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

(11) EP 1 319 832 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
18.06.2003 Bulletin 2003/25

(51) Int Cl.[7]: **F04B 17/04**

(21) Application number: **02102744.6**

(22) Date of filing: **12.12.2002**

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

(30) Priority: **13.12.2001 IT MI20012647**

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(54) Electromagnetically operated pump

(57) An electromagnetically operated pump to feed two-stroke internal-combustion engines with precise and controlled amounts of oil comprises, in a casing (1): a cylinder (2); a piston element (3) with a through pipe (4), axially movable in said cylinder (2); an electromagnetic coil (11) coaxial to the cylinder (2), to control the movements of the piston element (3) against the action of spring means (15, 16, 17, 18); a pumping chamber (8) for the oil to be fed, coaxial to the cylinder (2) and close to a first base (7) thereof; and valve means (19, 20) housed in said casing (1) and in said chamber (8), one of said means (19) cooperating with said piston element (3). According to the invention, said electromagnetic coil (11) is an annular coil which surrounds the piston element (3) and acts frontwards onto a keeper (14) of ferromagnetic material, close and parallel to the second base (9) of the cylinder (2) and connected to the second end (12) of the piston element (3), said annular coil (11) projecting from said second base (9) of the cylinder (2).

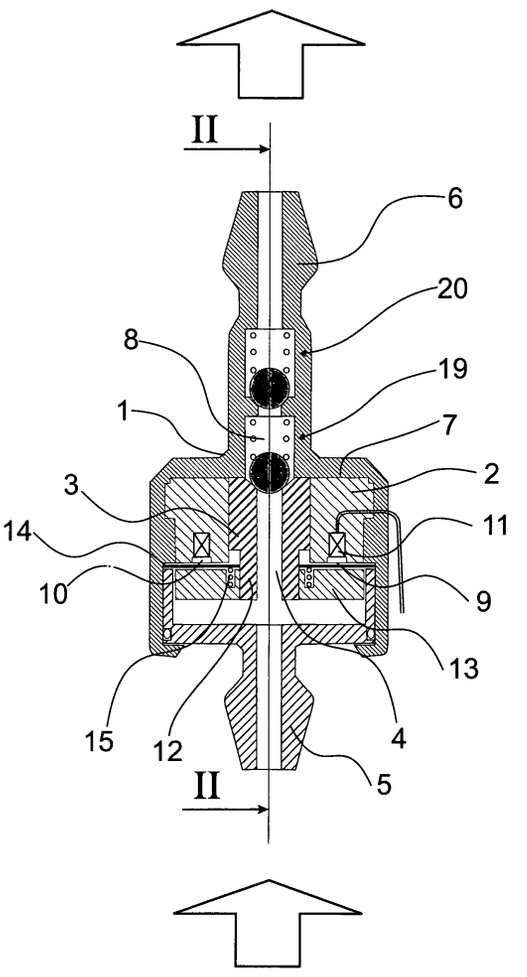

FIG.1

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Description

[0001] The present invention concerns an electromagnetically operated pump to feed two-stroke internal-combustion engines with precise and controlled amounts of oil.

[0002] According to known technique, there are many types of pumps which allow to feed two-stroke internal-combustion engines with precise and controlled amounts of oil, strictly correlated with the running of said engines. Amongst others, use has already been made since quite some time of electrically operated pumps, in which an electromagnetic coil controls the piston of a cylinder in axis therewith, against the action of a spring, so as to empty at each running cycle a pumping chamber of said cylinder into which the oil to be fed is metered.

[0003] The present invention concerns a pump of this type, the structure of which - while preserving the characteristics of a simple construction, a metering precision and an easy setting, which are indispensable for the specific use for which the pump is designed - allows to considerably reduce its overall dimensions and guarantees an improved reliability thereof.

[0004] For this purpose, the pump according to the invention - of the type comprising, in a casing: a cylinder; a piston element with a through pipe, axially movable in said cylinder, an electromagnetic coil coaxial to the cylinder, to control the movements of the piston element against the action of spring means; a pumping chamber for the oil to be fed, coaxial to the cylinder and close to a first base thereof; and valve means housed in said casing and in said chamber, one of said means cooperating with a first end of said piston element - is characterized in that, the electromagnetic coil is an annular coil which surrounds the piston element and acts frontwards onto a keeper of ferromagnetic material, close and parallel to the second base of the cylinder and connected to the second end of the piston element, said annular coil projecting from said second base of the cylinder. Preferably, said piston element is of nonmagnetic material and said annular coil is housed into a cavity of the cylinder formed on the front of said keeper in said second base of the cylinder.

