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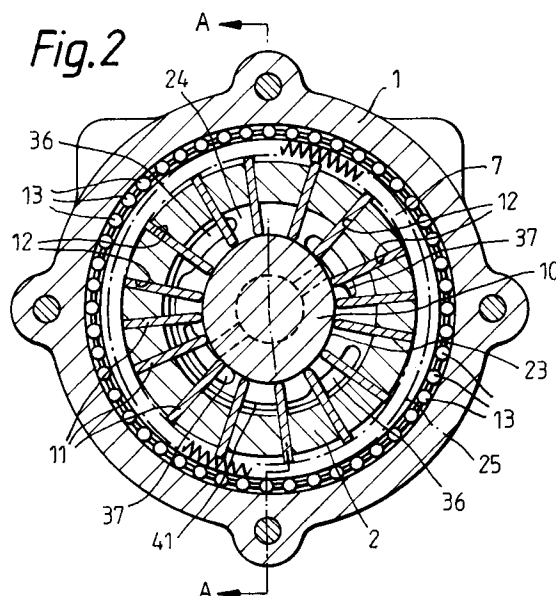
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Bedfordshire LU1 2SE (GB)(54) **Rotary vane pump.**

(57) A rotary vane pump comprising a stator (10) having a cylindrical outer surface (23); a rotor (2) which is substantially annular and positioned around the stator to define a fluid chamber (24) between the rotor and the stator, the rotor being rotatable about a longitudinal axis and having a number of radially extending slots (12) therein; a vane (11) slidably mounted in each slot and biased towards the fluid chamber and into engagement with the outer surface of the stator, the vanes reciprocating in their respective slots as the rotor rotates about the stator; a fluid inlet connecting with the fluid chamber; and a fluid outlet connecting with the fluid chamber. Improved efficiency and quieter design.

**EP 0 674 104 A1**

This invention relates to a rotary vane pump, and in particular to a rotary vane pump which is usable in a power steering system of a motor vehicle.

Designs of rotary vane pump are well known. These well known designs typically comprise a stator which has a cylindrical bore, and a rotor having a longitudinal axis about which the rotor rotates in the bore. Either the longitudinal axis of the bore is offset from the longitudinal axis of the rotor, or the bore has a contoured inner surface. The rotor has a number of circumferentially spaced, radially extending, slots therein. A vane is positioned in, and slidable in, each slot, with each vane being biased outwardly to engage the inner surface of the bore in the stator. A fluid inlet and a fluid outlet open into the bore. The arrangement is such that rotation of the rotor within the bore causes the vanes to reciprocate in their respective slots, and drives fluid from the inlet to the outlet. These designs, however, have a limitation with regard to efficiency. Typically a noise spike will be generated every ten rotations of the rotor. Increasing the number of vanes increases the efficiency of the pump, and increases the number of noise spikes, but the magnitude of the spikes is reduced (that is, the pump is quieter). However, increasing the number of vanes increases the risk of breakdown or cracking of the rotor across the inner radial ends of the slots due to the pumping pressure. With these known designs, therefore, there has to be a trade-off between efficiency, noise, and the pumping pressure.

It is an object of the present invention to provide an improved design of rotary vane pump.

A rotary vane pump in accordance with the present invention comprises a stator having a cylindrical outer surface; a rotor which is substantially annular and positioned around the stator to define a fluid chamber between the rotor and the stator, the rotor being rotatable about a longitudinal axis and having a number of radially extending slots therein; a vane slidably mounted in each slot and biased towards the fluid chamber and into engagement with the outer surface of the stator, the vanes reciprocating in their respective slots as the rotor rotates about the stator; a fluid inlet connecting with the fluid chamber; and a fluid outlet connecting with the fluid chamber.

In one embodiment of the present invention, the stator can have a substantially circular cross-section of fixed diameter, with the longitudinal axis of the stator being offset from the longitudinal axis of the rotor. In another embodiment, the outer surface of the stator may be contoured to define a cam surface. The slots in the rotor are symmetrically situated around the rotor, but may be equally or variably spaced.

