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

(11) EP 2 551 484 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
30.01.2013 Bulletin 2013/05

(51) Int Cl.:
F01P 5/12 *(2006.01)* ***F04D 15/00*** *(2006.01)*

(21) Application number: **12005234.5**

(22) Date of filing: **13.07.2012**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(30) Priority: **25.07.2011 IT MI20111379**

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(54) Pneumatically-operated cooling pump

(57) A pneumatically-operated cooling pump (10), especially suitable for conveying and circulating coolants in internal combustion engines, comprising a containment body (12) positioned above an underlying volute inside which is placed a shutter which surrounds an impeller keyed on a rotation shaft, immersed in a fluid of water and glycol and suitable for setting in motion said fluid, the pump comprising pneumatically-operated mechanical means with axial movement to operate the shutter defined by an actuator unit comprising a ring (42) and at least three rods (44) sliding axially with respect to the containment body (12) and static seal means defined by shaped diaphragms (52), stabilized to the rods (44) and to the containment body (12), positioned to separate between the containment body (12) and the underlying coolant and cooperating with the actuator unit for the movement of the shutter.

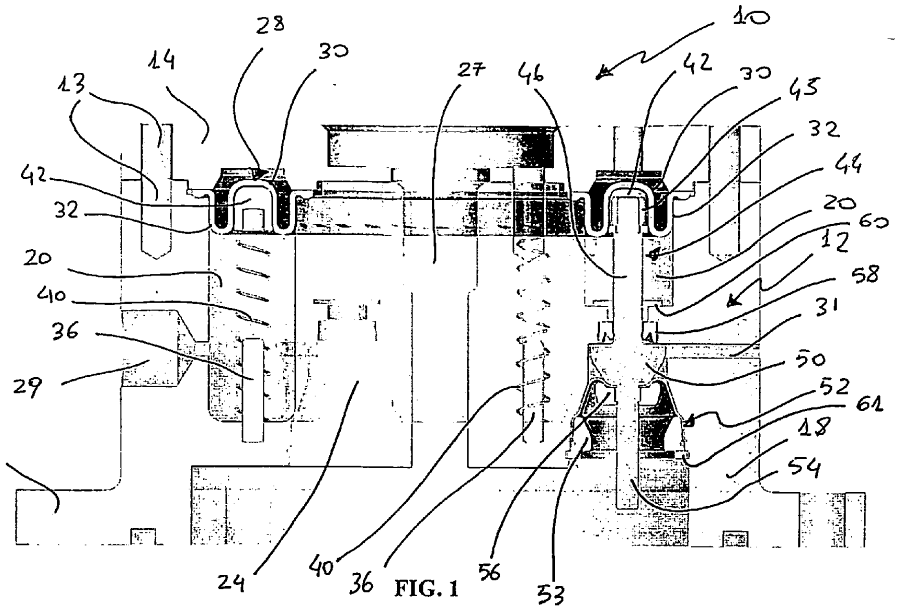

FIG. 1

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Description

[0001] The present invention refers to a pneumatically-operated cooling pump.

[0002] More in particular, the present invention refers to a cooling pump preferably used for conveying and circulating coolants, including but not limited to, inside internal combustion engines.

[0003] It is known that, generally but not only in the internal combustion engine sector, during the course of the operating process, some components and circuits of the same engines tend to reach very high temperatures, which are hazardous and potentially harmful both for the operation of such components, circuits and the engine as a whole and for its life-span or working life.

[0004] In order to prevent the occurrence of such serious and hazardous effects and provide cooling, the engine has a system suitable for guaranteeing the circulation of coolants such as to maintain a temperature suitable for the correct and long-lasting operation of the engine.

[0005] The types of pumps used for the purpose are numerous and different in terms of construction characteristics and as regards the way they operate (mechanical pumps, electromechanical pumps, magnetic-drive pumps).

[0006] Such and known types of pumps are characterised by the presence of an impeller keyed on a shaft placed in rotation by means of a belt drive, gear drive or the like (mechanical pumps) or the impeller is placed in rotation by means of a magnetic field induced through the use of permanent magnets coaxial with the rotation shaft of the impeller itself (magnetic drive pumps).

[0007] Such known types of pumps, however, have a major drawback correlated to the fact that in them the coolant circulates continuously with a flow capacity according to the number of revs per minute of the engine and, because of this, the pump continues to operate even when not strictly necessary, for example when the outside temperature is low or very low, with the result that engine cooling is excessive and, therefore, incorrect for its best operation at thermal speed for the control of consumption and/or the limitation of emitted pollutants.

[0008] To obviate this serious drawback, cooling pumps have been made equipped with a device for regulating the flow rate so as to allow the circulation of the coolant only when really required by the engine. One of these solutions is described in DE102005062200 which makes reference to a cooling pump for internal combustion engines suitable for guaranteeing continuous operation (fail-safe) even in the case of unfortunate drawbacks and comprising a pump body, a rotation shaft to which an impeller is connected, an annular shutter positioned in the pump body and having a series of pins or pistons coupled with coaxial seals suitable for moving the annular shutter in the direction of the impeller to check the quantity of coolant.

