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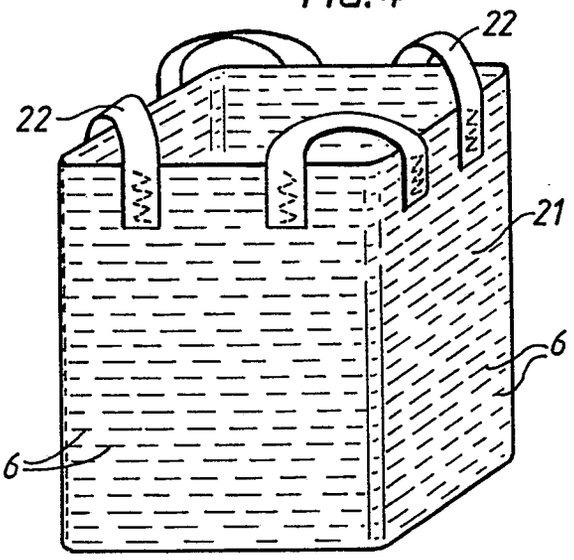
(54) Flexible intermediate bulk containers.

(57) A flexible intermediate bulk container includes at intervals in the yarns which lie horizontally in the wall of the container when the container is in use a yarn which is capable of bearing a load at least 50% greater than, and preferably at least twice, the load at which the other horizontal yarns in the wall of the container will break. The yarn of greater strength, which is advantageously a yarn of higher modulus, absorbs shock tensile loads when a loaded container is dropped and constitutes a region of greater strength which provides a cushioning effect for the other yarns against the resultant sudden surge in loop stress, thereby greatly increasing the burst-resistance of the container.

In a preferred container having a single wall part (21) of polypropylene yarns woven on a circular loom, a single weft yarn of 2400 denier polypropylene is replaced by a 6000 denier polyester yarn to provide a series of tensile stress absorbing regions (6) at intervals in each vertical section of the wall part (21) of the container.

FIG. 4



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Flexible Intermediate Bulk Containers

This invention relates to flexible intermediate bulk containers. Generally, flexible intermediate bulk containers are made of woven fabric material such as woven polypropylene or polyethylene fabrics which may be uncoated, coated or laminated fabrics.

If a flexible intermediate bulk container loaded with powdered material is subsequently dropped from a height, either deliberately or unintentionally, the bag portion of the flexible intermediate bulk container is liable to burst, often at a point about one third of the height of the bag from the point of contact with the ground. The burst occurs because at least one of the horizontal yarns in a wall part of the woven fabric material is subjected to a longitudinal tensile stress greater than its breaking load. When a yarn breaks due to such tensile stress, the break becomes a split spreading through the woven fabric material and resulting in part or all of the contents of the container being discharged.

The tendency of flexible intermediate bulk containers to burst on dropping can be substantially reduced by making the bag portion of such containers from stronger yarns. However the consequence is to increase the cost of the flexible intermediate bulk container to such an extent as to make the stronger containers too expensive. For example, a flexible intermediate bulk container made from standard polyester yarns of 2000 denier is substantially stronger than a similar container made from polypropylene yarns of 2000 denier, but is of the order of two to three times the cost.

It is an object of the present invention to provide an improved flexible intermediate bulk container which is commercially competitive with the standard flexible intermediate bulk container based on polypropylene yarns and which does not burst when dropped from a height of 1.2 metres which is currently the most demanding drop at which flexible intermediate bulk containers are tested, and which probably corresponds to the drop from the floor of a lorry.

According to the present invention it is surprisingly found that this object can be achieved by providing, at intervals in the yarns which lie horizontally in the wall of the flexible intermediate bulk container when the container is in use (usually the weft yarns of the woven fabric material), a yarn element stronger than the standard yarns used in the woven fabric. In this specification a stronger yarn element is defined as a yarn element capable of bearing a significantly higher load before break (at least 50% greater) than the conventionally used yarns such as polypropylene or polyethylene yarns. Preferably the stronger yarn element is capable of bearing at least twice the load before break that wll be borne by conventionally used, or standard, yarn elements which will continue to be used as the other horizontal yarns in the wall of the container.

Conveniently, the stronger yarn element is provided by a straight forward substitution of a stronger yarn element for a standard yarn element, the stronger yarn element being provided in a number of different ways, either as a single yarn or a plurality of yarns as will be described below.