The present invention will now be described, by way of example, with reference to the accompanying drawings, in which :-

Figure 1 is a cross-sectional view of a rotary vane pump in accordance with the present invention, taken on the line A-A of Figure 2;

Figure 2 is a cross-sectional view taken on the line B-B of Figure 1;

Figure 3 is an inner end view of the cover plate of the rotary vane pump of Figure 1;

Figure 4 is a cross-sectional view on the line C-C of Figure 3;

Figure 5 is an inner end view of the rotor of the rotary vane pump of Figure 1;

Figure 6 is a cross-sectional view on the line D-D of Figure 5;

Figure 7 is an inner end view of the pressure plate and stator of the rotary vane pump of Figure 1;

Figure 8 is a cross-sectional view on the line E-E of Figure 7; and

Figure 9 is an outer end view of the pressure plate of Figure 7.

Referring to Figures 1 and 2 of the drawings, the rotary vane pump comprises a housing 1 preferably of cast metallic material; a substantially annular rotor 2 positioned within the housing; a stator 10 formed on a pressure plate 3 and positioned within the rotor; and sixteen vanes 11 mounted in corresponding slots 12 in the rotor. The housing 1 is substantially cylindrical and defines a through bore 17 of stepped diameter. The larger open end 18 of the through bore 17 in the housing 1 is closed by a cover plate 6 which is secured to the housing by screws 19. An O-ring seal 16 forms a substantially fluid-tight seal between the housing 1 and the cover plate 6.

The rotor 2 is integrally formed with a back plate 20 and a drive shaft 21 which extends out of the smaller open end 22 of the through bore 17 in the housing 1. The drive shaft 21 is rotatably mounted in the through bore 17 by a bearing 4. A high pressure seal 5 acts between the through bore 17 and the drive shaft 21 to form a substantially fluid-tight seal at the smaller open end of the through bore. The rotor 2 is rotatably mounted in the through bore 17 by needle bearing 13 or a suitable bushing (such as a Babbitt bushing). Drive means (not shown) rotates the rotor 2 about its longitudinal axis L.

The pressure plate 3 is located in a predetermined position relative to the cover plate 6 by locating pins 14 which locate the pressure plate within the housing 1 with the stator 10 positioned inside the rotor 2. A fluid chamber 24 is defined between the rotor 2 and the stator 10. A coil spring 15 acting between the pressure plate 3 and the cover plate 6 biases the pressure plate 3 towards

the rotor 2. The stator 10 has an outer surface 23 (Figure 2) which is contoured to form a cam surface, and a longitudinal axis which is aligned with the longitudinal axis L of the rotor 2.

The slots 12 extend radially through the rotor 2. A circumferentially extending groove 25 is formed in the rotor 2 at the outer radial ends of the slots 12. Each vane 11 is slidably mounted in its respective slot and is capable of reciprocating movement therein. Each vane 11 protrudes out of its respective slot 12 and is biased by a garter spring 7 positioned in the groove 25 into engagement with the outer surface 23 of the stator 10. The positioning of the vanes 11 is symmetrical about the longitudinal axis L of the rotor 2, although the vanes are unequally spaced apart.

Referring to Figures 3 and 4, the cover plate 6 comprises a fluid inlet 26 which is connected to a fluid reservoir (not shown) and a fluid outlet 27. A flow control valve (not shown) may be positioned in the fluid outlet 27. A supercharge fluid passage 28 may interconnect the inlet 26 and outlet 27. In the inner surface 29 of the cover plate 6 is formed an annular groove 30 which fluidly connects the inlet 26 to two low pressure depressed areas 31 in the inner surface, and a central depressed area 32 fluidly connected by channels 33 to two high pressure depressed areas 34 and the outlet 27.