[0005] In a first embodiment of the pump according to the present invention, a disk is interposed between said second base of the cylinder and said keeper, said disk having a central hole through which said piston element freely passes. The spring means act between said disk and said keeper, opposing the movements of the piston element controlled by said coil, said spring means being positioned close to the hole of said disk, or close to its periphery. Alternatively, the spring means are housed peripherally into the pumping chamber, so as to act directly on the piston element, in correspondence of its first end. Said spring means preferably consist of a cylindrical helicoidal spring, coaxial to the cylinder of said pump.

[0006] According to the invention, the piston element is suitably formed - in the different variants of the aforedescribed embodiment - with a portion of reduced diameter towards its second end, the extension of said portion contributing to determine the capacity of the pump.

[0007] In a second embodiment of the pump according to the present invention, the piston element has instead a constant diameter and the capacity of the pump depends on the distance between the keeper and the cylinder, when the keeper is subject merely to the action of the spring means which oppose the movements of the piston element controlled by said coil. Such spring means can consist of a Belleville washer, coaxial to the cylinder of the pump and interposed between said second base of the cylinder and said keeper, or of a cylindrical helicoidal spring housed peripherally into the pumping chamber.

[0008] The invention will now be described in further detail, with reference to the accompanying drawings, in which:

[0009] Fig. 1 is an axial section view of a first embodiment of the pump according to the present invention;

[0010] Fig. 2 shows a detail of the pump of fig. 1, along the line II-II thereof;

[0011] Fig. 3 illustrates a first variant of the embodiment of the pump shown in fig. 1;

[0012] Fig. 4 illustrates a second variant of the embodiment of the pump shown in fig. 1;

[0013] Fig. 5 shows a second embodiment of the pump according to the present invention, illustrating a first variant thereof;

[0014] Fig. 6 illustrates a second variant of the embodiment of the pump shown in fig. 5; and

[0015] Fig. 7 shows a detail of the pump of fig. 6, along the line VII-VII thereof.

[0016] With reference to the drawings, the pump according to the present invention is of the type comprising - as clearly illustrated - a casing 1 housing a cylinder 2 and a piston element 3, axially movable in the cylinder 2 and crossed by a through pipe 4 connected to pipe unions 5 and 6 in the casing 1, for the inlet and respectively the outlet of oil. Close to a first base 7 of the cylinder 2, in contact with the casing 1 and along the corresponding pipe union 6, there is a pumping chamber 8 to pump the oil to be fed, said chamber also housing valve means of the pump, as described hereinafter. A cavity 10 is formed close to the second base 9 of the cylinder 2, into said cavity there being housed a compact electromagnetic annular coil 11 which surrounds the piston element 3 and which is fed with pulse current in strict correlation with the running of the two-stroke engine to be equipped with the pump. The depth of the cavity 10 slightly exceeds the height of the coil 11, so that this latter can be fully housed therein and be efficiently protected.

[0017] According to the invention, the piston element 3 is connected, at its end 12 in correspondence of the base 9 of the cylinder 2, to a keeper 13 parallel and close to said base 9. The electromagnetic coil 11 acts front-

wards onto said keeper 13 - which is of ferromagnetic material - against the action of spring means. The keeper 13 draws in its movements the piston element 3, preferably made of nonmagnetic material. Thanks to the efficiency of the frontward action - with a low magnetic gap and a magnetic circuit with low reluctance - of the electromagnetic coil 11 on the keeper 13, the movements of the piston element 3 of the pump according to the invention can be controlled by means of a coil 11 of very small dimensions and having a very compact structure. The efficiency of said action is in fact far higher than that which could be obtained up to date in the pumps having coils usually extending along the whole cylinder of the pump, externally thereof, and acting directly onto a piston of ferromagnetic material in an axial sense, in magnetic circuits with a very high reluctance. The arrangement of the present invention thus allows to considerably reduce the overall dimensions of the pump, providing an advantage which is particularly important for the applications pointed out in the introductory part of the present description, such as feeding oil in two-stroke internal combustion engines.

[0018] The pump according to the present invention can be conceived in different embodiments, some of which are illustrated on the accompanying drawings.

[0019] In a first embodiment (figs. 1 to 4), a disk 14 is interposed between the second base 9 of the cylinder 2 and the keeper 13, said disk 14 preferably being of nonmagnetic material and having a central hole through which freely passes the end 12 of said piston element 3 having a portion 12A of reduced diameter (fig. 2); the portion of wider diameter of said piston element 3 stops instead against said disk 14. Spring means act between said disk 14 and said keeper 13 opposing the movements of the piston element 3 controlled by the coil 11. In the embodiment of figs. 1 and 2, said spring means are centrally positioned - in 15 - close to the hole of the disk 14; whereas, in the variant of fig. 3, they are positioned - in 16 - close to the periphery of the disk 14. Alternatively, in the variant of fig. 4, said spring means consist of a cylindrical helicoidal spring 17, coaxial to the cylinder 2 and housed peripherally into the pumping chamber 8. Instead of acting on the keeper 13 - like the springs 15 and 16 - the spring 17 acts directly onto the piston element 3, in correspondence of its first end, opposite to that fixed to the keeper 13.

