(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 213 481 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
12.06.2002 Bulletin 2002/24

(51) Int Cl.[7]: **F04C 15/04**, F04C 2/18

(21) Application number: **01128459.3**

(22) Date of filing: **05.12.2001**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE TR
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **05.12.2000 IT TO001133**

(71) Applicant: **FIAT AUTO S.p.A.**
10135 Torino (IT)

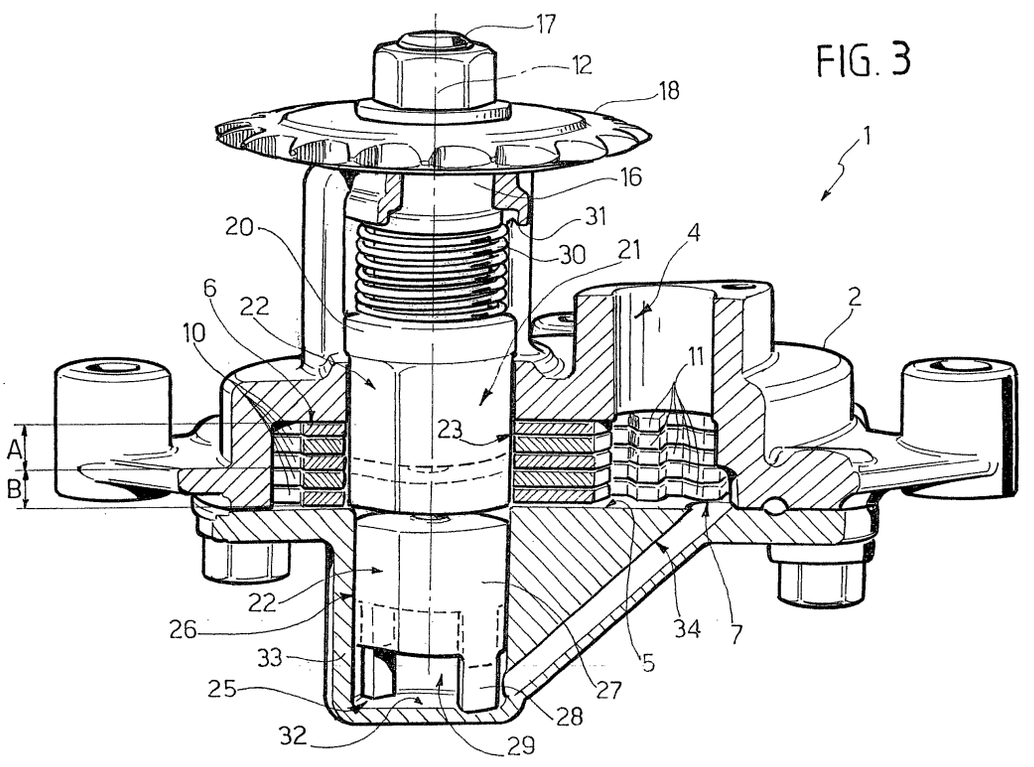
(72) Inventor: **The designation of the inventor has not yet been filed**

(74) Representative: **Franzolin, Luigi et al**
STUDIO TORTA S.r.l.,
Via Viotti, 9
10121 Torino (IT)

(54) Rotary pump with a variable flow rate, particularly for oil

(57) A rotary pump (1) with a variable flow rate, particularly for oil, has a support body (2), with a suction mouth (3), which, in use, is connected to an oil tank, and a delivery mouth (4), which, in use, is connected to a delivery circuit, and accommodates a drive rotor (6) and a driven rotor (7); the rotors (6, 7) can rotate around their own axes (12, 13), in order to convey oil from the suction mouth (3) to the delivery mouth (4), and are each defined by a corresponding set (6, 7) of toothed wheels (10, 11), which are superimposed axially on one another, each of which engages with a corresponding wheel (11, 10) of the other set (7, 6); in use, the sets (6, 7) have a first part of the wheels (A) which can rotate, and a second part of the wheels (B) which is fixed, the axial thicknesses of which sets are variable by means of a regulation unit (25), according to the delivery pressure.