Referring to Figure 8 and 9, the outer surface 35 of the pressure plate 3 has two low pressure through bores 36 and two high pressure through bores 37 which align with the corresponding depressed areas 31,34 in the inner surface 29 of the cover plate 6 on assembly of the rotary vane pump. Further, the outer surface 35 has a centrally positioned closed bore 38 which aligns with the central depressed area 32 in the cover plate 6, and which is fluidly connected with the high pressure through bores 37 by a channel 39 in the outer surface 35. On assembly, the coil spring 15 is situated in the closed bore 38. Referring to Figures 7 and 8, the inner surface 40 of the pressure plate 3 has the stator 10 integrally formed thereon, a channel 41 therein for fluidly connecting the low pressure through bores 36, and an annular channel 42 therein adjacent the outer edge 43 for the passage of high pressure fluid between the slots 12 in the rotor 2 adjacent the outer radial end of the slots. The high pressure fluid acts on the vanes 11 (along with the garter spring 7) to bias the vanes into engagement with the outer surface 23 of the stator 10.

Referring to Figures 5 and 6, the rotor 2 is shown with the back plate 20 and the drive shaft 21, radially extending slots 12, and circumferential groove 25. A pair of bores 44 extend through the back plate 20 and fluidly connect with radially extending channels 45 in the back plate to provide

an additional passage for high pressure fluid from the fluid chamber 24 to the outer radial end of each slot 12 to provide bias on the vanes 11 and a hydraulic balance of the rotor 2 relative to the cover plate 6.

In operation, the rotor 2 is driven by the drive means (not shown) to rotate about its longitudinal axis L relative to the housing 1 and stator 10. As the rotor 2 rotates with the vanes 11 in contact with the outer surface 23 of the stator 10, the vanes reciprocate within the slots 12, with the vanes being fully extended inwardly between the low pressure through bores 36 and the high pressure through bores 37 as the vanes move from the low pressure through bores 36 towards the high pressure through bores 37. Fluid at low pressure enters the fluid chamber 24 from the fluid reservoir (not shown) by way of fluid inlet 26 and the low pressure through bores 36. The vanes 11 drive the fluid towards and out through the high pressure through bores 37 to the fluid outlet 27, thereby increasing the pressure in the fluid. The pressurised fluid is used in a power steering system (not shown) of a motor vehicle. Excess fluid flow passes through the supercharge fluid passage 28 to the inlet 26 to help to pressurise the fluid entering the fluid chamber 24.

By positioning the rotor 2 around the stator 10, the number of vanes 11 can be increased to increase the efficiency of the rotary vane pump relative to previously known designs, without the risk of breakdown or fracture of the rotor. This is because the area of the rotor now subjected to high pressure is the outer circumferential edge of the rotor, at which point the slots are spaced furthest apart, and the rotor is at its strongest. The rotary vane pump of the present invention therefore overcomes the trade-off problems, mentioned above, associated with previously known designs, and can pump fluid at higher pressures. Higher pumping pressure allow for a reduction in fluid flow, with subsequent reduction in size of the associated components. The travel of the vanes can also be reduced relative to known designs, and the increase in the number of the vanes result in a quieter pump. with reduced vibration problems.

The above described embodiment of rotary vane pump can be modified within the scope of the present invention. For example, the slots in the rotor could be equidistantly spaced apart. Also, the stator could have a substantially circular cross-section, with the longitudinal axis of the stator offset from the longitudinal axis of the rotor to provide the required reciprocating movement of the vanes as the rotor rotates.

The rotary vane pump of the present invention may be modified as described and claimed in our patent application no. (MJD/G-9796),

filed the same day as the present application.

