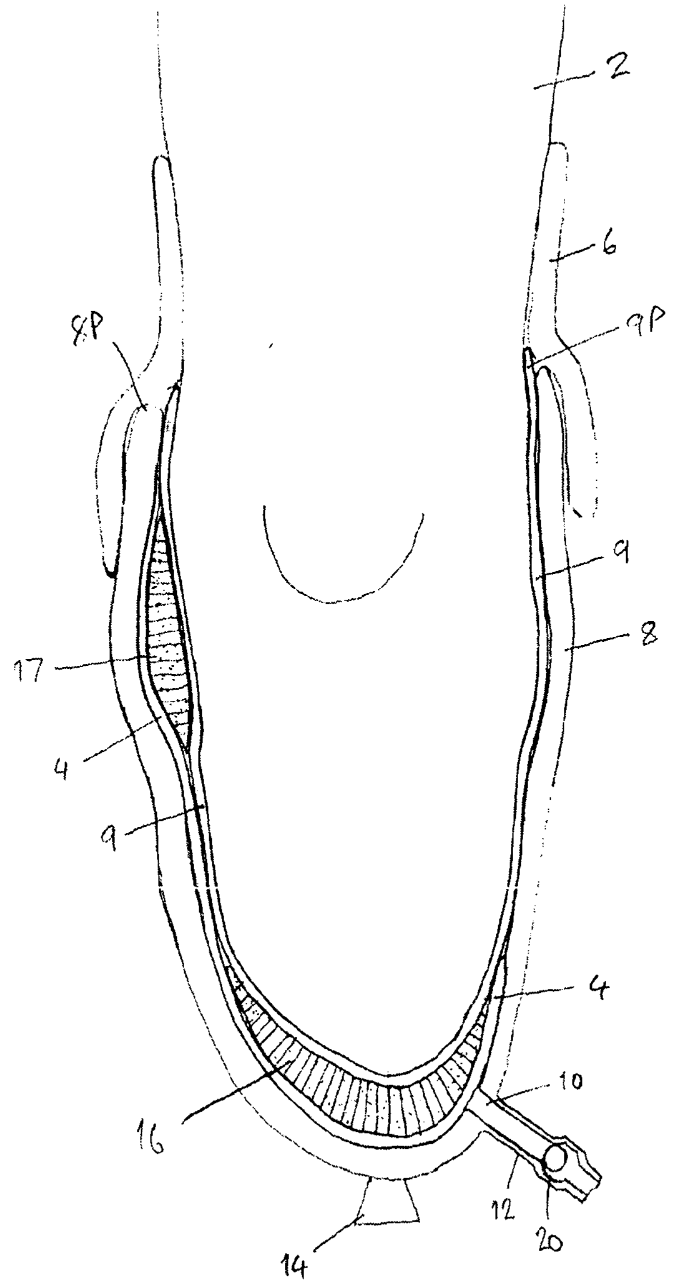

Fig. 3

VACUUM-ASSISTED SUSPENSION DEVICE

The present invention relates to a vacuum-assisted suspension device for a limb prosthesis or orthosis. The invention provided has particular use in securing a lower limb prosthesis to a residual limb portion of a transtibial amputee.

Maintaining an intimate fit between a residual body portion and the socket of a prosthetic limb is known to cause problems with the comfort and control of the limb prosthesis. It is known that these problems are, in part, due to the occurrence of relative movement between the residual body portion and the socket. Typically, this relative movement causes abrasions on the residual body portion and increased energy consumption during ambulation, as well as a lack of control of the prosthetic device.

It is known to use a vacuum to aid in the attachment of the body portion to a prosthesis by creating an airtight seal between the socket of the prosthesis and the body portion, and to then use a pump to evacuate air contained within the space between the socket and body portion. This vacuum contained by the seal can then be used to suspend a prosthetic device.

Several innovations over recent years have sought to restrict relative movement between a residual body portion and a prosthesis further by applying an active vacuum via the liner to the residual body portion. An active vacuum is defined as one that is less than atmospheric pressure and is generated by, usually, either a mechanical or electrically powered vacuum pump. It is known to use such a vacuum pump in combination with a non-porous liner that effectively insulates and seals off air flow to the residual body portion. By ensuring an intimate fit of the liner to the residual body portion and evacuating the space between them using the vacuum pump, it is possible to secure the liner to the residual body portion purely by vacuum while minimising relative movement between the residual body portion and the liner. It is then possible to secure the liner to the socket of a prosthetic device. The Otto Bock Harmony® system is an example using this technique.