[0020] In a second embodiment (figs. 5 and 6), the piston element 3 has a constant diameter, it being obtained from a ground bar (thereby reducing the costs in respect of the previous embodiment).

[0021] In the variant of fig. 5, there is no disk 14, while a simple Belleville washer 18 is interposed between the second base 9 of the cylinder 2 and the keeper 13, said washer being coaxial to the cylinder 2. In this variant, the washer 18 obviously forms said spring means which oppose the movements of the piston element 3 controlled by the coil 11. Whereas, in the variant of fig. 6, such spring means consist of a cylindrical helicoidal spring 17 - like that of the variant of fig. 4 - coaxial to the cylinder 2 and housed peripherally into the pumping chamber 8.

[0022] In operation, the coil 11 controls, when energized, the movements of the piston element 3 towards the chamber 8, while attracting the keeper 13 against the action of the spring means 15, 16 or 17. Such means produce movements in the opposite sense when the coil 11 is deenergized. Two ball valves 19 and 20 are provided, in known manner, in the pipe union 6 in the casing 1, in correspondence of the oil pumping chamber 8, the valve 19 cooperating with the end of the piston element 3 in correspondence of the base 7 of the cylinder 2. As better seen hereinafter, when the keeper 13 is attracted by the electromagnetic coil 11 and the piston element 3 moves towards the pipe union 6, the valve 19 is closed while the valve 20 opens. Viceversa, when the piston element 3 is moved back by the spring means 15, or 16, or 17, the valve 20 closes while the valve 19 opens again.

[0023] Fig. 2 shows a detail of fig. 1, illustrating how the capacity of the oil being pumped, for each stroke of the pump according to the invention, may be determined by varying the distance a-b in fig. 1, namely the ratio between the length of the portion of wider diameter and the length of the portion 12A of reduced diameter of the piston element 3. This obviously also applies to the other variants of the pump adopting a similar piston element 3 (figs. 3 and 4).

[0024] For what concerns the other embodiment of the pump according to the invention, illustrated in fig. 5, and its variant illustrated in fig. 6, wherein the piston element 3 has a constant diameter, the capacity of the oil being pumped for each stroke of the pump is instead determined, as clearly shown in fig. 7, by the distance a-b between the keeper 13 and the base 9 of the cylinder 2, when said keeper is subject merely to the action of the spring means 18 or 17 and the coil 11 is deenergized.

[0025] Thanks to the special configuration of its original magnetic circuit, the aforedescribed pump has a very simple structure and a highly reliable working but, above all - as already mentioned - it allows to drastically limit the dimensions of the electric circuit and of the coil controlling the movements of the piston element; this considerably affects the overall dimensions of the pump, so as to be able to assert that it leads to a miniaturization thereof. In the first embodiment of fig. 1, and its variants of figs. 3 and 4, the pump according to the invention can moreover be easily adapted, with reduced costs, to the most different requirements of capacity, by simply varying the axial position of the abutment of the piston element 3, formed in two portions of different diameter.

[0026] In the simpler embodiment of fig. 5, and its variant of fig. 6, the pump is instead less versatile, but it involves lower production costs.

[0027] It is anyhow understood that there can be other embodiments of the pump, differing from those described heretofore, without thereby departing from the

scope of the present invention.

Claims

1. Electromagnetically operated pump to feed two-stroke internal-combustion engines with precise and controlled amounts of oil - of the type comprising, in a casing (1): a cylinder (2); a piston element (3) with a through pipe (4), axially movable in said cylinder (2); an electromagnetic coil (11) coaxial to the cylinder (2), to control the movements of the piston element (3) against the action of spring means (15, 16, 17, 18); a pumping chamber (8) for the oil to be fed, coaxial to the cylinder (2) and close to a first base (7) thereof; and valve means (19, 20) housed in said casing (1) and in said chamber (8), one of said means (19) cooperating with a first end of said piston element (3) - **characterized in that**, the electromagnetic coil (11) is an annular coil which surrounds the piston element (3) and acts frontwards onto a keeper (13) of ferromagnetic material, close and parallel to the second base (9) of the cylinder (2) and connected to the second end (12) of the piston element (3), said annular coil (11) projecting from said second base (9) of the cylinder (2).