Claims

1. A rotary vane pump comprising a stator (10) 5
 having a cylindrical outer surface (23); a rotor
 (2) which is substantially annular and posi-
 tioned around the stator to define a fluid cham-
 ber (24) between the rotor and the stator, the
 rotor being rotatable about a longitudinal axis 10
 (L) and having a number of radially extending
 slots (12) therein; a vane (11) slidably mounted
 in each slot and biased towards the fluid
 chamber and into engagement with the outer
 surface of the stator, the vanes reciprocating in 15
 their respective slots as the rotor rotates about
 the stator; a fluid inlet (26) connecting with the
 fluid chamber; and a fluid outlet (27) connect-
 ing with the fluid chamber. 20
2. A rotary vane pump as claimed in Claim 1,
 wherein the cylindrical outer surface (23) of the
 stator (10) is contoured, and the stator has a
 longitudinal axis which is aligned with the lon-
 gitudinal axis (L) of the rotor. 25
3. A rotary vane pump as claimed in Claim 1,
 wherein the stator (10) has a circular cross-
 section, and the stator has a longitudinal axis
 which is offset from the longitudinal axis of the 30
 rotor.
4. A rotary vane pump as claimed in any one of
 Claims 1 to 3, wherein the slots (12) in the
 rotor (2) are symmetrically situated with regard 35
 to the longitudinal axis (L) of the rotor, the slots
 being unequally spaced apart.
5. A rotary vane pump as claimed in any one of
 Claims 1 to 4, further comprising a circum- 40
 ferentially extending groove (25) in the outer
 circumferential edge of the rotor (2) which
 opens into the slots (12), and a spring (7)
 positioned in the groove and acting on the 45
 vanes to bias the vanes into engagement with
 the outer surface (23) of the stator (10).
6. A rotary vane pump as claimed in any one of
 Claims 1 to 5, wherein the rotor (2) is integrally
 formed with a drive shaft (21). 50
7. A rotary vane pump as claimed in any one of
 Claims 1 to 6, wherein the stator (10) is integ-
 rally formed with a pressure plate (3) which is 55
 biased towards the rotor (2) and which com-
 prises through bores (17) to allow fluid to flow
 from the fluid inlet (26) through the fluid cham-
 ber (24) to the fluid outlet (27).