[0009] This solution makes use of seals associated with shafts for ensuring its axial sliding and allowing the opening and the closing of a shutter that opens/closes the channels to enable the flow of the fluid and, more specifically, the volute (i.e., the specific-geometry cavity that surrounds the pump impeller) of the pump itself. Nevertheless, such seals, being associated with sliding elements, tend to wear easily with the consequent drawback of causing coolant leaks.

[0010] The object of the present invention is to overcome the above drawbacks.

[0011] More in particular, the object of the present invention is to provide a pump equipped with a device for regulating the flow rate operated pneumatically and exempt from the use of seals with sliding parts typically subject to wear and characterised by potential and unfortunate coolant leaks.

[0012] A further object of the present invention is to place at the disposal of users a pneumatically-operated cooling pump suitable for providing a high standard of strength and reliability over time and such, furthermore, to be easily and inexpensively made.

[0013] These and other objects are achieved by the pneumatically-operated cooling pump of the present invention, which comprises a containment body placed above an underlying volute inside which a shutter is positioned which surrounds an impeller keyed on a rotation shaft, immersed in a fluid of water and glycol and suitable for putting said fluid in motion, the pump also comprising pneumatically-operated mechanical means with axial movement for operating the shutter and static seal means positioned to separate between the containment body and the underlying coolant and cooperating with said mechanical means for the movement of the shutter, the mechanical means and the static seals being housed in the containment body.

[0014] The construction and functional characteristics of the pneumatically-operated pump of the present invention can be better understood from the detailed description which follows, wherein reference is made to the attached drawing tables which represent a preferred embodiment of a portion of the pump itself, provided by way of example only and without being limitative wherein:

- the figure 1 schematically represents a partial longitudinal section view of a portion of the pump of the invention according to a first operative configuration;
- the figure 2 represents, at schematic level, a partial longitudinal section view of a portion of the pump of the invention according to a second operative configuration;
- the figure 3 schematically represents a section axonometric view of a component of the pump of the invention;
- the figure 4 represents a section axonometric view of a portion of the cooling pump of the invention;
- the figure 5 represents an enlarged section schematic detail of a portion of the pump of the invention according to the view of figure 4.

[0015] With reference to the mentioned illustrations, the pneumatically-operated cooling pump of the present invention, indicated by 10 in the illustrations as a whole, comprises a containment body 12 closed at the top, preferably but not only, by a lid 14 stabilized to the top front of the containment body 12 by means of screws fitted in holes 13 or by calking, gluing or equivalent known retention means.

[0016] Said containment body 12 is stabilized with its bottom front, opposite to the top front, closed by the lid 14, to an underlying volute (not shown in the illustration) inside which a shutter is positioned which surrounds an impeller keyed on a rotation shaft (the shutter and the impeller are not shown in the illustration either); with said shutter which opens/closes the channel for the flow of cooling fluid (water and glycol) in which the impeller is immersed.

[0017] The containment body 12 is defined, preferably but not only, by a discoid base 16 which centrally develops, in a vertical direction and substantially starting with its top front, a portion 18 centrally provided with a blind annular cavity 20 formed starting from the top front of the portion 18 itself. Inside said annular cavity 20 are formed, starting from the bottom of the cavity and partially developed in this in the direction of the top front of the containment body 12, at least three bodies 22, arranged angularly at 120°, provided inside with an axial chamber 24 with differentiated diameters, the function of which will be explained below; said axial chamber 24 communicates at the top with the annular cavity 20 and at the bottom with the bottom of the containment body 12.

[0018] The annular cavity 20 circumscribes a central portion 26 of the portion 18 of the containment body 12 extended vertically in the direction of the top front 12' of the portion 18 of the mentioned containment body 12 and for a height corresponding to that of the same portion 18.

[0019] The central portion 26 has an axial hole 27 suitable for defining the seat for housing the shaft for the rotation of the underlying pump impeller.

[0020] Along the lateral outer surface of the portion 18 of the containment body 12 and in a radial direction, a duct 29 is made communicating with the annular cavity 20; said duct is connected to a pneumatic supply system.

[0021] Further ducts 31 are made along the lateral surface of the portion 18 in a radial direction and in correspondence to each body 22; said further ducts put a specific portion of the axial chamber 24 in contact with the outside and, consequently, such chamber is in atmospheric pressure conditions.

[0022] The function of said duct 29 and further ducts 31 will be detailed below.

[0023] The annular cavity 20 is closed at the top by an annular seal 28, made of rubber or other known material with elastic characteristics and suitable for the purpose, wherein the flaps are in contact with the edges of the annular cavity 20. The annular seal 28 fits partially into the annular cavity 20 with its vertical peripheral surfaces in contact with the perimeter surfaces of the annular cavity itself.