2. Pump as in claim 1), wherein the piston element (3) is of nonmagnetic material.

3. Pump as in claim 1), wherein said annular coil (11) is housed into a cavity (10) of the cylinder (2) formed on the front of said keeper (13) in said second base (9) of the cylinder (2).

4. Pump as in claim 3), wherein said cavity (10) of the cylinder (2) housing the coil (11) has a depth which slightly exceeds the height of said coil (11).

5. Pump as in claim 1), wherein a disk (14) is interposed between said second base (9) of the cylinder (2) and said keeper (13), said disk (14) having a central hole through which said piston element (3) freely passes, between said disk (14) and said keeper (13) acting the spring means (15, 16) which oppose the movements of the piston element (3) controlled by said coil (11).

6. Pump as in claim 5), wherein said spring means (15) are positioned close to the hole of said disk (14).

7. Pump as in claim 5), wherein said spring means (16) are positioned close to the periphery of the disk (14).

8. Pump as in claims 5) to 7), wherein the spring means (17) consist of a cylindrical helicoidal spring, coaxial to the cylinder (2) of the pump.

9. Pump as in claims 5) to 8), wherein said disk (14) is of nonmagnetic material.

10. Pump as in claims 1) to 9), wherein the piston element (3) is formed with a portion of wider diameter and a portion of reduced diameter (12A) towards its second end (12).

11. Pump as in claims 1) to 4), wherein the piston element (3) has a constant diameter.

12. Pump as in claim 1), wherein a Belleville washer (18) is interposed between said second base (9) of the cylinder (2) and said keeper (13), coaxial to the cylinder (2) of the pump, said washer (18) forming the spring means which oppose the movements of the piston element (3) controlled by said coil (11).

13. Pump as in claim 1), wherein the spring means which oppose the movements of the piston element (3) controlled by said coil (11) consist of a cylindrical helicoidal spring (17), housed peripherally into the pumping chamber (8) and acting directly on the piston element (3), in correspondence of its first end.

