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AL BA HR MK YU• **Don, Alessandro****25089 Villanuova sul Clisi BS (IT)**• **Gatelli, Fabio****25021 Bagnolo Mella BS (IT)**• **Tanghetti, Giulio****25063 Gardone Val Trompia BS (IT)**(30) Priority: **09.11.2005 IT BS20050134**(71) Applicant: **METELLI S.p.A.****25033 Cologne BS (IT)**(74) Representative: **Lecce, Giovanni****Dott. Giovanni Lecce & C. S.r.l.****Via Fratelli Ruffini, 9****20123 Milano (IT)**

(72) Inventors:

• **Armellin, Luca****25082 Botticino BS (IT)**(54) **Cooling circuit pump with electromagnetic coupling**

(57) A pump for internal-combustion engine cooling circuits equipped with a dimensional and absorbed power optimization device comprising an impeller (10) keyed onto a shaft (12) being rotatably constrained on a body (14), manufactured by casting an aluminium alloy, or another suitable material and onto which a pulley (22, 22') is keyed, with rated diameter smaller than 80 mm, which presents a hollow (24, 24') with a section that is basically circular and coaxial with the pulley itself, which lodges inside one or more radially polarized magnets (28, 28') and an electric winding (26, 26'), which are stabilized inside the said hollow by means of a plate (30, 30') made from a nonmagnetic material, where also a disc (18) from a metallic material, arranged coaxially as to a hub (16) and connected to it by means of one or more thin plates (20) of small thickness, can be found; the magnetic field produced by the magnet(s) (28, 28') saturates the pulley (22, 22') and gets linked together with the disc (18).

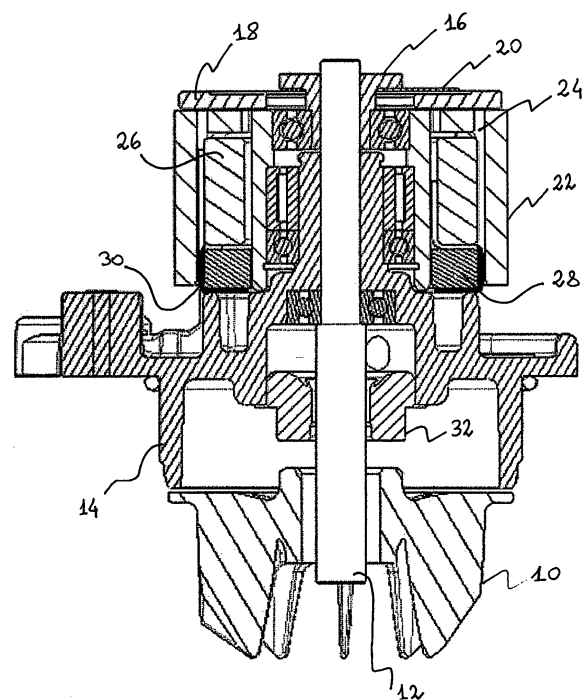


Fig. 1

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Description

[0001] This invention refers to a pump for internal-combustion engine cooling circuits equipped with a dimensional and absorbed power optimization device.

[0002] More specifically, this invention refers to a pump as defined above, equipped with a compact electromagnetic device which allows its miniaturization compared to a traditional pump used to cool motor vehicles circuits and the like, namely to cool internal-combustion engine circuits.

[0003] It is known that during vehicle running, the internal-combustion engine circuits reach very high temperatures, and hence require a proper cooling that causes excess heat to be dissipated and a basically constant temperature to be maintained, this being a basic requirement for proper operation.

[0004] To achieve such cooling, devices are used, typically mechanical pumps, which achieve the circulation of a coolant along a given route.

[0005] Various types of mechanical pumps are known, which accomplish this function, and these pumps typically have an impeller keyed onto a shaft that is driven by the motor through a belt drive system or the like.