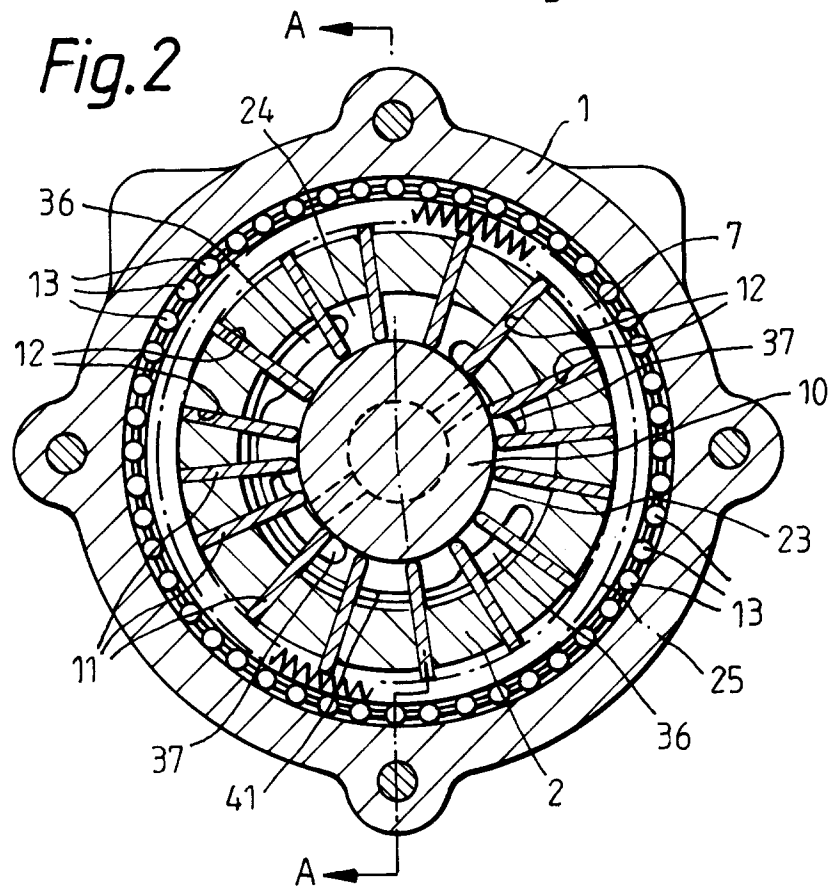
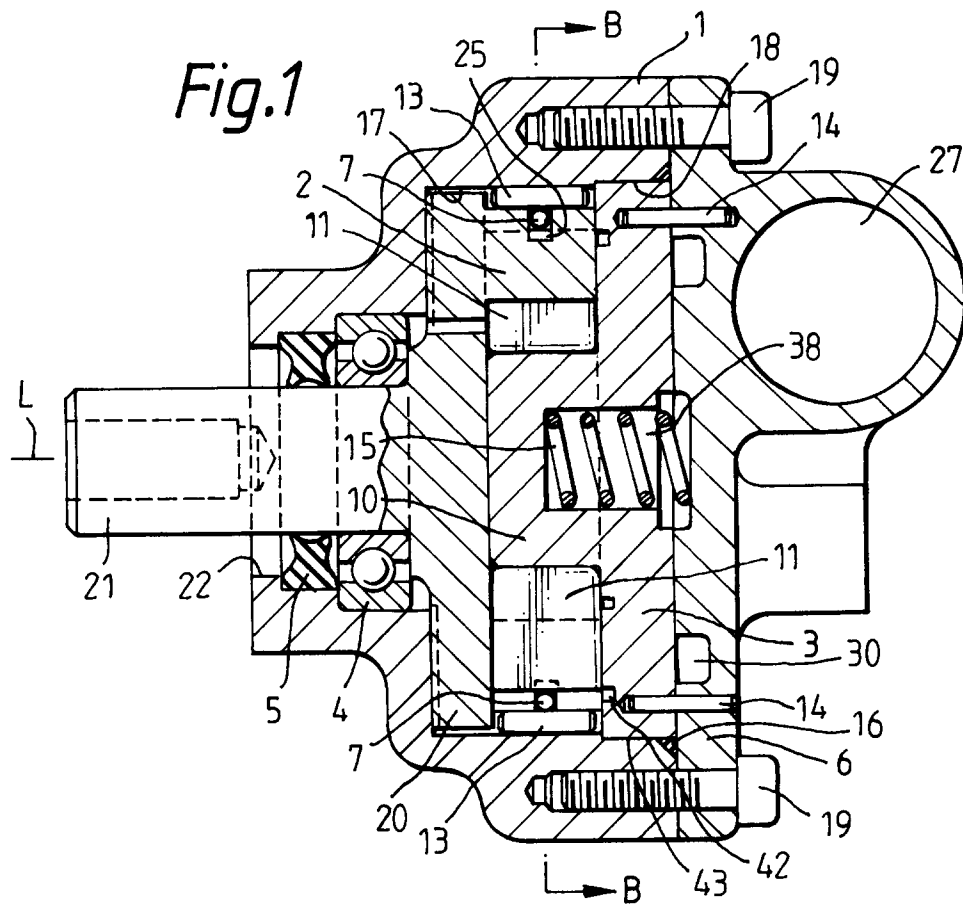


