



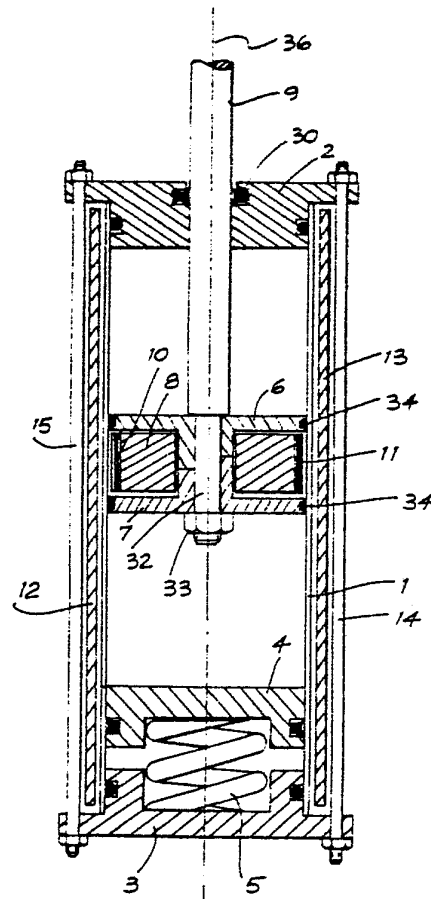
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<p>(21) International Application Number: PCT/AU87/00122 (22) International Filing Date: 30 April 1987 (30.04.87) (31) Priority Application Number: PH 5671 (32) Priority Date: 30 April 1986 (30.04.86) (33) Priority Country: AU</p> <p>(71) Applicant (for all designated States except US): COM-DOX NO. 70 PTY. LIMITED [AU/AU]; Roberts & Morrow, 328 Gray Street, Glen Innes, NSW 2370 (AU).</p> <p>(72) Inventor; and (75) Inventor/Applicant (for US only) : TRETHERWEY, Reginald [AU/AU]; Kameruka, Deepwater, NSW 2371 (AU).</p> <p>(74) Agent: GRIFFITH HASSEL & FRAZER; G.P.O. Box 4164, Sydney, NSW 2001 (AU).</p>		<p>(81) Designated States: AT (European patent), AU, BE (European patent), CH (European patent), DE (European patent), DK, FR (European patent), GB (European patent), IT (European patent), JP, LU (European patent), NL (European patent), NO, SE (European patent), US.</p> <p>Published <i>With international search report.</i></p>

(54) Title: IMPROVED LINEAR MOTION RESISTANCE CELL

(57) Abstract

A linear motion resistance cell particularly for use on an exercise machine comprising a hydraulic piston (6, 7) and cylinder (1) assembly filled with hydraulic fluid and provided with controllable ports in the piston between a rotatable disc (8) and piston flanges (6) and (7). The ports are opened and closed by rotation of the disc (8) relative to the piston, actuated by diametrically opposed pairs of magnets (10, 11) in the disc aligned with corresponding pairs of magnets (12, 13) in a collar on the outside of the cylinder (1).



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"IMPROVED LINEAR MOTION RESISTANCE CELL"TECHNICAL FIELD

This invention relates to an improved linear motion resistance cell and has been devised particularly though not solely as an improvement to the linear motion resistance cell described in our copending International patent application PCT/AU85/00090.

BACKGROUND ART

In the patent application referred to above there is described a linear motion resistance cell particularly adapted for use in an exercise machine and which incorporates a piston and cylinder assembly provided with valve means operable by control means so as to provide predetermined resistances to the movement of the piston within the cylinder selectable between at least two of the following three modes:

1. Controlled resistance to movement in both directions
2. Controlled resistance to movement in one predetermined direction only with relatively low resistance to movement in the other direction,
3. Controlled resistance to movement in the opposite predetermined direction to (2) with relatively low resistance to movement in the other direction.

While the apparatus described and claimed in our above-referenced earlier patent applications is effective in use it has been found that the valve mechanism is complex to manufacture, so increasing the cost of the linear motion resistance cell.

