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(54) **Diaphragm for a diaphragm pump or motor.**

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DE-A-2 106 560
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US-A-3 176 622

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Description

The present invention relates to a diaphragm for material handling devices such as pumps or motors.

Rotary pumps have already been proposed, of the so-called peristaltic type, which use a flexible tube bent in an arc of a circle, the tube being squeezed by a plurality of rollers carried on a rotating member which makes contact with the tube at angularly spaced positions. This results in "slugs" of the fluid carried in the tube being carried forward from the inlet of the tube to its outlet.

Such pumps are particularly suitable for services which require the fluid being pumped to be kept isolated from the mechanism itself, but its disadvantage is that the tube, if not restrained, "walks" in the direction of the outlet. In consequence, the anchoring of the tube to prevent this is a problem which increases with the size of the tube and the viscosity of the fluid being pumped. It is a further disadvantage of this type of pump, that, when pumping "heavy" substances, such as concrete, the tube tends to collapse at the inlet end and it is necessary to evacuate the chamber in which the pump tube operates in order to overcome this tendency.

Another disadvantage of this type of pump is the large effort required to distort the tube, especially when heavy duty tubes are used. e.g. in pumping concrete, which results in low mechanical efficiencies.

Diaphragm pumps have also been proposed, such as in German Patent 6243; British Patent Nos. 208,477; 562,409; French Patent No. 1,394,047 and United States Patent No. 2,794,400. These pumps include a housing having an internal surface, and a flexible resilient diaphragm mounted within the housing and secured thereto to form with the internal surface a chamber. First and second ports communicate with the chamber and a number of deflectors are each operable sequentially on the face of the diaphragm remote from the chamber, to urge the diaphragm towards the internal surface to form a closure or constriction which traverses the chamber. The closures or constrictions each move from the first to the second port, one of the closures being terminated after the succeeding closure has been initiated. A disadvantage of such a construction is that there is a necessity for the diaphragm to be resilient, to enable it to take up the necessary shapes, and there is a tendency for the diaphragm to flex towards the low pressure side of the pump, thus causing the "slug" of material being pumped to be of small volume. For this reason, pumps of this nature are limited both in their size and by the low rotation speeds at which they can operate.

It was proposed, in European Application No. 0052679 for the flexible diaphragm to be longitudinally reinforced so as to be substantially longitudinally inextensible and for the configuration of the device to be such that, as deflectors move sequentially along a path on said surface of the diaphragm remote from a chamber, the sum of the distances, measured along the diaphragm, between the clamping points at the longitudinal ends of the diaphragm and the deflector means adjacent thereto, and, where appropriate, between the adjacent deflector means in contact with the diaphragm, remains substantially constant.

The result of such a construction is that, because the length of the diaphragm remains substantially constant, whatever the position of deflector means, the diaphragm is prevented from collapsing into the reduced pressure zone or extending into the housing interior. This enables the pump to be operated at relatively high speeds and pressures for lighter materials including slurries. The pump is also capable of handling very heavy materials, such as mortars, and even concrete quite adequately.

The present invention relates to a flexible diaphragm for use in such a pump or motor device, having opposite ends and side edges, a longitudinally extending central zone and a clamping portion clampable between first and second housing parts of the pump or motor device, characterised in that said diaphragm is premoulded, in that said longitudinal central zone has therein a longitudinal reinforcement rendering said diaphragm substantially longitudinally inextensible, in that said clamping portion comprises a peripheral clamping portion extending around the full periphery of the diaphragm and in that two longitudinal corrugations are formed in the diaphragm, one on each side of said central zone, between said central zone and the peripheral clamping portion.

The diaphragm is premoulded so that its shape is such that it remains substantially undistorted when it is clamped in place and before the deflectors are placed in contact with the surface of the diaphragm remote from the internal surface of the housing. This construction means that the diaphragm only has to flex a small amount. The reinforcement may include, in addition to longitudinal fibres, other fibres which are arranged at an angle thereto in other parts of the diaphragm to give strength, but do allow the slight flexing necessary for the diaphragm to distort without stretching in the direction of movement of the deflectors.

