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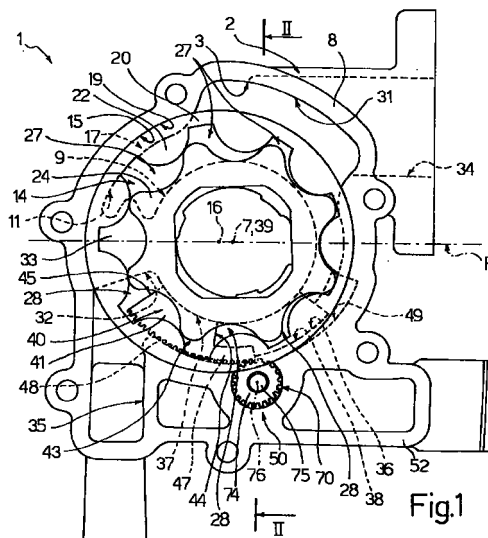
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(54) **Internal gear pump**

(57) A rotary pump (1) of fixed cubic capacity and variable flow, particularly for oil, has a support body (2) bounding a seat (3) comprising an intake chamber (31) adapted to be connected to an oil tank via a relative intake opening (34) and a delivery chamber (32) adapted to be connected to a circuit using the oil via a relative delivery opening (35), the delivery chamber (32) and the intake chamber (31) being separated from one another by a member (40) which can be moved in order to vary, in operation, the flow of compressed oil entering the delivery chamber (32) and is actuated by an actuator unit (50) as a function of the delivery pressure.



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Description

[0001] The present invention relates to a rotary pump, in particular for oil, and more particularly to a rotary pump of fixed cubic capacity and variable flow comprising a body adapted to be connected to a fixed support and bounding an intake chamber adapted to be connected to an oil tank and a delivery chamber adapted to be connected to a delivery circuit and separated from the intake chamber by a fixed baffle.

[0002] Pumps of the type described above can be keyed, for instance, on a drive shaft of an internal combustion engine of a vehicle in order to supply oil to the lubrication circuit of this engine. Since the speed of rotation of the pump is imposed by the speed of rotation of the drive shaft, it is necessary, on the one hand, to ensure a sufficient flow at minimum speeds and, on the other hand, to limit the flow and therefore the pressure of the oil in the lubrication circuit at high speeds of rotation of the pump.

[0003] For these reasons, known pumps of the type described above are provided with a relative bypass valve disposed downstream of the delivery chamber and adapted to cause the surplus oil to be re-circulated to the tank as a function of the pressure in the delivery circuit. Known pumps of the type described above, although widely used, are not very satisfactory, as the oil re-circulated via the bypass valve is compressed by the pump which therefore absorbs a relative mechanical compression energy from the drive shaft without the energy expended actually being used.

[0004] The object of the present invention is to provide a rotary pump of fixed cubic capacity and variable flow, particularly for oil, which makes it possible to resolve the problem described above in a simple and economic way.

[0005] The present invention therefore relates to a rotary pump of fixed cubic capacity and variable flow, particularly for oil, comprising a hollow support body bounding a cavity comprising an intake chamber adapted to be connected to a tank for a fluid via a relative intake opening and a delivery chamber adapted to be connected to a circuit using the fluid via a relative delivery opening and separator means for separating the delivery and intake chambers in a fluid-tight manner, characterised in that the separator means comprise a moving member, movement means being provided to displace the moving member and to vary the flow of compressed fluid entering the delivery chamber as a function of the delivery pressure of this fluid.

[0006] The invention will be described below with reference to the accompanying drawings, which show a non-limiting embodiment thereof, in which:

Fig. 1 shows a preferred embodiment of the rotary pump of the present invention;

Fig. 2 is a cross-section along the line II-II of Fig. 1;

Fig. 3 is a cross-section along the line III-III of Fig. 2

and shows, on an enlarged scaled, the pump of Fig. 1 disposed in an operating condition differing from that shown in Fig. 1;

Fig. 4 is a cross-section, on an enlarged scale, along the line IV-IV of Fig. 2;

Fig. 5 is a diagram, on a reduced scale, of a central portion of the pump of Fig. 1; and

Fig. 6 is a graph relating to the operation of the pump of Fig. 1.