One difficulty encountered with all vacuum-assisted suspension devices is that, in a hot environment or during exertion, sweating occurs, which allows relative movement between the residual body portion and the liner or the prosthetic device. Additionally, sweating creates a moist environment which softens the skin and provides a breeding ground for pathogens. The consequences of this are that the residual body portion is more prone to abrasion, tissue breakdown and infection. Ideally, relative motion between the skin and the socket interface is eliminated.

It is an object of the invention to provide an improved vacuum-assisted suspension device for a limb prosthesis or orthosis.

According to the present invention, a vacuum-assisted suspension device for a limb prosthesis or orthosis comprises: an air-impermeable outer wall member shaped to receive a limb portion, the wall member having a peripheral edge, an evacuation port, and a non-return valve associated with the evacuation port and arranged to maintain a vacuum between the wall member and the limb portion when the latter is received by the wall member; a resilient cushioning layer shaped and dimensioned to be located between an inner surface of the wall member and the limb portion, the cushioning layer having an inner surface and an outer surface; a porous distribution layer located between an inner surface of the wall member and the limb portion when the latter is received by the wall member, and adapted to allow transmission of air and moisture transversely through the distribution layer, the distribution layer extending over the outer surface of the cushioning layer and having a part which is in registry with the evacuation port; and means for forming a seal between the wall member and the limb portion in the region of the said peripheral edge; wherein the cushioning layer is made of an air-impermeable material at least part of which has perforations which extend through the layer from the inner surface to the outer surface thereof the arrangement of the device being such that corresponding apertures presented to the limb portion in use are less than 2mm across, e.g. by virtue of the perforations having a diameter of less than 2mm at the inner surface of the cushioning layer.

In use of such a suspension device, it is possible for an active vacuum to be produced on the inside of the wall member, the vacuum acting both on the human body portion and the wall member. The vacuum creates a force to suspend the device from a human body portion whilst also minimising the relative movement between them.

The active vacuum is formed by compression and decompression of the resilient cushioning layer during locomotion. When the device is worn by a user, air and moisture are evacuated from within the device through the evacuation port and prevented from re-entering the device by the non-return valve. Mechanical work by the user forces the device towards the limb portion. This force works to compress the resilient cushioning layer, thereby increasing the pressure of the air contained within the device. The pressurised air is expelled from the device through the evacuation port. Once the loading force acting on the resilient cushioning layer is removed, the then unloaded resilient cushioning layer expands. The expansion of the cushioning layer provides a force acting on both the limb portion and the wall member. This force maintains a vacuum within the device even when no net force is acting between the limb portion and the device.

The resilient cushioning layer has a plurality of perforations to allow air (and moisture) to pass through the cushioning layer, away from the limb portion. The perforations preferably have a diameter (or equivalent transverse extent) of less 1 mm at the surface of the cushioning layer nearest to the limb portion. The maximum transverse extent of the apertures presented to the residual body portion is set to minimise the risk of blistering the skin of the limb portion as a result of the vacuum transmitted through the perforations. If there is a fabric layer adjacent the inner surface of the cushioning layer, the diameter of the perforations at the inner surface may be greater than 1mm. The applicants have found that the apertures on the surface presented to the residual body portion should be less than 2mm across for best results.

The cushioning layer may be a liner or a pad, the perforations preferably being evenly distributed across an area of the liner or pad. Alternatively the perforations may be formed in one or more groups with each group having a plurality of perforations. The perforations may be formed using laser beams to melt or ablate the resilient material. A resilient porous layer, with very small pores, i.e. smaller than 0.25mm in diameter, may also be used.

The distribution layer is typically a synthetic fibre weave extending at least over the interface between the cushioning layer and the wall member.

The resilient cushioning layer may be manufactured from a silicone elastomer or a thermosetting gel material such as butyl-styrene. Materials other than the above may be used, especially those with similar physical properties. For instance, a sintered or porous resilient material may be used. Another alternative is a multiple-layer structure for the cushioning layer, having a sintered internal layer sandwiched between perforated layers formed of an impermeable material.

