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(54) **Geared positive-displacement pump with self-compensating gear chamber**

(57) The invention describes a positive-displacement pump (10) of the type comprising a driving gear (12) and a driven gear (14) perfectly coupled together and each mounted on a respective support shaft (16, 18). The driving gear (12) is operatively connected to a motor (20) to set the driven gear (14) in rotation and generate the pumping action on a fluid. The gears (12, 14) are contained in a chamber (40) provided with a closing plate (42). The support shafts (16, 18), the central body (38) of the pump (10), the chamber (40) that contains the gears (12, 14), the closing plate (42) of such a chamber (40), a inner magnet (36) and the base of the rear body (28) of the pump (10) are in turn housed inside a casing (30) of the pump (10). The chamber (40) and the relative closing plate (42) are mounted in a mobile manner with respect to one another and both with respect to the other components of the pump (10) as a function of the pressure of the fluid contained in such a pump (10). A self-compensating chamber (40) is thus made that is adaptable to the varying of the clearances due to the wearing of the internal components of the pump (10) that are in movement, or that are in contact with other moving components.

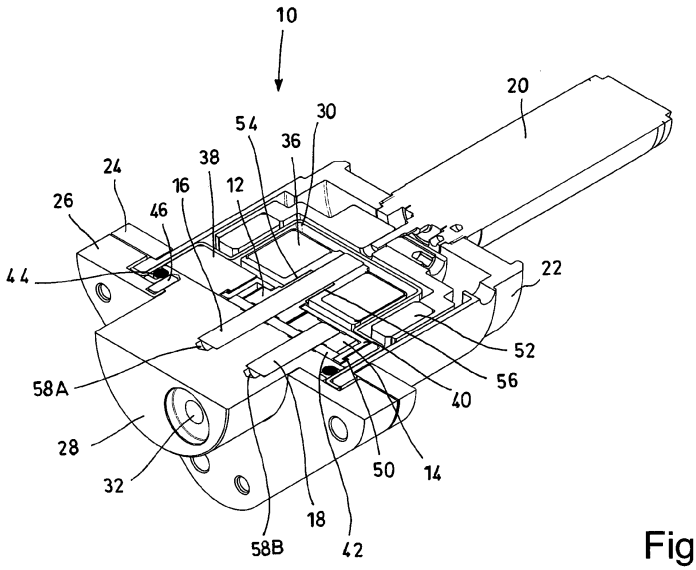


Fig.2

EP 2 639 456 A1

Description

[0001] The present invention refers in general to a positive-displacement pump and, more specifically, to an external gear positive-displacement pump with self-compensating gear chamber.

[0002] As known, a positive-displacement pump is a particular type of pump that exploits the variation of volume in a chamber to cause suction or thrust on an incompressible fluid. Among positive-displacement pumps there are rotary pumps of the type with gears, in which the variation of the volume of the work chamber is obtained through the rotation of elements, typically two gear wheels that mesh with one another, capable of defining rotating chambers of variable volume.

[0003] In particular, so-called external gear pumps consist of two gear wheels perfectly coupled together, arranged inside a case on which openings are made for the suction and the delivery of the liquid to be transferred. The gear wheels are normally fitted onto respective rotary shafts having axes parallel to one another. One of the two gear wheels is actuated by a motor, typically electric, which engages on the relative shaft, whereas the other wheel is set in rotation by the driving wheel. When the teeth of the two wheels separate and transit in front of the suction port, there is a certain depression that allows the liquid to enter into the pumping chamber, formed between the spaces of the teeth and the case. When the teeth reach the delivery port, the liquid no longer has space to stay inside the pump and it is forced to go out through the delivery port itself.

[0004] In a gear pump the coupling of the two gear wheels must be carried out with extreme precision, so as to prevent the reflux of the liquid from the delivery zone towards the suction zone, so that the liquid itself is transferred towards the delivery port only along the spaces comprised between the case and the teeth of the gear wheels. As a result the tolerances between the various elements, mobile and not, that make up a gear pump must be as small as possible.

[0005] A typical drawback encountered in gear pumps is due to the fact that the gears and the internal components in contact with the moving elements wear down with the passing of time. This leads to an increase in the internal clearances and, therefore, to a lowering of the efficiency of the pump, as well as to frequent problems linked to priming.