[0007] In Figs. 1 to 4, a flanged rotary pump of fixed cubic capacity for supplying oil for the lubrication of an internal combustion engine (not shown) for vehicles is shown overall by 1.

[0008] The pump 1 comprises a hollow body 2 which defines an inner cavity 3 and in turn comprises a tubular intermediate portion 4 bounded by an inner cylindrical surface 5 having an axis 7, and a shaped peripheral portion 8 rigid with the portion 4 and adapted to be connected, in operation, to a fixed support body, which is known and not shown, via a plurality of screws (not shown).

[0009] As shown in Figs. 1, 2 and 3, the portion 4 has, bounding the cavity 3, an outer cylindrical surface 9 and a plane annular surface 10 extending at right angles to the axis 7 between the surfaces 5 and 9. The portion 8 has, again bounding the cavity 3, a lateral surface 11 facing the surface 9 and connected to this surface 9 via a base surface 14 at right angles to the axis 7, an inner cylindrical surface 15 having an axis parallel to the axis 7 and excentric with respect to this axis 7, and an annular shoulder 17 extending between the surfaces 15 and 11 and co-planar with the surface 10.

[0010] In Fig. 1, the surfaces 15, 10 and the shoulder 17 define a circular housing 19, forming part of the cavity 3, for a pair of known toothed annular rotors, shown by 20 and 21, which form part of the pump 1, wherein the rotor 20 is coupled in a sliding manner to the shoulder 17 and to the surface 15 in order to rotate about the axis 16 and has inner teeth 22 (Fig. 1).

[0011] The rotor 21, however, is adapted to be connected to an actuation shaft (not shown) in order to rotate about the axis 7 and comprises an annular portion 23 housed within the rotor 20 in a position facing the surface 10 and provided with outer teeth 24 (Fig. 1) meshing with the teeth 22, and a centring collar 25, which projects from the portion 23 and is coupled in a fluid-tight manner to the portion 4 and, in particular, in a sliding manner to the surface 5.

[0012] The teeth 22 and 24 bound between one another first and second spaces, shown by 27 and 28 respectively, wherein the spaces 27 have, in operation, a volume increasing with the rotation of the rotors 20 and 21 (in an anticlockwise direction in Figs. 1 and 3), while the spaces 28 have a volume decreasing with this rotation.

[0013] As shown in Figs. 2 and 3, the rotors 20, 21 and the surfaces 9, 14 and 11 bound between one

another an intake chamber 31 and a delivery chamber 32 separated from one another by a fixed portion 33 of the body 2, which extends radially between the surfaces 9 and 11 along a plane P of the axes 7 and 16 and is axially bounded by the shoulder 17 in order axially to close the area in which the spaces 27 and 28 have a maximum volume.

[0014] The intake chamber 31 communicates with the spaces 27 and with an intake opening 34 adapted to be connected to an oil tank (not shown), while the delivery chamber 32 communicates with the spaces 28 and with a delivery opening 35 adapted to be connected to the lubrication circuit (not shown) of the engine.

[0015] As shown in particular in Fig. 2, the cavity 3 further comprises a seat 36 with a constant radial section, obtained between the chambers 31 and 32 on the side opposite the portion 33 at the location of the spaces 28. The seat 36 is bounded axially by the rotors 20, 21 and by the surface 14 and radially by cylindrical sections 37 and 38 of the surfaces 9 and 11 coaxial with an axis 39 coincident with the axis 7, and is engaged by a member 40, which separates the chambers 31 and 32 from one another in a fluid-tight manner and can move angularly about the axis 39 with respect to the body 2. The member 40 comprises a portion 41 in the form of a circular sector bounded by a lateral surface 43 which is coupled in a sliding manner to the sections 37 and 38, to the rotors 20 and 21 and to the base surface 14, and by two opposing radial surfaces 44 and 45, of which the surface 44 bounds the intake chamber 31 and the surface 45 bounds the delivery chamber 32, which form, between one another, with respect to the axis 39, an angle slightly in excess of the maximum angular amplitude of a space 28.

[0016] The member 40 further comprises a portion 47 in the form of an arc extending in a projecting manner from the surface 44 in an axial position adjacent to the rotor 20 and is provided with cylindrical outer teeth 48 coaxial to the axis 39, projecting from the portions 41 and 47 in order to engage a circular groove 49 obtained in the portion 8 in a fluid-tight manner.

