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(54) **IN-TANK SOLENOID FUEL PUMP**

IN-TANK-ELEKTROMAGNETKRAFTSTOFFPUMPE

POMPE A COMBUSTIBLE A SOLENOIDE PLACEE DANS UN RESERVOIR

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Description

Field of the Invention

[0001] The present invention relates to an electromagnetic fuel pump which draws in and pressurizes fuel stored inside a fuel tank and supplies this fuel to an internal combustion engine, and more particularly relates to an in-tank type electromagnetic fuel pump which is disposed inside the fuel tank in a state in which this fuel pump is submerged in the fuel inside this fuel tank. as shown in document EP 822 330 A.

[0002] further pump is shown in US 4 150 924 A.

Description of the Related Art

[0003] Conventionally, in vehicles, as is shown in Fig. 3, fuel F stored in a fuel tank 1 is drawn in and pressurized by a fuel pump 2 so that this fuel F is supplied to the intake passage 3 of an internal combustion engine via (for example) a fuel injection device 4.

[0004] Furthermore, a so-called in-tank type electromagnetic fuel pump which is disposed in a state in which this fuel pump is submerged in the fuel F inside the fuel tank is known as the fuel pump 2.

[0005] Furthermore, as is shown in Fig. 4, this electromagnetic fuel pump 2 comprises a cylinder 6 that forms a pressurizing chamber 5, a plunger 7 which is slidably mounted inside this cylinder 6, an inner yoke 8 which is disposed so as to surround the plunger 7, a pair of springs 9 and 10 which are interposed between both end parts of the plunger 7 and both end parts of the inner yoke 8, and which hold the plunger 7 in a neutral position, a bobbin 12 which is disposed so as to surround the inner yoke 8, and around which is wound a solenoid coil 11 that moves the plunger 7 in the intake direction by exciting this plunger 7, and a molding 13 in which these constituent members are accommodated.

[0006] Furthermore, an outlet check valve 14 which is pushed open by the pressurized fuel F is installed on one end part of the cylinder 6, on the side on which the pressurizing chamber 5 is formed, and a fuel introduction hole 16 is formed in the interior part of the plunger 7 such that the fuel introduction hole 16 communicates with a fuel inlet passage 15 formed in the opposite side of the plunger 7 from the pressurizing chamber 15, and also communicates with the pressurizing chamber 15. An inlet check valve 17 is disposed at an intermediate point in the fuel introduction hole 16, so that this inlet check valve 17 is opened when the plunger is moved in the intake direction so that the pressure in the pressurizing chamber 5 is reduced, thus allowing the flow of fuel F from the d fuel introduction hole 16 into the pressurizing chamber 5, and is closed when the plunger 7 is moved in the pressurizing direction.

[0007] In the electromagnetic fuel pump 2 constructed as described above, when the excitation by the solenoid coil 11 is stopped, the plunger 7 is moved in the pressurizing direction by the spring 9, whereby, the fuel F inside the pressurizing chamber 5 is pressurized, and at the point in time at which the pressure of this fuel F exceeds a specified value, the outlet check valve 14 is opened, and the fuel F is discharged.

[0008] Furthermore, when a driving current flows through the solenoid coil 11, the plunger 7 is excited by this solenoid coil 11 and caused to move in the intake direction. As a result of this movement, the outlet check valve 14 is closed and the pressure in the pressurizing chamber 5 is reduced. The inlet check valve 17 is thereby opened, and fuel F is drawn into the pressurizing chamber 5 via the fuel inlet passage 15 and fuel introduction hole 16.

[0009] Fuel F is successively discharged by the repetition of the above operation.

[0010] In such a conventional electromagnetic fuel pump 2, the following problems requiring amelioration remain.

[0011] Specifically, during the discharge operation of the fuel F, heat is generated in the solenoid coil 11 as a result of the flow of current through this solenoid coil 11, or heat is generated as a result of friction during the sliding movement of the plunger 7.

[0012] Furthermore, the fuel F inside the fuel inlet passage 15 and fuel introduction hole 16 is heated by this heat via the inner yoke 8 and cylinder 6, so that vapor is generated in this fuel F.