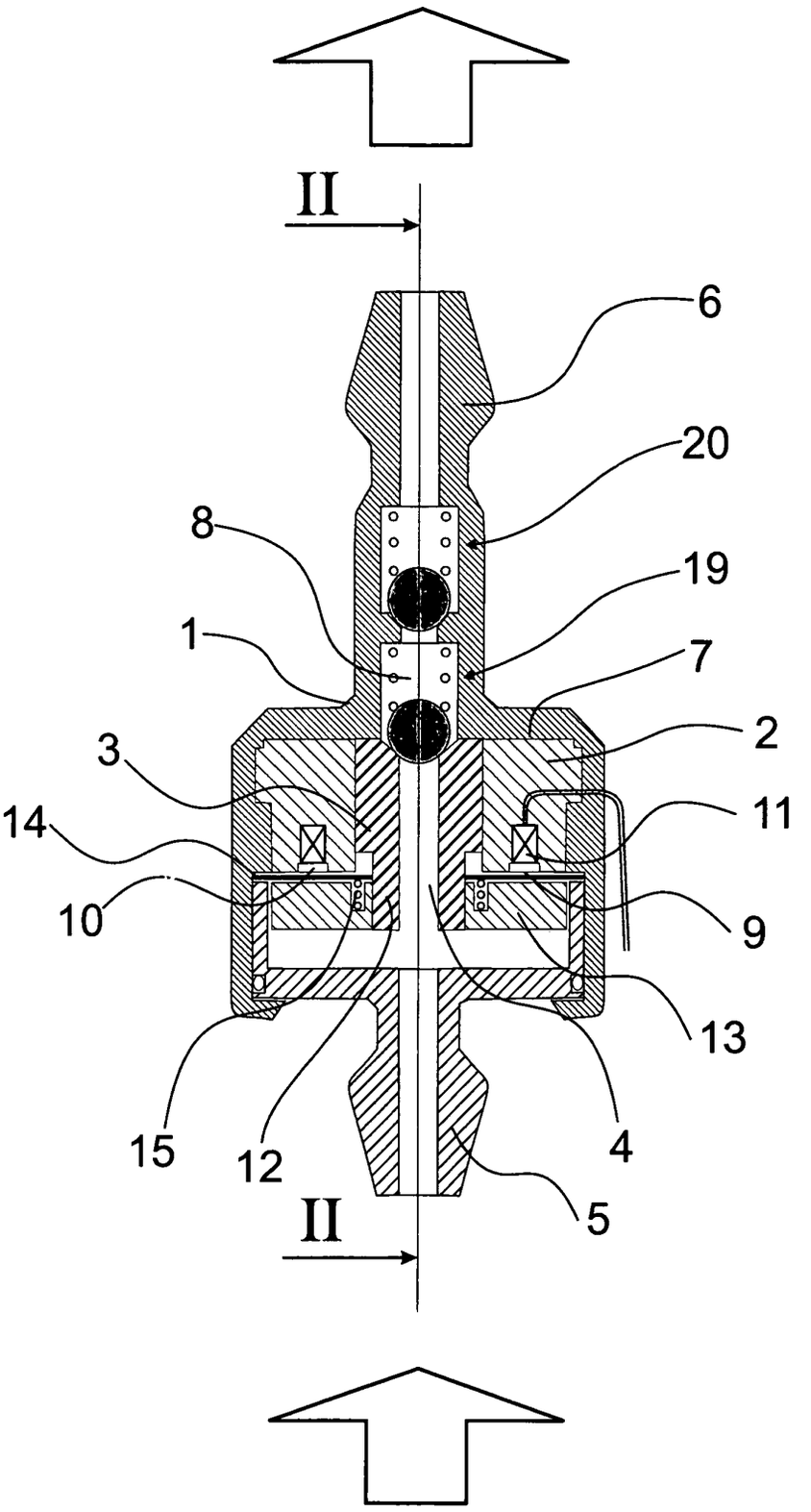
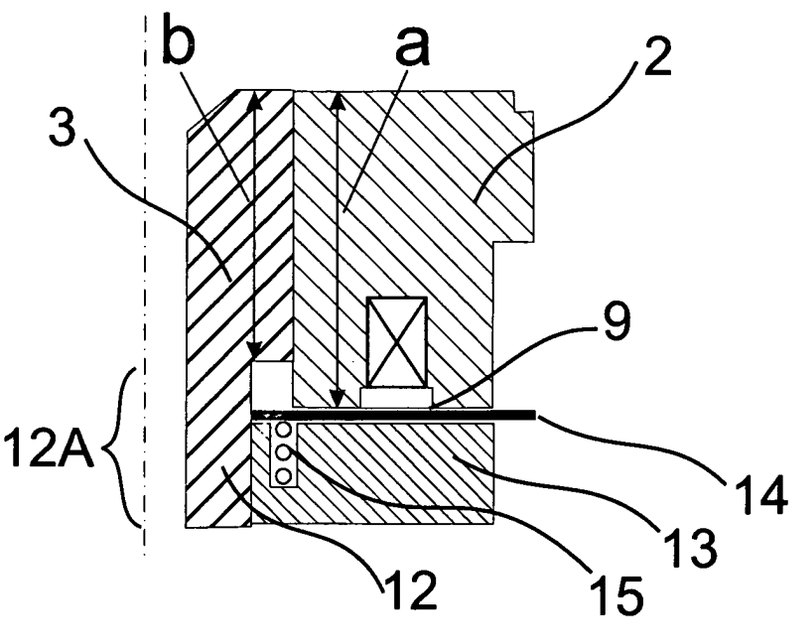