The stronger yarn element may be provided by allowing two or more of the standard yarns to lie together and be woven into the fabric as one, thus effectively replacing a standard yarn by a thicker yarn. A similar effect can be achieved by retaining the standard yarn and introducing a yarn of another material to lie with the standard yarn and be woven into the fabric as one with the standard yarn.

Alternatively the stronger yarn element may be provided by substituting, for a standard yarn, either a yarn of similar or greater size to the standard yarns but made of a material of greater strength, for example a polyester yarn may be substituted for a polypropylene yarn in a woven polypropylene fabric, or a yarn of the same material as the standard yarns but of a higher denier, for example a polypropylene yarn of 3000 denier or 4000 denier where the standard yarns are 2000 denier polypropylene.

The introduction of the stronger yarn element provides a tougher area in the woven fabric. The tougher area may, however, be created by providing, not one yarn element of greater strength in each tougher area as described above, but by providing, in place of a plurality of adjacent standard yarns, a plurality of adjacent parallel yarns of greater strength in each tougher area, the stronger yarn elements being such as those used in all the alternatives mentioned above.

The fabric which is used in the wall part of the bag portion of a flexible intermediate bulk container according to this invention is not novel in itself. Fabrics with stronger yarns present among the standard yarns have previously been proposed and used in a "rip-stop" context, for example, in order to prevent tearing of a fabric from a point of weakness.

The function of the stronger yarns in a flexible intermediate bulk container according to the present invention is to absorb shock tensile loads arising when a loaded container is dropped and to provide a cushioning effect for the standard fabric yarns against the resultant sudden surge in hoop stress. The wall part of the bag portion of a flexible

intermediate bulk container according to the present invention has an improved ability to absorb longitudinal tensile stress in the horizontal direction thereby substantially reducing the tendency of a container to burst, and is not concerned with limiting the extent of a tearing action as in the "rip-stop" feature acknowledged above.

If desired or necessary, a similar parallel series of tougher areas formed by stronger yarn elements may be created additionally in the other (usually the warp) direction of the weave of the woven fabric material constituting the bag portion of the flexible intermediate bulk container. These tougher areas, which will extend vertically and parallel to one another in the wall of the container, will be formed in similar manner to that described for the tougher horizontal areas in the wall of the container, and will provide for absorption of shock tensile loads which may occur in the vertical direction in the wall part of the container, if the container does not fall vertically to a point of impact.

When there are tougher areas in both weft and warp directions, the woven fabric material from which the bag portion of the flexible intermediate bulk container is made is effectively divided into small areas of fabric woven from standard yarns and separated from one another by regions in which at least one standard yarn has been substituted by a stronger yarn element.

It is already known from U.K. Patent Specifications No. 1,591,091 and 2,059,915 to provide for fixing lifting loops to specially reinforced vertically extending bands in the wall part of a bag portion of a flexible intermediate bulk container. These bands where the fabric is reinforced vertically by additional yarns provide for strengthening of the bag at the points where the greatest forces are applied when the container is lifted and reduce the chances of failure due to the concentration of force in the fabric of the bag portion where the lifting loops are secured to it.

According to one aspect of the present invention there is provided a flexible intermediate bulk container comprising a bag portion formed from a woven fabric material comprising first yarns extending down the height of a wall of the bag portion and second yarns extending substantially at right angles to the first yarns in a wall of the bag portion, the said second yarns including yarns of substantially greater strength than the majority of said second yarns, the yarns of substantially greater strength being arranged in the woven fabric to provide regions of greater strength spaced at intervals throughout the woven fabric.

Additionally, the said first yarns in the flexible intermediate bulk container may include yarns of substantially greater strength than the majority of said first yarns arranged in the woven fabric to provide regions of greater strength extending vertically and spaced at intervals throughout the woven fabric.

The present invention may be practised in a flexible intermediate bulk container of any shape formed from woven fabric material. However the present invention is particularly advantageously employed in a flexible intermediate bulk container which includes a bag portion formed from a base part and a single wall part secured to the base part. The single wall part is a fabric woven on a circular loom so that the horizontal or weft threads run continuously through the fabric and there are no areas where adjacent sections of the wall part of the bag portion are joined together by stitching as in the known flexible intermediate bulk container which comprises a rectangular bag portion having four side walls and a base. Although the present invention does have application in this latter form of flexible intermediate bulk container and will enhance the performance of such a container, it is preferred that the invention be employed in a flexible intermediate bulk container having a single wall part.

