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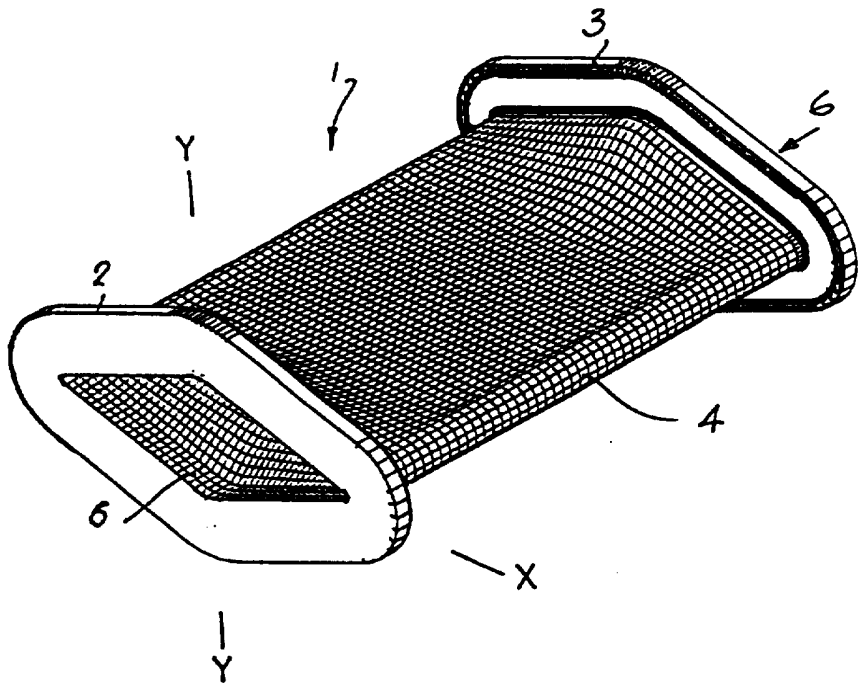
(54) Title: IMPROVEMENTS IN MEMBRANES FOR PERISTALTIC PUMPS AND PUMPS INCORPORATING SUCH MEMBRANES



(57) Abstract

A membrane (1) for use in a pumping device, the membrane (1) having an elongated flexible body (4) with flanges (2, 3) at each end of the body (4), a bore (5) through the body (4) with permanently open ends (6) and a normally closed off central portion where there is engagement between opposed portions (9) of inner surfaces of the body bore (5). The bore (5) is openable by subjecting the exterior of said body (4) to negative pressure when mounted in a membrane mounting chamber.

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IMPROVEMENTS IN MEMBRANES FOR PERISTALTIC PUMPS AND PUMPS INCORPORATING SUCH MEMBRANES

FIELD OF THE INVENTION

The present invention has relevance to peristaltic pumps and in particular peristaltic pumps formed of a number of coupled membrane housing pump elements. The configuration of the membrane of the invention facilitates the mounting of the membrane in the pump element and minimises the stresses which develop in the membrane during pumping operations.

BACKGROUND ART

Peristaltic pumps for flowable materials are known and have wide application. Conventionally, pumping action is achieved by sequentially locally deforming a normally open flexible elastic tubular member to create advancing chambers which transport the material being pumped. Where pumps comprise a number of coupled pump elements each provided with a flexible membrane the pumping action is achieved by sequentially deforming the membranes of the respective pump elements to create the advancing chambers. Pumps of this type are disclosed in our PCT application AU94/00696 and can generate suction and compression to draw material into the pump chambers and can be used to pump in one direction or the opposite direction.

In the latter form of peristaltic pump the membrane is normally open thereby providing a passage through the membrane. The flexing of the membranes in the pump elements is conveniently achieved by housing the membranes in a liquid charged chamber and pressurising the membrane to close the passage through the membrane and depressurising the liquid to allow the membrane

to return to the open condition. To achieve full closure of the membrane but avoid damage to the membrane the amount of liquid placed in the chamber must be very accurately controlled. With the membrane of the present invention the problem of overfilling the membrane chamber is overcome.