FIG.1

FIG.2



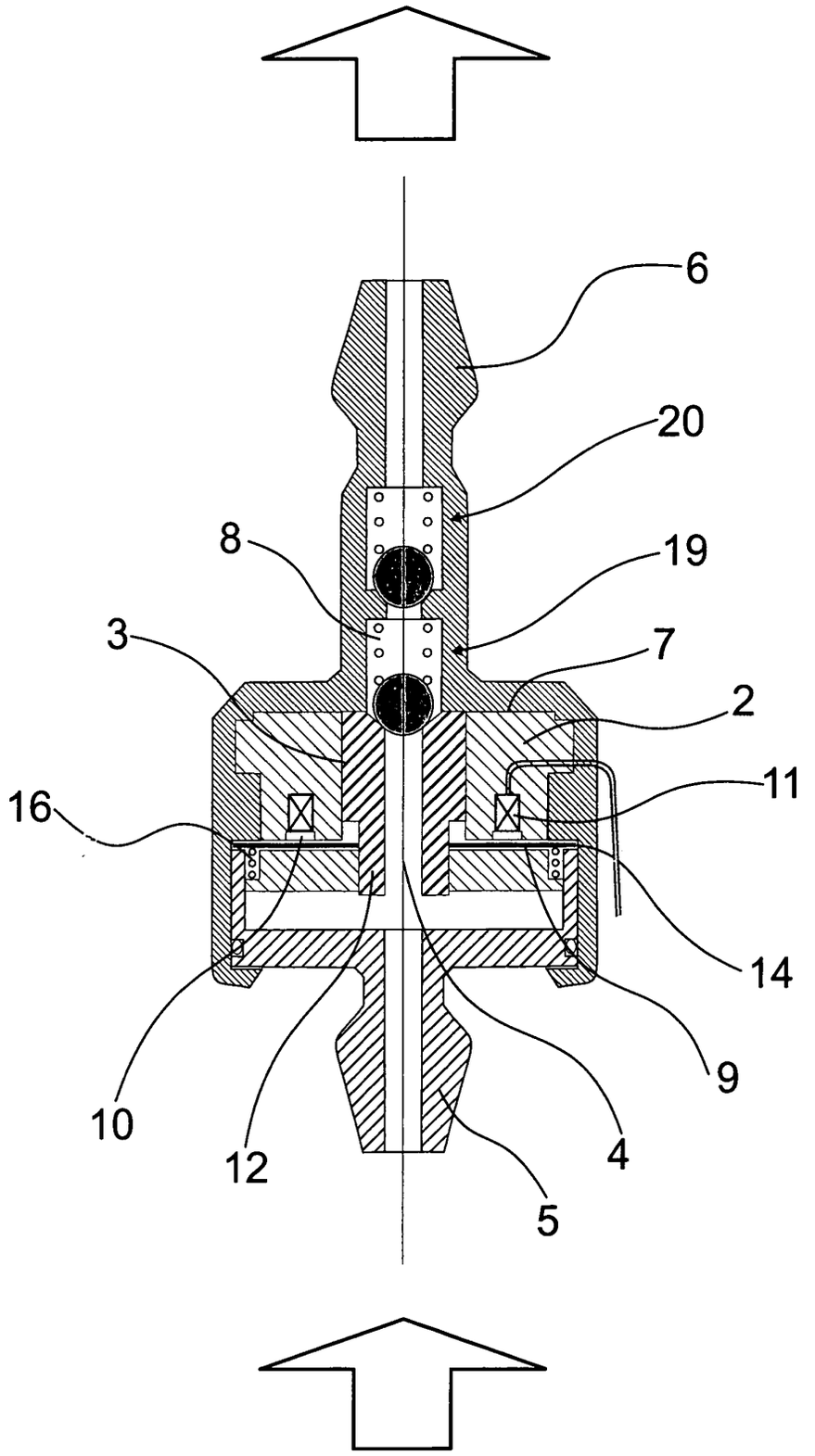


FIG.3