[0006] These devices present a main problem, in connection with the fact that the impeller, which has to rotate at an r.p.m. speed that equals that of the motor, is not optimized in such a manner as to ensure a maximum performance.

[0007] A further limit is in that these devices, while the motor is running, keeps the impeller rotating, and hence the system operates even when this is not strictly necessary; for example, when the outer temperature is quite low or very low, a motor cooling is even self-counterproductive in the perspective of an optimum and regular running, consumption control and limitation of burnt gas emissions.

[0008] The object of this invention is to remedy the foregoing problems.

[0009] More specifically, the object of this invention is to provide a pump for internal-combustion engine cooling circuits equipped with a dimensional and absorbed power optimization device aimed at allowing overall dimensions, fuel consumptions and burnt gas emissions to be substantially reduced.

[0010] A further object of the invention is to provide a pump as detailed above wherein the impeller is only set to rotate when required so that both the cooling and consumptions can be optimized.

[0011] A further object of this invention is to provide users with a pump for internal-combustion engine cooling circuits equipped with a dimensional and absorbed power optimization device aimed at guaranteeing a high level of resistance and reliability over time.

[0012] In its most general aspect, this invention allows these and other objects to be achieved, as it will be obvious from the description that follows, through a pump for internal-combustion engine cooling circuits equipped

with a dimensional and absorbed power optimization device that includes an impeller that is keyed onto a shaft that can freely rotate within a body and onto which a pulley is also keyed, which lodges, inside, some magnets and an electrical winding; this pump is mainly characterized in that the magnets are radially polarized so as to allow a magnetic field flux directly linked inside the pulley, resulting in a smaller size of the pulley and it is also characterized in that it allows the impeller not to run in continuous mode.

[0013] The functional characteristics of the pump for internal-combustion engine cooling circuits equipped with the dimensional and absorbed power optimization device can be better understood from the detailed description that follows, wherein reference is made to the attached drawings that depict a preferential embodiment, without thereby intending any limitation, and wherein:

figure 1 is an axial sectional view of the pump for internal-combustion engine cooling circuits;

figure 2 is an axonometric view of a partial section of the foregoing pump;

figure 3 is an axonometric view of the pump of this invention, partly sectioned;

figure 4 is a schematic view of an axial section of an alternative embodiment of the pump at issue in this invention.

[0014] With reference to the mentioned figures, the pump for internal-combustion engine cooling circuits equipped with the dimensional and absorbed power optimization device comprises an impeller 10, already known in itself, and traditionally keyed to the lower end of a shaft 12 that is rotatably inserted into a body 14, the latter being advantageously made by casting of an aluminium alloy or any other suitable material.

[0015] Onto the shaft 12, just next to the projecting upper end, a hub 16 is also keyed.

[0016] A disc 18, made from a metallic and ferromagnetic material is located in a coaxial manner as to the hub 16 and connected to the latter by means of one or more thin plates 20 of small thickness; this/these thin plate/s 20, flexible and torsionally hard, are tied up, in a known manner, at one end to the disc 18 and at the other end to the hub 16.

[0017] A pulley 22 is rotatably located as to the shaft 12 and the body 14; the rotation of this pulley 22 as to the above-mentioned shaft 12 and body 14 is guaranteed by elements such as, for instance, bearings. In the foregoing pulley 22, a hollow 24 featuring a section that is basically circular and coaxial with the pulley itself is made; this pulley 22 also presents some appropriate machining made in the upper portion and preferably made by milling, as schematized in figure 1, whose function will be dealt with hereinafter.

[0018] Inside the hollow 24 of pulley 22, an electrical winding 26 basically cylindrical, preferably toroidal, in shape is located along with one or more magnets 28;

this/these magnet/s 28, which are preferably, but not critically, permanent magnets, are made from materials such as e.g. ferrite, NdFeB (Neodymium-Iron-Boron) or any other appropriate material and are radially polarized.