In order that the invention may be more clearly understood, the following description is given, merely by way of example, reference being made to the accompanying drawings, in which:—

Figure 1 is a section through one embodiment of pump made according to European Application 0052679;

Figure 2 is a section in two parts, the first on line A—A and the second on line B—B of the pump illustrated in Figure 1; and

Figure 3 is a perspective view of a diaphragm as used in the pump of Figures 1 and 2 and according to the present invention.

Referring first to Figures 1 and 2 of the drawings, the pump comprises a first housing part 12 and a second housing part 16 mounted thereon. The housing part 12 includes a central dished portion having an upper internal surface or curved portion 12A blending into a first port 13 and a second port 14. As can be seen from Figure 2, the curved portion 12A has associated therewith, on each side, a raised clamping surface which is formed by a curved surface 12B and a straight surface 12C and which faces generally upwardly, that is in the same direction as the surface 12A. Curved surfaces 12B end with a straight surface at 12C at each end which extends over the ports 13 and 14.

Thus, the clamping surfaces completely surround the periphery of the internal surface 12A and the ports 13 and 14.

The second housing part 16 is provided with surfaces 16B which cooperate with the curved surfaces 12B and straight surfaces 16C which cooperate with the end portion of the surfaces 12C so that the surfaces 16B and 16C together define a second peripheral clamping surface. These clamping surfaces 12B, 12C and 16B, 16C, are used to clamp the edge portions of a diaphragm 15 which is of the premoulded structure illustrated in Figure 3. As will be seen it has a corrugation at 15E on each side and a central portion 21 which is lower than the edge portions 21A beyond the corrugations. The diaphragm is moulded with a reinforcement therein, including fibres 15C (Figure 3) which extend longitudinally, that is from left to right in Figure 1, in the central zone and includes other reinforcements 15D in other parts which are preferably at 45°, thus on the bias, to allow for some flexing, the longitudinal ones preventing extension in the longitudinal sense. These reinforcements are preferably placed on or just below the upper surface 15B.

Referring again to Figure 1 and 2, it will be seen that a rotary member 17 is rotatable about a central axis 17A and is mounted in bearings 25 in the second housing part 16. Member 17 carries three rollers 18 which can bear on the upper surface 15B of the diaphragm. The rollers urge the diaphragm at spaced locations towards, and preferably against, the upper surface 12A. In this condition, the surface 12A and the diaphragm lower surface form a pumping chamber 10.

The particular manner in which the diaphragm is mounted enables it to be held very firmly and prevents any tendency of the diaphragm to "walk" as the rotary member 17 rotates in the direction indicated by the arrow.

Because of ohe configuration of the pump, the effective length of the upper surface of the diaphragm remains constant. That is, the sum of the distances, measured along the diaphragm, because the clamping surfaces 12C, 16C at one end of the diaphragm and the adjacent roller 18, and from that roller to the next roller, when two rollers are in contact with the diaphragm, and from the next roller to the other clamping surfaces 12C, 16C, remains constant regardless of the position of the rotor and regardless of whether one or two rollers are in contact. This means that the diaphragm need not elongate at all during the action of the rollers and it is for this reason that it is possible to provide the reinforcement in the diaphragm. The reinforcement in the longitudinal direction indeed prevents the diaphragm from elongating and the reinforcement arranged on the bias prevents too much distortion, but allow an adequate amount for the flexure of the diaphragm under the action of the rollers 18. As the rotary member 17 rotates, the constricted or closed off chamber 10 is moved from the first port 13 to the second port 14, and because there are at least three rollers 18, the capsule thus formed is always isolated from at least one of the ports. Because the sum of the distances mentioned above is constant, a positive pumping action can take place in an adequate manner. It will be appreciated that the closure caused by one roller is terminated after the succeeding closure is initiated.

It will be appreciated that the diaphragm clamping surfaces 12B, 16B are so arranged that they partially form arcs of a circle with substantially the same centre as the rotary member. The rollers 18 are shown as being freely rotatable, but it is contemplated that they could be caused to rotate continuously thus to reduce the wear on the upper surface. An additional wear sheet of flexible material may be secured above the diaphragm at the righthand side, as viewed in Figure 1, and extend over the full path covered by the rollers 18. This not only reduces wear, but can be used to adjust the thickness of the diaphragm to take up any manufacturing tolerances in the housing part 12.