At least some of the perforations of the cushioning layer may have a cross-sectional area which varies along the length of the respective perforation, the diameter of each such perforation preferably being greater at the outer surface of the cushioning layer than at the inner surface thereof. If the cross-sectional area of a section of such a perforation increases as the distance from the residual limb portion contained within the suspension device increases, the velocity of a fluid travelling through the perforation away from the limb portion increases. This effect of the shaped perforations increases efficiency of the cushioning layer in transporting moisture away from the limb portion within the suspension device and inhibiting passage back through the perforations towards the limb portion.

The wall member may be shaped as a hollow elongate socket to receive an elongate residual limb portion, the socket having a proximal open end defined by its peripheral edge, and a distal closed end. The cushioning layer is preferably located at the distal closed end of the socket to maximise the pumping effect of the residual limb portion moving longitudinally within the elongate socket, and is shaped and arranged such that its inner surface abuts the residual limb portion over the whole of that inner surface.

The vacuum-assisted suspension device may having a cushioning layer as a single liner or pad, or it may have plural cushioning pads spaced apart from each other and located between the inner surface of the wall member and the distribution layer. The pad or pads may themselves have multiple layers. Beneficially, one pad may be located at the distal end of the socket and another adjacent to the peripheral edge of the wall member. The second cushioning pad adds to the pumping effect produced by the pad at the distal end of the socket. Further, if a second cushioning pad is orientated within the socket substantially in a different plane to that of a first cushioning pad, movement of the residual limb portion movement of the residual limb portion generally parallel to one of the cushioning pads tends to compress the other. A second cushioning pad may, therefore, provide a more efficient pumping effect within a suspension device compared to a single cushioning pad.

The comfort to the user of the suspension device and magnitude of the vacuum achieved within the suspension device is affected by the material of the cushioning layer. Resilience is the property of a material to absorb energy when it is deformed elastically and then, upon unloading, to have this energy recovered. One measure of resilience is its durometer. Silicone rubber, for instance, typically has a shore durometer of between 20 and 55 (shore 00). Perforating the material of the cushioning layer reduces the durometer and modulus of rigidity. The material is chosen to have a durometer which suits the activity for which the prosthesis or orthosis is designed. Thus, running produces greater loads than walking and requires a material of higher durometer. Generally, the cushioning layer material, including perforations, has an effective modulus of rigidity in the region of the perforations such that it is capable of being compressed by the pressures produced between the wall member and the limb portion during the gait cycle.

The invention will now be described by way of example with reference to the drawings in which:

Figure 1A is a partly-sectioned schematic view of a preferred vacuum-suspension device in accordance with the invention, shown mounted on a lower limb residuum;

Figures 1B and 1C are details from Figure 1A;

Figure 2A is a cross-sectional view of part of a cushioning layer having perforations of a first shape;

Figure 2B is a cross-sectional view of part of a cushioning layer having perforations of a second shape;

Figure 2C is a cross-sectional view of part of a cushioning layer having perforations of a third shape;

Figure 2D is a cross-sectional view of part of a cushioning layer having a plurality of voids, some of which constitute perforations; and

Figure 3 is a partly-sectioned schematic view of an alternative vacuum-suspension device in accordance with the invention, shown mounted in a lower limb residuum.

Embodiments of the invention described herein each comprise a vacuum assisted suspension device with a resilient cushioning layer to be disposed between the stump of an amputated limb and a socket of the suspension device. The cushioning layer is made at least partly of a resilient air-impermeable material. The construction of the suspension devices is generally similar to those disclosed in WO2009/093020, the entire disclosure of which is incorporated herein by reference.

Referring to Figures 1A to 1C, a first vacuum-assisted suspension device in accordance with the invention is for attaching a lower limb prosthesis to a lower limb residuum or stump 2. The stump 2 is housed within a socket 8 of the lower limb prosthesis. Within the socket 8 there is a resilient cushioning layer in the form of a cushioning pad 16 (see detail B shown in Figure 1B) and a porous distribution layer 4. The distribution layer 4 is sandwiched between the outer surface of the cushioning pad 16 and the wall of the socket 8. The extent of the distribution layer 4 is such that the entire outer surface of the cushioning pad 16 is covered by the distribution layer.

A suspension sleeve 6 fits around a peripheral edge 8P of the socket 8. The suspension sleeve creates an airtight seal between the socket 8 and the skin of the stump 2. The suspension sleeve 6 allows a vacuum to be maintained within the socket 8 when a stump 2 is present within the socket 8.