FIG. 3



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Description

[0001] The present invention relates to a rotary pump with a variable flow rate, and in particular to a gear pump for oil, to which the following description refers explicitly, without however detracting from generality. As is known, a gear pump comprises a support body, which delimits a suction mouth, which, in use, is connected to an oil tank, and a delivery mouth, which, in use, is connected to a delivery circuit, and accommodates two toothed rotors which engage with one another, and delimit a plurality of apertures, in order to convey oil from the suction mouth to the delivery mouth.

[0002] The known gear pumps of the above-described type are used for example in motor vehicles, in order to convey the oil to the lubrication circuit of a corresponding internal combustion engine, the drive shaft of which actuates one of the rotors of the pump, and thus sets the speed of rotation of the rotors themselves.

[0003] In use, it is necessary to meet the requirements both of guaranteeing a sufficient flow rate of oil to the lubrication circuit, in minimum conditions of rotation, and of limiting the flow rate, and thus the oil pressure at high speeds of rotation.

[0004] For this purpose, the known pumps of the above-described type are provided with a corresponding by-pass valve, which can re-circulate the excess oil from the delivery mouth to the tank, according to the pressure present in the delivery circuit.

[0005] Although they are widely used, the known pumps of the above-described type are unsatisfactory, since the oil which is re-circulated through the by-pass valve is compressed by the pump, which thus absorbs corresponding mechanical compression energy from the engine shaft, without this energy then being actually used.

[0006] The object of the present invention is to provide a rotary pump with a variable flow rate, particularly for oil, which makes it possible to solve the above-described problems simply and economically.

[0007] According to the present invention, a rotary pump with a variable capacity, particularly for oil, is provided, comprising a support body with has a suction mouth, which can be connected to a tank for a fluid, and a delivery mouth which can be connected to a circuit for delivery of the fluid itself; a toothed drive rotor and driven rotor, which engage with one another, and are accommodated in the said support body in a manner such as to rotate around their own axes, in order, in use, to convey the said fluid from the said suction mouth to the said delivery mouth; characterised in that it comprises means for regulation, to vary the axial dimension of the said rotors, according to the delivery pressure of the said fluid.

[0008] The invention will now be described with reference to the attached drawings, which illustrate a non-limiting embodiment of it, in which:

- Figure 1 illustrates in perspective, and with parts removed for the sake of clarity, a preferred embodiment of the pump with a variable flow rate, particularly for oil, produced according to the present invention;
- Figure 2 is a perspective view of a detail of the pump in Figure 1; and
- Figure 3 is a further perspective view of the pump in Figure 1, with parts illustrated in cross-section, according to the line III-III in Figure 2.

[0009] In Figure 1, 1 illustrates a pump with a variable flow rate, in particular a pump which can be fitted in a motor vehicle (not illustrated), in order to convey oil to a lubrication circuit of an internal combustion engine (not illustrated) of the motor vehicle itself.

[0010] With reference to the attached Figures, the pump 1 is of the gear type, and comprises a support body 2, which can be connected integrally, in a manner which is known and is not described in detail, to a portion of the engine, and has a suction mouth 3 (Figure 2) which can be connected to an oil tank (not illustrated), and a delivery mouth 4, which can be connected to the lubrication or delivery circuit. The body 2 delimits a cavity 5, which communicates with the exterior by means of the mouths 3 and 4, and accommodates two sets 6 and 7 of wheels respectively 10 and 11, which are toothed on the exterior.

