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A LIFTING CUSHION

The present invention relates to a lifting cushion for supporting, raising or moving objects.

Lifting cushions of the invention may for example be used for rescuing people who are trapped by collapsible walls, girders, concrete slabs or heavy road vehicles.

These lifting cushions can also be used for prising steering columns, removing windscreens and for forcing doors. Industrial uses of the lifting cushions include lifting heavy machinery, rail locomotives and pipelines, supporting tensioning in mining, splitting slabs in quarries, and use as compression or spreader elements.

In operation, the lifting cushion is placed in its flattened condition beneath the object to be raised. The cushion is then inflated thereby raising the object. If further lift is required one or more lifting cushions may be inserted one above the other and subsequently inflated to provide a required degree of lift of the object.

In order to provide a maximum lifting force the lifting cushions are generally of rectangular form. With the previously known lifting cushions the problem arises that when the cushion is inflated the cushion changes from its non-inflated flat rectangular form to a form having a generally oval vertical cross-section. This change in shape of the cushion considerably reduces the contact area between the cushion area and the object to be raised thereby producing a corresponding reduction in the lifting force that can be applied by the cushion to the object. There is also a significant risk arising from the difficulty of calculating the force required to lift the object from the trapped person or to gain clearance

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to insert cribbage. It will be appreciated that this change of shape in the cushions makes it extremely difficult to provide sufficient stability to be able to use a plurality of cushions one on top of the other.

It is an aim of the invention to alleviate the above-mentioned disadvantages, and according to one aspect of the present invention there is provided an inflatable envelope for a lifting cushion, said envelope comprising two opposed major members and a plurality of cell structures extending between and through the said two members to retain said two major members of the envelope at a preselected attitude to one another when the envelope is inflated, in which each cell structure comprises two opposed generally U-shaped half cell members with the opposed facing end portions of the two half cell members connected to the outer surfaces of the major members.

The length of the mid portion of the half cell members will define the preselected relative attitude of the two major members of the envelope, and also the spacing of these major members, when the envelope is fully inflated.

In one example of the invention, the length of the mid portion of the half cell members may be 100mm in length but the invention is not restricted to cell structures of any specific dimension.

In a preferred embodiment of the invention the two major members and the half cell members may be constructed of a polyaramid material such as polyaramid cord, and the material may be coated on both sides with uncured neoprene.

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According to another aspect of the invention there is provided a lifting cushion comprising the above-mentioned inflatable envelope and a first layer extending around the envelope.

The first layer may extend in a first direction, and be folded around the envelope so as to have folded over regions.

The invention may include a second layer extending in a second direction and being folded around the said first layer to have folded over regions. The folded over regions of the second layer may be on the opposite side of the lifting cushion to the folded over regions of the first layer, and in a preferred embodiment the said first and second directions are at 90° to one another.

In a construction in which the envelope is rectangular, the said first and second directions of the layers may extend parallel to first and second sides of the rectangular envelope.

In another embodiment of the invention the first layer comprises two sheet portions which are laid one on each of the associated major members of the envelope, and folded over the sides of the envelope.

An embodiment of the invention will now be described by way of example with reference to the accompanying drawings in which:-

Figure 1 is a perspective view of an envelope of a previously proposed lifting cushion,

Figure 2 is a perspective view of the first and second

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layers of the cushion of Figure 1,

Figure 3 is a perspective view of a nipple for an air valve,

Figure 4 is a perspective view of a metallic fitting for the nipple of Figure 3,

Figure 5 is a diagrammatic side elevation of a double unit lifting cushion before folding the second layer,

Figure 6 is a diagrammatic side elevation of the lifting cushion of Figure 5 when the second layer has been folded, at 90° to the cushion of Figure 5.

Figure 7 is a diagrammatic side elevation of another previously proposed lifting cushion envelope,

Figure 8 is a diagrammatic side elevation of the lifting cushion envelope of the invention, and

Figures 9 and 10 are diagrammatic views of parts of Figure 8.

Referring to the drawings, the previously proposed lifting cushion comprises an inflatable envelope 2, a first layer 4 and a second layer 6. The lifting cushion is manufactured in a press using hot vulcanisation, and the material of the components of the cushion is unvulcanised before hot vulcanisation takes place.

Alternatively, the lifting cushion may be hand assembled prior to hot vulcanisation.

The envelope 2 includes two rectangular sheets 8 and 10

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of woven polyaramid cloth or polyaramid cord superimposed with steel tyre cord. The sheets 8 and 10 are connected by a very large number of closely adjacent polyaramid filaments 12, and the length of these filaments defines the maximum separation distance of the sheets 8 and 10. In the illustrated embodiment all the filaments are of equal length to ensure that the sheets 8 and 10 are parallel to one another when the envelope 2 is fully inflated. However, different filaments may have different lengths to enable the sheets 8 and 10 to be inclined to one another at a required angle when the envelope 2 is fully inflated. The filaments 12 may have any desired length in order to provide the required attitude and spacing of the sheets 8 and 10.