A port 10 is formed in a distal end portion of the wall of the socket 8, adjacent a connection interface 14 with the remainder of the prosthesis (not shown) and in registry with the cushioning pad 16. The position of the port 10 in the socket wall is also such that it is in registry with the distribution layer 4. The port 10 transmits air and fluid from the interior of the socket 8 via the port 10 through a non-return valve 20 in an evacuation pipe 12 connected via a pipe union to the socket wall. The valve 20 is oriented so as normally to prevent flow of air into the socket from the outside. In this example, the connection interface 14 is a conventional pyramid-shaped spigot secured to the extreme distal end of the socket 8.

The cushioning pad 10 is formed of a resilient elastomeric material which is, itself, air and water-impermeable in this instance. Formed in the cushioning pad 16 are a plurality of perforations 16P. These perforations extend through the pad 16 from the inner surface thereof next to the stump 2, to an outer surface next to the wall of the socket 8. The perforations 16P render the cushioning layer formed by the pad 16 permeable to air and liquid in its perforated area or areas.

It is not necessary for the cushioning pad 16 to be perforated over the whole of its area, although in the case of the pad being confined to the distal end portion of the suspension device, as shown in Figure 1A, it is preferred that the whole area is perforated as shown.

On the inner surface of the pad 16 there is an air and fluid permeable fabric layer in the form of a sock 9 which extends beyond the periphery of the cushioning pad 16 over the whole of the inner surface of the socket 8, terminating in the proximal edge portion 9P adjacent the peripheral edge 8P of the socket 8.

The socket 8 is conventional insofar as it is made of a thermoplastics material such as a nylon based thermoplastics which is rigid compared to the pad 16, albeit with some resilience.

As shown in Figure 2A, each perforation 16P of the cushioning layer 16 is formed as a void in the material of the cushioning layer 16, the void taking the shape of a truncated cone and extending from the outer surface 16O of the cushioning layer 16 to the inner surface 16I thereof. The perforation 16P is flared outwardly, i.e., owing to the generally conical shape, it has a larger diameter at the outer surface 16O (adjacent the distribution layer 4, as shown in Figure 1A) than its diameter at the inner surface 16I (adjacent the sock 9 and the stump 2).

In use of the suspension device, with a prosthetic shin and foot attached to the socket 8 by means of the pyramidal spigot 14, the repeated application and removal of a compression force on the cushioning layer 16 inside the socket 8 as the wearer is walking or running initially expels air from the space between the wall of the socket 8 and the stump 2 through the port 10. Owing to the presence of the non-return valve 20 in the pipe section 12 connected to the port 10, this creates a vacuum between the socket 8 and the stump 2 to hold the socket firmly on the stump.

The distribution layer 4 between the pad 16 and the wall of the socket 8 allows transverse passage of air and moisture, i.e. across the outer surface of the pad 16, equalising the reduction in pressure across the entire surface area of the pad. In addition, the perforations 16P allow air to be evacuated from between the pad 16 and the skin of the stump 2, equalising the reduction in pressure on opposite sides of the pad 16.

As described in the above-mentioned WO 2009/093020, the perforations 16P also serve to transport moisture away from the surface of the stump 2, the pumping action of the pad 16 and the non-return valve 20 serving to draw moisture through the perforations 16P and the distribution layer 4, to be evacuated via the port 10. In this way, not only is the socket retained in close proximity to the stump 2, but also the build-up of moisture on the stump is reduced.

The outward flaring of the perforations 16P increases the flow velocity of air and moisture through the pad 16, helping to prevent the return of fluid when the pressure differential across the pad 16 reverses during walking or running.

The socket 8 is conventional insofar as it is made of a thermoplastics material such as a nylon based thermoplastics which is rigid compared to the pad 16, albeit with some resilience.

Referring still to Figure 2A, the cross-sectional area of each of the perforations 16P at the cushioning pad inner surface 16I is such that, for a circular cross-section, the diameter is no more than 2mm. In the absence of a sock 9, the maximum diameter of the perforations of the inner surface 16I is 1mm.

Alternative cushioning pad configurations are shown in Figures 2B, 2C and 2D. Referring to Figure 2B, the perforations 16P may be parallel-sided, so that the cross-sectional area at the pad outer surface 16O is the same as at the pad inner surface 16I. As a further alternative, the perforations 16P may have a larger cross-sectional area at an intermediate depth, i.e. in the body of the pad 16 between the inner and outer surfaces 16I, 16O, as shown in Figure 2C.