BROAD STATEMENT OF THE INVENTION

Broadly stated, the invention can be said to provide a membrane for use in a flowable material handling device, said membrane including a body with a normally open through bore extending between ends of the body and defined by a generally uniform thickness flexible body wall, securement means at each end of the body whereby the membrane can be end connected into a flowable material handling device, said body and bore except for a portion associated with a flex zone in said body is of substantially uniform cross-sectional shape and symmetrical throughout its length with a major and a minor axis generally at right angles thereby providing said body with four longitudinally extending sides and said bore with four longitudinally extending surfaces, said body flex zone is provided by four channel forming sections of the respective sides of said body where the channels formed are circumferentially aligned and each has a cross-sectional area which decreases from a maximum at the ends of the minor axis of the bore cross-section to a minimum adjacent t he ends of the major axis of the bore cross-section.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view of the membrane of the invention in its normal closed condition,

Fig. 2 is a sectional elevation of the membrane of Fig. 1 with the opened elevational shape shown in broken lines,

Fig.3 is a sectional end view of the section line 3-3 of Fig.2,

Fig. 4 is a view similar to Fig. 1 but showing the membrane in the opened condition,

Fig. 5 is a sectional end view on the section line 5-5 of Fig. 3,

Fig. 6 is a perspective view of a typical pump element housing for use with the membrane of the previous drawings, several such elements cyclically operated providing a peristaltic pumping action, part of the illustrated housing has been removed to facilitate description of a piston arrangement which controls the opening of the membrane,

Fig. 7 is a diagrammatic cross-sectional elevation of a membrane housin g having a piston arrangement which differs from that shown in Fig. 6, with the piston at its upper travel limit and

Fig. 8 is a view similar to Fig. 7 with the piston arrangement at its lower travel limit.

DETAILED DESCRIPTION OF THE DRAWINGS

The membrane 1 of the invention is illustrated in Figs. 1 through 5. The main features of the membrane are best seen in Figs. 1 to 3. The membrane 1 comprises end flanges 2 and 3 of generally diamond shape with long and short axes X-X and Y-Y respectively, see Fig. 3. The flanges 2 and 3 lie at opposite

ends of an elongated membrane body 4 with a bore 5 therethrough which is normally substantially closed off by engagement between zones of inner surfaces of the body bore. The bore has permanently open ends 6, also of generally diamond shape, with axes X-X and Y-Y co-incident with the X & Y axes of the flanges 2 and 3.

From Fig. 2 it will be seen that the open bore ends 6 of the membrane include short parallel sided entry portions 7 which end in inwardly convexly curved shoulders 8 which blend into wall portions 9 of the membrane which are in contact and close off the bore. The sectional view Fig. 5 shows in full lines the manner in which inner surfaces of the membrane walls come together to close off the bore and in broken lines the shape of the membrane body when in the open condition.

Fig. 5 also shows that the width of the open membrane body in the X- X direction decreases as the membrane opens in the Y-Y di rection. In effect the ratio defined by the length of the major axis of the opened membrane portion divided by the length of the minor axis of the opened membrane portion is less than the ratio defined by the length of the major axis of the open bore end divided by the length of the minor axis of the open bore end.

Fig. 4 illustrates the general appearance of the membrane when in the open condition.

The membrane is made from a flexible abrasion resistant material which has appropriate thicknesses in the central and flange areas to provide shape stability in the rest condition illustrated in Fig. 1. Suitable materials would be kevlar, neoprene, polyurethane, natural rubber, or blends of materials with appropriate reinforcement where required. The reinforcement could be

provided by embedded sheet or strand material. The membrane could be fabricated or could be moulded. Elasticity is no longer an essential of the membrane material but limited elasticity could be present.

Fig. 6 illustrates a typical pump element for use with a membrane of the type provided by this invention. The pump element comprises a membrane housing having two half-shell body members 10 and 11 with joining flange s 12 and end flanges 13. The interior surfaces of the body members 10 and 11 define a membrane chamber. The body member 11 is provided with a cylinder 14 housing a work piston 15 coupled by a piston rod 16 to a power piston 17 housed in a further cylinder 18 mounted over the cylinder 14. The cylinder 14 below the piston 15 is an extension of the membrane chamber.

The membrane end flanges 2 and 3 are held in sealing engagement with the outer faces of the housing flanges 13 when the pump element of Fig. 6 is end connected to like pump element to form a pump.