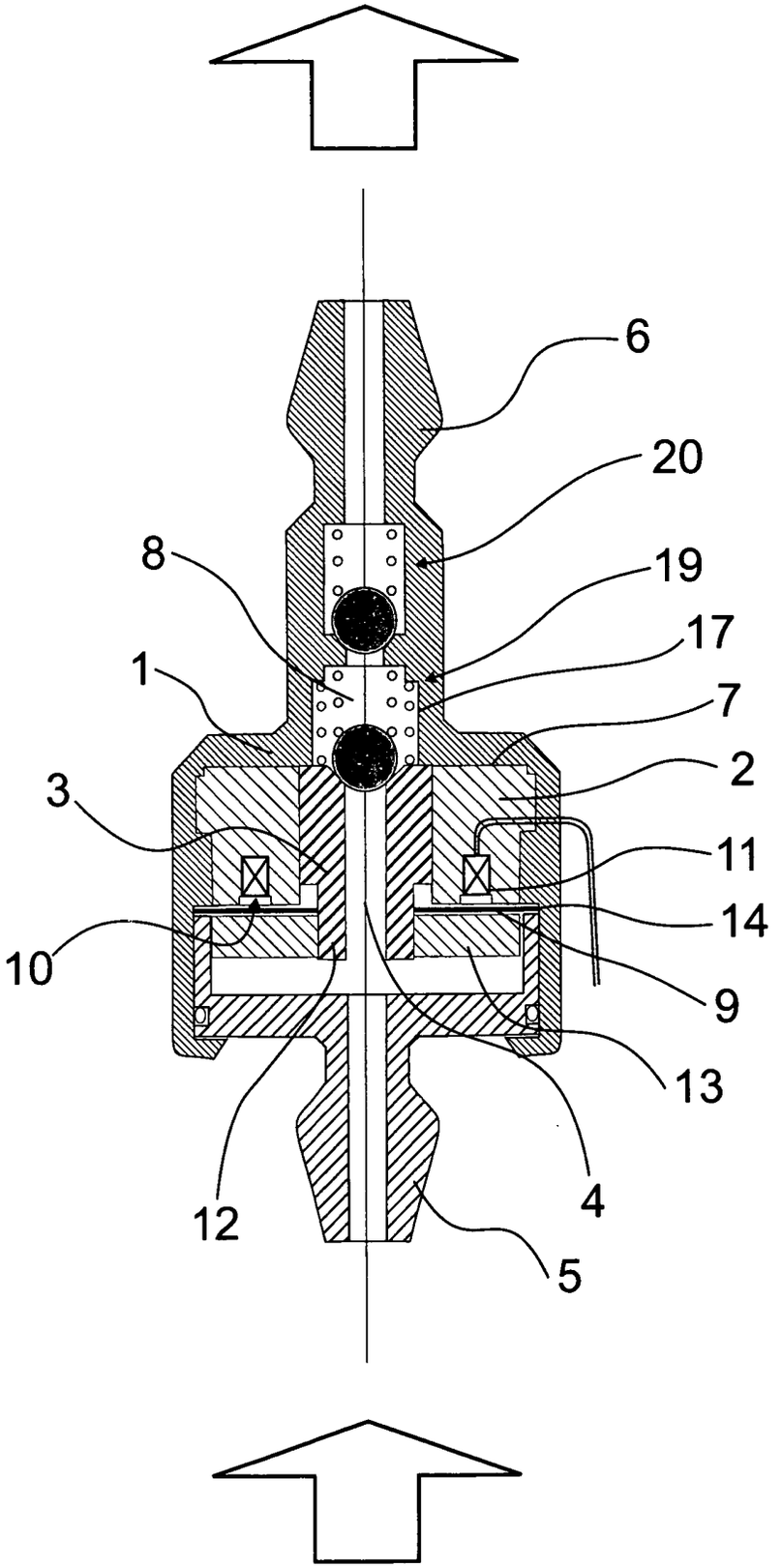


FIG.4

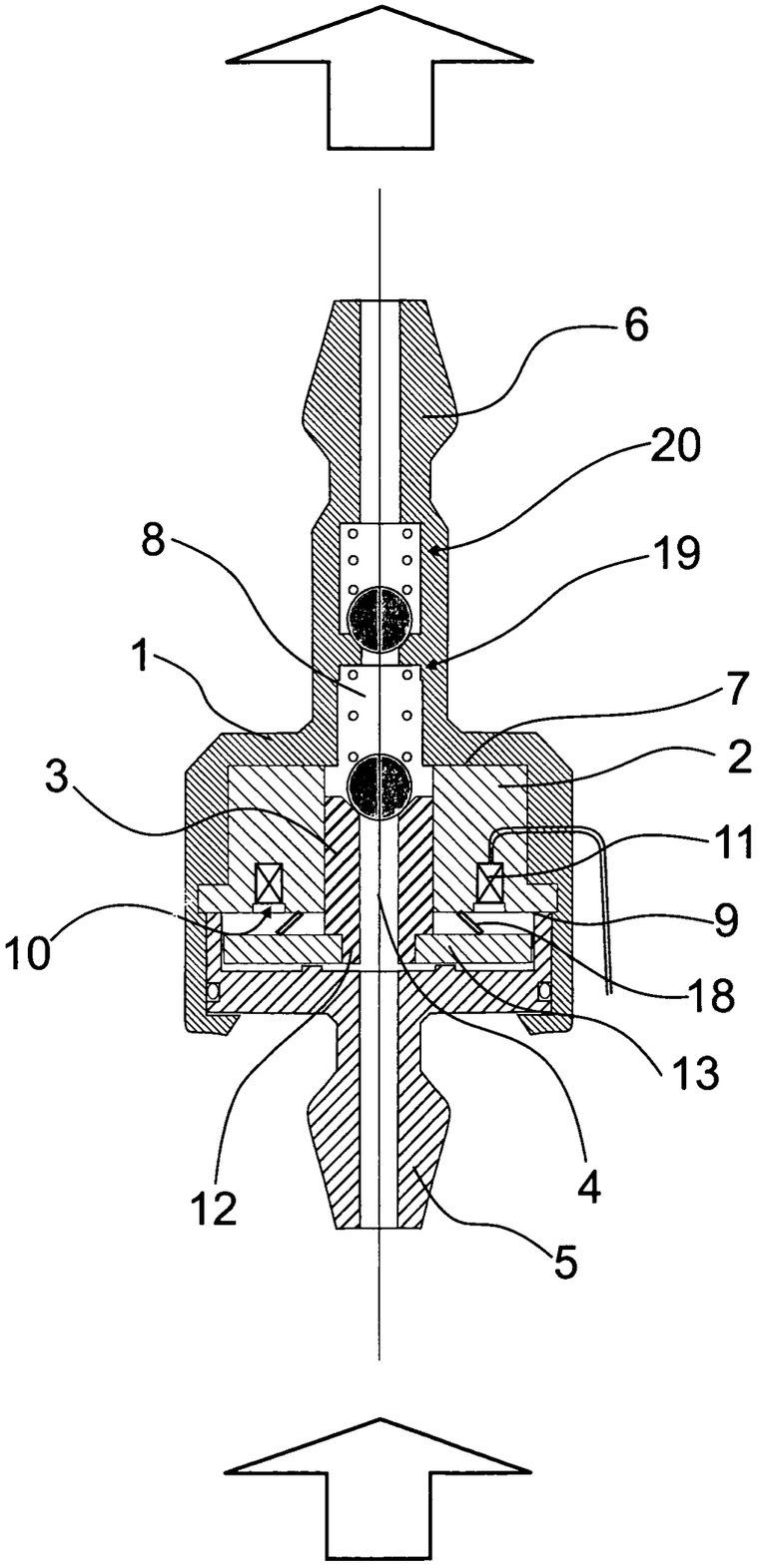