DISCLOSURE OF INVENTION

The present invention therefore provides a linear motion resistance cell comprising an hydraulic piston and cylinder assembly sealed at both ends and filled with hydraulic fluid, the piston incorporating valve means operable to control the flow of fluid from one side of the piston to the other and hence the resistance to movement

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of the piston within the cylinder, the valve means comprising a disc rotatable about the axis of the cylinder relative to the piston and incorporating ports moveable into and out of register with ports in the piston, the
5 disc incorporating magnetic poles arranged to align with a magnetic field rotatable about the outside of the cylinder such that the orientation of the disc relative to the piston is controllable by rotation of the magnetic field.

Preferably the disc incorporates a pair of permanent
10 magnets diametrically opposed at the periphery of the disc and the magnetic field is similarly formed from a pair of diametrically opposed permanent magnets located in a collar or the like rotatable about the cylinder.

Preferably the piston is formed from two spaced
15 flanges and the disc is located between the flanges with axial clearance allowing the disc to move axially between the flanges.

Preferably the flow of fluid through the piston is arranged such that reversal of piston movement causes the
20 disc to move axially between the flanges.

Preferably the ports in the piston and the disc are arranged such that axial movement of the disc between the flanges acts as a non-return valve, opening and/or closing selected ports to the flow of fluid therethrough.

Preferably the cylinder is provided with a volume
25 compensator arranged to compensate for the decrease in contained volume within the cylinder as the piston is advanced into the cylinder under the influence of an actuation rod.

30 BRIEF DESCRIPTION OF DRAWINGS

Notwithstanding any other forms that may fall within its scope one preferred form of the invention will now be described by way of example only with reference to the accompanying drawings in which:-

35 Fig. 1 is a cross-section through the axis of a linear motion resistance cell according to the invention.

Fig. 2 is an exploded perspective view to an enlarged

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scale of the piston and contained disc used in the linear motion resistance cell shown in Fig. 1.

Fig. 3 is a cross-sectional view to an enlarged scale of an alternative form of volume compensation apparatus used in the cylinder shown in Fig. 1, and

Fig. 4 is a plan view of the compensator shown in Fig. 3.

MODES FOR CARRYING OUT THE INVENTION

In the preferred form of the invention a linear motion resistance cell is formed in the configuration of a hydraulic piston and cylinder assembly having a tubular cylinder wall (1) closed by an upper end cap (2) and a lower end cap (3). The lower end cap (3) is closed and the upper end cap (2) is provided with a seal (30) forming a sliding fit with a piston actuation rod (9). The end caps (2) and (3) are conveniently held in place on the cylindrical tube (1) by way of tie rods (14) and (15).

The piston actuation rod (9) is arranged to support and actuate a piston for linear movement within the cylinder. The piston is formed in two halves in the form of an upper flange (6) and a lower flange (7) interconnected by a central spigot (31) (Figure 2) engageable about a reduced end portion (32) on the actuation rod (9) and held in place by a threaded nut (33). It is preferred that the spigot (31) is formed from a first half downwardly depending from the flange (6) and a second half upwardly depending from the flange (7), and that the mating faces of the two spigot halves are offset as shown in Figure 1 to maintain the two halves of the piston at a predetermined orientation relative to each other and also to the piston actuation rod (9). The outer edges of the flanges (6) and (7) are provided with seals (34) forming a sliding fit against the inner peripheral wall of the cylinder (1).

The piston is further provided with a valve disc (8) located between the flanges (6) and (7) and being of such thickness that there is an axial clearance between the

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disc and the inner faces of the flanges (6) and (7) allowing the disc to move axially between the flanges. Although described as a disc, the component (8) in fact also comprises upper and lower flanges or faces (34) and (35) as can be clearly seen in Figure 2.