The membrane chamber defined by the interior of the half shells not occupied by the membrane and the portion of the cylinder 14 below the piston 15 when at its lowest position is filled with a liquid. By applying pressurised fluid to the bottom or top of the piston 17 the piston 15 can be raised or lowered. When the piston 15 is raised a negative pressure will develop in the membrane chamber and the membrane will be opened to the shape shown in broken lines in Fig. 4. When the piston 15 is lowered the membrane will return to closed rest configuration as shown in Figs. 1 and 2.

By means of suitable valving to apply pressurised fluid to the sides of the piston 17 the membranes in a gang of pump elements can be opened and closed to provide the linearly advancing chambers which are characteristic of

peristaltic pumps. The valving means is not described in detail as it is not part of this invention and can be varied to suit the required operational characteristics of the pump.

The arrangement described above with reference to Fig. 6 is one form of pump element. Another, and preferred form of pump element, is illustrated in Fig. 7. The Fig. 7 arrangement includes a housing 20 for the membrane 1 with a cylinder 21 mounted on the housing 20. The cylinder 21 is divided into two zones identified 22 and 23 by a separation wall 24. There is a piston assembly mounted in the cylinder, the piston assembly comprises an upper piston 25 housed in the cylinder zone 22 and a lower piston 26 housed in the cylinder zone 23 with the pistons 25 and 26 connected by a piston rod 27 sealed in a bore through the separation wall 24.

The cylinder zone 23 is held sealed from the membrane chamber 27 by a flexible sleeve-like bank 28 provided wi th clamping flanges 29 and 30. As can be seen from Figs. 7 and 8 the band configuration when at the upper travel limit and at the lower travel limit of the piston assembly includes a bend bounded on opposite sides by a long and a short section of the band. It follows that at the mid-point of travel of the piston assembly the band would be o f substantially "U" form with the flanges 29 and 30 substantially aligned and extending in opposite directions. Each pump element is provided with a control valve 31 for the fluid to move the piston assembly, the control valve is coupled to fluid supply and return lines 32 and 33.

CLAIMS :

1. A membrane for use in a flowable material handling device, said membrane including an elongated body with a through bore extending between ends of the body and defined by a generally uniform thickness flexible body wall, securement means at each end of the body whereby the membrane can be end connected in a sealed manner into a membrane mounting chamber of a flowable material handling device, said bore at each end of said body having a permanently open condition and at least a portion of said bore between said body ends being normally substantially closed off by engagement between opposed zones of inner surfaces of said bore, said bore being openable by subjecting the exterior of said body to negative pressure when mounted in a membrane mounting chamber.

2. A membrane as claimed in claim 1 wherein the membrane body has continuous flange at each of its ends to provide the securement means whereby the membrane can be sealingly mounted in a membrane mounting chamber.

3. A membrane as claimed in claim 1 wherein the open ends of the body bore each have a major axis and a minor axis generally at right angles.

4. A membrane as claimed in claim 3 wherein the membrane portion which is normally closed has when opened a major axis and a minor axis corresponding in orientation with the major and minor axes of the body bore ends.

5. A membrane as claimed in claim 3 wherein said zones of the body bore inner surfaces are substantially flat when in contact to close off said bore and have a width transverse to the length dimension of the membrane which is aligned with the major axes of the open ends of said bore.

6. A membrane as claimed in claim 4 wherein the ratio defined by the length of the major axis of the opened membrane portion divided by the length of the minor axis of the opened membrane portion is less than the ratio defined by the length of the major axis of the open bore end divided by the length of the minor axis of the open bore end.

7. A peristaltic pump unit comprising a housing with a chamber in which a membrane as claimed in claim 1 is mounted, liquid externally surrounding the membrane and a piston in communication with said chamber, control means to move said piston relative to said chamber to induce a membrane opening negative pressure in said chamber.