[0019] The winding 26 and the magnet 29 are stabilized within the hollow 24 by means of a plate 30 of small thickness, opportunely shaped as schematized in figure 2 and made from a nonmagnetic material such as, for example, a stainless steel.

[0020] The disc 18 is not in direct contact with the pulley 22, whereas between the two items there is a clearance whose size, though reduced, varies as a function of the materials being used.

[0021] A mechanical seal 32 that is keyed onto the shaft 12 and tied up in a known manner to the body 14, guarantees the absence of fluid or lubricant leaks.

[0022] When no voltage is injected to the winding 26 (the feeding voltage is, for instance, 12 Volt), the magnetic field that is produced by the magnet/s 28, owing to the presence of the working on the pulley 22, as already mentioned above, saturates the pulley itself, goes through it and gets linked together with the disc 18.

[0023] This magnetic field linked in the disc 18 brings about an axial movement of the disc, that brings the latter into contact with the upper base of the pulley 22; as a consequence of the magnetic contact created between the pulley 22 and the disc 18 and owing to the friction that is produced between the two elements, the shaft 12 and the impeller 10 that is keyed onto it are set to rotate at the same speed as the pulley 22 itself.

[0024] Whereas when voltage is injected into the winding 26 and the winding is crossed by a current that is said to be "direct", in the winding an electromagnetic field is created whose magnitude is such as to suppress the one that is produced by the magnet/s 28; this situation causes the disc 18 to separate from the pulley 22, makes it reach back its resting position and interrupts the rotation of the shaft 12 and the impeller 10 leaving the pulley 22 to rotate idly.

[0025] In cases when, on the other hand, the winding is crossed by a current that is said to be "inverse" such as to generate a magnetic field within the pulley 22 that adds to the one generated by the magnet 28, the resulting magnetic field gets linked up with the disc 18 and causes it to be attracted to the pulley itself; in these conditions of contact between the disc 18 and the pulley 22, a greater torque is transmitted to the impeller 10 than the one that is transmitted in the condition described above and related to the winding 26 not crossed by an electric current.

[0026] In an alternative embodiment, depicted in figure 4, the pump for internal-combustion engine cooling circuits of this invention presents a pulley 22' basically cylindrical in shape and tied up with the body 14 in a known manner. The pulley 22' is basically in the shape of a "J" wherein the circular-developing walls that form a hollow 24' develop in the direction of the impeller with different lengths.

[0027] With special reference to figure 4, the circular-

developing wall formed along the outer edge of the pulley 22' preferably presents a shorter length compared to the circular-developing wall that is formed along the inner edge of the pulley.

[0028] This pulley, moreover, forms just next to its upper face turned toward the disc 18 one or more races or slots 23 whose function is similar to that of the working made on the upper portion of the pulley 22 of the preferential embodiment described with reference to figures 1 to 3.

[0029] The pulley 22' and in its lower portion turned toward the impeller 10 (not shown in figure 4), pairs off with a closing member 25 featuring circular development and basically in the shape of a "J" in section; this closing member 25 is made from a ferromagnetic material to accomplish to functions that will be described hereinafter.

[0030] The closing member 25, which is rigidly tied up to the body 14 that supports the pump, by pairing off with the pulley 22' defines a hollow 24' that is similar to hollow 24, whose function has already been dealt with above. This hollow lodges at least one coil 26' or electrical winding and one or more magnets 28', completely similar to magnets 28 as described above with reference to the preferential embodiment shown in figures 1 to 3.

[0031] The magnet/s 28' is/are tied up in a known manner, as shown in figure 4, as to the pulley 22' and is/are set to rotate with it; in a further alternative embodiment, this/these magnet/s can be fixed and not in rotation with the pulley 22'.

[0032] The coil 26' or electrical winding, is instead inserted into the closing member 25 and is rigidly stabilized as to the latter by means of a thin plate 30', which is "L"-shaped, of small thickness and made from a nonmagnetic material such as, for instance, a stainless steel; alternatively, this plate can be made from a ferromagnetic material.