5 The disc or valve block (8) is rotatable about the axis (36) of the piston and cylinder assembly and is controlled in its rotation by a pair of permanent magnets inserted into diametrically opposed slots (10) and (11) on 10 the periphery of the valve block. The cylinder (1) is also provided with a pair of elongate diametrically opposed permanent magnets (12) and (13) on the outer surface of the cylinder arranged so that the permanent magnets may be rotated relative to the cylinder (1). To 15 this end the permanent magnets (12) and (13) may be located in an outer sleeve or may be supported in any other convenient manner. The outer magnets (12) and (13) can be conveniently manipulated by the user of the linear motion resistance cell to rotate the magnets relative to 20 the cylinder (1) and hence to rotate the valve block (8) relative to the piston. The inner magnets (10) and (11) are of course attracted to the outer magnets (12) and (13) and the rotation of the valve block (8) will faithfully follow the rotation of the outer magnets (12) and (13) 25 about the cylinder (1).

The flow of hydraulic fluid contained within the cylinder (1) from one side of the piston to the other, and hence the resistance to movement of the piston within the cylinder is controlled by a number of ports in the flanges 30 (6) and (7), and further ports in the form of cut-outs or restriction gates (15), (16) and (17) in the valve block (8). Because the valve block (8) can float axially relative to the piston, flow of fluid through the ports in the piston serves to force the valve block against the 35 inner face of either flange (6) or (7) depending on the direction of movement of the piston within the cylinder, blocking various ports within the flanges (6) and (7) and

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therefore acting as a non-return valve.

The cut-out gate (17) is arranged to provide a clear opening to any of the ports (18), (19), (20) or (21) when aligned therewith, but the restriction gates (15) and (16) have spiral inner edges arranged such that the inner edge progressively closes an aligned port during rotation of the disc (8) relative to the piston over the arc of the restriction ports. In this manner the degree of resistance to the flow of fluid through a port aligned with the restriction gates (15) or (16) may be controlled by rotation of the disc using the magnets (12).

The operation of the valve block within the piston has been designed to achieve the same three types of selectable resistance to movement as those described in our copending patent application earlier referred to. These three types of movement are, bi-directional resistance to movement, uni-directional resistance to upward movement, and uni-directional resistance to downward movement. The operation of the ports (18), (19), (20) and (21) in the piston flanges (6) and (7) and of the restriction gates (15), (16) and (17) in the valve block (8) will now be described with reference to each of these three desired modes of operation.

(i) Bi-Directional resistance to shaft (9) movement

To achieve this mode the outer magnets (12) and (13) are rotated so that valve block (8) rotates until the restriction gates (15) and (16) align with ports (18) and (20).

When the shaft (9) is moved downward the upper face of valve block (8) engages with the inner face of the upper piston half (6) thus sealing port (19). Fluid is then forced to travel past the restriction gate (15) into port (18). At the same time the lower face of valve block (8) disengages with the inner face of the lower piston half (7) allowing fluid to be introduced through ports (20) and (21)

When the shaft (9) is moved upward the lower face

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of valve block (8) engages with the inner face of the lower piston half (7) thus sealing port (21). Fluid is then forced to travel past the restriction gate (16) into port (20). At the same time the upper face of valve block (8) disengages with the inner face of upper piston half (6) allowing fluid to be introduced through ports (18) and (19).

(ii) Uni-Directional resistance to upward shaft (9)

Movement

10 In this mode valve block (8) is rotated so restriction gate (16) aligns with port (21).

As shaft (9) is moved upward the lower face of valve block (8) engages with the inner face of lower piston half (7) thus sealing port (20). Fluid is then forced to travel past restriction gate (16) into port (21). At the same time the upper face of valve block (8) disengages with the inner face of the upper piston half (6) allowing fluid to be introduced through ports (18) and (19).

20 As the shaft (9) is moved downwards the lower face of valve block (8) disengages with the inner face of lower piston half (7) allowing fluid to be introduced through ports (20) and (21). The upper face of valve block (8) engages with the inner face of the upper piston half (6) thus sealing port (18). However fluid can still flow freely through port (19) because upper return gate (17) is aligned with it.

(iii) Uni-Directional Resistance to downward shaft (9)

Movement

30 Valve block (8) is rotated so restriction gate (15) aligns with port (19) and the operation is the reverse of the previous mode.