It is not necessary for all of the voids to penetrate the full thickness of the pad 16. Accordingly, as shown in Figure 2D, the pad 16 may have perforations 16P as well as voids 16V each having an opening on the outer pad surface 16O but a blind end in the body of the pad. Such voids assist in evacuating air from between the socket 8 and the stump 2 when the pad 16 is repeatedly compressed. Blind voids 16V may be formed so as to open out on the inner surface 16I as well as, or instead of, those opening out onto the outer surface 16O. In some circumstances, if moisture dispersal is not required, the cushioning pad may be formed without, or with very few, perforations 16P, air evacuation being performed entirely by means of blind voids such as those shown in 16V in Figure 2D.

The perforations 16P and blind voids 16V may be formed in a number of ways: by using a laser to cut the perforations in a pre-formed cushioning layer, or by driving one or more rods into the preformed cushioning layer. Alternatively, they may be produced during the forming of the cushioning layer, e.g. by appropriately shaping a mould in which the cushioning layer is moulded.

Referring to Figure 3, a second vacuum-assisted suspension device in accordance with the invention has a first, distal resilient cushioning pad 16 and a second lateral resilient cushioning suspension pad 17. The first pad 16 is positioned remotely from the peripheral edge 8P of the socket 8 at the distal end, while the second pad 17 is positioned adjacent the peripheral edge 8P of the socket 8. The first cushioning pad 16 acts to evacuate air from within the suspension device as a result of longitudinal motion of the stump 2 within the device, while the second cushioning pad 17 acts to evacuate air from within the suspension device as a result of transverse or rocking motion of the stump 2 within the device, or as a result of hydrostatic loading of the stump 2. It should be noted that the distribution layer 4, in this case, extends proximally to cover the entire outer surface of the lateral cushioning pad 17 and also connects that outer surface to the outer surface of the distal cushioning pad 16 to allow transmission of air and moisture from the region of the lateral pad 17 to the evacuation port 10.

In Figure 3, the second cushioning pad 17 is positioned laterally. It is also possible to have the second cushioning pad positioned medially or anteriorly.

In a further alternative embodiment, the resilient cushioning layer comprises a resilient liner, as shown in Figure 1 of the above-mentioned WO 2009/093020. In this case, the liner is in the form of hollow, elongate internal socket lining which has a perforated distal region. The peripheral portion of the liner is not perforated and is not, therefore, permeable. It extends beyond the proximal periphery of the socket stump. This means that the sealing sleeve 6 of the embodiments described above with reference to Figures 1 and 3 can be dispensed with. It is also possible to incorporate a second perforated area positioned laterally, medially or anteriorly in the liner to assist with evacuation of the space between the socket and the stump providing a distribution layer extends over the outer surface of the liner in registry with each perforated area, and a path to the evacuation port is provided.

As yet a further alternative, a perforated resilient pad can be used in conjunction with a standard impermeable liner to aid in its retention. In addition, the pad can be formed as part of a multi-layered liner providing, again, a distribution layer is included as a means of transmitting air and moisture from the outside of the perforated section to an evacuation port, as in the above-described embodiments.

Claims

1. A vacuum-assisted suspension device for a limb prosthesis or orthosis, comprising:

an air-impermeable outer wall member shaped to receive a limb portion, the wall member having a peripheral edge, an evacuation port, and a non-return valve associated with the evacuation port and arranged to maintain a vacuum between the wall member and the limb portion when the latter is received by the wall member;

a resilient cushioning layer shaped and dimensioned to be located between an inner surface of the wall member and the limb portion, the cushioning layer having an inner surface and an outer surface;

a porous distribution layer located between an inner surface of the wall member and the limb portion when the latter is received by the wall member, and adapted to allow transmission of air and moisture transversely through the distribution layer, the distribution layer extending over the outer surface of the cushioning layer and having a part which is in registry with the evacuation port; and

means for forming a seal between the wall member and the limb portion in the region of the said peripheral edge;

wherein the cushioning layer is made of an air-impermeable material at least part of which has perforations which extend through the layer from the inner surface to the outer surface thereof, the apertures presented to the limb portion being less than 2mm across.

2. A device according to claim 1, wherein the perforations have a diameter of less than 1mm at the cushioning layer inner surface.

3. A device according to claim 1 or claim 2, wherein at least some of the perforations are tapered, the diameter of each such perforation being greater at the outer surface of the cushioning layer than at the inner surface thereof.