FIG.5

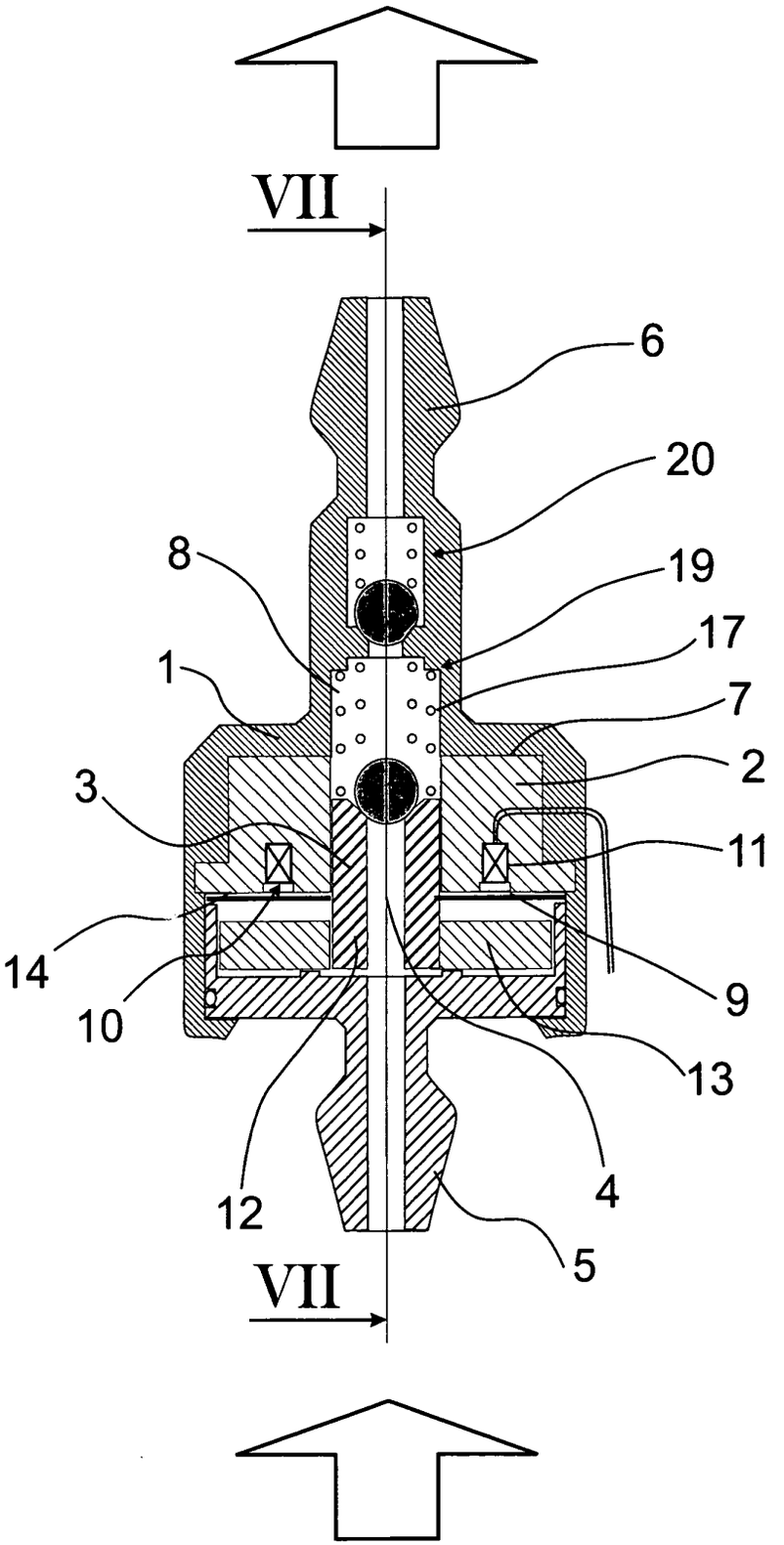


FIG.6

FIG.7