The cylinder is also supplied with a floating piston (4) to allow for internal volume changes due to the shaft (9) travelling in and out of the cylinder. The region between the floating piston (4) and the lower end cap (3) is sealed so no fluid can be introduced. The

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floating piston (4) is loaded by a powerful spring (5). Because the cross-sectional area of the shaft (9) is about one sixteenth the area of the piston halves (6) and (7) it is relatively easy to compress the spring (5) by
5 introducing more of the shaft (9) into the cylinder. However if the valve block (8) is adjusted so no fluid can pass from the lower side of the piston half (7) to the upper side of the piston half (6), then the shaft load required to compress spring (5) is very high. The action
10 of the floating piston (4) and the spring (5) form a return mechanism that causes the cylinder to attain its extended position when unloaded.

Although the volume compensation apparatus described above works well to compensate for volume
15 changes due to the introduction of the actuation rod (9) into the cylinder it has been found in practice that the floating piston (4) and spring (5) can introduce unacceptable levels of sponginess in the down pressure stroke of the cylinder shaft. An alternate arrangement
20 has therefore been developed and is shown in Figs. 3 and 4.

Floating piston (4) and spring (5) are replaced by the valved piston (22) and O-rings (23) and (24). This arrangement is placed in the end of the cylinder with a groove (28) in which the O-ring (24) is located on the
25 upper side. A sealed, air filled, plastic bladder (29) is contained in the space (25) on the lower side of the valved piston (22). On the lower surface of the O-ring groove (28) is a plurality of small holes (26) that communicate with the space (25). There is also a single
30 small hole (27) that places the upper surface of the valved piston (22) in limited communication with the space (25). The lower surface of the valved piston (22) rests against the upper surface of the lower end cap (3),
(Fig. 1).

35 When pressure is applied to the upper surface of the valved piston (22), pressure is also applied to the O-ring (24) which causes it to seal the holes (26). Thus

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as more of the shaft (9) is introduced into the cylinder the displaced oil is forced to flow through the hole (27) and suitably compress the bladder (29). Due to the restriction introduced by the restricted diameter of the hole (27) no appreciable sponginess is evident.

When the shaft (9) is withdrawn from the cylinder, oil must flow from the space (25) into the cylinder, allowing the bladder to expand. The pressure on the O-ring (24) is now relieved which allows it to move away from the holes (26). This places the holes (26) in parallel with hole (27) and oil flows freely in this direction.

O-ring (23) prevents oil flow between the valved piston (22) and the cylinder (1).

In this manner an improved linear motion resistance cell is provided which is simple and therefore inexpensive to manufacture due to the simple nature of magnetically controlled valve within the piston and yet which is as effective in use to provide the free selectable mode of resistance to movement of the piston within the cylinder.

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CLAIMS

1. A linear motion resistance cell comprising an hydraulic piston and cylinder assembly sealed at both ends and filled with hydraulic fluid, the piston incorporating valve means operable to control the flow of fluid from one side of the piston to the other and hence the resistance to movement of the piston within the cylinder, the valve means comprising a disc rotatable about the axis of the cylinder relative to the piston and incorporating ports moveable into and out of register with ports in the piston, the disc incorporating magnetic poles arranged to align with a magnetic field rotatable about the outside of the cylinder such that the orientation of the disc relative to the piston is controllable by rotation of the magnetic field.

2. A linear motion resistance cell as claimed in claim 1, wherein the disc incorporates a pair of permanent magnets diametrically opposed at the periphery of the disc and the magnetic field is similarly formed from a pair of diametrically opposed permanent magnets located in a collar or the like rotatable about the cylinder.

3. A linear motion resistance cell as claimed in either claim 1 or claim 2, wherein the piston is formed from two spaced flanges and the disc is located between the flanges with axial clearance allowing the disc to move axially between the flanges.

4. A linear motion resistance cell as claimed in claim 3, wherein the flow of fluid through the piston is arranged such that reversal of piston movement causes the disc to move axially between the flanges.