[0006] The general purpose of the present invention is therefore to make a geared positive-displacement pump with self-compensating gear chamber that is able to solve the aforementioned drawbacks of the prior art in an extremely simple, cost-effective and particularly functional manner.

[0007] In detail, a purpose of the present invention is to make a geared positive-displacement pump that is capable of solving, or at least minimising, the problem of wearing of the components. Of course, it is not possible to prevent the wearing of the moving parts, and therefore the gear pump according to the present invention is configured to avoid the problem in terms of "automatic" limitation of the clearances between the components of the pump itself.

[0008] These purposes according to the present invention are accomplished by making a geared positive-displacement pump with self-compensating gear chamber as outlined in claim 1.

[0009] Further characteristics of the invention are highlighted by the dependent claims, which are an integral part of the present description.

[0010] According to the invention, starting from the presumption that the gears are the first components to wear down, and therefore lose the original dimensions, we have thought to insert such gears inside a casing that is adaptable to the varying of the inner volume occupied by the gears themselves. The adaptation to the variation in volume is obtained by means of a "mobile" chamber. The chamber, through an elastic support system and by also exploiting the difference in pressures of the pumped fluid, "compresses" following the consumption of the gears, thus keeping the clearances almost constant and keeping the performances of the pump unchanged.

[0011] The characteristics and advantages of a geared positive-displacement pump with self-compensating gear chamber according to the present invention will become clearer from the following description, given as an example and not for limiting purposes, referring to the attached schematic drawings, in which:

figure 1 is a perspective view of a geared positive-displacement pump with self-compensating gear chamber according to the present invention, shown without the generic electric motor associated with it;

figure 2 is a section view, obtained along the rotation axes of the gears, of the pump of figure 1, in which the generic electric motor associated with it is also shown;

figure 3 is a section view, obtained along the rotation axes of the gears, of a component (the so-called "bowl" and the relative content) of the pump of figure 1;

figure 4 is another section view of the bowl of figure 3 and of the group containing the suction and delivery ducts of the pump;

figure 5 is a detailed view, through a graph that has been simplified by excess, which shows the operation, the system of clearances and the forces acting on the self-compensating gear chamber of the pump of figure 1; and

figure 6 is a perspective view that shows the rear side of the central body and of the chamber of the gears, without bowl and inner magnet, of the pump of figure 1.

[0012] With reference to the figures, a geared positive-displacement pump with self-compensating gear chamber according to the present invention is shown, wholly

indicated with reference numeral 10. The pump 10 firstly comprises a pair of gear wheels or gears 12 and 14 perfectly coupled together, each mounted on a respective support shaft 16 and 18. The support shafts 16 and 18 are oriented along respective axes A-A and B-B that are parallel to one another (figure 3). One of the gears, for example the gear 12, is operatively connected to a motor 20, for example of the electric type, so that it can operate as a driving gear to set the other gear 14 in rotation, which thus acts as a driven gear. The motor 20 is fixed to the body of the pump 10 through an adapter element 22.

[0013] The clamping between the upper flange 24, the lower flange 26, the rear body 28 and the adapter element 22 of the pump 10 ensures the hermetic insulation between the outside and the components arranged inside the casing or bowl 30 of the pump 10 itself, allowing fluid to enter and exit only through the suction 32 and delivery ducts 34 formed in the rear body 28. The bowl 30 houses an inner magnet 36, the support shafts 16 and 18 and the respective gears 12 and 14, the central body 38, the chamber 40 that contains such gears 12 and 14, a closing plate 42 of such a chamber 40 and the base of the rear body 28 equipped with a gasket 44. The rear body 28 is aligned with the central body 38 and with the lower flange 26 through suitable pins 46 and 48.

[0014] According to the invention, the chamber 40 that contains the gears 12 and 14 and the relative closing plate 42 are mounted in a mobile manner with respect to one another and both with respect to the other components of the pump 10 as a function of the pressure of the fluid contained in the pump 10 itself. In this way there is adaptability of the chamber 40 and of the relative closing plate 42 to the varying of the clearances due to the wearing down of the inner components of the pump 10 that are in movement, or that are in contact with other moving components.

[0015] Advantageously, between the support base 38A of the central body 38 and the support edge 40A of the chamber 40 at least one elastic component 50 (figure 5) is interposed, that allows the relative displacement, with respect to the central body 38, of such a chamber 40 as a function of the pressure of the fluid contained in it.