The diaphragm is moulded so that it naturally has the shape illustrated in Figure 3, that is with the lower and upper surfaces of the edge portions 21A having the same shape as the clamping surface 12B and 16B respectively.

The amount of moulded material in the moulded and reinforced diaphragm on the surface 15B (the length of which remains substantially constant at all positions of the roller) is such that it is only slightly in excess of that which allows the rollers to distort the diaphragm while avoiding rupture, but does not allow the diaphragm to deform further under negative pressure. The reinforcement in the diaphragm is not elastic and is moulded to the diaphragm at or near the surface on which the rollers make contact. This not only reinforces the diaphragm to cater for negative and positive pressure developed during the pumping cycle, but also reduces wear on the diaphragm due to the action of the rollers.

If the pump is provided with the modification indicated in phantom, that is with the intermediate port 20 at the centre of the chamber 10, that is at the centre of the surface 12A, then the device can be used as a valve, by moving the member 17 to the position in which the rollers take up the position 18′ and 18″ as illustrated in phantom. This connects the port 20 to the port 14 and disconnects the port 13. A similar symmetrical position could be assumed in which the port 13 is connected to the port 20 isolating the port 14. It is contemplated that if one rotates the member 17 continuously to cause pumping while shutting off the port 20, then the pump could be used to start off a syphon action, the pump then being moved to the other position communicating port 13 with port 20, allowing the syphon action to continue upon opening of the port 20.

It will be seen that the second housing part 16 is provided with a removable cover 26. One of the rollers 18 is also removably mounted on the member 17. The reason for this is that, because of the shaping of the diaphragm and the configuration of the pump, it is important to clamp the diaphragm around its full periphery before any of the rollers contact the diaphragm so that the diaphragm can take up its natural position without any distortion or strain thereon during the clamping. Thus, in order to mount a new diaphragm, the second housing part 16 is removed and the used diaphragm taken away and the new diaphragm put into position. The cover 26 is removed from the second housing part, and one of the rollers is then taken off. The member 17 is rotated until the other two rollers are at the top, that is so that the zone of the removed roller is at the bottom. The second housing part is then put in place and bolted down. The dimensions of the rotary member 17 are such that the zone adjacent where the roller which had been removed is located does not touch the diaphragm, so that during the clamping operation no disturbance of the diaphragm can take place. The rotary member is then rotated until the location of the removed roller is at the top and the roller put back in place whereafter the cover 26 can be fixed.

It has been found that unless this technique is used, the diaphragm is distorted and the pumping action possible with this pump reduces and indeed practically ceases.

It is thus important that the configuration of the pump should be chosen to give the necessary constant path length. This can be determined fully theoretically, but in practice it has been found possible to design the pump empirically by taking a piece of flexible inextensible material, such as cord, fitting around a model of the rotary member 17 and its rollers, and determining the position of the clamps which provide a fully tensioned cord at all times.

While the device has been described as a pump, it could equally well be used as a compressor or indeed as a motor.

The diaphragm must be flexible and substantially inextensible and is rendered so by reinforcement. The reinforcement illustrated includes a central portion with fibres 15C extending longitudinally only. In practice, however, the reinforcement shown only at the sides at 15D will extend across the full width of the diaphragm and the central portion will have a reinforcement made of an open mesh fabric which includes the longitudinal fibres 15C and other fibres (not shown) at right angles thereto, making the diaphragm laterally inextensible.

Claims

1. A flexible diaphragm for a diaphragm pump or motor device, having opposite ends and side edges, a longitudinally extending central zone and a clamping portion clampable between first and second housing parts of the pump or motor device, characterised in that said diaphragm (15) is premoulded, in that said longitudinal central zone (21) has therein a longitudinal reinforcement (15c) rendering said diaphragm substantially longitudinally inextensible, in that said clamping portion comprises a peripheral clamping portion (21A) extending around the full periphery of the diaphragm and in that two longitudinal corrugations (15E) are formed in the diaphragm, one on each side of said central zone (21), between said central zone (21) and the peripheral clamping portion (21A).

2. A diaphragm according to claim 1, characterised in that transverse reinforcement (15D) is provided to render the diaphragm substantially laterally inextensible.