The outer surfaces of the envelope sheets 8 and 10 are coated with an air retaining rubber compound such as neoprene thereby enabling the envelope 2 to be vulcanised to the other components of the lifting cushion. This coating is spread on the sheets 8 and 10 with rollers.

An air valve for the envelope 2 includes a rubber nipple 14 attached to a nozzle 16, and a metal fitting 18 which is located in the nozzle 16.

The outer surfaces of the envelope sheets 8 and 10 are coated with an air retaining rubber compound such as neoprene thereby enabling the envelope 2 to be vulcanised to the other components of the lifting cushion. This coating is spread on the sheets 8 and 10 with rollers.

The first layer 4 consists of a rectangular sheet 20 of polyaramid which is coated with a neoprene layer on both the upper and lower surfaces. This sheet 20 has the same width 24 as the width 25 of the envelope 2, and the

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length of the sheet 20 is chosen so that it can be wrapped round the envelope 2 with the sheet edges 26 overlapping one another in the centre of the lifting cushion. The direction of reinforcement of the sheet 20 extends in the direction 23.

The second layer 6 consists of a second rectangular sheet 28 which is made of the same material as, and neoprene coated the same as, the first sheet 20 except that all its directions and dimensions are rotated through 90°. The sheet 28 has the same width 29 as the length 31 of the envelope 2, and the length of the sheet 28 is chosen so that it can be wrapped round the first layer 4 with its edges 32 overlapping in the centre of the lifting cushion. The direction of reinforcement 33 of the sheet 28 runs perpendicularly to the direction of reinforcement 23 of the sheet 20.

During manufacture, the first and second layers 4 and 6 are carefully pressed by a roller in order to prevent air from being trapped in the two layers. Any such trapped air would breathe during inflation and evacuation of the lifting cushion thereby producing unwanted separation of the components of the cushion.

The envelope 2 is placed in the centre portion of the laid out first sheet 20. The two outer portions of the sheet 20 are folded over the envelope 2 so that the two sheet edges 26 overlap one another. The rubber nipple 14 of the air valve is inserted in one corner of the envelope 2 with the attached nozzle 16 extending from the envelope 2.

The sheet 20, envelope 2 and nipple 14 are then heated and compressed by a platen, and hot vulcanised to secure

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these components to one another. The attached sheet 20 and envelope 2 are then placed on the centre portion of the laid out second sheet 28 which is located at 90° to the first sheet 20. The two outer portions of the sheet 28 are then folded over the first sheet 20 so that the two sheet edges 32 overlap one another on the opposite face of the lifting cushion to the edges 26 of the first sheet 20. The direction of reinforcement 33 of the sheet 28 runs perpendicularly to the direction of reinforcement 23 of the first sheet 20.

The folded sheet 28 is heated and compressed by a platen and hot vulcanised to secure the sheet 28 to the sheet 20 and envelope 2. The sheets 20 and 28 are preferably folded over suitable templates which can be manufactured from a metal sheet.

Figures 1 to 4 illustrate the components of a single unit lifting cushion. The invention includes within its scope a lifting cushion having two or more units. Referring to Figures 5 and 6, a two unit lifting cushion includes two units 34 and 36 with each unit constructed as previously described herein with reference to Figures 1 to 4. This double unit lifting cushion includes a central hinge strip 38 extending around a space 40 located between the two units 34 and 36. This hinge strip is made of a polyaramid sheet coated on both its surfaces with neoprene. This strip 38 is folded centrally to form a V cross-section and each arm of the V is vulcanised to the adjacent opposed sheets 20 and 28 of the upper and lower cushion units 34 and 36 which define the upper and lower surfaces of the space 40. This two unit assembly requires only a single air valve which is located in either one of the units. Coaxial central orifices are made in the envelope sheets 20 and 28 of the first and

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second layers 4 and 6 adjacent to the space 40 between the two units to enable air from the air valve to enter both these units.

A lifting cushion of three or more units can be assembled in the same way by connecting all adjacent units by a hinge strip and providing coaxial central orifices between the sheets of adjacent units.

The lifting cushion of the invention may have any convenient dimensions. One embodiment of the invention may have the following dimensions:-

The envelope 2:-

The sheets 8 and 10 are each 510 x 510mm and the filaments 12 are 100mm in length.

The first layer 4 is 610 x 610mm when folded, and 610 x 1220mm when laid out flat. 50mm is added to the length for the edge overlap.

The second layer 6 is 610 x 610mm when folded and 610 x 1220mm when laid out flat. 50mm is added to the length for the edge overlap.