[0016] Preferably, the aforementioned elastic component 50 consists of an O- ring. The presence of the elastic component 50 is particularly useful to facilitate the priming step of the pump 10 and to allow its possible reversible operation. In addition, in non- operative conditions of the pump 10, between the chamber 40 and the base of the rear body 28 there is a space D to allow such a chamber 40 to be brought up to and away from the base of the rear body 28 as a function of the pressure of the fluid, as will be specified more clearly hereafter.

[0017] The operation of the pump 10 according to the invention takes place in the following way. Once the motor 20 is actuated, it is able to transmit the rotary motion to the external magnet 52 which, through magnetic drive, in turn transmits the motion to the inner magnet 36. The inner magnet 36 is equipped with a recess 54 suitable for the insertion inside it, in shape coupling, of a protuberance 56 formed in the driving gear 12, so that the motion generated by the motor 20 is transmitted directly to such a driving gear 12. The support shaft 16 of the driving gear 12, on the other hand, is fixed, because it is planted in a seat 58A of the rear body 28, just as the support shaft 18 of the driven gear 14 is fixed, planted in a respective seat 58B of such a rear body 28. In this way the use of bushings becomes superfluous.

[0018] The motion of the driving 12 and driven gears 14 is thus able to generate the pumping action. The increase in volume caused by the divergent engagement of the teeth of the gears 12 and 14 creates a depression at the entry of the hole 60 (figure 3) present in the closing plate 42. Such a closing plate 42, through the suction duct 32 of the rear body 28 with which it is aligned, sucks the fluid that is outside of the pump 10. The convergent engagement of the teeth of the gears 12 and 14, on the other hand, causes a decrease in volume and therefore an increase in pressure of the fluid, which will find a way out through a hole 62 (figure 6) positioned on the bottom of the chamber 40.

[0019] From the hole 62 the fluid flows into the portion of bowl 30 that houses the inner magnet 36. The gaps M and R (figure 5) formed between the inner magnet 36, the central body 38 and the chamber 40 are thus saturated with the fluid at a higher pressure with respect to that which can be measured inside and upstream of the chamber 40 itself. By reaction, this greater pressure in the gaps M and R will tend to push the chamber 40 towards the rear body 28, reducing the space D between the chamber 40 and the base of the rear body 28 and the clearances P, T and V between the outer surfaces of the gears 12 and 14 and the inner surfaces of the chamber 40 and of the relative closing plate 42.

[0020] In other words, the high pressure of the fluid contained in the gaps M and R ensures that the closing plate 42 enters deeper inside the chamber 40, just as it causes such a chamber 40 to move closer to the side surface of the gears 12 and 14. The elastic component 50 arranged between the support base 38A of the central body 38 and the support edge 40A of the chamber 40 will also thrust the latter towards the rear body 28 as a function of the pressure of the fluid contained in the gaps M and R, contributing to decreasing the clearances T and V and the space D. The possibilities of moving the closing plate 42 and the chamber 40, as the height and diameters of the gears 12 and 14 decrease following wear, keep the distances between such components and the gears 12 and 14 themselves constant, preventing excessive clearances P, T and V between the outer surfaces of the gears 12 and 14 and the inner surfaces of the chamber 40 and of the closing plate 42 from creating refluxes of the fluid such as to cause the worsening of the performance of the pump 10 and making priming impossible, even in the case of small air bubbles in the flow, with consequent zeroing of the pumping action.

[0021] At the end of the pumping cycle the fluid is then

pushed through a hole 64 formed in the central body 38 and connected to the delivery duct 34 of the rear body 28, so that such a fluid can come outside of the pump.

[0022] It has thus been seen that the geared positive-displacement pump with self-compensating gear chamber according to the present invention achieves the purposes highlighted earlier. The separate mobile parts that make up the self-compensating gear chamber, which houses the gear wheels suitable for generating the pumping action, allow the adaptability of such a chamber as the clearances vary due to the wearing of the inner parts of the pump that are in movement, or that are in contact with the moving parts of the pump itself. This characteristic also allows priming whenever the pump is totally or partially without fluid inside it, for example in the start-up step or in the case of interruption of supply of the fluid itself.