3. A diaphragm according to claim 2, characterised in that the transverse reinforcement (15D) comprises fibres extending transversely across the full width of the diaphragm.

4. A diaphragm according to any preceding claim, characterised in that the diaphragm is premoulded to an arcuate shape, the centre of curvature of the arc extending along an axis parallel to the surface of the diaphragm and perpendicular to the length of the diaphragm, so that the diaphragm has part cylindrical, concave and convex major surfaces.

5. A diaphragm according to claim 4, characterised in that the central zone (21) between the corrugations (15E), has a radius of curvature greater than that of the clamping portions beyond the two corrugations (15E).

6. A diaphragm according to claim 4 or 5, characterised in that the reinforcement is positioned within the thickness of the diaphragm closer to the concave major surface than to the convex major surface thereof.

Patentansprüche

1. Flexible Membran für eine Membranpumpen- oder Motoreinrichtung mit einander gegenüberliegenden Enden und Seitenrändern, einem sich longitudinal erstreckenden zentralen

Bereich und einem Klemmbereich, der zwischen ersten und zweiten Gehäuseteilen der Pumpe oder Motoreinrichtung klemmbar ist, dadurch gekennzeichnet, daß die Membran (15) vorgeformt ist, daß der longitudinale zentrale Bereich (21) eine longitudinale Verstärkung (15c) aufweist, wodurch die Membran im wesentlichen longitudinal nicht ausdehnbar wird, daß der Klemmbereich einen peripheren Klemmbereich (21A) aufweist, der sich um die ganze Peripherie der Membran erstreckt, und daß zwei longitudinale Furchen (15E) in der Membran jeweils auf jeder Seite des zentralen Bereichs (21) zwischen dem zentralen Bereich (21) und dem peripheren Klemmbereich (21A) gebildet sind.

2. Membran nach Anspruch 1, dadurch gekennzeichnet, daß eine transversale Verstärkung (15D) vorgesehen ist, um die Membran im wesentlichen lateral nicht ausdehnbar zu machen.

3. Membran nach Anspruch 2, dadurch gekennzeichnet, daß die transversale Verstärkung (15D) sich transversal über die ganze Breite der Membran erstreckende Fasern aufweist.

4. Membran nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß die Membran in einer bogenförmigen Form vorgeformt ist, wobei der Krümmungsmittelpunkt des Bogens sich entlang einer zur Oberfläche der Membran parallelen und zur Länge der Membran perpendikularen Achse erstreckt, so daß die Membran teils zylindrische, konkave und konvexe Hauptflächen hat.

5. Membran nach Anspruch 4, dadurch gekennzeichnet, daß der zentrale Bereich (21) zwischen den Furchen (15E) einen größeren Krümmungsradius hat als jener der Klemmbereiche über die zwei Furchen (15E) hinaus.

6. Membran nach Anspruch 4 oder 5, dadurch gekennzeichnet, daß die Verstärkung innerhalb der Dicke der Membran näher an deren konkaver Hauptfläche als an ihrer konvexen Hauptfläche angeordnet ist.

Revendications

1. Diaphragme flexible pour une pompe ou un moteur à diaphragme, possédant des extrémités opposées et des bords latéraux, une zone centrale s'étendant longitudinalement et une partie de pincement susceptible d'être pincée entre une première et une seconde parties de boîtier de la pompe ou du moteur, caractérisé par le fait que ledit diaphragme (15) est prémoulé, que ladite zone centrale longitudinale (21) possède un renfort longitudinal (15C) rendant ledit diaphragme sensiblement inextensible longitudinalement, que ladite partie de pincement comprend une partie de pincement périphérique (21A) s'étendant autour de toute la périphérie du diaphragme et que deux ondulations longitudinales (15E) sont formées dans le diaphragme, chacune d'un côté de ladite zone centrale (21) entre ladite zone centrale (21) et la partie de pincement périphérique (21A).

2. Diaphragme selon la revendication 1, caractérisé par le fait qu'un renfort transversal (15D) est prévu pour rendre le diaphragme sensiblement inextensible latéralement.