[0013] When vapor is thus generated in the fuel F inside the fuel inlet passage 15 and fuel introduction hole 16, this vapor is sucked into the pressurizing chamber 5 via the inlet check valve 17, thus leading to the problem of a drop in the pump discharge capacity.

[0014] The present invention was devised in the light of such conventional problems. It is an object of the present invention to provide an in-tank type electromagnetic fuel pump which makes it possible to prevent vapor in the fuel from entering the pressurizing chamber even if such vapor is generated as a result of the generation of heat in the solenoid coil itself or during the sliding movement of the plunger.

SUMMARY OF THE INVENTION

[0015] In order to achieve the object, the in-tank type electromagnetic fuel pump according to claim 1 of the present application is an in-tank type electromagnetic fuel pump which is disposed inside a fuel tank, and comprises a cylinder that forms a pressurizing chamber, a plunger which is slidably mounted inside this cylinder, an inner yoke which is attached to the outer circumference of the cylinder, and a bobbin which is disposed so that it surrounds the inner yoke, and around which a solenoid coil that excites the plunger is wound. In this electromagnetic fuel pump, a fuel circulation passage is formed on the outside of the cylinder along the longitudinal direction of this cylinder, and both end portions of this fuel circulation passage open into the interior of the fuel tank in the vicinity of both end portions of the cylinder in the longitudinal direction of the cylinder.

[0016] The in-tank type electromagnetic fuel pump according to claim 2 of the present application is characterized in that the fuel circulation passage described in claim 1 is formed by a groove that is formed in the inside surface of the bobbin along the longitudinal direction of this bobbin.

[0017] The in-tank type electromagnetic fuel pump according to claim 3 of the present application is characterized in that a plurality of the grooves described in claim 2 are formed at specified intervals around the axial line of the bobbin.

[0018] The in-tank type electromagnetic fuel pump according to claim 4 of the present application is characterized in that a collar is disposed between the bobbin and the inner yoke described in claim 1, and the fuel circulation passage is formed in this collar.

[0019] The in-tank type electromagnetic fuel pump according to claim 5 of the present application is characterized in that the inner yoke described in any of claims 1 through 4 is divided into two parts in the longitudinal direction of the cylinder, and [these parts] are disposed at a specified spacing in the longitudinal direction of the cylinder, so that a portion of the cylinder is exposed to the fuel circulation passage.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020]

Fig. 1 is a longitudinal sectional view which shows one embodiment of the present invention;
Fig. 2 is a transverse sectional view which shows one embodiment of the present invention;
Fig. 3 is a schematic diagram which shows an example of the construction of the fuel supply system in an internal combustion engine; and
Fig. 4 is a longitudinal sectional view which shows an example of prior art.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0021] An embodiment of the present invention will be described below with reference to Figs. 1 and 2.

[0022] Furthermore, in the following description, since the principal constituent members of the fuel supply system shown in Fig. 3 and the in-tank electromagnetic fuel pump shown in Fig. 4 are common to both systems, these common parts are labeled with same symbols, and description of these common parts is omitted.

[0023] The in-tank electromagnetic fuel pump of the present embodiment, which is indicated by the symbol 20 in Fig. 1, is an in-tank electromagnetic fuel pump which is disposed inside a fuel tank 1. This electromagnetic fuel pump has an overall construction which comprises a cylinder 6 that forms a pressurizing chamber 5, a plunger 7 which is slidably mounted inside this cylinder 6, an inner yoke 8 which is attached to the outer circumference of the cylinder 6, and a bobbin 21 which is disposed so as to surround the inner yoke 8, and around which a solenoid coil 11 that excites the plunger 7 is wound, and in which a fuel circulation passage 22 is formed on the outside of the cylinder 6 along the longitudinal direction of this cylinder 6, and both end parts of this fuel circulation passage 22 open into the interior of the fuel tank 1 in the vicinity of both end parts in the longitudinal direction of the cylinder 6.