In one example of a double unit lifting cushion of the invention each unit will have the above dimensions.

The above-mentioned first and second layers 4 and 6 are larger than the envelope sheets 8 and 10 to allow for the 100mm length of the filaments. When the lifting cushion is inflated the surface areas of the first and second layers contract to 510 x 510mm to allow for the fully stretched filaments 12.

When manufacturing a lifting cushion having two or more

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units, each unit may be vulcanised separately and adjacent units and the connecting hinge assembly then vulcanised to one another. Alternatively, all the units and their connecting hinge strips may be secured together in a single vulcanising operation.

The above-described and illustrated lifting cushion is designed for an internal working pressure of 800 Kpa when the filaments 12 are fully extended to their operational length of 100mm. This enables the lifting cushion to lift and support a weight of 20,714 kg.

Although the described embodiment includes filaments 12 of polyaramid, the invention includes within its scope a lifting cushion having filaments of any suitable material such as, for example, a polyaramid/nylon mixture. The advantage of polyaramid is that it can sustain a working pressure greater than some other materials.

The described and illustrated embodiment includes within its scope a filament density in the range from 230 to 40,000 filaments 12 per square metre.

The important feature of the filaments 12 is that they retain the envelope sheets 8 and 10 in a preselected required relative attitude and spacing. It will be appreciated that the most common relative attitude will be when the sheets 8 and 10 are parallel to one another but the invention is not restricted to this configuration.

Figures 1 to 4 illustrate the components of a single lifting cushion in which the first layer 4 consists of a first single rectangular sheet 20, and the second layer 6 consists of a second single rectangular sheet 28. In

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another embodiment of the invention the second layer 6 is not used, and the single sheet 20 of the first layer 4 is replaced by two half sheets as illustrated in Figure 7.

Referring to Figure 7, another single unit lifting cushion of the invention includes the inflatable envelope 2 previously described herein and illustrated in Figure 1. The illustrated dimension L of the envelope 2 will be referred to herein as its length, and the breadth is the dimension perpendicular to the length.

The first layer 42 of the lifting cushion includes upper and lower half sheets 44 and 46 of polyaramid which are coated with a neoprene layer on both their upper and lower surfaces. Both sheets are rectangular, the same as the envelope sheets 8 and 10, but the half sheets 44 and 46 have a greater length and breadth than the sheets 8 and 10 in order that these sheets can cover the sides of the envelope 2. For example, if the envelope sheets 8 and 10 are held 100 mm apart when the envelope 2 is fully inflated, then the upper and lower half sheets 44 and 46 would each need to have a length and breadth 100 mm greater than the length and breadth of the envelope sheets 8 and 10. As an example, if the envelope sheets 8 and 10 are each 510 mm x 510 mm, then the upper and lower half sheets 44 and 46 will each be 610 mm x 610 mm.

During manufacture, the upper and lower half sheets 44 and 46 are carefully pressed by a roller in order to prevent air from being trapped in the two layers.

The envelope 2 is placed centrally on the lower half sheet 46, and the envelope 2 and half sheet 46 are then heated and compressed by a platen, and hot vulcanised to secure these components to one another. The upper half

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sheet 44 is then placed centrally on the envelope upper sheet 8, and the envelope 2 and upper half sheet 44 are then heated and compressed by a platen and hot vulcanised to secure the components to one another. A strip 50 is made of a polyaramid sheet coated on both its surfaces with neoprene. This strip 50 is folded centrally to form a V cross-section with the arms of the V extending inwardly towards the envelope filaments 12 when the V is in its folded configuration. The strip 50 extends completely around the sides of the envelope 2, and the inner surfaces of the V arms are coated with mellamex.

The peripheral portions of the upper and lower half sheets 44 and 46 are folded over the envelope sides to form side sheets 52 and 54 which extend around the envelope 2. A small central gap 56 is left between the inner edges of the side sheets 52 and 54 which are each connected to the outer surface of the V strip 50. The rubber nipple 14 of the air valve is inserted in one corner of the envelope 2 with the attached nozzle 16 extending from the envelope 2.

The assembly is then hot vulcanised to secure the side sheets 52 and 54 to their respective arms of the V strip 50. The mellamex coating prevents the V strip 50 from being vulcanised into the permanently closed position. When the lifting cushion is inflated the V strip 50 and the side sheets 52 and 54 adopt the generally straight configuration illustrated in Figure 7. When the lifting cushion is deflated the V strip 50 closes inwardly causing the side sheets 52 and 54 to adopt a V shape with the point of the V extending outwardly along the generally central plane of the envelope 2.

Figure 7 illustrates the components of another single

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unit lifting cushion. The invention includes within its scope a lifting cushion having two or more units in which all or some of the units are as described herein and illustrated in Figure 7. Such a lifting cushion having two or more units will be constructed as described and illustrated in Figures 5 and 6.