According to this preferred aspect of the present invention there is provided a flexible intermediate bulk container comprising a bag portion, which has a base part and a single wall part secured to the base part, and a plurality of lifting loops fastened to the single wall part of the bag portion, the bag portion being formed from woven fabric material which includes a region of greater strength than the majority of the woven fabric material, the region of greater strength extending continuously around the wall part of the bag portion so as to provide, in any vertical section of the wall part, regions of greater strength at a plurality of different distances from the junction of the wall part with the base part.

The present invention will be further understood from the following detailed description of embodiments thereof which is made, by way of example, with reference to the accompanying drawings, in which:-

Figure 1 is a perspective view of one embodiment of a flexible intermediate bulk container in accordance with the present invention,

Figure 2 is an enlarged plan view of a part of a wall of the container of Figure 1,

Figures 3 and 4 are perspective views of two preferred embodiments of a flexible intermediate bulk container in accordance with the present invention, and

Figure 5 is a diagrammatic comparative representation of the stress/strain relationships for polyester and polypropylene yarns.

In the drawings the same or similar parts are designated by like reference numerals.

Referring to Figure 1 of the drawings there is shown a flexible intermediate bulk container which comprises a bag portion 1 to which four lifting loops 2 are attached. The bag portion 1 is formed from a substantially U-shaped piece 3 of woven fabric material which forms two sides and the base of the bag portion and two rectangular pieces 4 and 5 of woven fabric material forming the other two sides of the bag portion 1. The three pieces of woven fabric material are joined by stitching along the seams and the loops 2 are also secured to the bag portion by stitching.

The woven fabric material from which the three pieces of fabric 3, 4 and 5 are constituted may be a woven polypropylene fabric with fifteen threads of 2000 denier polypropylene tape per inch in the warp or vertical direction, and twelve threads of 2000 denier polypropylene tape per inch in the weft or horizontal direction.

In Figure 2 of the accompanying drawings there is shown on an enlarged scale a plan view of a portion of the woven polypropylene fabric comprising warp yarns 11 and weft yarns 12.

As shown diagrammatically in Figure 1 the pieces 3, 4 and 5 of woven fabric material include regions 6 of greater strength which extend horizontally in each of the walls of the bag portion 1. These regions 6 may be comprised by a single weft thread or yarn of greater strength than the 2000 denier polypropylene yarns and substituted for one of the weft yarns 12 shown in Figure 2, the substituted yarns occurring at intervals of about one inch (2.5 cms).

Conveniently the substituted weft yarn is a 2000 denier polyester yarn which has a tenacity of 8 to 10 Cn/dtex as compared with a tenacity of the order of 4 to 6 Cn/dtex for the 2000 denier polypropylene yarns.

Polyester yarn has a specific gravity of 1.38 whereas the specific gravity of polypropylene yarn is 0.922. Therefore, a polyester yarn is about twice as strong as a polypropylene yarn of the same dimensions.

Alternatively the 2000 denier polypropylene yarn may be substituted by a 3000 denier polypropylene yarn or a 4000 denier polypropylene yarn.

As a further alternative a pair of 2000 denier polypropylene yarns may be woven into the fabric in the place of a single weft yarn 12.

As still further alternatives a 2000 denier polypropylene yarn and either a 1000 denier polyester yarn or a 2000 denier polyester yarn may be woven into the fabric in the place of a single weft yarn 12.

Referring to Figure 3 of the accompanying drawings there is shown a preferred embodiment of flexible intermediate bulk container according to the present invention which has a circular bag portion 20 formed from a circular base part of woven fabric material and a single wall part 21 of woven fabric material which is joined at its lower edge to the circular base part. Four lifting loops 22 are attached to the bag portion 20.

In addition to being circular or cylindrical in shape, the bag portion 21 of the embodiment of Figure 3 further differs from the bag portion 1 of Figure 1 in that the woven fabric from which the bag portion is made includes vertical regions 7 of greater strength in addition to the horizontal regions 6 of greater strength. The vertical regions 7 are formed by effecting a substitution of a warp yarn 11 by a stronger yarn element in similar manner to that already described for the substitution of a weft yarn 12 in the formation of the regions 6.

The base part (not shown) of the bag portion 20 may also include first and second series of regions (similar to regions 6 and 7) of greater strength than the majority of the woven fabric material of the circular base portion.