[0011] The wheels 10, 11 of each set 6, 7 are superimposed on one another along respective axes 12 and 13, which are parallel to one another, and each engage with a corresponding wheel 11, 10 of the other set. The wheels 10, 11 all have the same axial thickness, they are disposed in fixed axial positions, and can rotate around the corresponding axes 12 and 13, in order to convey oil from the mouth 3 to the mouth 4 by means of a plurality of compartments 14, which are delimited by the body 2 and by the wheels 10, 11 themselves. The wheels 11 are keyed in an idle manner onto a cylindrical pin 15 (Figure 2) which is connected to the body 2, whereas at least some of the wheels 10 are rotated by a coaxial shaft 16, which is connected to the body 2, in a fixed axial position and in a rotary manner.

[0012] The shaft 16 comprises an external end section 17, onto which there is keyed, in a fixed position, a gear 18 which is actuated by a drive shaft (not illustrated) of the motor vehicle, by means of a chain (not illustrated) which is wound around the gear 18 itself.

[0013] The shaft 16 additionally comprises a grooved end section (not visible), onto which there is keyed a coaxial body 20, which is in the shape of a cup, and is connected to the grooved section itself in a manner which is axially sliding and angularly fixed. The body 20 is delimited externally by a lateral surface 21, which has two flattened parts 22, it is complementary to through axial seats 23 provided in the wheels 10, and engages the seats 23 themselves in a manner which is axially sliding and angularly fixed.

[0014] The body 20 constitutes part of a regulation unit 25, in order to vary the flow rate of the pump 1 according to the delivery pressure of the oil.

[0015] The unit 25 also comprises a pin 26 which is coaxial relative to the body 20, disposed on the side opposite the shaft 16, and comprises an axial end 27, which abuts the body 20, has in transverse cross-section the same outer profile as the body 20, and comprises two integral projections 28, which are opposite the body 20 itself.

[0016] The pin 26 defines the mobile unit of a single-effect hydraulic actuator 29, which constitutes part of the unit 25, and comprises a pre-loaded spring 30, which is interposed axially between the body 20 and an axial shoulder 31 of the shaft 16. The actuator 29 additionally comprises a control chamber 32, which is provided in a hollow portion 33, which, in its interior, has a transverse cross-section which is complementary to that of the end 27, is delimited by the end 27 itself, and communicates with the mouth 4 via a duct 34. Thus, in relation to the portion 33, the pin 26 is angularly fixed, and slides axially in a manner sealed against fluids, under the action of the pressure in the chamber 32, in order to thrust the body 20 against the resilient action of the spring 30.

[0017] With reference to Figure 1, the pump 1 additionally comprises a hydraulic accumulator device 35, which in turn comprises a cylindrical cavity 36 provided in the body 2 along an axis 38. The cavity 36 is engaged in a manner which is axially sliding and sealed against fluids, by a plate 39, which, on opposite axial sides, delimits two chambers 40 and 41, of which the chamber 40 has a variable volume, and communicates with the mouth 4 via a passage not illustrated, whereas the chamber 41 is preferably put into communication with the tank, and accommodates a pre-loaded spring 42, which is interposed axially between the plate 39 itself and a fixed stop ring 43. The plate 39 is subject to the opposing thrusts of the pressure in the chamber 40 and the resilient action of the spring 42, in order to transfer oil between the chamber 40 and the mouth 4, according to the delivery pressure, and to compensate for any variations in the delivery pressure itself.

[0018] Starting from an outer edge, on part of the lateral surface which delimits the chamber 41, there is provided a groove 45, which also imparts to the device 35 the function of a safety by-pass valve. In use, as the delivery pressure increases, the spring 42 is compressed progressively by the plate 39, and the volume of the chamber 40 increases to a limit value which corresponds to a maximum delivery pressure level, when the chamber 40 enters into communication with the groove 45, and the oil flows from the chamber 40 towards the exterior.

[0019] Starting from an initial condition, in which the engine runs in conditions of minimum rotation, the resilient action of the spring 30 maintains the body 20 and the pin 26 in a position of end of travel, in which the projections 28 are supported against a base wall of the chamber 32, and the pin 26 is disconnected from the wheels 10, whereas the body 20 is connected to all the wheels 10, and rotates fully the sets 6 and 7, which thus define respectively the drive and driven rotors of the pump 1.