[0024] In the configuration shown in figure 1, which defines a first configuration or idle configuration of the pump device of the invention, the section profile of the annular seal 28 has an undulated shape or "W" shape with a crest or dome 30 included between two parallel and opposite grooves 32.

[0025] In the configuration in figure 2, which represents a second configuration or operating configuration of the pump device of the invention, the profile of the same annular seal 28 takes on a "U" type shape with a groove 34.

[0026] Inside the annular cavity 20, in an intermediate position with respect to the bodies 22 and at 120° the one to the other, at least three possible guide pins 36 are arranged stabilized with one extremity with respect to a seat 38 formed on the bottom surface or base of the annular cavity 20. A possible elastic element, defined by a helical spring 40, is fitted coaxially over each guide pin 36.

[0027] In an alternative embodiment the assembly defined by the guide pin 36 and by the helical spring 40 is not present.

[0028] The annular cavity 20 defines the housing and axial movement seat of an actuator unit comprising a ring 42, coaxial with the annular cavity 20, coupled at the top with the seal 28 inside the crest 30 (in idle conditions) and comprising at least three circular cavities or seats 43 with respect to which are connected at the bottom at least three stems 44 arranged coaxially to each body 22 and partially sliding with respect to the axial chamber 24 of the bodies themselves.

[0029] Each stem 44 consists of a first rod 46 protruding from the axial chamber 24 in the annular cavity 20 and stabilized, in correspondence to its upper extremity, in the round cavity or seat 43 of the ring 42 by means of an elastic retention ring 45, by a truncated-cone expansion 50 with a lower smaller-diameter portion or base turned in the direction of the bottom of the axial chamber 24 and in contact with a diaphragm 52, by a second rod 54 extending starting from the smaller-diameter portion or base of the truncated-cone expansion 50 which crosses the axial chamber 24 and is connected to the shutter (not shown in the illustration).

[0030] The diaphragm 52 is cup shaped with the outer lateral surface of the edge in correspondence to the lower open extremity of the diaphragm itself in contact with the lateral walls of the axial chamber 24; such diaphragm is blocked at the lateral surface of the axial chamber 24, in correspondence to its open extremity, by means of at least one shaped ring 53 placed in contact with the inner lateral surface of the seal 52 in correspondence to the open extremity of the seal itself, said at least one shaped ring 53 is, in turn, fastened to the lower portion of the cavity 24 by means of stop ring 61 or by other traditional and known means of retention.

[0031] At least one further stop ring 56, placed on the bottom of the diaphragm 52 on the opposite side compared to the open extremity, ensures a stable and safe coupling between the diaphragm itself and the second rod 54 of the stem 44 of the actuator unit.

[0032] The diaphragm 52 creates the static seal between the axial chamber 24 of the containment body 12 and the lower portion of the pump wherein water and glycol are present under pressure; said diaphragm, furthermore, cooperates with the up and down movement of the stems connected to the ring 42 of the actuator unit without this moving in any way with respect to its housing seat.

[0033] The first rod 46 of each stem 44 is sliding with respect to a further seal 58 arranged inside the axial chamber 24 in correspondence to the upper greater-diameter portion or base of the truncated-cone expansion 50 of the stem 44 and to a bush 60 of the flanged type arranged above the further seal 58 and outside the axial chamber 24.

[0034] The upper extremity of the elastic element or helical spring 40 (if fitted) is engaged in contact with the bottom front of the ring 42 of the actuator unit which, in the configuration shown in figure 1 or idle configuration, is shown fitted inside the crest 30 of the annular seal 28.

[0035] The operation of the pneumatically-operated cooling pump of the present invention, described in detail above with reference to its technical-structural components, is described below.

[0036] In non-operating or idle conditions, when the shutter is open and does not prevent the fluid from accessing the volute, the pump impeller is in rotation, causing the circulation of the coolant inside the cooling circuit; the device of the invention is in the configuration shown in figure 1.

[0037] Starting with such idle configuration, the air supply circuit takes air from the annular cavity 20 through the duct 29 creating a vacuum inside the annular cavity 20 and, consequently, the annular diaphragm 28 is deformed with the crest 30 which drops adding onto the grooves 32 and defining a single groove 34. Due to the effect of such deformation the ring 42 of the actuator unit is moved by axial sliding inside the annular cavity 20 causing the stems 44 to slide coaxially to the axial chamber 24, the truncated-cone expansion 50 of each stem 44 presses on the diaphragm 52 causing a downward deformation of the closed bottom of same, as schematized in the figure 2.

[0038] The deformation of the annular diaphragm 28 and, consequently, the axial sliding of the ring 42, also determine a compression of any elastic element or helical spring 40 with respect to the guide pin 36 as schematized in the figure 2.