[0017] As shown in particular in Fig. 4, the member 40 is actuated by a movement unit 50, which forms part of the pump 1 and comprises a linear hydraulic actuator 51. The actuator 51 in turn comprises a hollow portion 52 rigid with the portion 8 and defining a cylindrical seat 53 along an axis 55 and communicating with the delivery chamber 32 via an axial passage 57 bounded by an annular shoulder portion 58. The actuator 51 further comprises a member 60 sliding axially in a fluid-tight manner in the seat 53 and comprising an intermediate elongate rod 61 provided with a rack 63, and two end axial portions 65 and 66, of which the portion 65 defines a plate bounding the passage 57, while the portion 66 is coupled to the portion 52 via the interposition of a preloaded spring 68 adapted to exert an elastic action along the axis 55 in order to maintain the plate 65 in abutment against the annular portion 58.

[0018] In Figs. 1 to 4, the unit 50 further comprises a geared transmission unit 70 interposed between the actuator 51 and the member 40 and in turn comprising the rack 63 and the teeth 48, a pinion 72 engaging with the rack 63 and a toothed wheel 74, whose diameter is double that of the pinion 72, engaging with the teeth 48 in the groove 49. The pinion 72 and the wheel 74 are rigidly connected by a pin 75 made rigidly with the pinion 72 and the wheel 74, and coupled to the portion 52 in order to rotate with respect to the body 2 about an axis 76 parallel to the axis 39 and at right angles to the axis 55.

[0019] In operation, as the speed of rotation of the rotors 20 and 21 increases, the flow supplied by the pump 1 and therefore the pressure of the oil in the engine lubrication circuit tend to increase. The action exerted by the delivery pressure on the plate 65 is countered by the action of the spring 68 as a result of which, when the delivery pressure exceeds a threshold value such as to overcome the preloading of the spring 68, the member 60 moves in translation along the axis 55 and the pin 75 rotates about the axis 76.

[0020] Following the rotation of the pin 75, the member 40 rotates in the seat 36 about the axis 39 with respect to the body 2 in the direction of rotation opposite that of the pin 75, reducing the passage area of the oil from the spaces 28 entering the delivery chamber 32. As the delivery pressure increases from the threshold value, the member 40 rotates gradually from a first angular end-of-stroke position (Fig. 3) to a second angular end-of-stroke position (Fig. 1), corresponding to a maximum and a minimum value respectively of the passage area of the oil to the delivery chamber 32.

[0021] With reference in particular to the graph of Fig. 5, when the member 40 is disposed in a regulation position, the surface 45 forms an angle X with respect to the plane P. During the rotation of the rotors 20 and 21, each space 28 communicates with the delivery chamber 32 and the passage area of the oil from the space 28 to the delivery chamber 32 decreases from a maximum value AO to a value Ax corresponding to the angle X, as a result of which the pump 1 supplies part of the oil contained in the space 28 proportional to the difference between the values AO and Ax to the delivery chamber 32 and, from there, to the delivery opening 35, carrying out a relative compression operation.

[0022] Again following the rotation of the rotors 20 and 21, each space 28 is firstly axially closed by the lateral surface 43 and, once the member 40 has been passed, enters into communication with the intake chamber 31 as a result of which the pump 1 discharges the remaining portion of the oil contained within each space 28 proportional to the value Ax, directly to the intake chamber 32, without carrying out any compression operation on this portion of oil.

[0023] Fig. 6 shows the course of the passage area of the oil from a single space 28 to the delivery chamber 32 as a function of the angle X. As the angle X

increases, the value A_x of the area progressively decreases from the value A_O until it is cancelled out in respect of an angle close to 180° , as a result of which the difference between the values A_O and A_x increases and therefore the flow of oil supplied by the pump 1 increases.

[0024] It will be appreciated from the above description that the pump 1 of fixed cubic capacity supplies a variable flow of oil in a continuous and automatic manner as a function of the delivery pressure, and absorbs from the drive shaft only the energy needed to compress the oil actually supplied.