4. A device according to claim 1 or claim 2, wherein the cross-sectional area of each of at least some of the perforations varies along the length of the perforation.

5. A device according to any preceding claim, wherein the wall member is an elongate socket shaped to receive a residual limb portion, the socket having a proximal open end defined by the peripheral edge and a distal closed end, and wherein the cushioning layer is located at least at the distal closed end of the socket.

6. A device according to claim 5, wherein cushioning layer comprises first and second perforated cushioning pads, the first pad being located at the distal closed end of the socket and the second pad being located in registry with a side wall portion of the socket, and wherein the distribution layer extends over the outer surfaces of both cushioning pads.

7. A device according to claim 6, wherein the second cushioning pad is located adjacent the peripheral edge of the wall member.

8. A device according to claim 5, wherein the cushioning layer comprises at least two non-overlapping cushioning pads each having a plurality of said perforations, the distribution layer extending over both pads..

9. A device according to any of claims 6 to 8, wherein the second cushioning pad is located so as to abut a medial surface or a lateral surface of the residual limb portion when the device is fitted thereto, whereby lateral movement of the residual limb portion within the device causes compression of the said second cushioning pad.

10. A device according to any of claims 6 to 8, wherein the second cushioning pad is located so as to abut an anterior surface or a posterior surface of the residual limb portion when the device is fitted thereto, whereby movement of the residual limb portion in the anterior-posterior direction causes compression of the said second cushioning pad.

11. A device according to any preceding claim, wherein the material of the cushioning layer has an effective modulus of rigidity in the region of the perforations

such that it is capable of being compressed by the pressures produced between the wall member and the limb portion during the gait cycle.

12. A device according to any preceding claim, wherein the material of the cushioning layer is a material with a durometer value of between 20 and 55 shore 00.

13. A device according to claim 5, wherein the distribution layer extends over the entire inner surface of the socket.

14. A device according to any preceding claim, including a porous inner fabric layer at least a part of which extends over the inner surface of the cushioning layer.

15. A device according to claim 14, wherein the porous layer extends over and is in registry with the entire inner surface of the socket.

16. A suspension device for a lower limb prosthesis comprising:

an air-impermeable socket shaped to receive a residual limb portion, the socket having an inner surface and an outer surface, a distal end and a proximal end, the proximal end being open and surrounded by a peripheral socket edge,

a resilient cushioning layer shaped and dimensioned to be located between the inner surface of the socket and the residual limb portion when the socket is fitted to the residual limb portion, wherein the cushioning layer has an inner surface and an outer surface and is formed of a resilient air-impermeable material, at least a portion of the layer having voids which are open at least at the outer surface of the liner, and

a sealing member arranged to form a seal between the socket and the residual limb portion when the socket is fitted to the residual limb portion, the seal enclosing the said portion of the cushioning layer having voids,

and wherein the socket has an evacuation port in communication with said voids and a non-return valve in communication with the evacuation port, which valve is oriented so as to maintain a vacuum generated inside the socket.

17. A device according to claim 16, wherein the voids include voids which are open only to the outer surface of the cushioning layer.

18.A device according to claim 16, wherein the voids include perforations which pass through the cushioning layer from the inner surface to the outer surface thereof and which present to the residual limb portion apertures of less than 2mm across.

19. A lower limb prosthesis including a vacuum-assisted suspension device according to any preceding claim.

20. A vacuum-assisted suspension device constructed and arranged substantially as herein described and shown in the drawings.

Application No:	GB1122135.5	**Examiner:**	Dr Matthew Parker
Claims searched:	1-15	**Date of search:**	23 March 2012

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1-15	WO2009/093020 A2 (BLATCHFORD), see whole document
X	1-15	WO2007/030609 A2 (KING), see Figures 12a-12c
X	1-15	EP0182412 A1 (JONGEENGEL), whole document relevant
X	1-15	WO2009/017762 A2 (OSSUR), see compressible porous layer 62, outer porous layer 64, and impermeable layer 72
A	-	WO2010/141960 A2 (CASPERS)
A	-	WO2009/042240 A1 (SCUSSEL)

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

Worldwide search of patent documents classified in the following areas of the IPC

A61F

The following online and other databases have been used in the preparation of this search report

EPODOC, WPI

International Classification:

Subclass	Subgroup	Valid From
A61F	0002/80	01/01/2006
A61F	0002/78	01/01/2006