[0023] The geared positive-displacement pump with self-compensating gear chamber thus conceived can in any case undergo numerous modifications and variants, all of which are covered by the same innovative concept; moreover, all of the details can be replaced with technically equivalent elements. In practice, the materials used, as well as the shapes and sizes, can be whatever according to the technical requirements.

[0024] The scope of protection of the invention is therefore defined by the attached claims.

Claims

1. Positive-displacement pump (10) of the type comprising a driving gear (12) and a driven gear (14) perfectly coupled together and each mounted on a respective support shaft (16, 18), the driving gear (12) being operatively connected to a motor (20) to set the driven gear (14) in rotation and generate the pumping action on a fluid, said gears (12, 14) being contained in a chamber (40) provided with a closing plate (42), the support shafts (16, 18), the central body (38) of the pump (10), the chamber (40) that contains said gears (12, 14), the closing plate (42) of said chamber (40), an inner magnet (36) and the base of the rear body (28) of the pump (10) in turn being housed inside a casing (30) of the pump (10), **characterised in that** said chamber (40) and the relative closing plate (42) are mounted in a mobile manner with respect to one another and both with respect to other components of the pump (10) as a function of the pressure of the fluid contained in said pump (10), so as to allow the adaptability of said chamber (40) and of the relative closing plate (42) as the clearances vary due to the wearing of the internal components of the pump (10) that are moving, or that are in contact with other moving components.

2. Positive-displacement pump (10) according to claim 1, **characterised in that** between the support base (38A) of the central body (38) and the support edge (40A) of the chamber (40) at least one elastic component (50) is interposed, that allows the relative displacement, with respect to said central body (38), of said chamber (40) as a function of the pressure of the fluid contained in it.

3. Positive-displacement pump (10) according to claim 2, **characterised in that** said at least one elastic component (50) consists of an O-ring.

4. Positive-displacement pump (10) according to any one of claims 1 to 3, **characterised in that** between the chamber (40) and the base of the rear body (28) there is, in non-operative conditions of the pump (10), a space (D) to allow said chamber (40) to be brought towards and away from said base of the rear body (28) as a function of the pressure of the fluid.

5. Positive-displacement pump (10) according to claim 4, **characterised in that** between the outer surfaces of the gears (12, 14) and the inner surfaces of the chamber (40) and of the relative closing plate (42) there are clearances (P, T, V) that can vary based on the pressure of the fluid contained in the gaps (M, R) formed between the inner magnet (36), the central body (38) and said chamber (40).

6. Positive-displacement pump (10) according to claim 5, **characterised in that** the elastic component (50) is configured to push the chamber (40) towards the rear body (28) as a function of the pressure of the fluid contained in said gaps (M, R), contributing to decreasing at least part of said clearances (T, V) and said space (D), the pressure of the fluid contained in said gaps (M, R) also causing the displacement of the closing plate (42) inside said chamber (40) and the approach of said chamber (40) to the side surface of the gears (12, 14).

7. Positive-displacement pump (10) according to any one of the previous claims, **characterised in that** the motor (20) is able to transmit the rotary motion to an external magnet (52) that in turn transmits the motion to the inner magnet (36) through magnetic drive.

8. Positive-displacement pump (10) according to claim 7, **characterised in that** the inner magnet (36) is equipped with a recess (54) suitable for the insertion inside it, in shape coupling, of a protuberance (56) formed in the driving gear (12), so that the motion generated by the motor (20) is transmitted directly to said driving gear (12).

9. Positive-displacement pump (10) according to claim 8, **characterised in that** the support shafts (16, 18) of the gears (12, 14) are fixed, because they are

planted in respective seats (58A, 58B) of the rear body (28), in this way making the use of bushings superfluous.