[0020] As the speed of rotation of the engine, and thus of the shaft 16 increases, the flow rate of the pump 1 increases, such that the delivery pressure also increases. When the pressure in the chamber 32 reaches a threshold value which is dependent on the pre-loading by the spring 30, the pin 26 and the body 20 move axially against the action of the spring 30 itself. During this displacement, the body 20 becomes detached from some wheels 10, whereas simultaneously, the pin 26 engages the seats 23 of the wheels 10, which are left free by the body 20. When a position of equilibrium has been reached (indicated schematically by the broken line in Figure 3), only a part A of the sets 6, 7 is rotated by the body 20, and defines the drive and driven rotors of the pump 1, whereas a remaining part B of the sets 6, 7 themselves is maintained in a fixed position by the pin 26, such that the volume of each compartment 14 which conveys oil decreases in relation to the above-described initial condition.

[0021] If the pressure in the chamber 32 decreases, for example owing to an increase of oil used by the delivery circuit, or to a decrease in the speed of the shaft 16, the pin 26 and the body 20 withdraw under the thrust of the spring 30, such that the body 20 engages with other wheels 10, so that the number of wheels of the part A and the volume of the compartments 14 increase, whereas the number of wheels of the part B decreases.

[0022] It is apparent from the foregoing that the cylinder capacity of the pump 1 is variable, owing to the unit 25, which thus makes it possible to regulate the flow rate output from the mouth 4 simply and efficiently, according to the delivery pressure, without wasting energy, which is not then actually used, in compressing flow rates of oil, which on the other hand is the situation in the known solutions which are provided with by-pass valves.

[0023] In fact, the unit 25 regulates the number of wheels 10 and 11 which belong to the parts A and B of the sets 6 and 7, and thus, the axial thickness of the drive and driven rotors, which are actually defined by the rotary part A of the sets 6 and 7 themselves. Thus, the unit 25 varies the axial dimension of the mobile compartments 14, the volume of which is proportional to the flow rate of oil distributed by the pump 1. By blocking angularly the part B of the sets 6 and 7, the pin 26 prevents this part B from being driven by friction by the part A.

[0024] In addition, the flow rate is regulated accurately, since the sets 6, 7 comprise a relatively large number of wheels 10, 11, which have the same axial thickness, and, simultaneously, the unit 25 is very simple and compact.

[0025] Finally, the device 35 makes it possible to compensate for any temporary and relatively sudden drops

and peaks of pressure in the delivery circuit, and, simultaneously, to allow oil to be vented when the delivery pressure reaches a maximum safety level.

[0026] Finally, it is apparent from the foregoing description that modifications and variants which do not depart from the field of protection of the present invention can be made to the pump 1 described and illustrated.

[0027] In particular, the pump 1 could be of the lobe type instead of of the gear type, and/or it could be used for applications other than that indicated.

[0028] In addition, the number and dimensions of the wheels 10 and 11, and the shape of the pin 26 and of the body 20 could be different from those illustrated, and/or a drive other than of the chain type could be provided.

Claims

1. Rotary pump (1) with a variable flow rate, particularly for oil, comprising a support body (2), with a suction mouth (3), which can be connected to a tank for a fluid, and a delivery mouth (4), which can be connected to a circuit for delivery of the fluid itself; a toothed drive rotor (6) and driven rotor (7), which engage with one another and are accommodated in the said support body (2) such as to rotate around their own axes (12, 13), in order, in use, to convey the said fluid from the said suction mouth (3) to the said delivery mouth (4); **characterised in that** it comprises means (25) for regulation, in order to vary the axial dimension of the said rotors (6, 7) according to the delivery pressure of the said fluid.