[0025] At low speeds of rotation of the engine, the member 40 of the pump 1 is disposed in the first end-of-stroke position, enabling the pump 1 to behave as a conventional pump, while at high speeds of rotation it limits the flow of oil supplied without dissipating energy with the result that the pump 1 absorbs a lower power than known pumps.

[0026] The member 40 separates the chambers 31 and 32 from one another in a fluid-tight manner and can be moved to vary the passage area from the spaces 28 to the delivery chamber 32 and therefore the flow of oil supplied via the delivery opening 35, and in order directly to re-circulate the surplus portion of oil on which no compression is carried out to the tank.

[0027] The movement unit 50 makes it possible, moreover, to regulate the angular position of the member 40 in a continuous and precise manner as a function of the action exerted by the delivery pressure on the plate 65 and with a transmission ratio such as to achieve a stroke of the member 40 which is greater than that of the member 60.

[0028] It will be appreciated that modifications and variations that do not depart from the scope of protection of the present invention may be made to the pump 1 described above.

[0029] In particular, the member 40 could be shaped in a different manner and/or could rotate about an axis 39 excentric with respect to the axis 7, and/or the movement unit 50 could be other than that illustrated by way of example.

Claims

1. A rotary pump (1) of fixed cubic capacity and variable flow, particularly for oil, comprising a hollow support body (2) bounding a cavity (3) comprising an intake chamber (31) adapted to be connected to a fluid tank via a relative intake opening (34) and a delivery chamber (32) adapted to be connected to a circuit using this fluid via a relative delivery opening (35), and separator means (33, 40) adapted to separate the delivery chamber (32) and the intake chamber (31) from one another in a fluid-tight manner, characterised in that the separator means (33, 40) comprise a moving member (40), movement means (50) being provided to displace the moving

member (40) and to vary the flow of compressed fluid entering the delivery chamber (32) as a function of the delivery pressure of this fluid.

2. A pump as claimed in claim 1, characterised in that it comprises a rotor (20, 21) rotating about a relative axis of rotation (7, 16), in order to convey the fluid from the intake chamber (31) to the delivery chamber (32), the moving member (40) rotating about an axis (39) parallel to the axis of rotation (7, 16).
3. A pump as claimed in claim 2, characterised in that the moving member (40) is disposed in an axial position facing the rotor (20, 21).
4. A pump as claimed in any one of the preceding claims, characterised in that the movement means (50) comprise a hydraulic actuator (51) adapted to displace the moving member (40) and transmission means (70) interposed between the hydraulic actuator (51) and the moving member (40).
5. A pump as claimed in claim 4, characterised in that the transmission means (70) comprise at least one geared transmission (63, 72) (74, 48).
6. A pump as claimed in claim 5, characterised in that the transmission means (70) comprise a rack and pinion transmission (72, 63).
7. A pump as claimed in claim 5 or 6, characterised in that the transmission means (70) comprise a first toothed wheel (72) coupled to the hydraulic actuator (51) and a second toothed wheel (74) interposed between the moving member (40) and the first toothed wheel (72).
8. A pump as claimed in claim 7, characterised in that the transmission means (70) comprise a rotary pin (75) made rigidly with the toothed wheels (72, 74).
9. A pump as claimed in claim 7 or 8, characterised in that the second toothed wheel (74) has a diameter greater than that of the first toothed wheel (72).
10. A pump as claimed in any one of claims 4 to 9, characterised in that the hydraulic actuator (51) is a linear actuator.
11. A pump as claimed in claims 7 and 10, characterised in that the hydraulic actuator (51) comprises a thrust head (65) on which the delivery pressure acts, in operation, and a rack (63) rigidly connected to the thrust head (65) in order to move in translation together with the thrust head (65) and engaging with the first toothed wheel (72).
12. A pump as claimed in claim 11, characterised in

that the hydraulic actuator (51) comprises elastic means (68) adapted to exert an action opposing that exerted by the delivery pressure on the thrust head (65), in order to urge the moving member (40) towards an end-of-stroke position, in which the moving member (40) remains until the delivery pressure exceeds a threshold value.