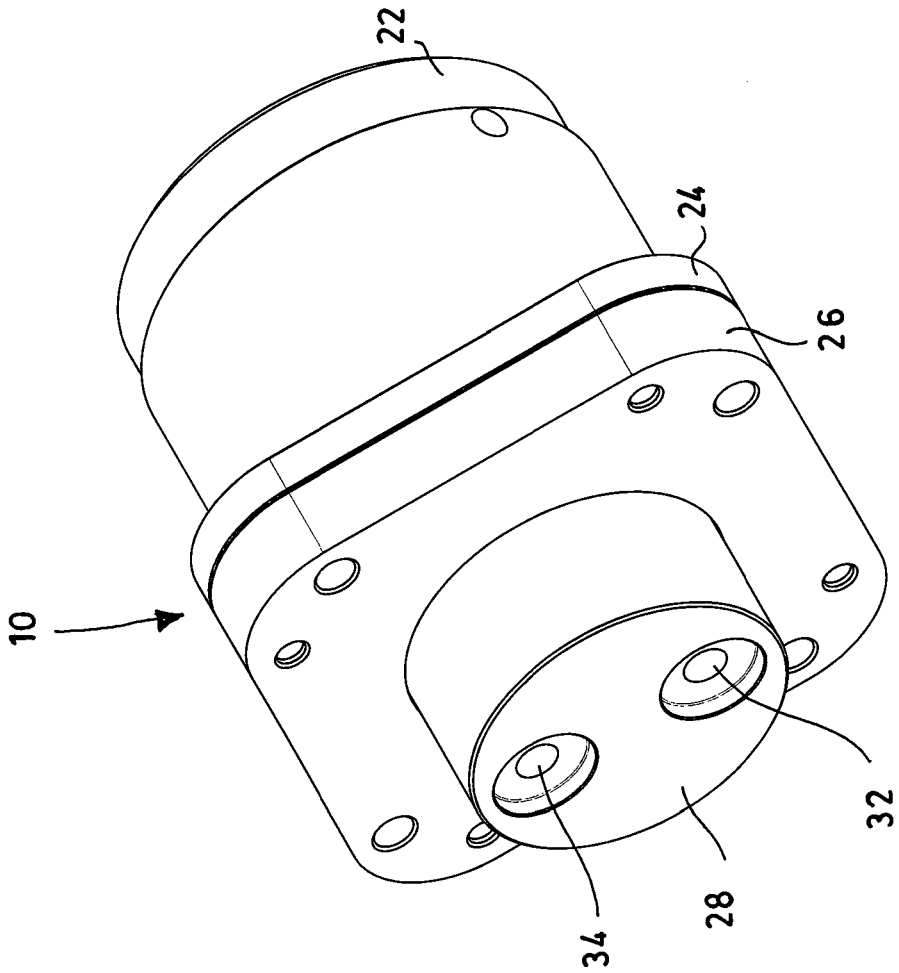