[0039] This way, the shutter, to which the second rods 54 of the stems 44 are connected, drops and goes and fits over the pump impeller so as to interrupt the circulation of the coolant in the pump itself; the impeller, nevertheless, continues to turn without circulation of the coolant inside the circuit.

[0040] When the air supply circuit interrupts the extraction of the air from the annular chamber 20, the pressure of the coolant in the region below the containment body 12, acting on the diaphragm 52, together with the return force of any elastic elements or helical springs 40, returns the system to the idle configuration schematized in the figure 1.

[0041] In an alternative embodiment, the elastic elements or return-action springs 40 and, consequently, the guide pins 36 are not present; the return action or axial sliding reversal of the ring 42 and of the stems 44 of the actuator unit is defined by the pressure of the liquid in the part below the containment body 12 applied on the diaphragm 52. As can be seen from the above, the advantages achieved by the pneumatically-operated pump of the invention are evident.

[0042] The pneumatically-operated cooling pump of the invention advantageously allows separating the portion of the pump immersed in the fluid (water and glycol) and the portion immersed in air, by means of the use of static seals.

[0043] A further advantage is the fact that the pump of the invention uses static seals defined by the diaphragms 52; these define static seals which are not subject to relative movements during the sliding of the piston, and are not therefore subject to wear by sliding and provide the pump as a whole with a longer working life, without the risk of coolant leaks occurring.

[0044] A further advantage is represented by the fact that the pneumatically-operated pump of the invention allows enabling/disabling the supply of coolant to the circuit, while always maintaining the rotation of the pump impeller.

[0045] Although the invention has been described above with particular reference to one of its embodiments provided by means of example only and without intending to be limitative, numerous modifications and variations will appear evident to a technician in the field in the light of the description provided above. The present invention, therefore, intends embracing all the modifications and variations falling within the spirit and scope of the following claims.

Claims

1. A pneumatically-operated cooling pump (10), especially suitable for conveying and circulating coolants in internal-combustion engines, comprising a containment body (12) positioned above an underlying volute inside which is placed a shutter which surrounds an impeller keyed on a rotation shaft, immersed in a fluid of water and glycol and suitable for setting in motion said fluid, the pump **characterised by** the fact that it comprises pneumatically-operated mechanical means with axial movement to operate the shutter defined by an actuator unit comprising a ring (42) and at least three rods (44) sliding axially with respect to the containment body (12) and static seal means defined by shaped diaphragms (52), stabilized to the rods (44) and to the containment body

(12), positioned to separate between the containment body (12) and the underlying coolant and co-operating with the actuator unit for the movement of the shutter.

2. The cooling pump according to the claim 1, **characterised by** the fact that the containment body (12) comprises a discoid base (16) which centrally develops, in a vertical direction and starting with its top front, a portion (18) centrally provided with a blind annular cavity (20) formed starting from the top front (12') of the portion (18) itself, inside which annular cavities (20) are formed, starting from the bottom of the cavity and partially extended in this in the direction of the top front of the containment body (12), at least three bodies (22) arranged angularly at 120° and provided inside with an axial chamber (24) with differentiated diameters and communicating at the top with the annular cavity (20) and at the bottom with the bottom of the containment body (12), said bodies (22) and axial chambers (24) being suitable for defining the housing for the operating mechanical means and for the static seals, the portion (18) of the containment body (12) being provided with a duct (29) communicating with the annular cavity (20) and with further ducts (31) communicating with the axial chambers (24), with said duct (29) and further ducts (31) made in radial direction and suitable for connecting the annular cavity to the air supply system and each axial chamber to the outside environment in atmospheric-pressure conditions respectively.

3. The cooling pump according to the claim 2, **characterised in that** the annular cavity (20) of the containment body (12) is closed at the top by an annular seal (28) the perimeter flaps of which are in contact with the edges of said annular cavity, the annular seal (28) being partially fitted in the annular cavity (20) with its opposite vertical peripheral surfaces in contact with the perimeter surfaces of the annular cavity itself, said angular seal which in idle conditions has an undulated shape or a "W" shape with a crest or dome (30) being positioned between two parallel and opposite grooves (32) and which in operating conditions has a "U" shape with a groove (34).

4. The cooling pump according to the claim 1, **characterised in that** the ring (42) is coaxial with the annular cavity (20) and coupled at the top with the seal (28), the at least three stems (44) are arranged at 120°, sliding axially with respect to the bodies (22) and stabilized below the ring (42) in correspondence to circular cavities or seats (43) of the same, each stem (44) comprising a first rod (46) protruding from the axial chamber (24) in the annular cavity (20) and the upper extremity of which is fastened with respect to the circular cavity or seat (43) of the ring (42) by means of an elastic retention ring (45), a truncated-cone expansion (50) having a lower portion or base of smaller diameter turned in the direction of the bottom of the axial chamber (24) and a second rod (54) extending starting from the portion or base of smaller diameter of the truncated-cone expansion (50) crossing the axial chamber 24 and connected with the mobile element or shutter for enabling/disabling the circulation of the coolant.