However the cylindrical bag portion 20 may have only horizontal regions 6 of greater strength in the wall part 21, as in another preferred embodiment of the invention illustrated in Figure 4.

In Figure 4, there is shown another flexible intermediate bulk container having a bag portion of which the wall part 21 is made in a single piece in a conventional manner on a circular loom. However the single wall part 21 is secured to a rectangular base part of woven fabric material (not shown) so that the resultant container is of generally rectangular shape with rounded corners. The wall part 21 includes horizontal regions 6 of greater strength resulting from the use of a thicker polyester yarn in place of a standard weft polypropylene yarn as will be described below.

The preferred woven fabric for the single wall part 21 of the flexible intermediate bulk container according to Figure 4 comprises a woven polypropylene fabric with six threads of 3000 denier polypropylene tape per inch (2.5 cms) in the warp or vertical direction, and ten threads of 2400 denier polypropylene tape per inch (2.5 cms) in the weft or horizontal direction, one in every eight of the weft threads being replaced by a 6000 denier twisted multifilament polyester yarn. This woven fabric is made on a circular loom having eight shuttles laying the weft threads continuously, seven of the shuttles feeding the standard polypropylene yarn and the eighth shuttle feeding the stronger polyester yarn. Because the woven fabric for the wall part 21 is made on a circular loom, the horizontal regions 6 of greater strength are constituted by a continuous polyester thread running through the fabric of the wall part 21 and reappearing at dif-

ferent heights in any vertical section of the wall part 21.

Drop tests have been carried out using a flexible intermediate bulk container as described with reference to Figure 4. The container, having survived ten drops at the current "most demanding" drop height of 1.2 metres, has been dropped, fully loaded, at heights of 1.4 metres and 1.7 metres without bursting. The container has survived four drops of 1.7 metres without bursting.

It is thought that the greatly enhanced performance of this container is because the higher modulus polyester yarns serve to absorb shock tensile loads arising when the loaded container is dropped. The higher modulus polyester yarns thus provide a cushioning effect against the sudden surge in hoop stress which would otherwise be applied to the standard polypropylene yarns as a result of the impact following the drop.

Briefly, the technical effect in the woven fabric employed in a wall part of a flexible intermediate bulk container lies in the enhancement of the ability of the fabric to absorb longitudinal tensile stresses applied in the weft direction.

Reference will now be made to Figure 5 of the accompanying drawings for a suggested explanation of this technical effect, which affords advantageous protection against premature fabric failure in a flexible intermediate bulk container subjected to shock tensile load conditions.

Figure 5 is a diagrammatic comparative representation of the stress/strain curves I and II showing the percentage extension E resulting from an applied load L for polypropylene yarns and for polyester yarns respectively. The situation depicted is of the application of a shock hoop load D which results from a drop, and which lies between the ultimate, or breaking, load U of the polypropylene yarns and the ultimate, or breaking, load V for the polyester yarns. The extension occurring in the fabric yarns as a result of the drop load D is limited by the higher modulus polyester yarns, with the result that the polypropylene yarns are extended by only about 10% against a notional extension of about 25% which would have ruptured the polypropylene yarns. There is thus an effective limitation of the load applied to the polypropylene yarns as a result of the presence of the polyester yarns.

Instead of substituting a single yarn at intervals of about two centimetres in the woven fabric, as described with reference to Figure 4, a pair of adjacent yarns may be substituted by a pair of stronger yarn elements with a gap of the order of 1.5 centimetres between the pairs of stronger yarn elements. It may be preferred to make the regions of greater strength in the woven fabric even larger by substituting three, or even four, adjacent yarns by a corresponding number of stronger yarn elements.

The woven fabric for the single wall part of the flexible intermediate bulk container of Figure 4 would then be made with two, three or four adjacent shuttles supplying polyester yarn and the other shuttles feeding polypropylene yarn into the weft of the fabric.

The interval or gap between the regions of greater strength, whether in the warp or the weft direction, may also be increased or decreased, for example to an interval of one centimetre.

As a further alternative in the manufacture of a single wall part of a flexible intermediate bulk container on a circular loom, polyester yarns of the same denier as, or a greater denier than, the standard polypropylene yarns may be supplied by alternate shuttles so that the stronger regions constituted by the polyester yarns alternate with the standard polypropylene yarns.