[0024] To describe this in greater detail, the inner yoke 8 is divided into two parts in the longitudinal direction of the cylinder 6, and these parts are attached with a specified spacing in the longitudinal direction of the cylinder 6, so that a portion of the cylinder 6 is exposed to the fuel circulation passage 22 between these two parts of the inner yoke 8.

[0025] The fuel circulation passage 22 is formed by grooves 23 that are formed in the inside surface of the bobbin 21 along the entire length of this bobbin 21. As is shown in Fig. 2, these grooves 23 are formed in four places at specified intervals in the circumferential direction of the cylinder 6.

[0026] Furthermore, both end parts of these grooves 23 are caused to communicate with the outside of the in-tank electromagnetic fuel pump 20, that is, with the interior of the fuel tank 1, via opening parts 13a and 13b that are formed in both end parts of the molding 13.

[0027] In the in-tank type electromagnetic fuel pump 20 of the present embodiment constructed as described above, as in a conventional electromagnetic fuel pump, the plunger 7 is caused to perform a reciprocating motion through the cylinder 6 by the repeated excitation and de-excitation of this plunger 7 by the solenoid coil 11. As a result, fuel F is sucked into the pressurizing chamber 5 from the fuel inlet passage 15 and fuel introduction hole 16 via the inlet check valve 17. Furthermore, as a result of the pressurization of the fuel F inside the pressurizing chamber 5, this fuel F is supplied to the fuel injection device 4 via the outlet check valve 14.

[0028] During the operation of such an in-tank electromagnetic fuel pump 20, heat is generated by the passage of current through the solenoid coil 11; furthermore, heat is also generated by the sliding movement of the plunger 7. This heat is transmitted to the fuel F inside the fuel circulation passage 22.

[0029] Here, when the fuel F inside the fuel circulation passage 22 is heated, the density of the fuel drops, so that this fuel F moves toward both end parts of the fuel circulation passage 22, and flows out from the opening parts 13a and 13b at the opposite ends of the molding 13, into the fuel tank 1.

[0030] Since such a flow of the fuel F is continuous, a continuous flow of fuel F is formed inside the fuel circulation passage 22.

[0031] Consequently, low-temperature fuel F inside the fuel tank 1 is supplied to the interior of the fuel circulation passage 22. As a result, heated fuel F is removed from the surface of the inner yoke 8, and low-temperature fuel F is caused to contact this surface, so that the rise in the temperature of the inner yoke 8, and therefore the rise in the temperature of the cylinder 6 that is contacted by this inner yoke 8, is inhibited (specifically, the inner yoke 8 and cylinder 6 are cooled); furthermore, the heating of the fuel F inside the fuel inlet passage 15 and fuel introduction passage 16 is inhibited.

[0032] Accordingly, the generation of vapor in the fuel F inside the fuel inlet passage 15 and fuel introduction passage 16 is prevented, and the entry of vapor into the pressurizing chamber 5 is prevented.

[0033] As a result, the drop in the discharge capacity of the in-tank type electromagnetic fuel pump 20 is inhibited.

[0034] Furthermore, in the present embodiment, since a portion of the cylinder 6 is exposed to the fuel circulation passage 22, the cooling action of the fuel F inside the fuel circulation passage 22 on the cylinder 6 is efficiently accomplished; as a result, the effect that prevents the generation of vapor in the fuel F inside the fuel inlet passage 15 and fuel introduction passage 16 is greatly heightened.

[0035] Meanwhile, it might be envisioned that vapor will be generated in the fuel F inside the fuel circulation passage 22 as a result of the fuel F inside this fuel circulation passage 22 being heated; however, if vapor is thus generated inside the fuel circulation passage 22, this vapor is also released into the fuel tank 1 from the opposite end parts of the fuel circulation passage 22 via the opening parts 13a and 13b in the opposite ends of the molding 13.

[0036] Furthermore, during the movement of vapor as described above, the fuel F inside the fuel circulation passage 22 is pushed out by this vapor, thus causing the fuel F inside this fuel circulation passage 22 to be forcibly moved.

[0037] This results from the fact that a bubble pump is formed by the vapor.