2. Pump according to Claim 1, **characterised in that** it comprises two sets (6, 7) of toothed wheels (10, 11), each of which is coaxial relative to the wheels (10, 11) of the same said set (6, 7), and engages with a corresponding wheel (11, 10) of the other said set (7, 6); the said means (25) for regulation comprising first angular means (20) for constraint, in order to render angularly integral, in each said set (6, 7), a first plurality of wheels (A) defining a corresponding said rotor, second angular means (26) for constraint, which are supported by the said support body (2), in order to lock angularly remaining second plurality of wheels (B), and actuator means (29), in order to vary the quantity of wheels (10, 11) which belong to the said first and second plurality of wheels (A, B), according to the delivery pressure.

3. Pump according to Claim 2, **characterised in that** the said first second means (20, 26) for angular constraint are associated with a single said set (6) of wheels (10).

4. Pump according to Claim 3, **characterised in that** the said actuator means (29) comprise a single actuator (29) in order to regulate the said first and second means (20, 26) for angular constraint.

5. Pump according to Claim 4, **characterised in that** the said actuator (29) is a single-effect hydraulic actuator, and comprises pre-loaded resilient means (30), in order to keep the said second means (26) for angular constraint disconnected from the corresponding said set (6) of wheels (10).

6. Pump according to Claim 5, **characterised in that** the said first and second means (20, 26) for angular constraint comprise respectively a first (20) and a second (26) body, which are connected to the corresponding said set (6) of wheels (10), in a manner which is angularly fixed and axially sliding; the said second body (26) constituting part of the said actuator (29), and defining an axial thrust unit of the said first body (20).

7. Pump according to Claim 6, **characterised in that** the said second body (26) is connected such as to be sealed against fluids, in a manner which is axially sliding and angularly fixed, to a hollow portion (33) of the said support body (2), which communicates with the said delivery mouth (4).

8. Pump according to Claim 6 or Claim 7, **characterised in that** the said first body (20) is interposed between the said drive rotor (6) and a shaft (16) for actuation of the drive rotor (6) itself, and is connected in a manner which is angularly fixed and axially sliding to the said shaft (16).

9. Pump according to any one of Claims 6 to 8, **characterised in that** the said second body (26) comprises an end portion (27) which, in transverse cross-section, has the same outer profile as the said first body (20), and at least one end projection (28) opposite the first body (20) itself.

10. Pump according to any one of Claims 2 to 9, **characterised in that** the said wheels (10, 11) have the same axial dimension.

11. Pump according to any one of the preceding claims, **characterised in that** it additionally comprises hydraulic accumulator means (35), comprising a chamber (40) with a variable volume, which communicates with the said delivery mouth (4).

12. Pump according to Claim 11, **characterised in that** the said chamber (40) with a variable volume is provided in the said support body (2), and is delimited by a plate (39) which slides in a manner which is sealed against fluids, in a seat (36) provided in the support body (2) itself.

13. Pump according to Claim 11 or Claim 12, **characterised in that** it additionally comprises means (45) for venting the said fluid, which constitute part of the said hydraulic accumulator means (35).

14. Pump according to Claim 13, **characterised in that** the said means (45) for venting comprise a channel (45) which communicates with the said chamber (40) with a variable volume, when the volume itself reaches a maximum limit value.

15. Pump according to Claims 12 and 14, **characterised in that** the said channel (45) is provided in part of the surface of lateral delimitation of the said seat (36).