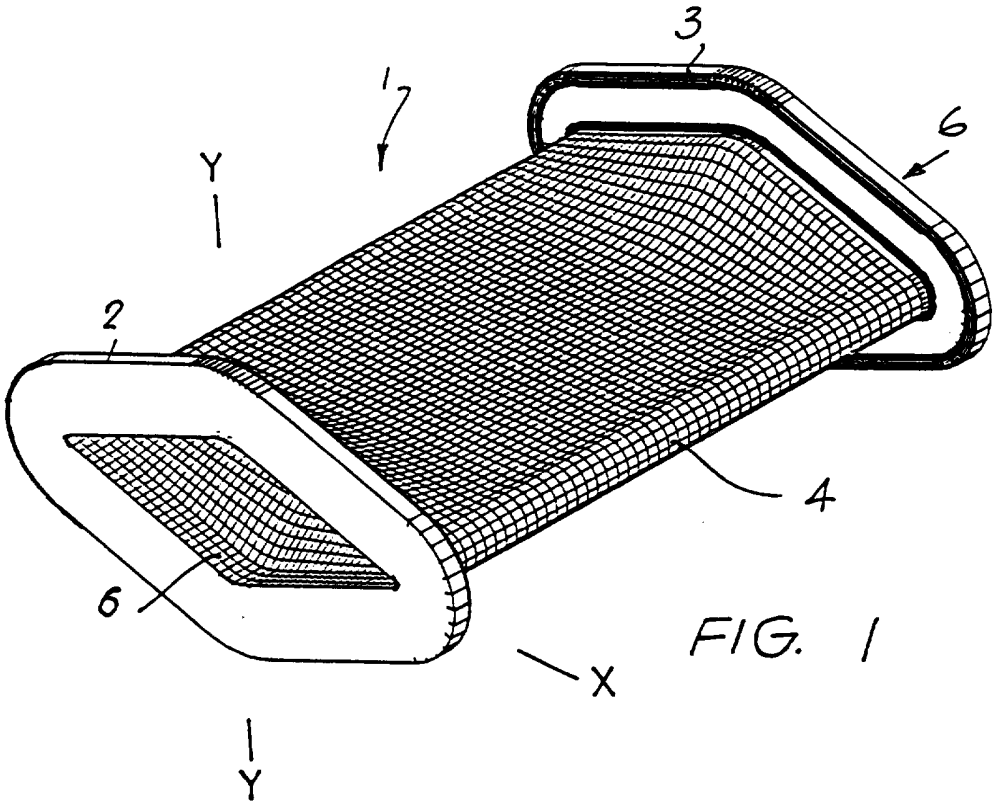

FIG. 1

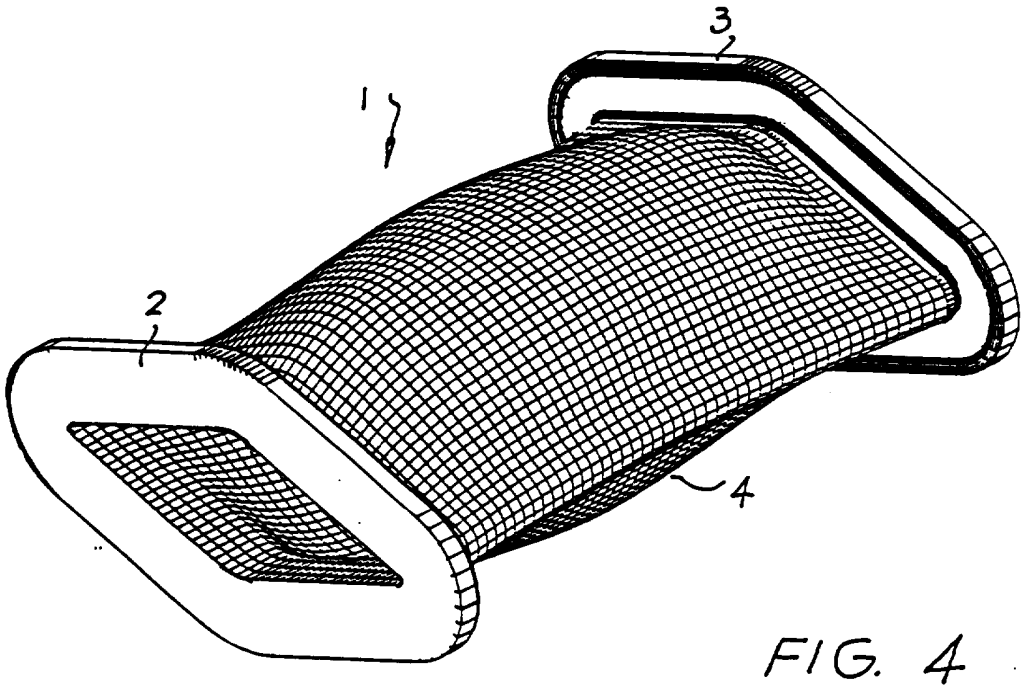

FIG. 4

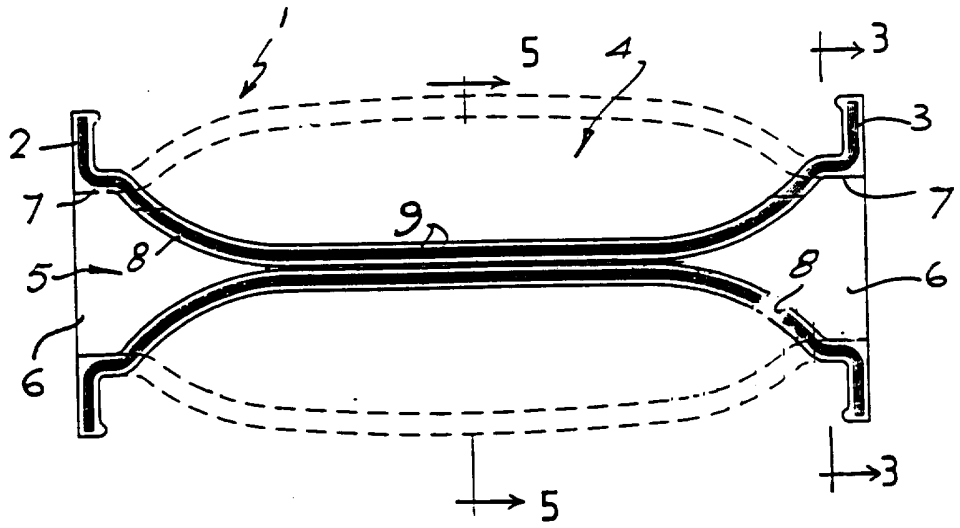