5. A linear motion resistance cell as claimed in either claim 3 or claim 4, wherein the ports in the piston and the disc are arranged such that axial movement of the disc between the flanges acts as a non-return valve, opening and/or closing selected ports to the flow of fluid therethrough.

6. A linear motion resistance cell as claimed in

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any one of the preceding claims, wherein the cylinder is provided with a volume compensator arranged to compensate for the decrease in contained volume within the cylinder as the piston is advanced into the cylinder under the influence of an actuation rod.

5 7. A linear motion resistance cell as claimed in claim 6, wherein the volume compensator comprises a floating piston adjacent one end of the cylinder, the floating piston being supported relative to the end of the cylinder by way of a compression spring.

10 8. A linear motion resistance cell as claimed in claim 6, wherein the volume compensator comprises a separate chamber adjacent one end of the piston and cylinder assembly communicating with the cylinder by way of a restricted aperture and a non-return valve in parallel with one another, the non-return valve being arranged to open allowing fluid to flow from the chamber into the cylinder via the non-return valve but not vis-a-versa, and a bladder of compressible gas located within the chamber.

15 9. A linear motion resistance cell as claimed in claim 8, wherein the chamber is separated from the cylinder by way of a transverse baffle through which the restricted aperture extends, and wherein the non-return valve comprises an O-ring located in a circular groove let into the cylinder side of the baffle such that the O-ring can float axially within the groove between an upper shoulder and the bottom of the groove, and one or more holes through the baffle in the bottom of the groove which are covered by the O-ring when it rests in the bottom of the groove.