Referring to Figure 8, an inflatable envelope 64 of the invention includes two rectangular sheets 66 and 68 made of polyaramid cord 70. The sheets 66 and 68 are connected by a plurality of cell structures 72 which extend along the length of the envelope 64 in a direction perpendicular to the plane of Figure 8. The end portions of the sheets 66 and 68 in the direction perpendicular to the plane of Figure 8 extend approximately 60mm from each end of the cell structures 72.

Each cell structure 72 consists of two opposed generally U-shaped half cell members 74 and 76. Each half cell member is made of polyaramid cord, and the inner and outer surfaces of the half cell members and the sheets 66 and 68 are coated with an air retaining rubber compound such as neoprene.

This coating is spread on the half cell members 74 and 76 with rollers and enable the half cell members 74 and 76 to be hot vulcanised to the other components of the lifting cushion.

Slits 78 extend through the sheets 66 and 68 in the direction perpendicular to the plane of Figure 8. These slits 78 are of the same length as the half cell members 74 and 76 and are located symmetrically in the sheets 66 and 68 so that these slits 78 end at a distance of 60mm from the adjacent edges of the sheets 66 and 68.

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As shown in Figure 8, the two half cell members 74 and 76 of each cell structure 72 are threaded through adjacent slits 78 in the sheets 66 and 68 so that the end arms 80 and 82 of the two half cell members extend towards one another to leave a small gap 84 therebetween. Strips of uncured rubber/neoprene of the width of the whole cell are positioned under the sheet 66 and over the sheet 68 in each cell. These strips fill in the gaps at the corners of each cell 72. Strips of melamine or other suitable barrier material of the width of the whole cell are laid on the uncured rubber or neoprene strips on the sheet 68. These strips prevent the sheets 66 and 68 from sticking together during the hot vulcanising of the assembly.

The envelope of the invention illustrated in Figure 8 can be used in place of the envelope 2 in the production of any of the lifting cushions described in this specification and illustrated in Figures 1 to 7. When the assembly is hot vulcanised to produce the finished lifting cushion, the half cell members 74 and 76 and the sheets 66 and 68 become homogenous to close the slits 78, and the half cell members' end arms 80 and 82 of each cell structure 72 join together to close the gaps 84.

Figures 9 and 10 illustrate the polyaramid cord structure of the half cell members 74 and 76 in the vertical and horizontal modes.

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CLAIMS:-

1. An inflatable envelope for a lifting cushion, said envelope comprising two opposed major members and a plurality of cell structures extending between and through the said two members to retain said two members of the envelope at a preselected attitude to one another when the envelope is inflated, in which each cell structure comprises two opposed generally U-shaped half-cell members with the opposed facing end portions of the two half-cell members connected to the outer surfaces of the major members.
2. An inflatable envelope as claimed in claim 1 in which the mid-portions of the half-cell members are all of substantially the same length.
3. An inflatable envelope as claimed in claim 2 in which the said mid-portions are approximately 100mm in length.
4. An inflatable envelope as claimed in any preceding claim in which the two major members are constructed of a polyaramid material.
5. An inflatable envelope as claimed in claim 4 in which the polyaramid material is polyaramid cord.
6. An inflatable envelope as claimed in any preceding claim in which the half-cell members are constructed of a polyaramid material.
7. An inflatable envelope as claimed in claim 6 in which the polyaramid material is polyaramid cord.

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8. An inflatable envelope as claimed in any preceding claim in which the half-cell members are coated on both sides with uncured neoprene.
9. An inflatable envelope as claimed in any preceding claim in which the major members are coated on both sides with uncured neoprene.
10. A lifting cushion comprising an inflatable envelope as claimed in any preceding claim and a first layer extending around the envelope.
11. A lifting cushion as claimed in claim 10 in which the first layer extends in a first direction and is folded around the envelope to have folded over regions.
12. A lifting cushion as claimed in claim 10 or claim 11 including a second layer extending around the first layer.
13. A lifting cushion as claimed in claim 12 in which the second layer extends in a second direction and is folded around the first layer to have folded over regions.
14. A lifting cushion as claimed in claim 13 in which the folded over regions of the second layer are on the opposite side of the lifting cushion to the folded over regions of the first layer.
15. A lifting cushion as claimed in claim 13 or claim 14 in which said first and second directions are at approximately 90° to one another.
16. A lifting cushion as claimed in claim 15 in which

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the envelope is rectangular and the said first and second directions of the two layers are parallel to the first and second sides of the envelope.

17. A lifting cushion as claimed in claim 10 in which the first layer comprises two half portions laid one on each of the associated major members of the envelope, and folded over the sides of the envelope.

18. A lifting cushion substantially as herein described and illustrated in the accompanying drawings.

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