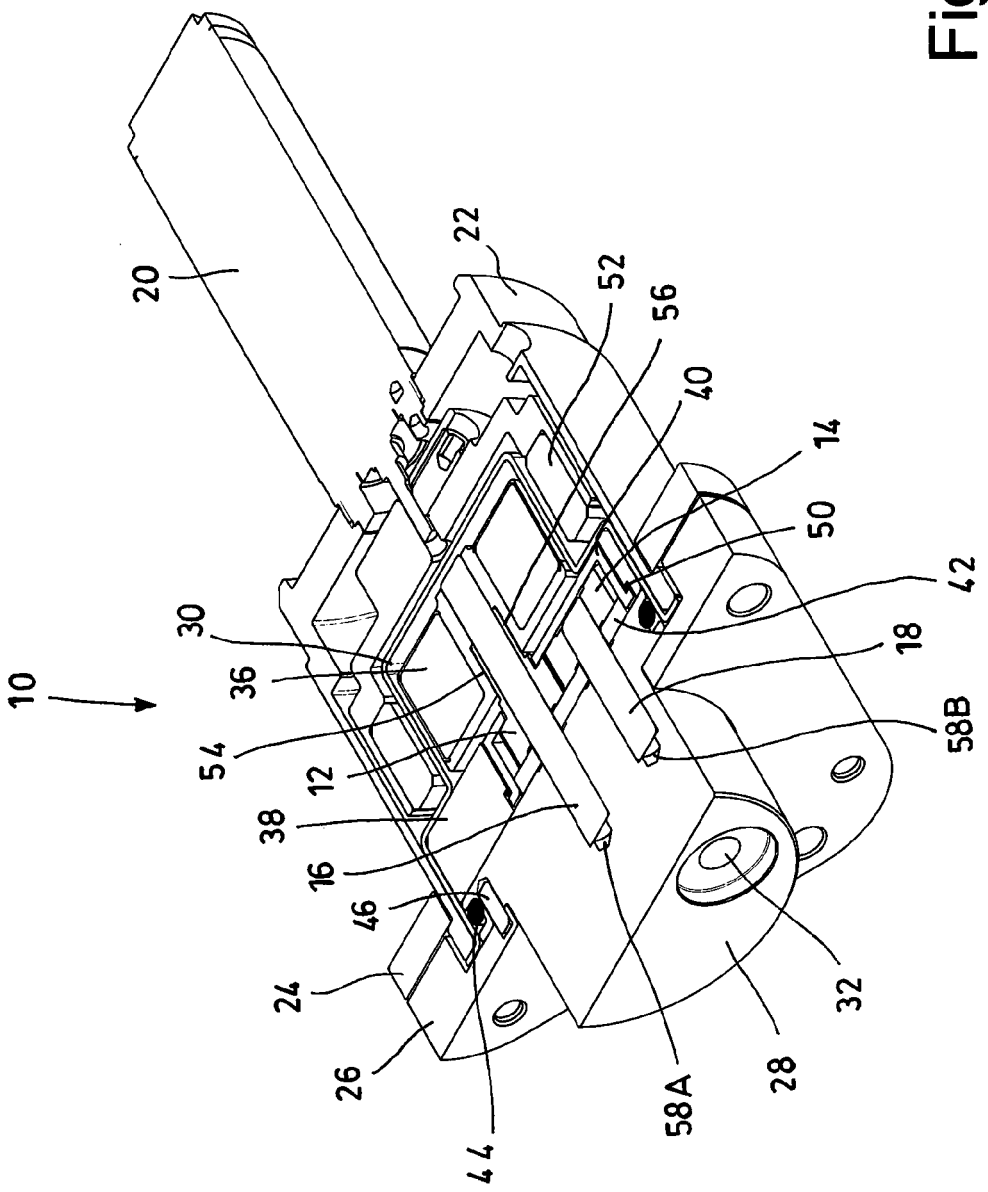