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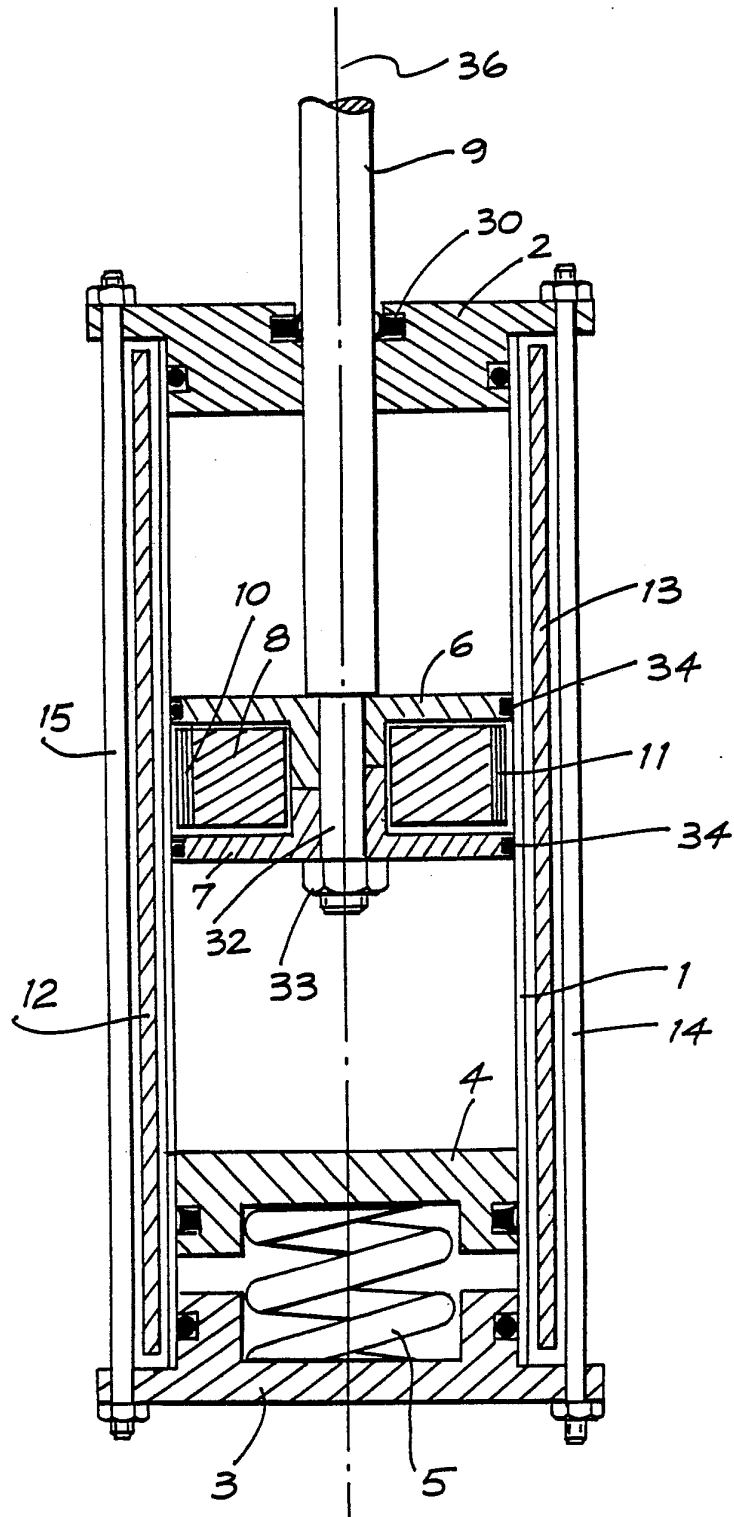
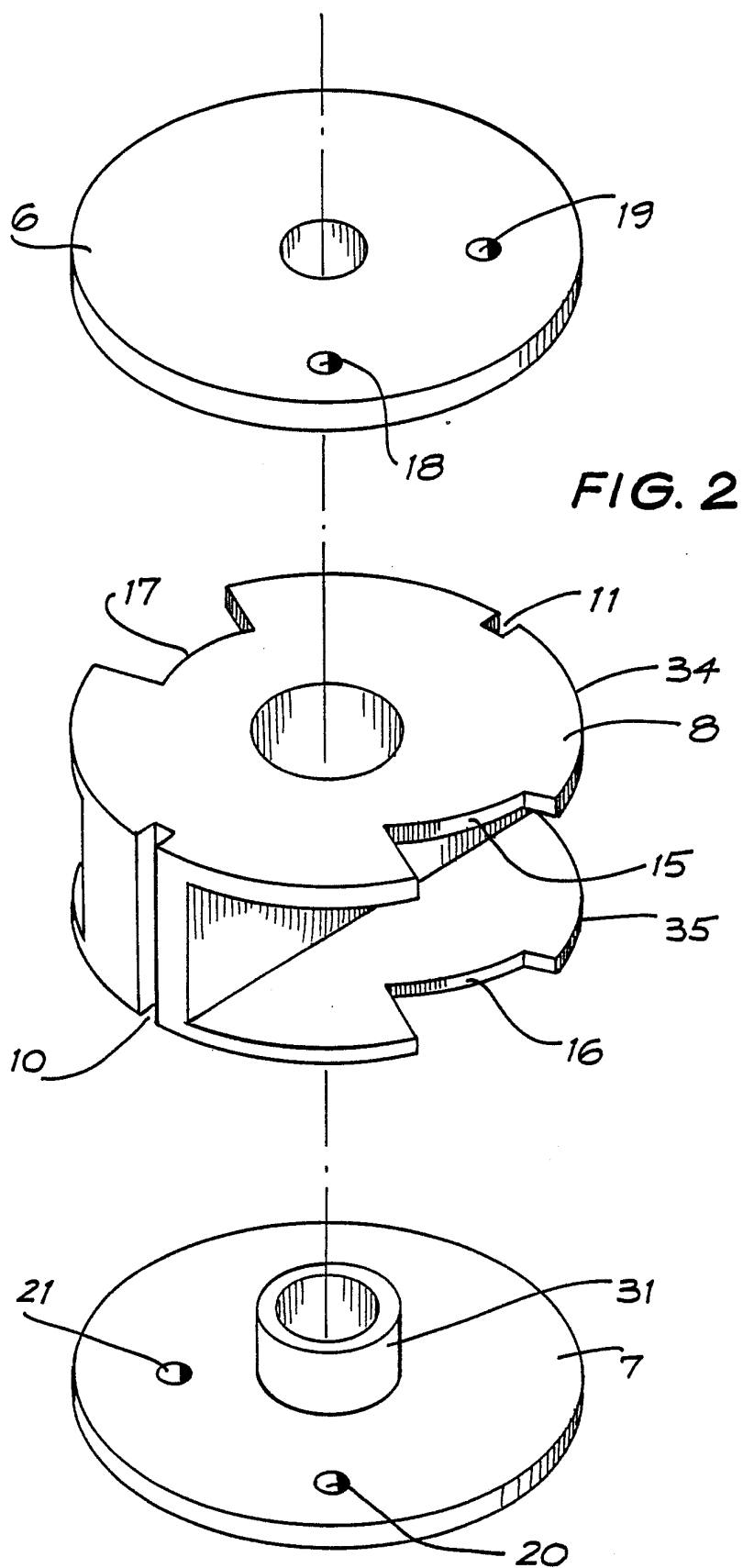