[0033] When the coil 26' is fed with a "direct" current, a magnetic field is created within the pulley 22' that suppresses that of the magnet 28' and the disc 18 does not come into contact with the pulley 22'; as a consequence, no torque is transmitted to the impeller 10.

[0034] In cases when the coil 26' is not fed and, hence, is not crossed by any electric current, the disc 18 comes into contact with the upper face of the pulley 22', and this is so because the magnetic field produced by the magnet 28', owing to the presence of races or slots 23 on the pulley 22', saturates the pulley itself, crosses it and gets linked with the said disc 28' by attraction. In these conditions, the impeller 10 of the pump is set to rotate and a torque is transmitted.

[0035] Whereas when the coil 26' is fed with an "inverse" current that is such as to generate a magnetic field within the pulley 22' that adds to the one generated by the magnet 28', the resulting magnetic field gets linked up with the disc 18 and causes it to be attracted to the pulley itself; in these conditions of contact between the disc 18 and the pulley 22', a greater torque is transmitted to the impeller 10 than the one that is transmitted in the

condition previously described and related to the winding 26' not being crossed by any electric current.

[0036] The foregoing disclosure has illustrated the obvious advantages brought about by this invention.

[0037] The pump for internal-combustion engine cooling circuits equipped with the dimensional and absorbed power optimization device, by using one or more magnets as described above and radially polarized, and by defining, additionally, a simple magnetic circuit that directly links the magnet/s 28 to the pulley 22, advantageously allows the space inside the pulley to be reduced and, hence, a pulley that is smaller in size to be used, whose rated diameter is smaller than 80 mm and is preferably 65 mm in size.

[0038] A further advantage of the device of this invention is that, as the disc 18 comes into contact with the pulley 22 by the action of the linked magnetic field and separates from the pulley when the mentioned field is suppressed, the impeller 10 is only set to rotate when it is strictly necessary and, therefore, allows the absorbed power and the engine cooling to be optimized, and consumptions and burns gas emissions to be controlled.

[0039] Further advantageous is the use of the plate/s 20, which allow(s) the disc 18 to move axially without operating a simultaneous and axial movement of the shaft 12.

[0040] A further advantage of this invention is in that it provides a device which, in the event of an electrical failure or fault, allows the pump to continue to perform its function, though in a possibly limited manner.

[0041] While the invention has been illustrated and described in detail above with special reference to one exemplary embodiment, to be considered as illustrative and not restrictive in character, many variations and modifications will be obvious to one of ordinary skill in the art in the light of the above disclosure. Therefore, the invention is meant to include all modifications and variations that fall under the scope of the claims appended hereto.

Claims

1. A pump for internal-combustion engine cooling circuits equipped with a dimensional and absorbed power optimization device comprising an impeller (10) that is keyed onto a shaft (12) being rotatably tied up to a body (14), made by casting of an aluminium alloy, or any other suitable material and onto which a pulley (22, 22') is also keyed having a hollow (24, 24') featuring a section that is basically circular and coaxial with the pulley; such pump for cooling circuits including:

- inside the pulley (22, 22') one or more magnets (28, 28') that are radially polarized and an electrical winding (26, 26') which are stabilized within the hollow by means of a plate (30, 30') of small thickness made from a nonmagnetic material;

- a disc (18) made from a metallic material, located coaxially with a hub (16) and connected to it by means of one or more thin plates (20) of small thickness;

- a magnetic field produced by the magnet/s (28, 28') that saturates the pulley (22, 22') and gets linked up with the disc (18) and

- the mentioned pulley (22, 22') having a rated diameter smaller than 80 mm.

2. A pump for cooling circuits according to claim 1, wherein the pulley (22, 22') has a rated diameter equalling 65 mm.

3. A pump for cooling circuits according to the previous claims, wherein the magnets(s) (28, 28') is/are permanent magnets made from ferrite, NdFeB (plastic neodymium) or any other suitable material.