FIG. 2

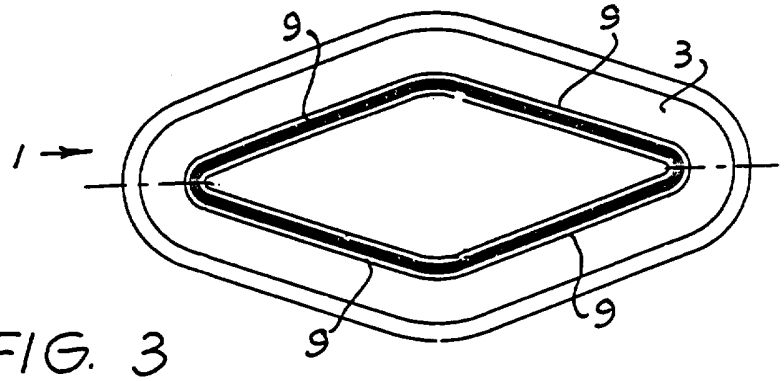

FIG. 3

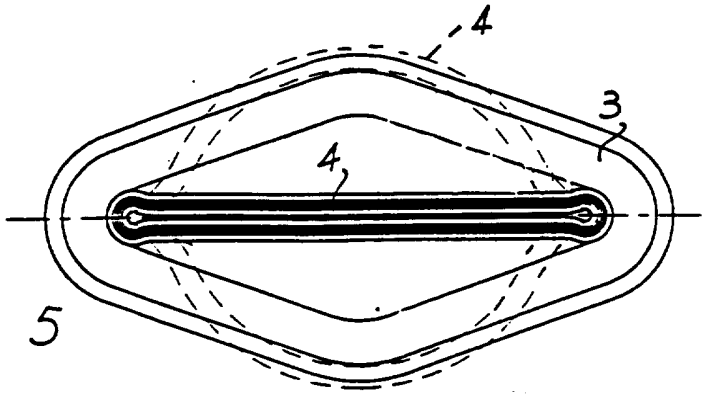

FIG. 5