Fig. 3

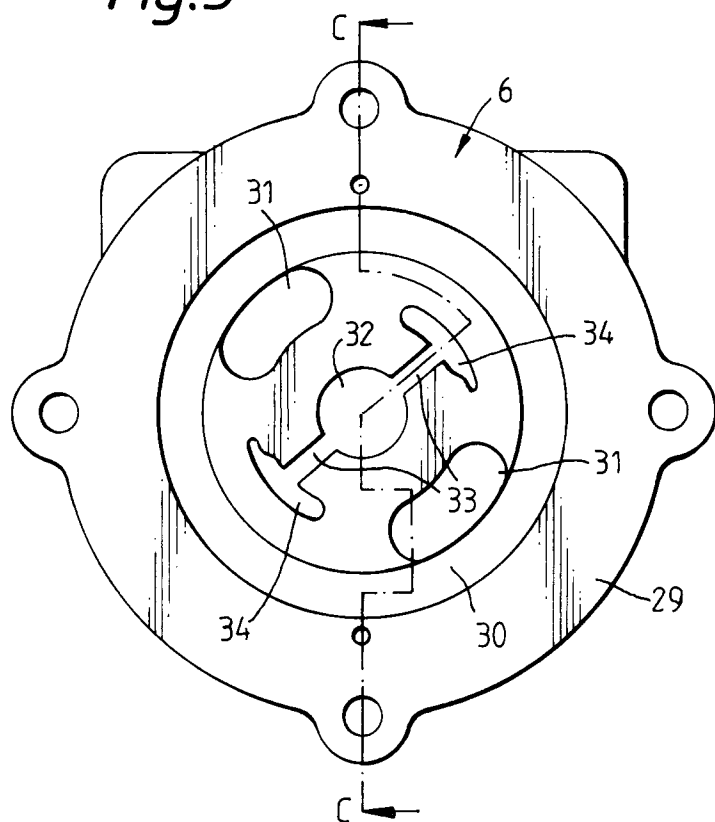


Fig. 4

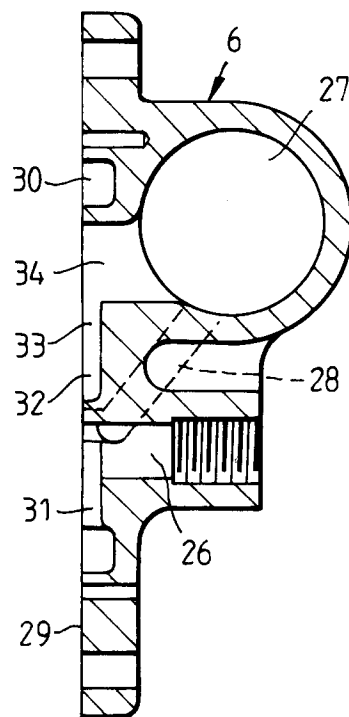


Fig. 5

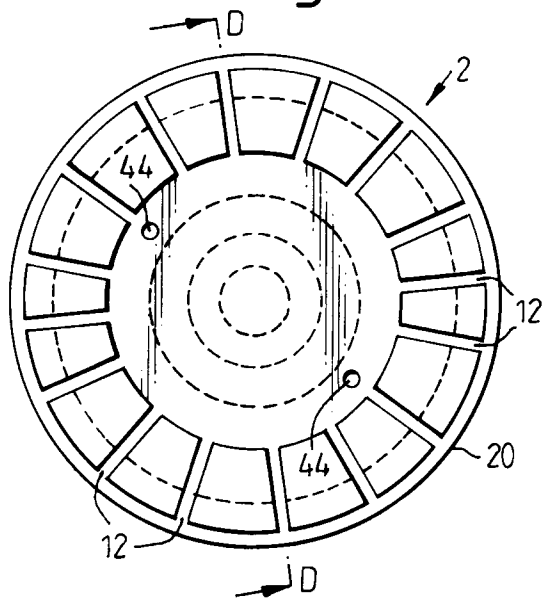


Fig. 6

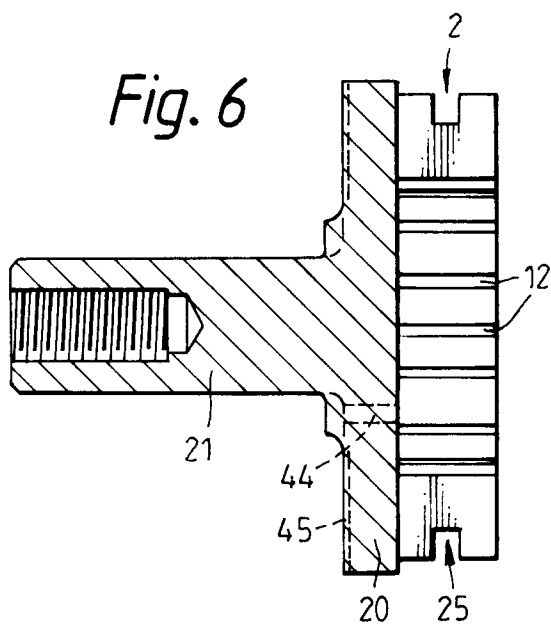


Fig.7

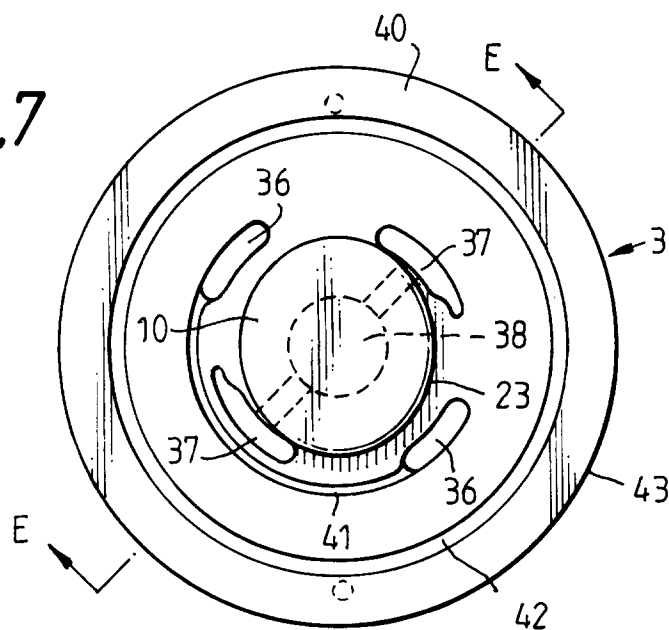


Fig. 8

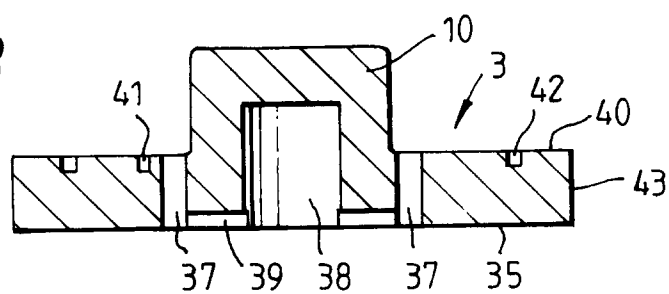
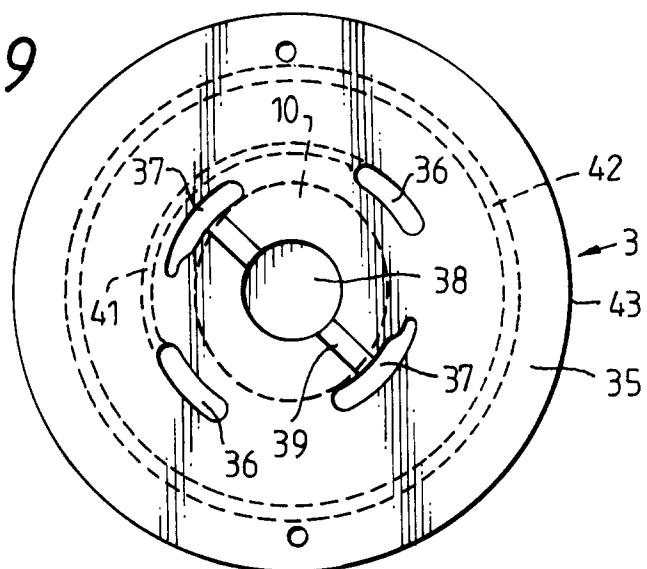


Fig. 9





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EUROPEAN SEARCH REPORT

Application Number
EP 95 20 0456

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.6)
X	DE-A-23 62 810 (BERTRAMS)	1,3,5	F04C2/34
Y	* the whole document *	2	F04C2/348

Y	GB-A-1 213 360 (ALCOLEA)	2	
	* the whole document *		

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The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 27 June 1995	Examiner Dimitroulas, P
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X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	