5. The cooling pump according to the claim 1, **characterised in that** the diaphragm (52) is cup shaped, with the outer lateral surface of the edge in correspondence to the lower open extremity in contact with the lateral surface of the axial chamber (24) and fastened to this by means of at least one shaped ring (53) placed in contact with the inner lateral surface of the seal (52) in correspondence to the open extremity of same, with said at least one shaped ring (53) fastened to the lower portion of the axial cavity (24) by means of the retention ring (61), the outer bottom surface of the diaphragm (52) being in contact with the lower portion or base of smaller diameter of the expansion (50) of the piston (44), with said diaphragm having at least one further retention ring (56) placed on the inner bottom of the diaphragm (52) on the opposite side with respect to the expansion (50), coaxial with the second rod (54) of the piston (44) and suitable for stabilizing said diaphragm with respect to said second rod (54) of the stem (44) of the actuator unit.

6. The cooling pump according to the claim 4, **characterised in that** the first rod (46) of the stem (44) is sliding with respect to one further seal (58) arranged inside the axial chamber (24) in correspondence to the upper portion or base with greater diameter of the truncated-cone expansion (50) of the stem itself and with respect to a flanged bush (60) arranged above the diaphragm (58) and outside the axial chamber (24) on the top front or base of the body (22).

7. The cooling pump according to the claim 1, **characterised in that** the pneumatically-operated mechanical means comprise at least three possible elastic elements or helical springs (40) each fitted coaxially over a guide pin (36) arranged inside the annular cavity (20) in intermediate position with respect to the bodies (22) and with the lower extremity stabilized with respect to a seat (38) formed on the bottom the upper extremity of the elastic element or helical spring (40) resting on the bottom front of the ring (42) of the actuator unit.

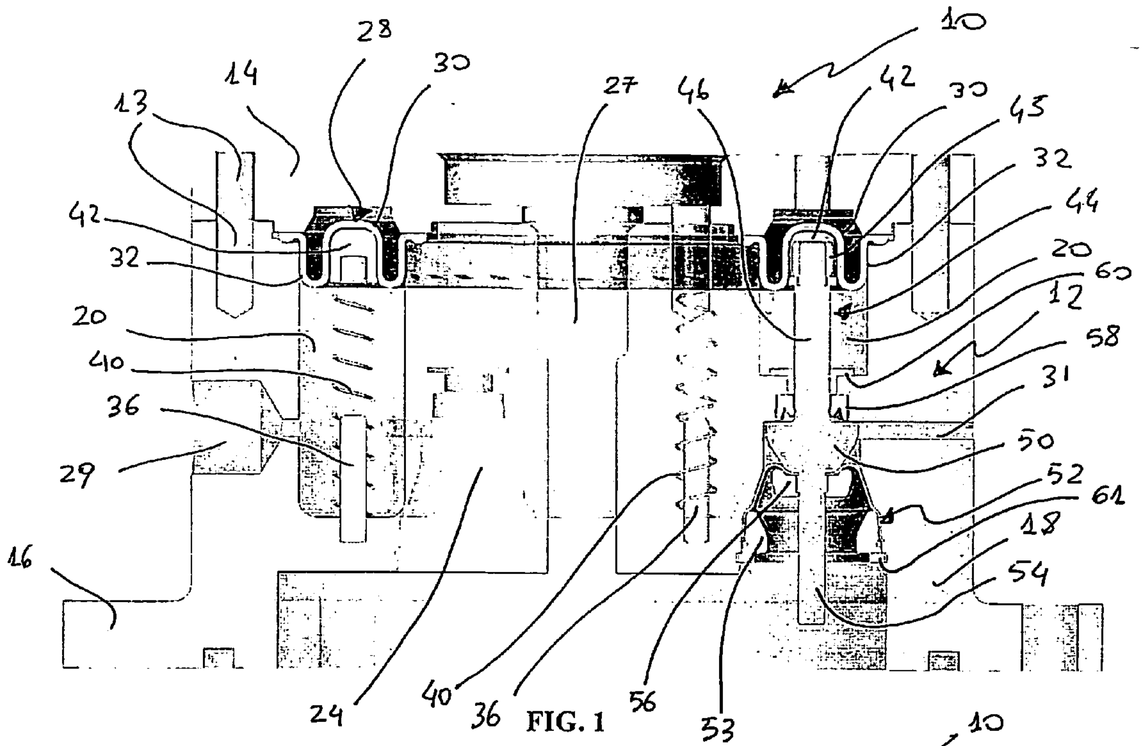
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FIG. 1