In addition to the embodiments of the invention described and illustrated, the present invention has application in flexible intermediate bulk containers in which the lifting loops are formed integrally with the wall part or parts of the container, instead of being separate pieces of material stitched to the wall part. The methods of making both rectangular and cylindrical containers with such integral lifting loops are well known and may readily be applied to containers in accordance with the present invention.

The essence of the present invention is the provision of the horizontal regions of greater strength in the wall part or each wall part of a flexible intermediate bulk container. These horizontal regions of greater strength ensure that, when a sudden shock hoop load is applied as a result of a drop, the effect of this load on the standard yarns is cushioned and the resistance of the flexible intermediate bulk container to bursting is significantly increased.

Claims

1. A flexible intermediate bulk container comprising a bag portion formed from a woven fabric material comprising first yarns extending down the height of a wall of the bag portion and interwoven with second yarns extending substantially at right angles to the first yarns in a wall of the bag portion, the said second yarns including yarns of substantially greater strength than the majority of said second yarns, the yarns of substantially greater strength being arranged in the woven fabric to provide regions of greater strength spaced at intervals throughout the woven fabric.

2. A flexible intermediate bulk container according to Cliam 1 wherein the yarns of substan-

tially greater strength are capable of bearing at least twice the load before break that can be borne by the others of said second yarns.

3. A flexible intermediate bulk container according to Claim 1 or Claim 2, wherein the said first yarns include yarns of substantially greater strength than the majority of said first yarns arranged in the woven fabric to provide regions of greater strength extending vertically and spaced at intervals throughout the woven fabric.

4. A flexible intermediate bulk container including a bag portion formed from a base part and a single wall part secured to the base part, the single wall part being a fabric material woven from standard yarns conventionally used for this purpose and the yarns being at right angles to one another with one set of yarns being substantially horizontal in the wall part of the bag portion, wherein there is a substitution of a horizontal standard yarn, or a plurality of adjacent horizontal standard yarns, by a yarn element, or a plurality of adjacent yarn elements, capable of bearing at least 1.5 times the load before break that can be borne by a standard yarn or a plurality of standard yarns, respectively.

5. A flexible intermediate bulk container comprising a bag portion, which has a base part and a single wall part secured to the base part, the single wall part of the bag portion being formed from woven fabric material which includes a region of greater strength than the majority of the woven fabric material, the region of greater strength extending continuously around the wall part of the bag portion so as to provide, in any vertical section of the wall part, regions of greater strength at a plurality of different distances from the junction of the wall part with the base part.

6. A flexible intermediate bulk container according to Claim 5 wherein the woven fabric material of the wall part includes further regions of greater strength than the majority of the woven fabric material, the further regions of greater strength each extending down the height of the wall part of the bag portion and the further regions of greater strength being spaced at regular intervals in the wall part of the bag portion.

7. A flexible intermediate bulk container according to Claim 5 or Claim 6 wherein the base part of the bag portion includes first and second series of regions of greater strength than the majority of the woven fabric material, the regions of the first series being substantially at right angles to the regions of the second series.

8. A flexible intermediate bulk container according to any one of Claims 5 to 7 wherein the base part of the bag portion is substantially rectangular and the wall part is secured to the base part such that the wall part of the bag portion is held in a substantially rectangular shape.

9. A flexible intermediate bulk container according to any one of Claims 5 to 7 wherein the base part of the bag portion is substantially circular and the wall part is secured to the base part such that the wall part of the bag portion defines a cylindrical container.

10. A flexible intermediate bulk container including a bag portion having one or more wall parts formed of a woven fabric material comprising vertically extending polypropylene yarns and horizontally extending polypropylene yarns, each wall part further including, at intervals throughout the height of the wall part, a single horizontally extending polyester yarn of at least the same denier as the horizontally extending polypropylene yarns, the polyester yarn being woven into the fabric instead of a polypropylene yarn.

11. A flexible intermediate bulk container according to Claim 10 wherein the horizontally extending polypropylene yarns are 2400 denier polypropylene tapes, and the polyester yarn is 6000 denier polyester yarn.

12. A flexible intermediate bulk container according to Claim 10 wherein, instead of the polyester yarn, there is provided a single horizontally extending polypropylene yarn of at least 1.5 times the denier of the other horizontally extending polypropylene yarns.