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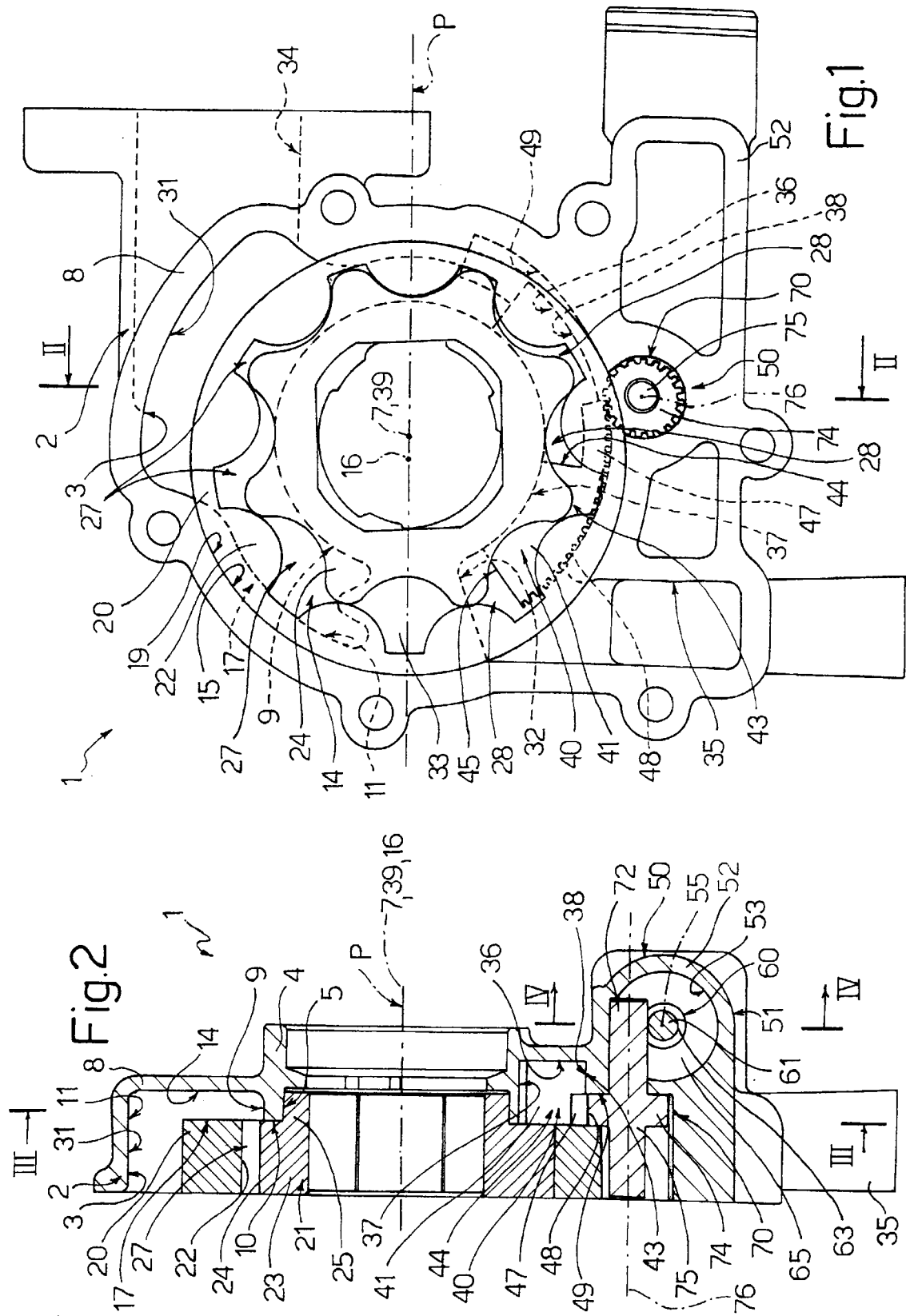
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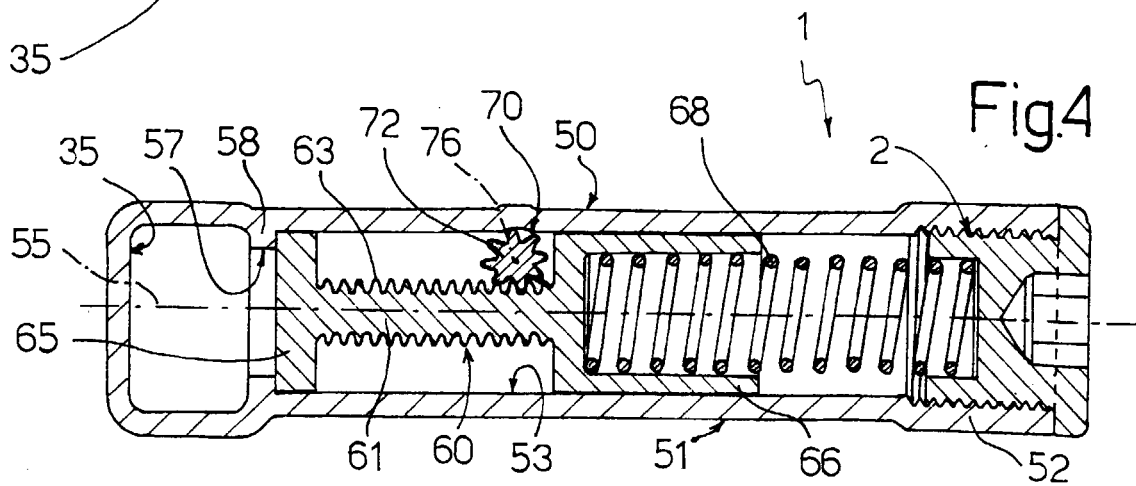
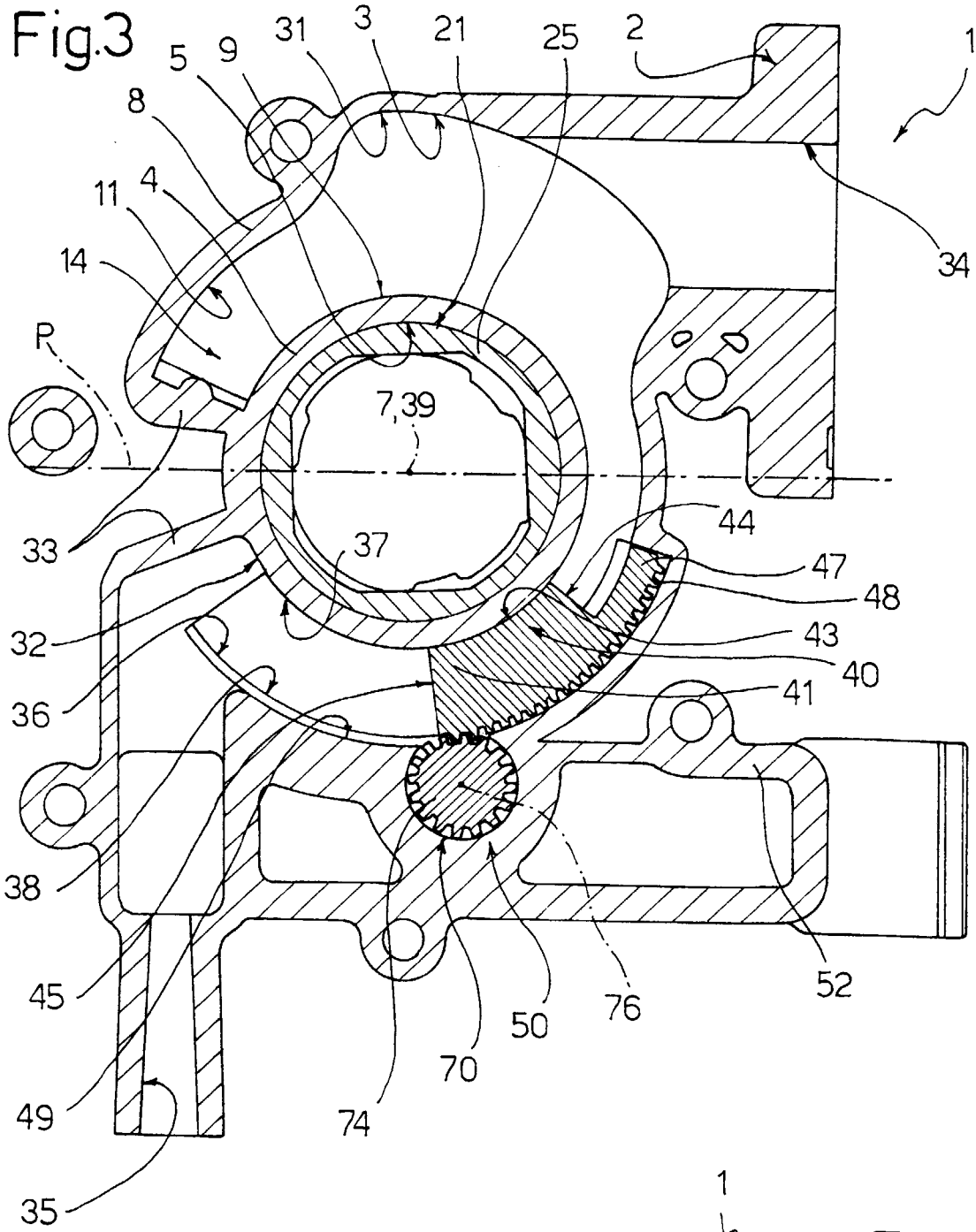
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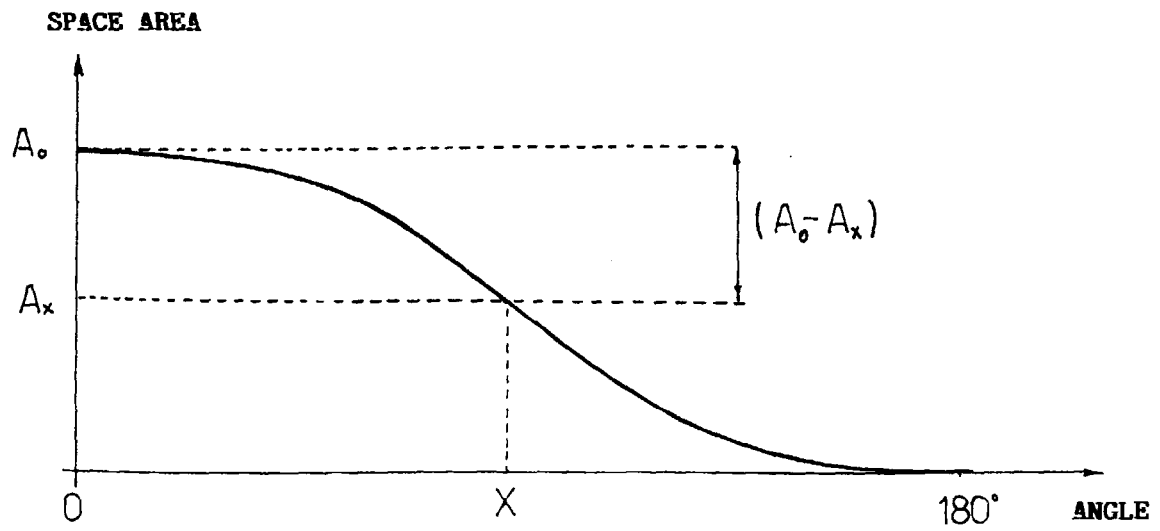


Fig.6

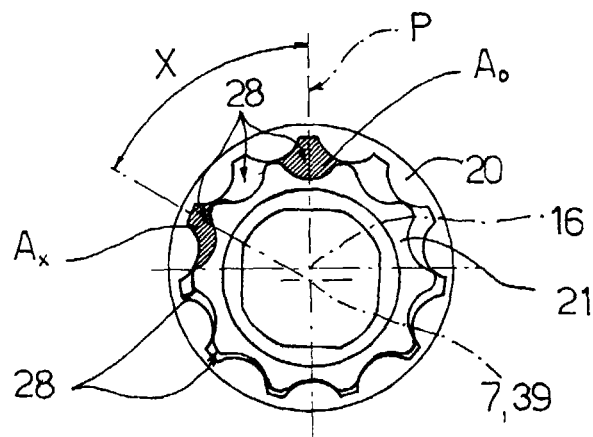


Fig.5



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EUROPEAN SEARCH REPORT

Application Number
EP 00 12 1895

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Y	* claims 1,2; figures 19-22 *	2,5,6,10	
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			TECHNICAL FIELDS SEARCHED (Int.CI.7)
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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 2 January 2001	Examiner Dimitroulas, P
CATEGORY OF CITED DOCUMENTS 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			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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