Fig.1


10
20
22
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56
40
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58B
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Fig.2

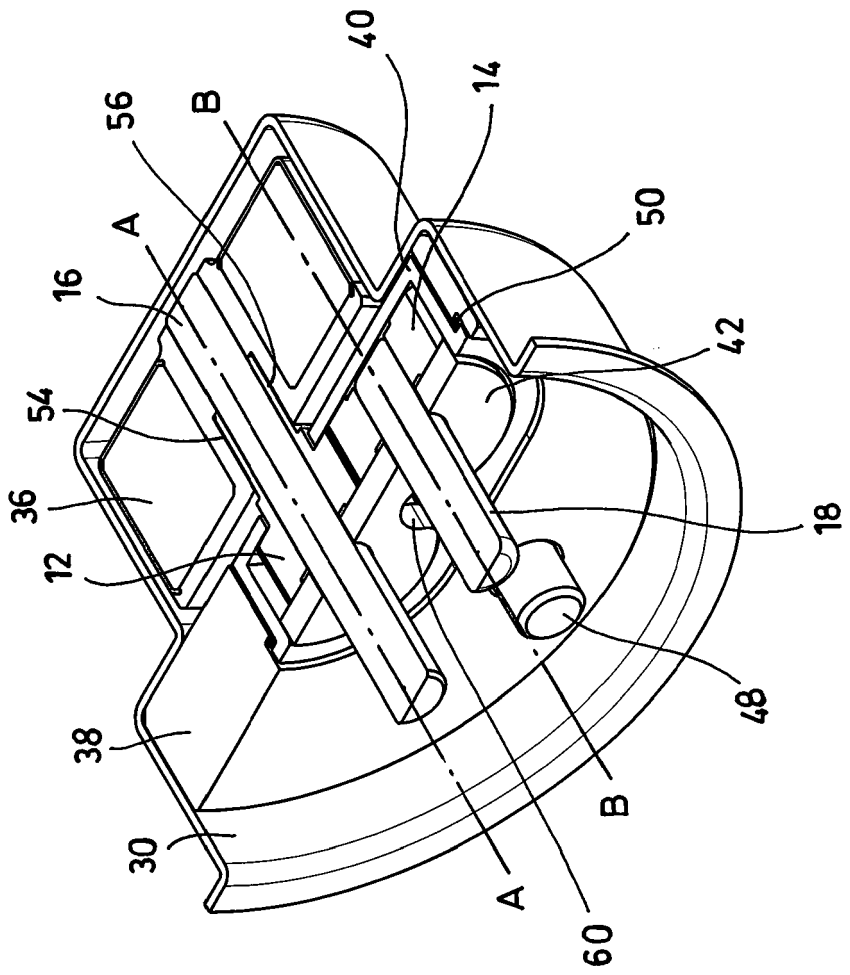

Fig.3

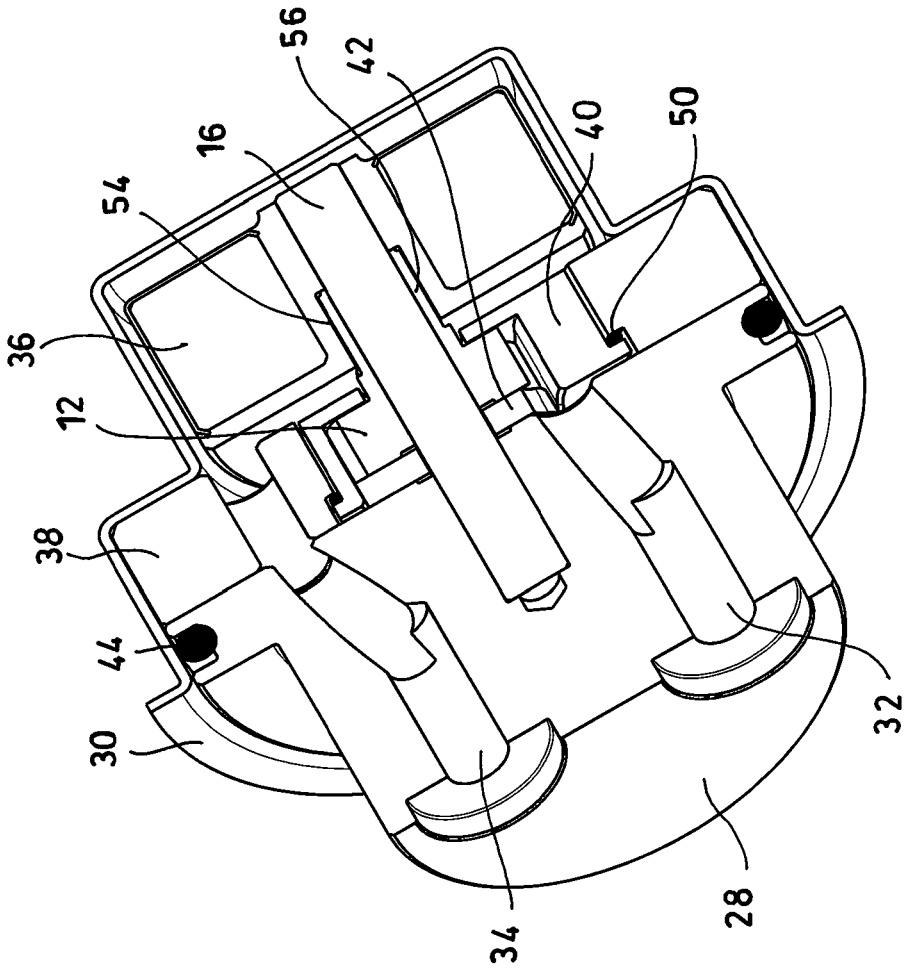

Fig.4

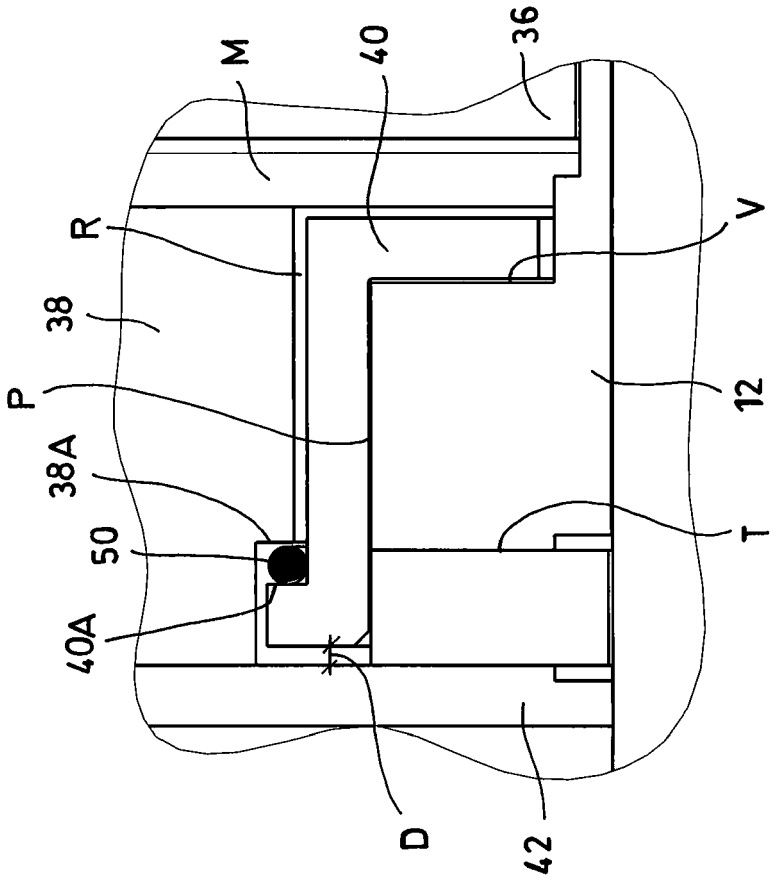

Fig.5

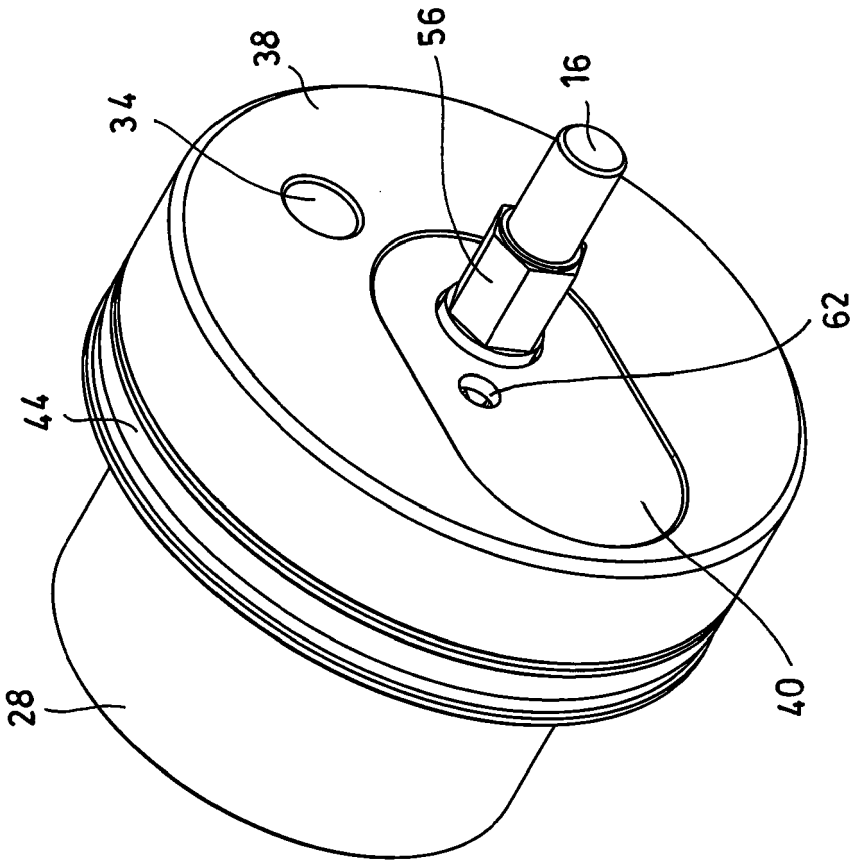

Fig.6

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EUROPEAN SEARCH REPORT

Application Number
EP 13 15 8475

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	US 3 433 168 A (BANKER OSCAR H) 18 March 1969 (1969-03-18) * column 2, line 26 - column 3, line 63 * * figures 1,2 * * column 4, line 16 - column 5, line 32 * -----	1	INV. F04C15/00
Y	GB 1 172 579 A (BORG WARNER [US]) 3 December 1969 (1969-12-03) * the whole document * -----	1	
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			TECHNICAL FIELDS SEARCHED (IPC) F04C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	20 June 2013	Papastefanou, M

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