4. A pump for cooling circuits according to the previous claims, wherein the disc (18) is made from a ferromagnetic material.

5. A pump for cooling circuits according to the previous claims, wherein the plate (30, 30') is made from a nonmagnetic material.

6. A pump for cooling circuits according to the previous claims, wherein the plate (30, 30') is made from a stainless steel.

7. A pump for cooling circuits according to the previous claims, wherein the plate (30') is made from a ferromagnetic material.

8. A pump for cooling circuits according to the previous claims, wherein the plate (30') is "L"-shaped and stabilizes the coil (26') within the hollow (24').

9. A pump for cooling circuits according to the previous claims, wherein the plate(s) (20) is/are tied up with one end to the disc (18) and with the other one to the hub (16).

10. A pump for cooling circuits according to the previous claims, wherein the magnet(s) (28') is/are inserted into the pulley (22'), tied up to the same and set to rotate with it.

11. A pump for cooling circuits according to the previous claims, wherein the magnet(s) (28') is/are fixed as to the pulley (22').

12. A pump for cooling circuits according to the previous claims, wherein the hollow (24') is formed by the pulley (22') and by a closing member (25) that is rigidly tied up with the body (14).

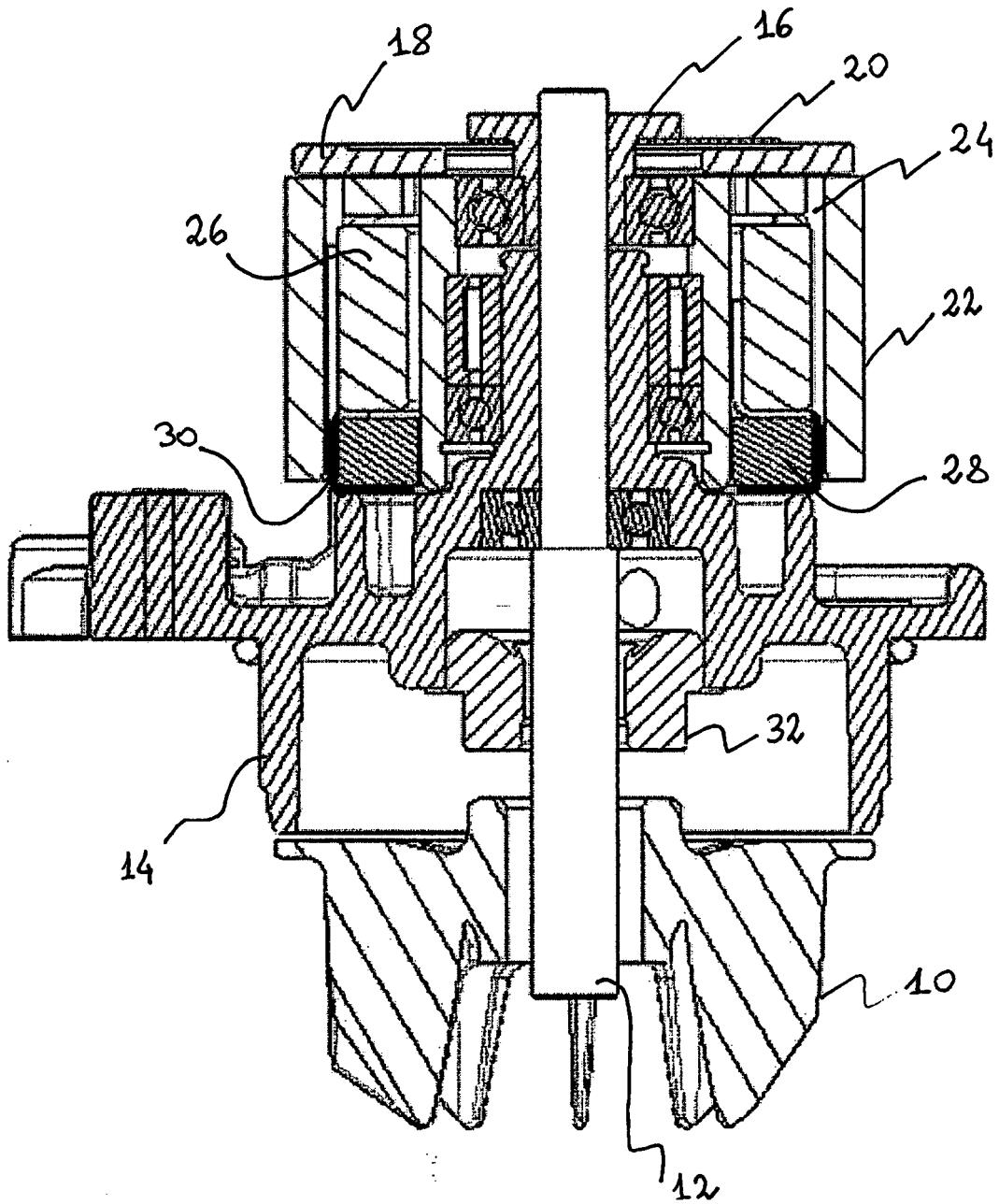


FIG. 1

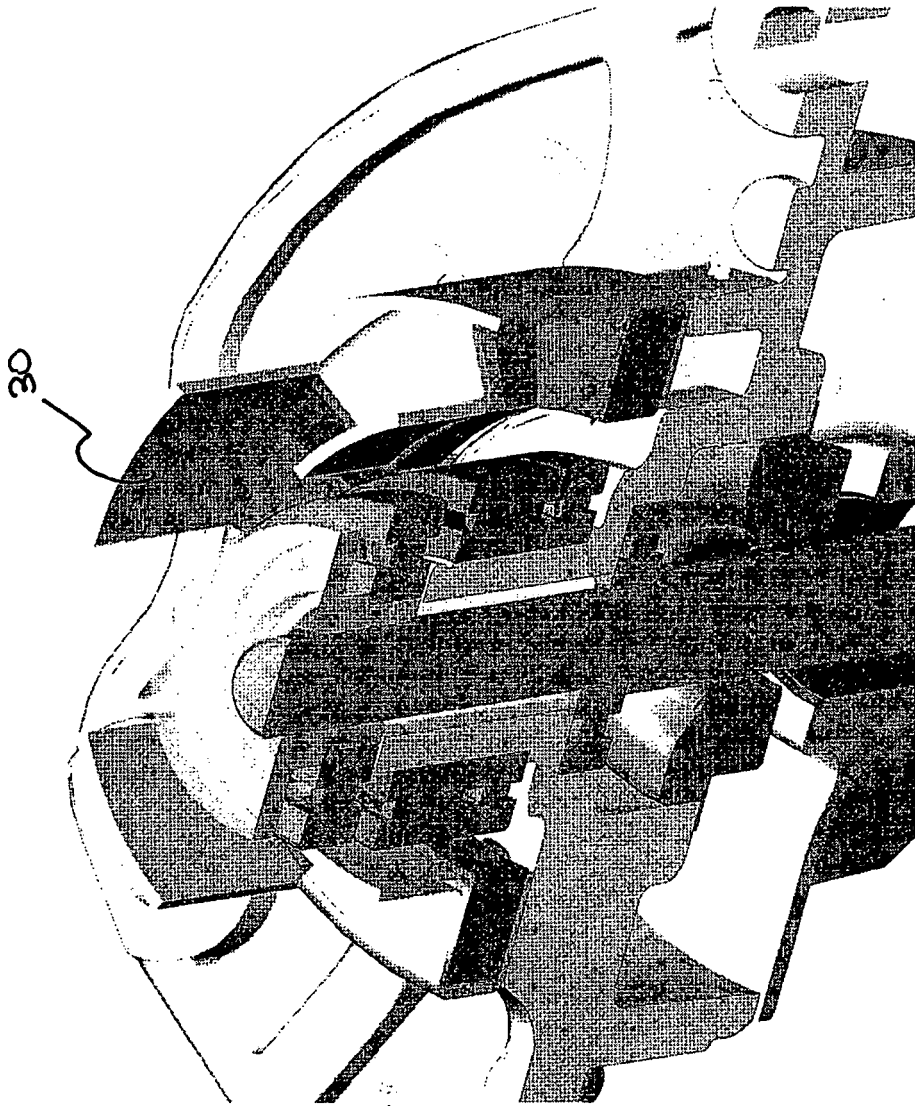


FIG. 2

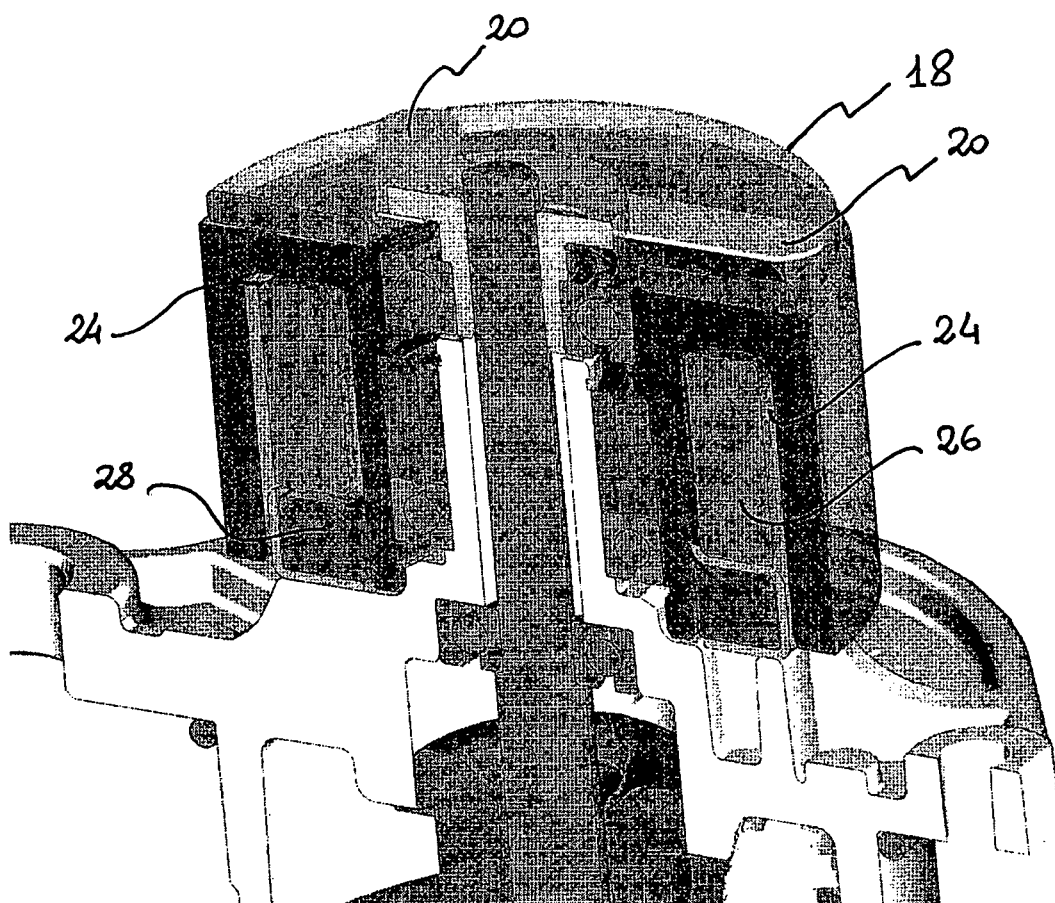


FIG. 3

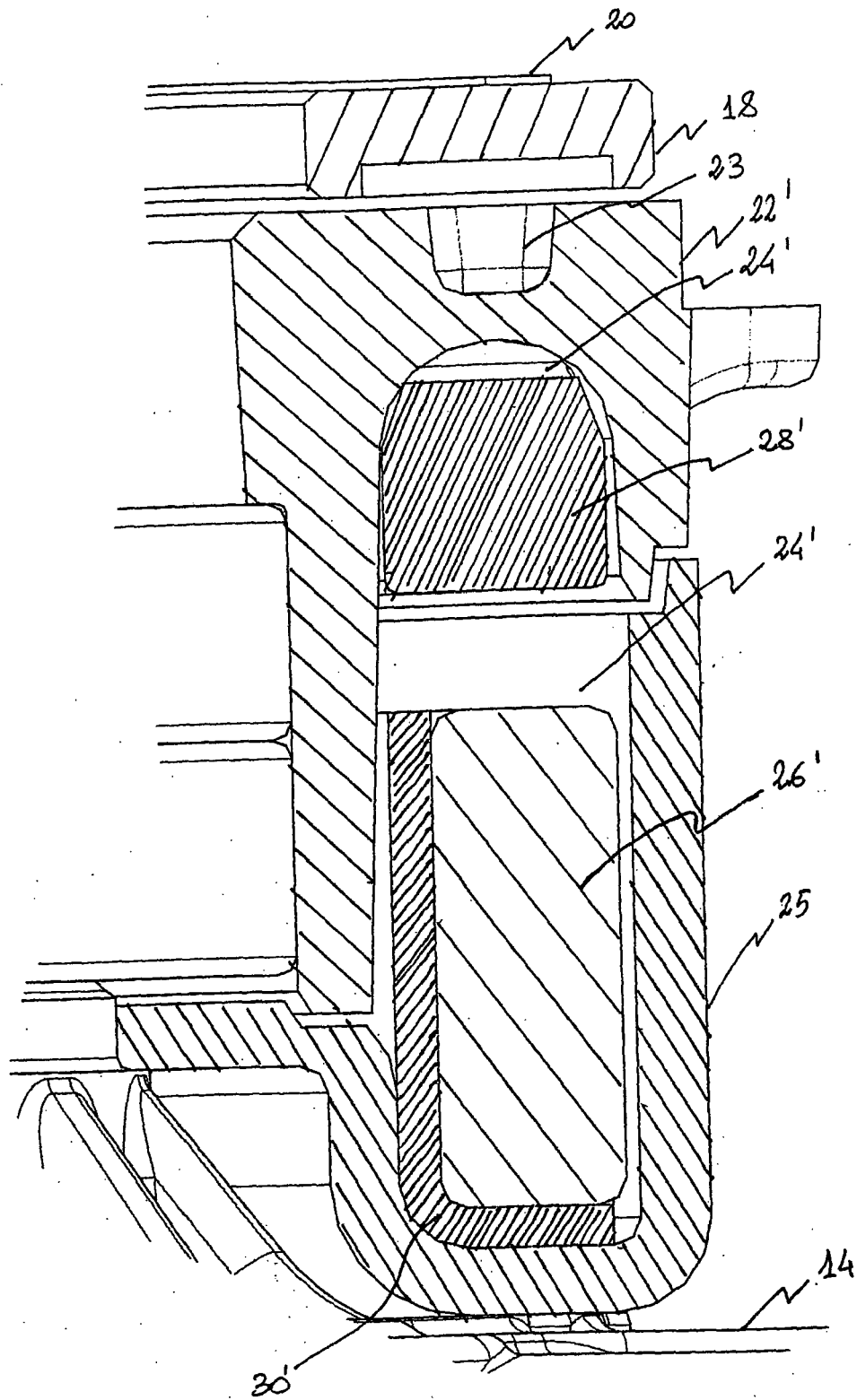


FIG. 4