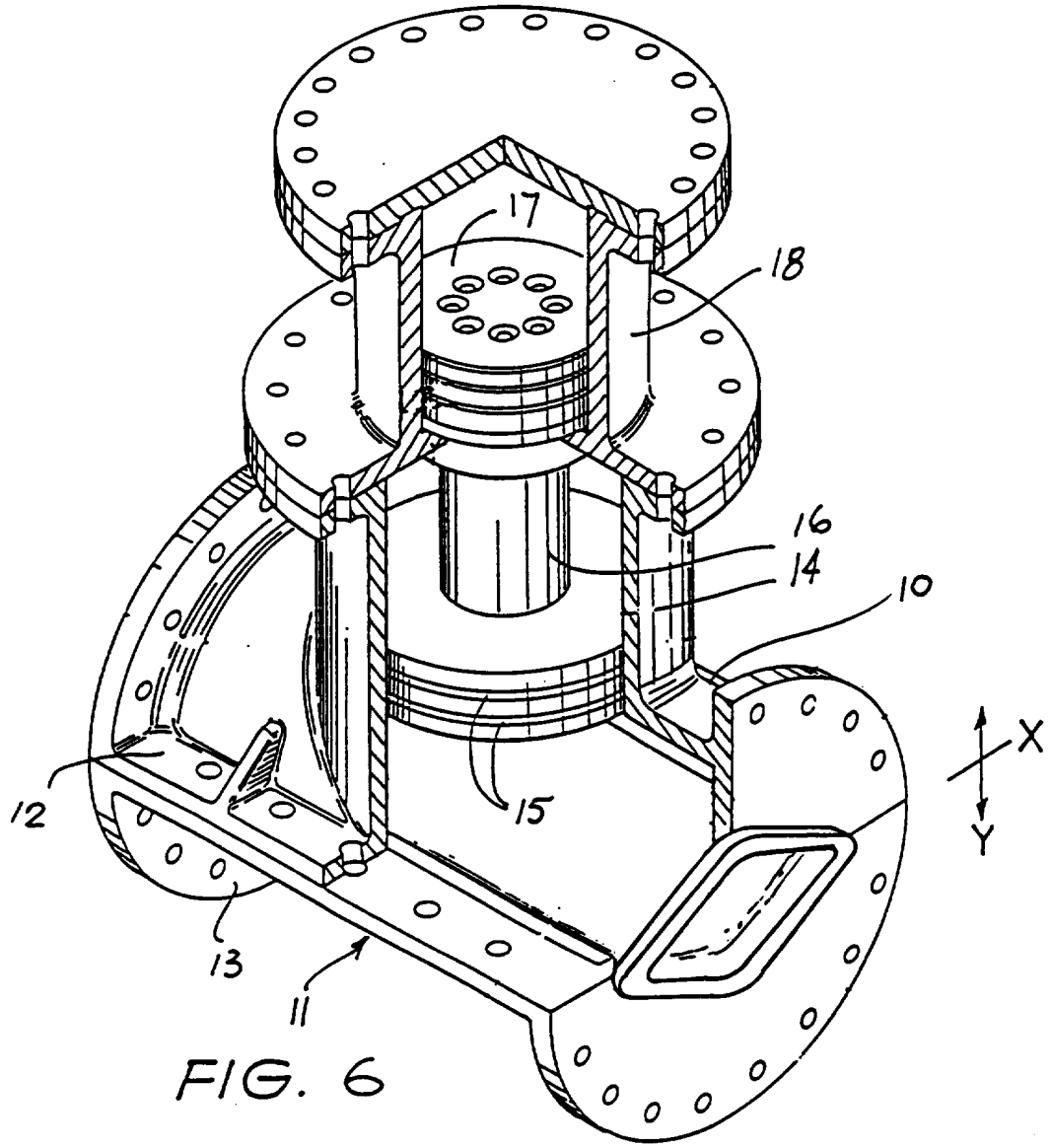

FIG. 6

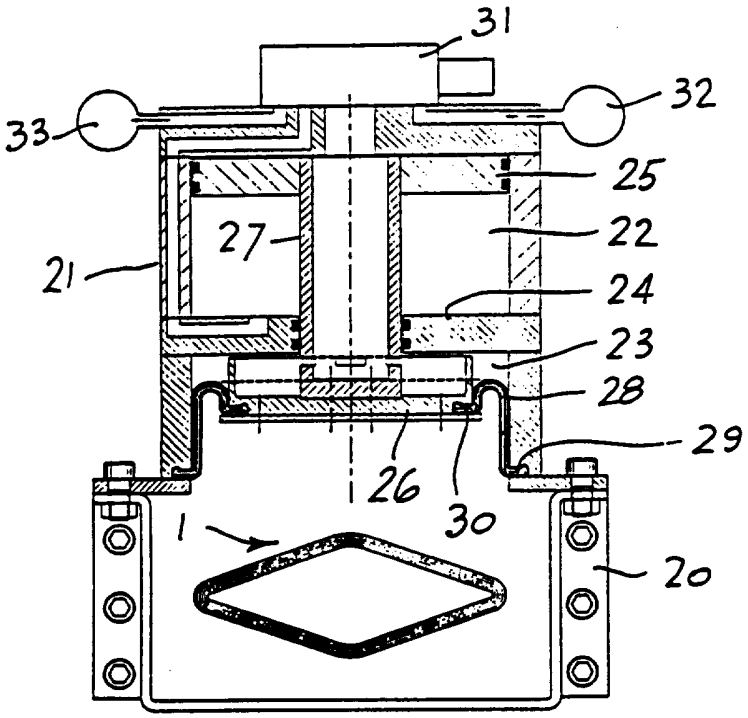
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FIG. 7