FIG. 1

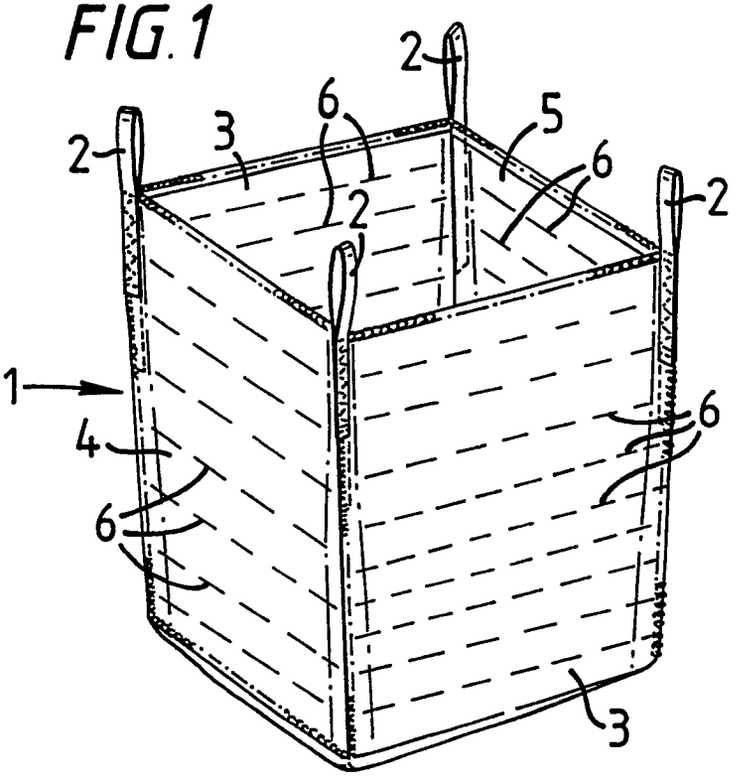


FIG. 2

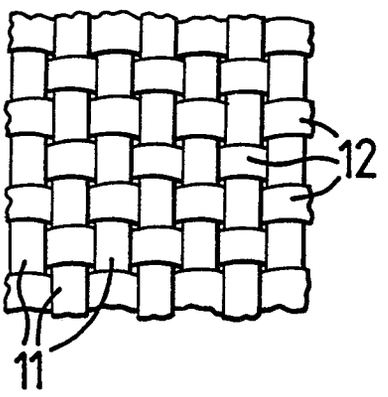


FIG. 3

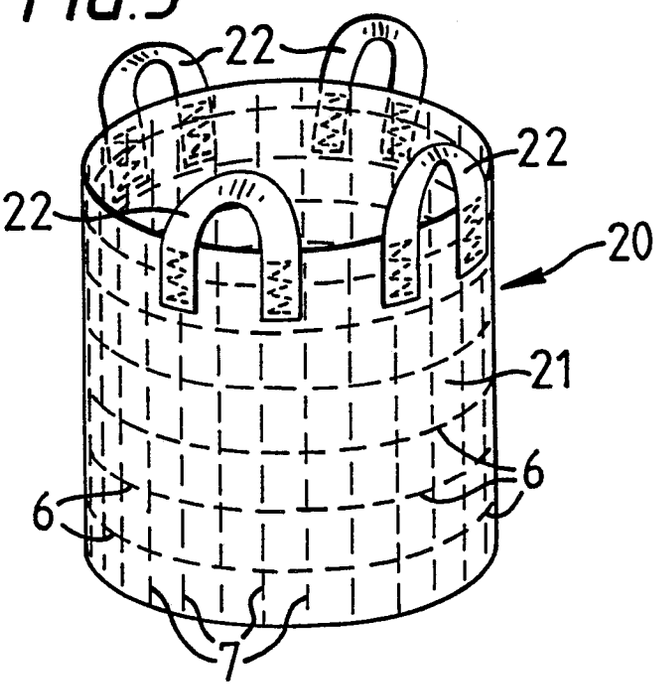


FIG. 4

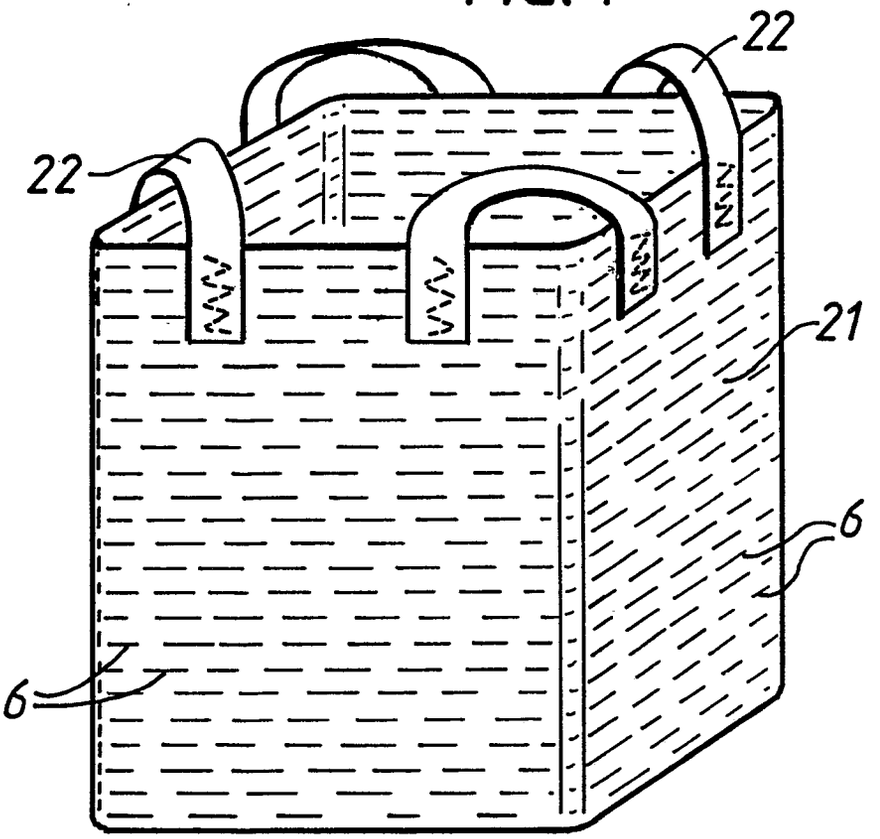
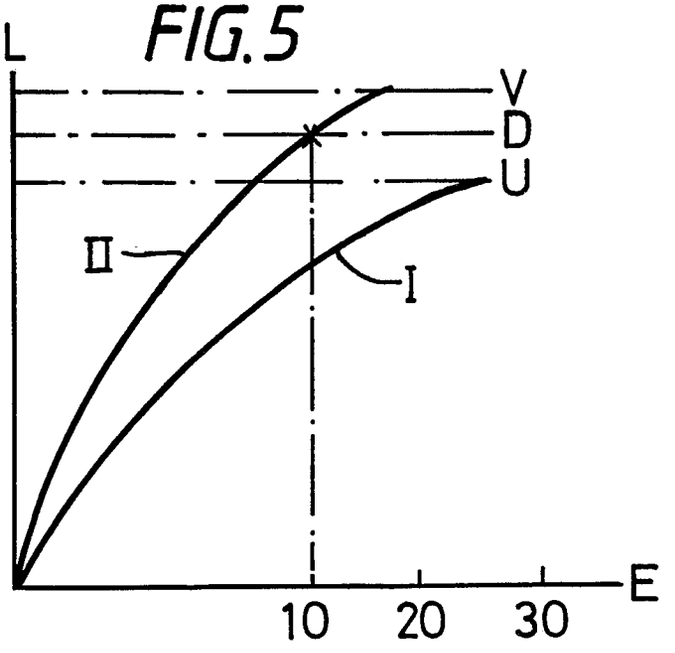


FIG. 5



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EUROPEAN SEARCH REPORT

Application Number

EP 89 31 0839

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	FR-A- 743 414 (DANTZER et al.) * Whole document *	1,2,4	B 65 D 88/16
Y		1-6,10	
A		11,12	

D,Y	GB-A-1 591 091 (MILLER WEBLIFT) * Whole document *	1-10	
D,A		11,12	

Y	DE-A-1 535 634 (J.B. SANDERS UND SÖHNE) * Page 2, line 7 - page 3, line 12; figures 1,2 *	7-9	
A		11,12	

A	FR-A-1 443 272 (SAINT FRERES et al.) * Page 2, left-hand column, lines 21-23; figure 1 *	1,3,5,6	

A	GB-A-2 022 054 (NORSK HYDRO)	1	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

B 65 D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	29-01-1990	NEVILLE D.J.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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