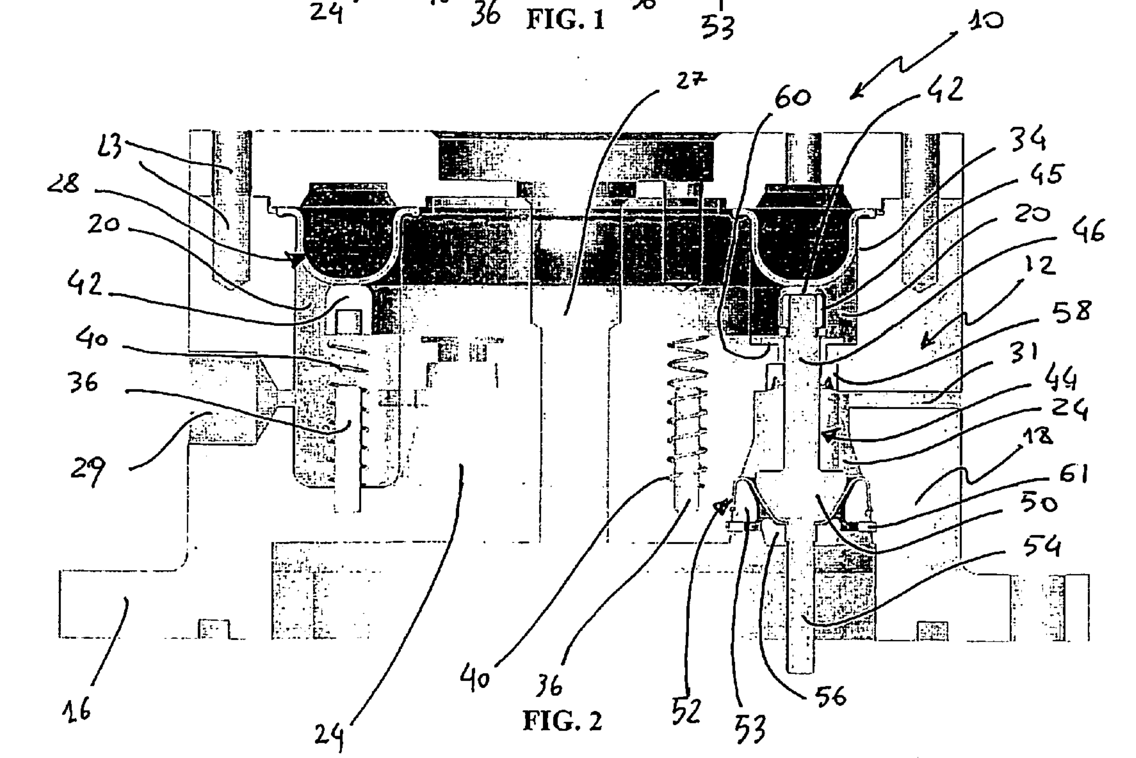
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FIG. 2