3. Diaphragme selon la revendication 2, caractérisé par le fait que le renfort transversal (15D) comprend des fibres s'étendant transversalement en travers de toute la largeur du diaphragme.

4. Diaphragme selon l'une quelconque des revendications précédentes, caractérisé par le fait que le diaphragme est prémoulé en une forme en arc, le centre des courbures de l'arç s'étendant le long d'un axe parallèle à la surface du diaphragme et perpendiculaire à la longueur du diaphragme, de sorte que le diaphragme possède des surfaces principales partiellement cylindriques, concave et convexe.

5. Diaphragme selon la revendication 4, caractérisé par le fait que la zone centrale (21) entre les ondulations (15E) possède un rayon de courbure plus grand que celui des parties de pincement au-delà des deux ondulations (15E).

6. Diaphragme selon l'une quelconque des revendications 4 et 5, caractérisé par le fait que le renfort est positionné dans l'épaisseur du diaphragme plus près de sa surface principale concave que de sa surface principale convexe.

Fig. 1.

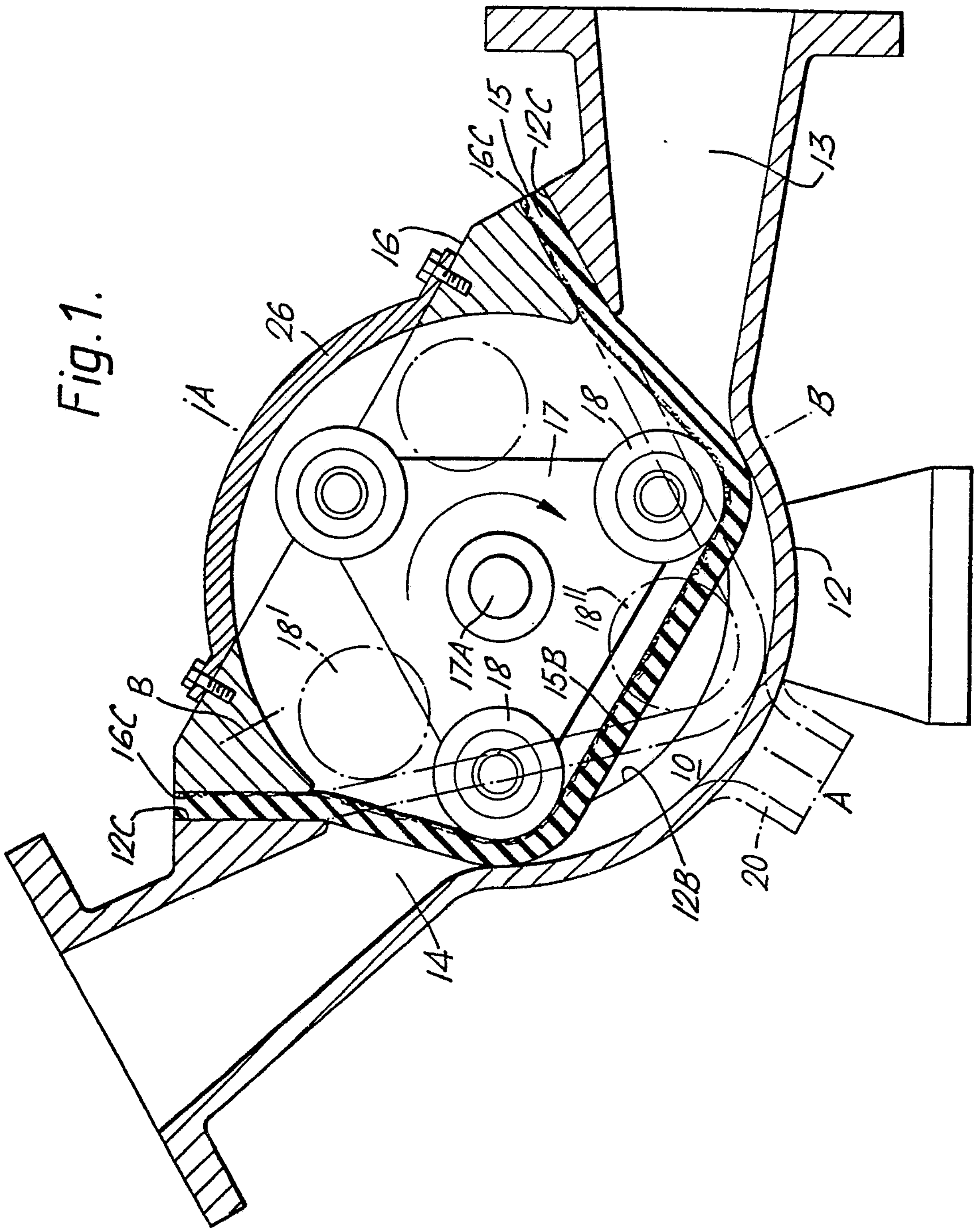


Fig. 2.

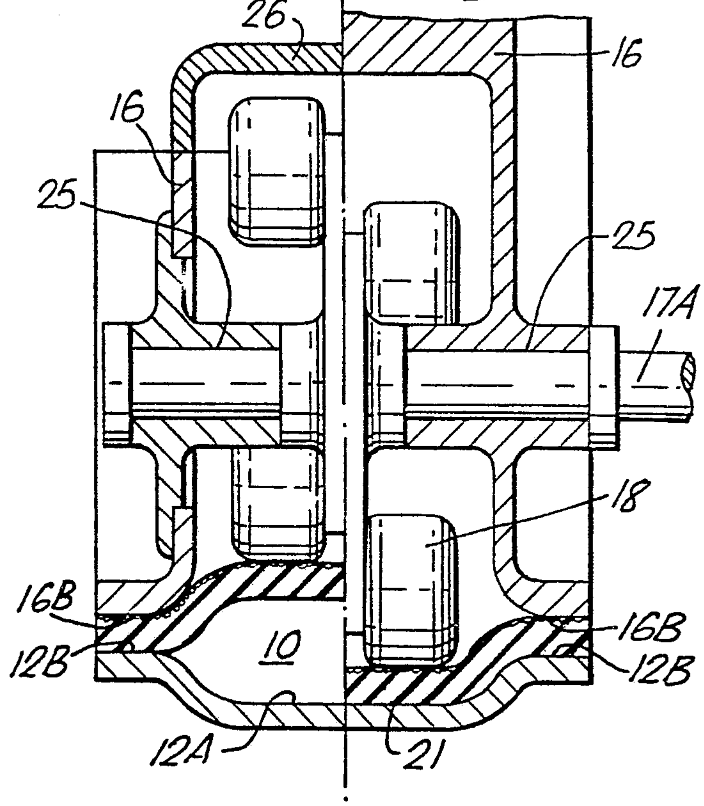
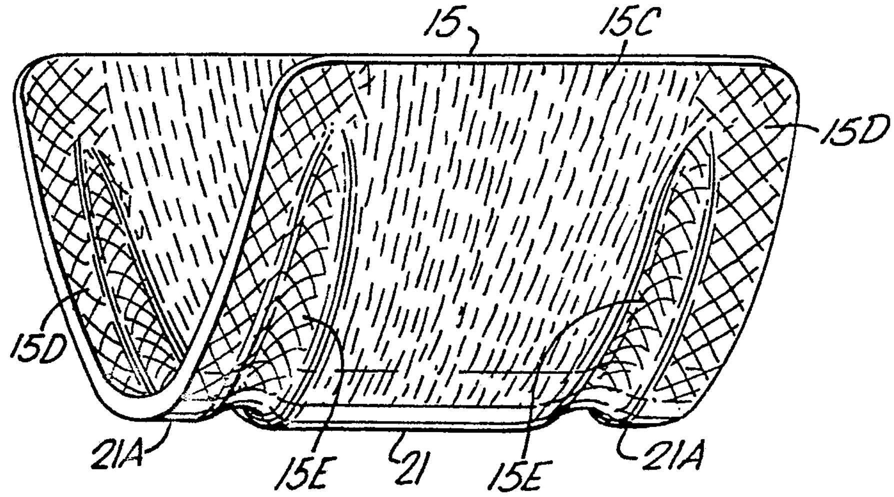

26
16
16
25
25
17A
18
16B
16B
12B
12B
10
12A
21

Fig. 3.


15
15C
15D
15D
21A
15E
21
15E
21A