FIG. 1



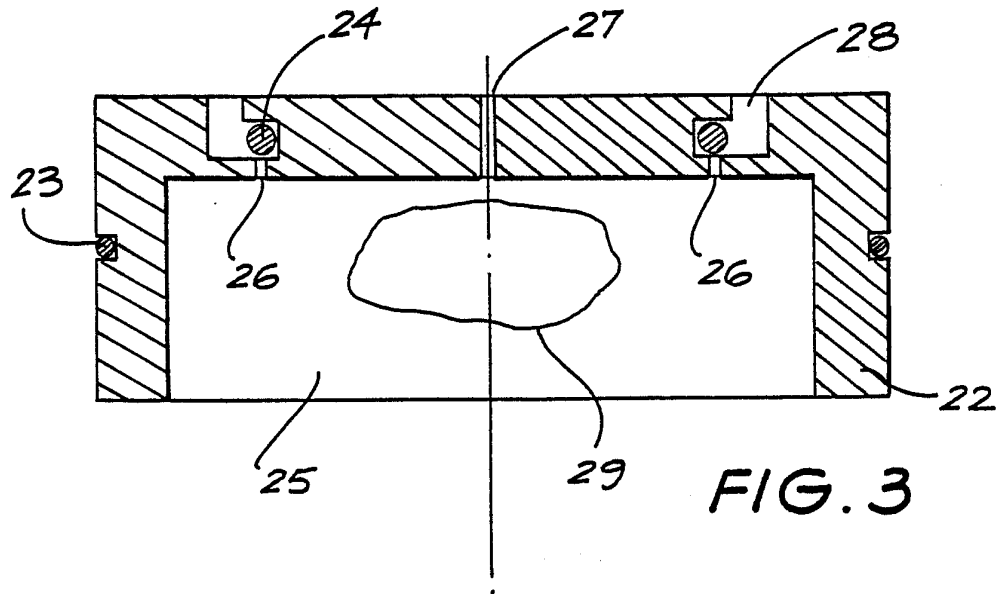


FIG. 3

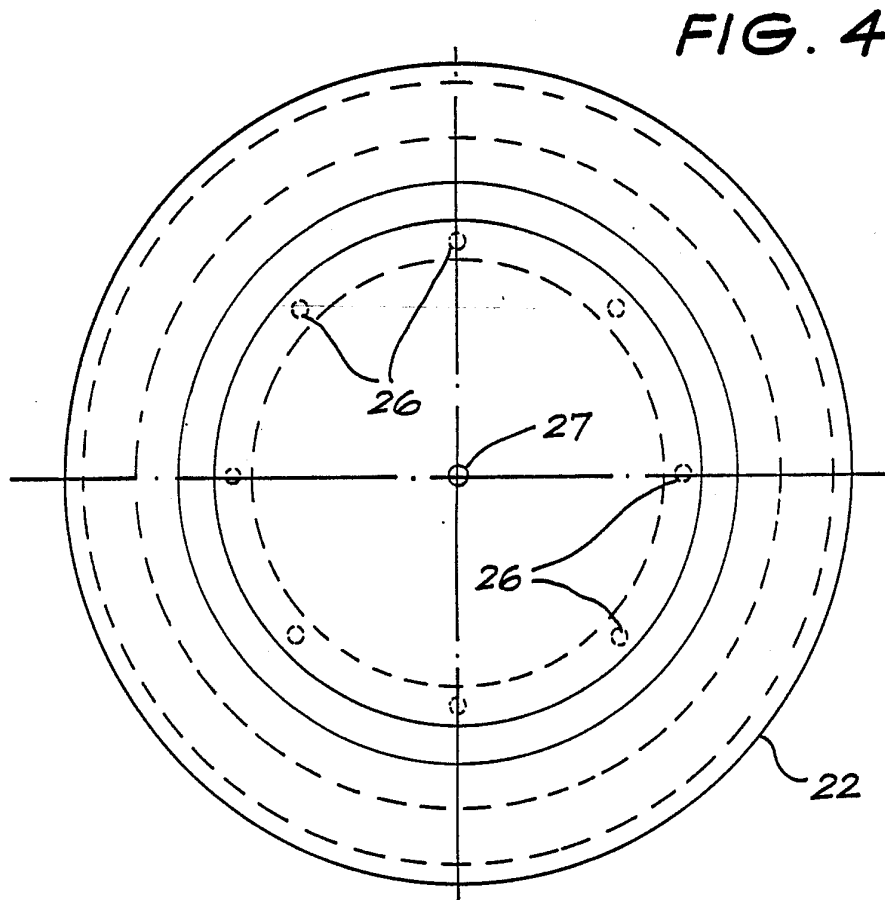



FIG. 4

INTERNATIONAL SEARCH REPORT

International Application No PCT/AU 87/00122

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) *		
According to International Patent Classification (IPC) or to both National Classification and IPC		
Int. Cl. ⁴ F16F 9/34, 9/44		
II. FIELDS SEARCHED		
Minimum Documentation Searched ⁷		
Classification System	Classification Symbols	
IPC	F16F 9/34, 9/44; A63B 21/00	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched *		
AU : IPC as above		
III. DOCUMENTS CONSIDERED TO BE RELEVANT *		
Category *	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
A	AU,A, 42973/85 (TRETHERWEY) 7 November 1985 (07.11.85)	
A	Patent Abstracts of Japan, M-233, page 156, JP,A, 58-81245 (KAYABA KOGYO K.K.) 16 May 1983 (16.05.83)	
A	Patent Abstracts of Japan, M-224, page 148, JP,A, 58-57534 (KAYABA KOGYO K.K.) 5 April 1983 (05.04.83)	
A	US,A, 3152665 (DICKINSON et al) 13 October 1964 (13.10.64)	
A	GB,A, 2164120 (BOGE GMBH (FR GERMANY)) 12 March 1986 (12.03.86)	
A	GB,A, 460851 (NEWTON) 14 August 1936 (14.08.36)	
A	GB,A, 458895 (BECHEREAU) 29 December 1936 (29.12.36)	
A	EP,A, 135346 (HORNG MEEI SPRING ENTERPRISE CO. LTD) 27 March 1985 (27.03.85)	
A	FR,A, 1294113 (TATRA) 16 April 1962 (16.04.62)	
<p>* Special categories of cited documents: ¹⁰</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"A" document member of the same patent family</p>		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
30 July 1987 (30.07.87)	(10.08.87) 10 AUGUST 1987	
International Searching Authority	Signature of Authorized Officer	
Australian Patent Office	 (G.M. COX)	

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON
INTERNATIONAL APPLICATION NO. PCT/AU 87/00122

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report	Patent Family Members			
AU 42973/85	DK 6029/85 WO 8604935	EP 179818	NO 855326	
GB 2164120	BR 8504168 FR 2569800	DE 3432465 JP 61065929	ES 545579	

END OF ANNEX