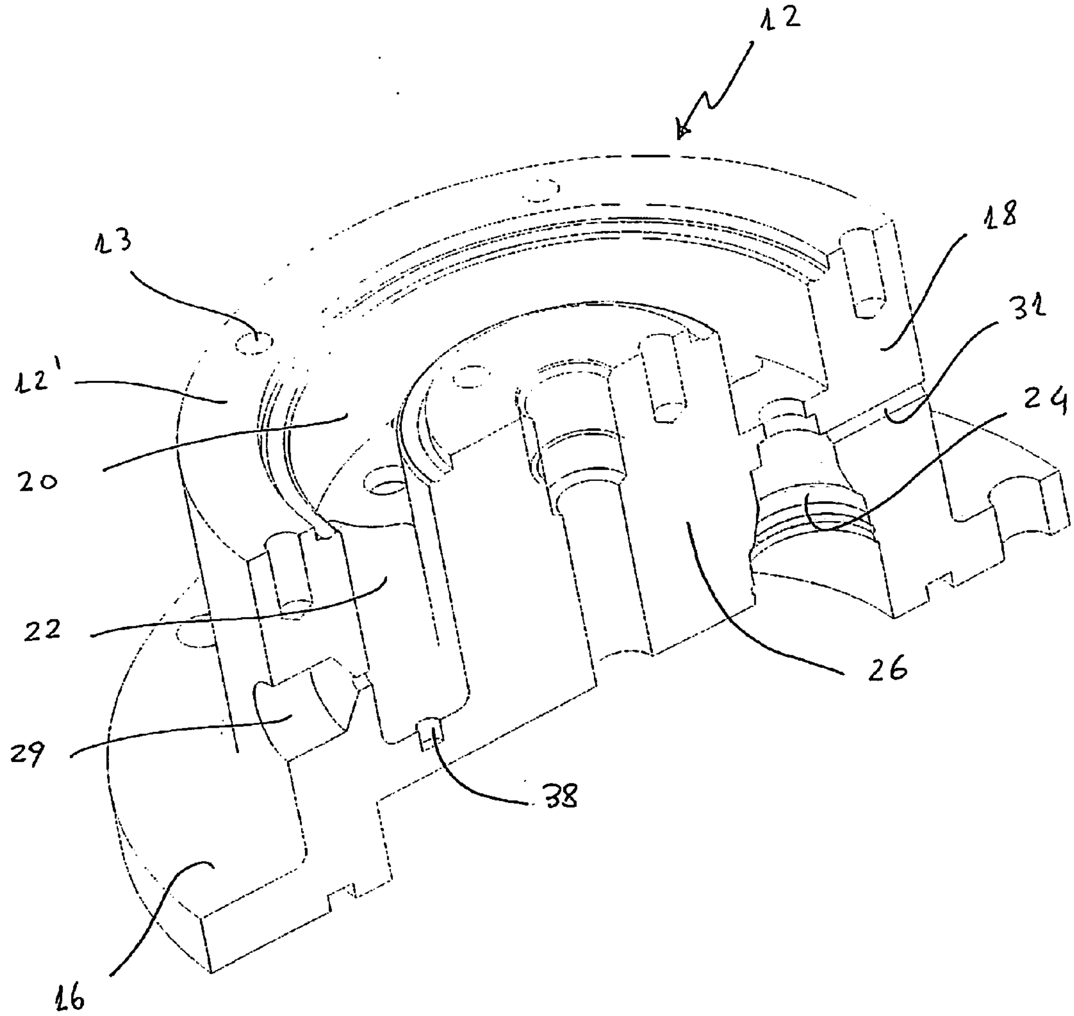

FIG. 3

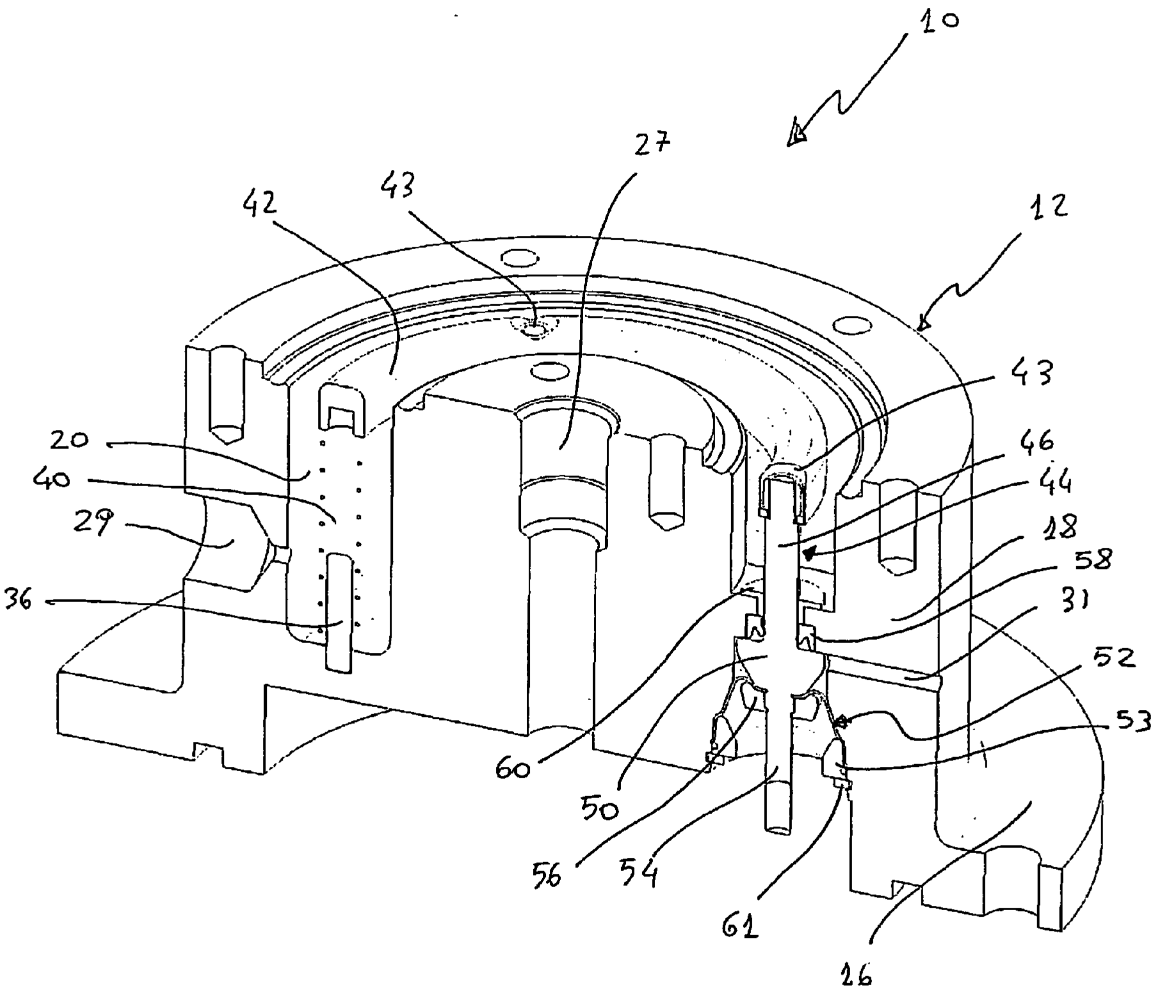

FIG. 4

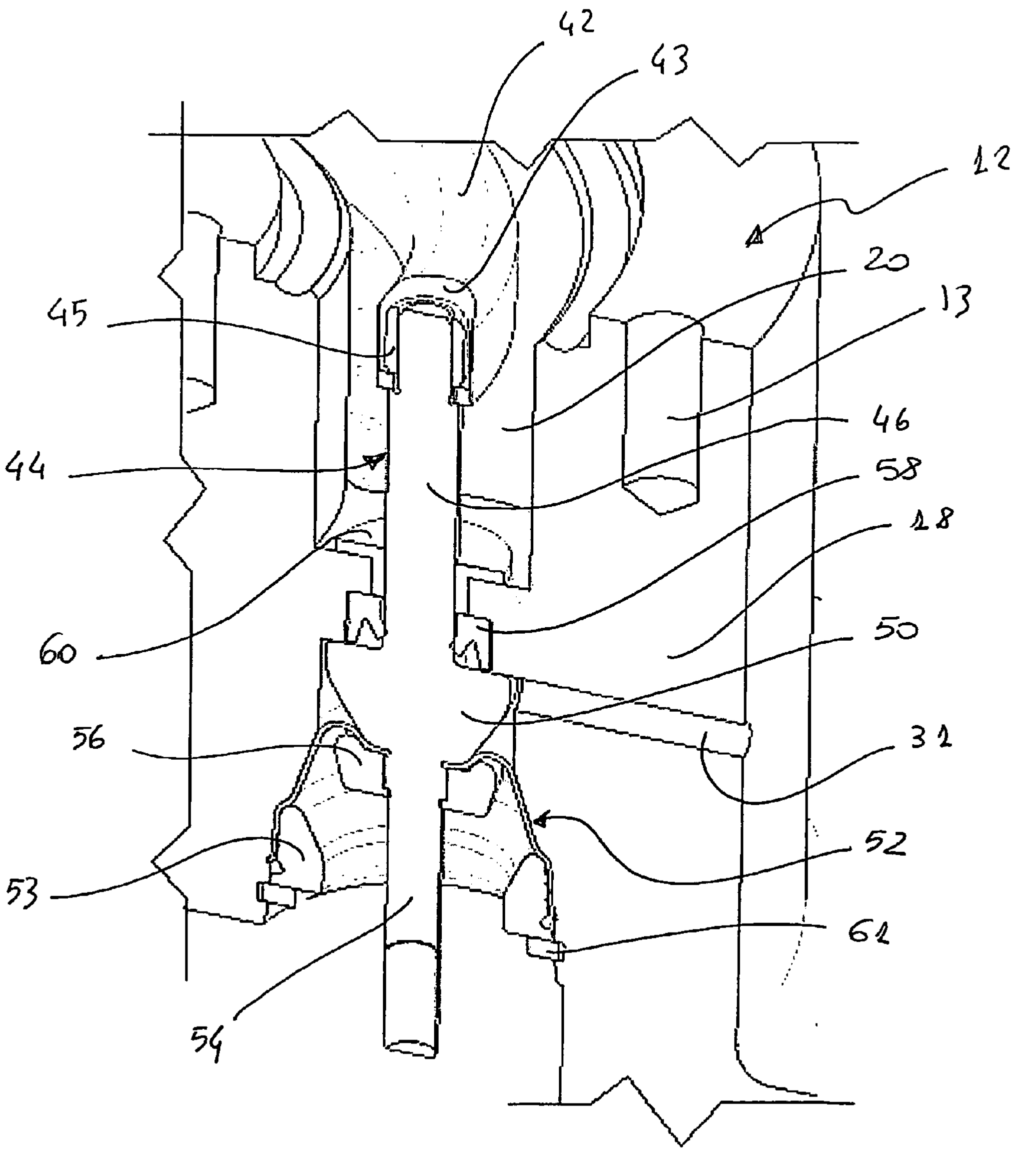

FIG. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 12 00 5234

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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TECHNICAL FIELDS SEARCHED (IPC)

F01P
F04D

The present search report has been drawn up for all claims

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Place of search	Date of completion of the search	Examiner
Munich	7 November 2012	Luta, Dragos

CATEGORY OF CITED DOCUMENTS

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