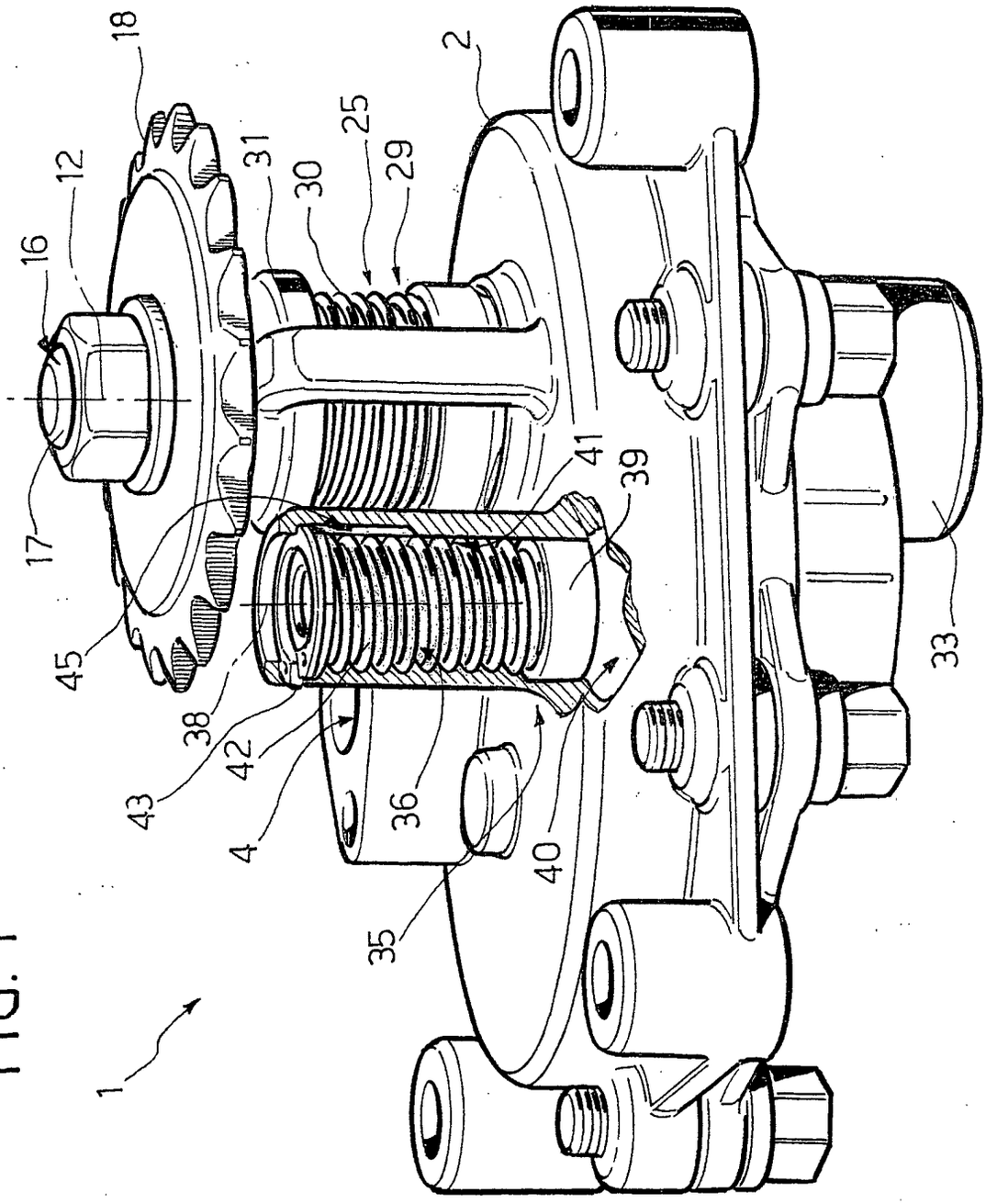


FIG. 1

FIG. 2

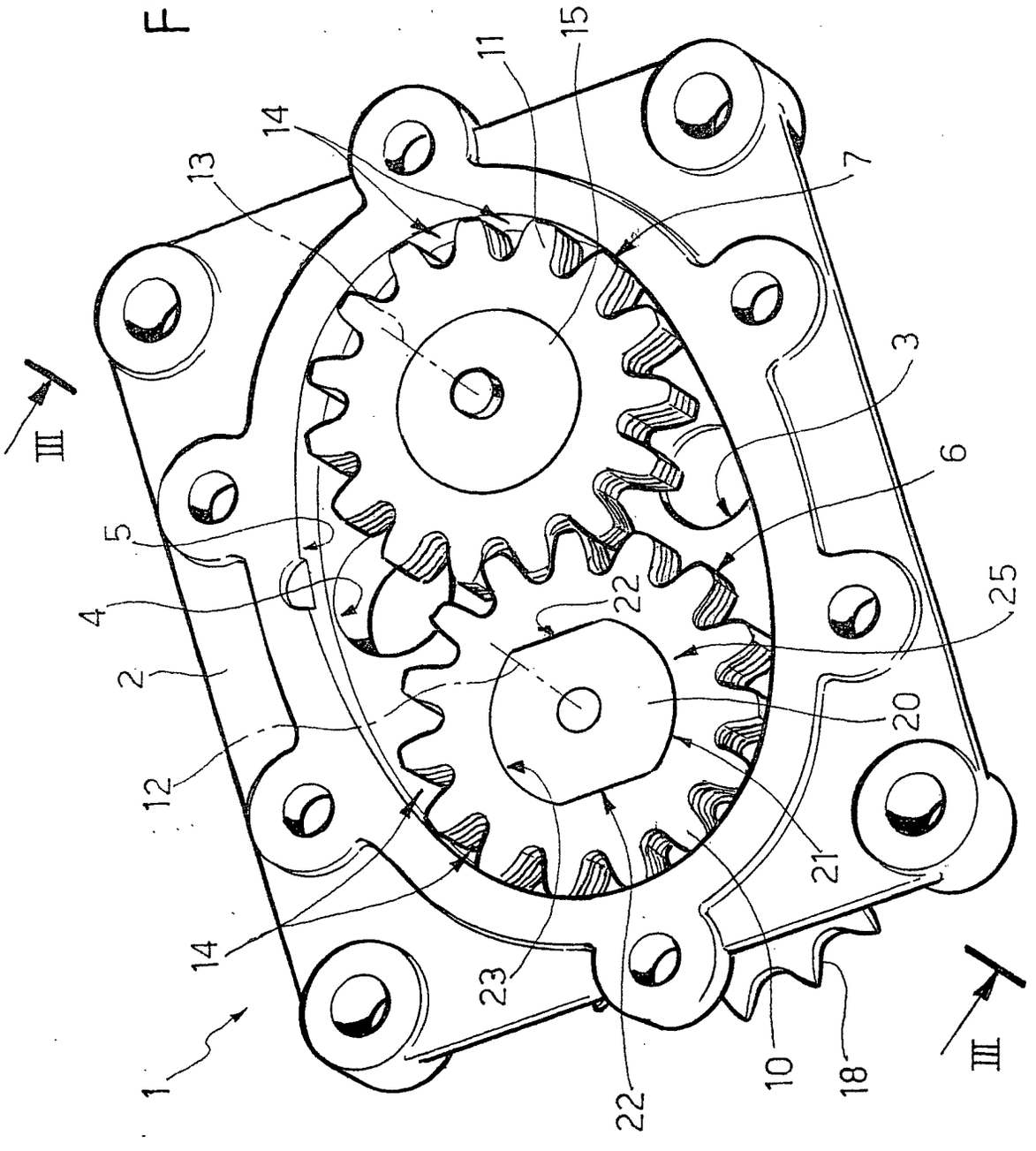
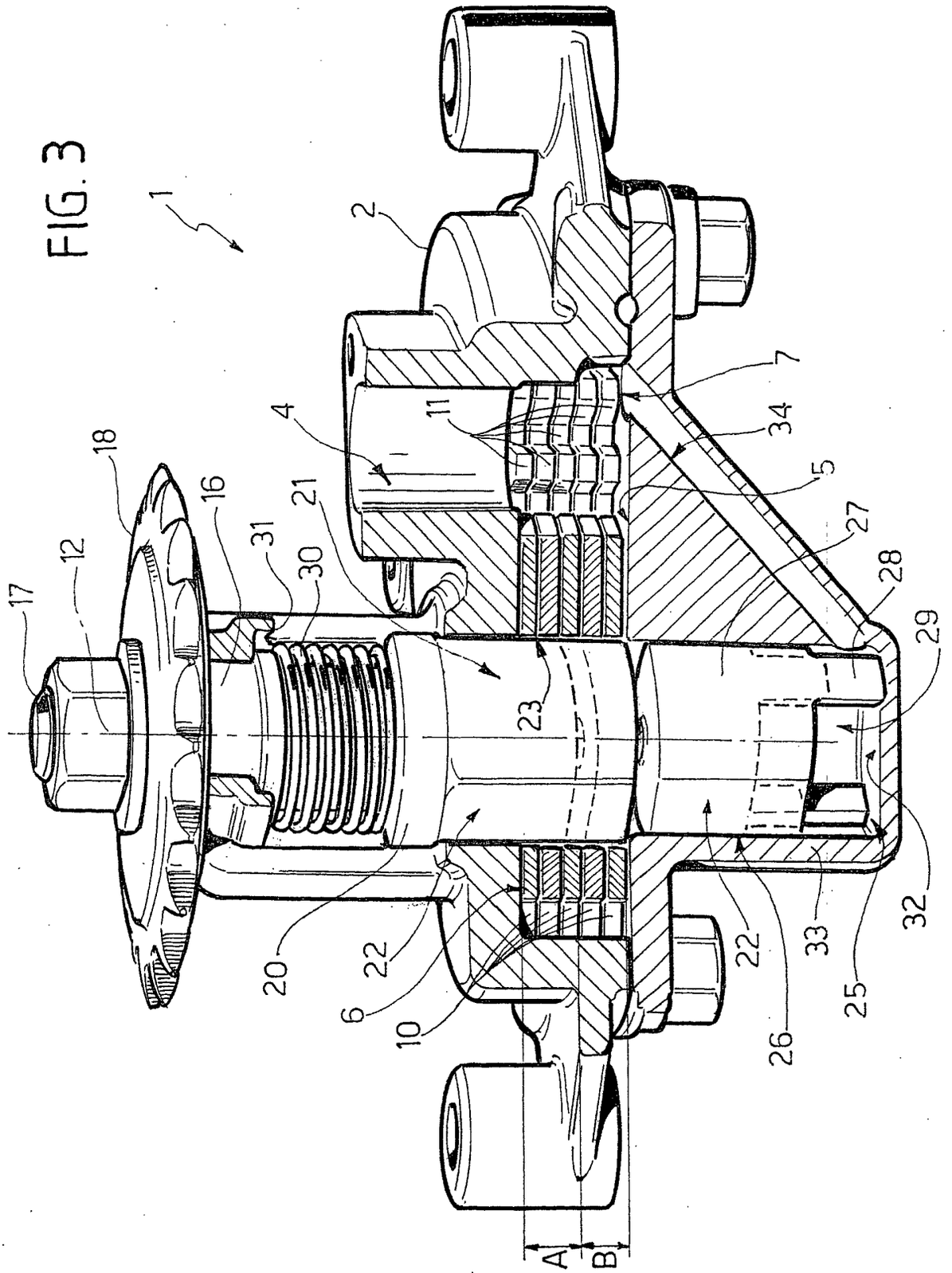


FIG. 3



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EUROPEAN SEARCH REPORT

Application Number
EP 01 12 8459

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.7)
X Y	DE 511 495 C (RETTERATH) 30 October 1930 (1930-10-30) * page 2, line 111 - page 3, line 13; figures 5,6 *	1 2-10	F04C15/04 F04C2/18
X Y	BE 443 167 A (DELETAILLE) * page 24, line 9 - page 27, line 1; figures 19,20 *	1 2-10	
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			TECHNICAL FIELDS SEARCHED (Int.Cl.7) F04C F01C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	14 March 2002	Kapoulas, T

CATEGORY OF CITED DOCUMENTS

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14-03-2002

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