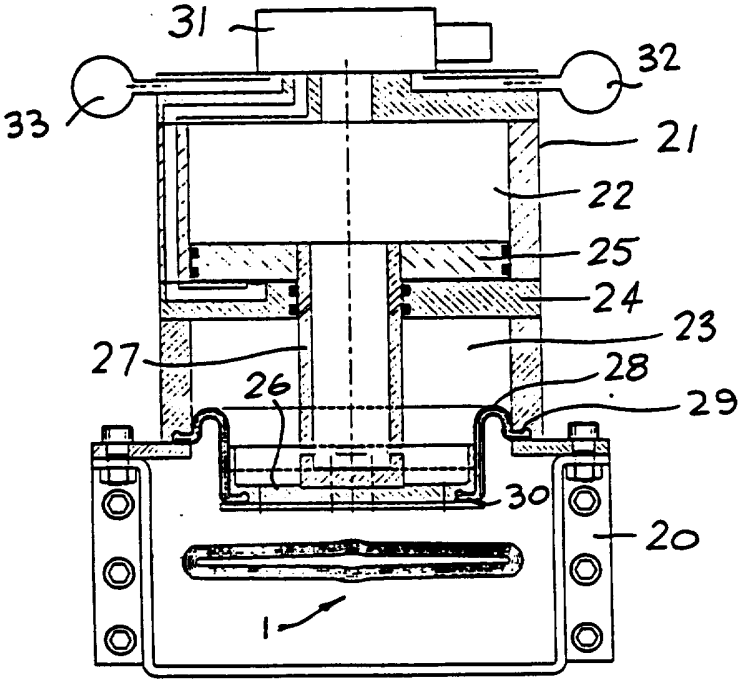
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FIG. 8

INTERNATIONAL SEARCH REPORT

International Application No.
PCT/AU 96/00239

A. CLASSIFICATION OF SUBJECT MATTER

Int Cl[6]: F04B 43/08, 43/10, 43/12, 43/14

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC F04B 43/08, 43/10, 43/12, 43/14

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
AU: IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
DERWENT

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X,Y	US 4,102,612 A (RITTER) 25 July 1978 column 3, line 18 - column 4, line 3	1-7
X Y	US 4,936,760 A (WILLIAMS) 26 June 1990 column 3, line 50 - column 5, line 68 column 3, line 50 - column 5, line 68	1, 3, 4, 5-7 2
X Y	GB 1,409,412 A (MILTON ROY COMPANY) 8 October 1975 page 1, line 40 - page 2, line 105 and figs 1-7 line 56, page 2 - line 61, page 2	1, 2, 7 3 - 6

[X] Further documents are listed in the continuation of Box C

[X] See patent family annex

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C (Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X, Y	DE 2,530,440 A (DAIWA MACHINERY MANUFACTURE LTD) 29 January 1976 whole document	1-7
Y	US 5,273,406 (FEYGIN) 28 December 1993 column 3, line 14 - column 4, line 42	1-7
A	AU 79844/94 A (JONES) 27 April 1995	
A	Derwent Abstract Accession No. b1164 E/05, class Q56, Se 8004309 A (CARLNAS) 18 January 1982	

INTERNATIONAL SEARCH REPORT

Information on patent family members

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Patent Document Cited in Search Report		Patent Family Member					
US	4102612	DE	2530149				
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DE	2530440	FR	2277998	JP	51086811		
AU	79844/94	WO	9511383				

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