[0038] Accordingly, the movement of the fuel F inside the fuel circulation passage 22 is accomplished forcibly and securely, so that the cooling action on the inner yoke 8 and cylinder 6 is enhanced.

[0039] Furthermore, the vapor generated inside the fuel circulation passage 22 is caused to move to the top of the fuel tank 1 by buoyancy at the point of time when this vapor is discharged to the outside of the molding 13, and the vapor is released into the upper space of the fuel tank 1.

[0040] Accordingly, no vapor will enter the fuel inlet passage 15.

[0041] Thus, in the in-tank type electromagnetic fuel pump 20 of the present embodiment, the heat generated from the solenoid coil 11 and heat generated by the sliding movement of the plunger 7 during the discharge operation is efficiently removed, so that vapor can be prevented from entering in the fuel F that is sucked into the pressurizing chamber 5.

[0042] Furthermore, by utilizing the buoyancy of the vapor that is generated around the inner yoke 8 and cylinder 6 to cause forcible circulation of the fuel F around this inner yoke 8 and cylinder 6, it is possible to remove the heat around the inner yoke 8 and cylinder 6 in an efficient manner.

[0043] The shapes, dimensions and the like of the constituent members shown in the embodiment are just examples; various alterations may be made on the basis of design requirements and the like.

[0044] For example, it would also be possible to install a collar between the bobbin 21 and the inner yoke 8, and to form the fuel circulation passage 22 in this collar.

[0045] In the in-tank type electromagnetic fuel pump of the present invention, as was described above, the heat generated from the solenoid coil and heat generated by the sliding movement of the plunger during the discharge operation can be efficiently removed, so that vapor can be prevented from entering in the fuel that is sucked into the pressurizing chamber.

[0046] Accordingly, a drop in the discharge capacity can be prevented.

[0047] Furthermore, by utilizing the buoyancy of the vapor that is generated around the inner yoke and cylinder to cause forcible circulation of the fuel around this inner yoke and cylinder, it is possible to remove the heat around the inner yoke and cylinder in an efficient manner, and the effect that prevents vapor from entering the pressurizing chamber can be heightened.

Claims

1. An in-tank type electromagnetic fuel pump (2, 20) disposed inside a fuel tank (1), comprising:

    a cylinder (6) that forms a pressurizing chamber (5);
    a plunger (7) which is slidably mounted inside this cylinder (6);
    an inner yoke (8) which is attached to the outer circumference of said cylinder (6); and
    a bobbin (21) which is disposed so as to surround said inner yoke (8), and around which a solenoid coil (11) that excites said plunger(7) is wound;

    characterised in that
    a fuel circulation passage (22) is formed on the outside of said cylinder (6) along the longitudinal direction of the cylinder (6), and the opposite end portions of this fuel circulation passage (22) open into the interior of said fuel tank (1) in the vicinity of the opposite end portions of said cylinder (6) in the longitudinal direction of the cylinder (6).

2. The in-tank type electromagnetic fuel pump (2, 20)

according to claim 1, wherein said fuel circulation passage (22) is formed by a groove (23) that is formed in the inside surface of said bobbin (21) along the longitudinal direction of said bobbin (21).

3. The in-tank type electromagnetic fuel pump (2, 20) according to claim 2, wherein a plurality of said grooves (23) are formed at specified intervals around the axial line of said bobbin (21).

4. The in-tank type electromagnetic fuel pump (2, 20) according to claim 1, wherein a collar is disposed between said bobbin (21) and said inner yoke (8), and said fuel circulation passage (22) is formed in this collar.

5. The in-tank type electromagnetic fuel pump (2, 20) according to any of claims 1 through 4, wherein said inner yoke (8) is divided into two parts in the longitudinal direction of said cylinder (6), and these parts are disposed at a specified spacing in the longitudinal direction of said cylinder (6), so that a portion of said cylinder (6) is exposed to said fuel circulation passage (22).

Patentansprüche

1. Tankinterne elektromagnetische Kraftstoffpumpe (2, 20), die in einem Kraftstofftank (1) angeordnet, mit:

   einem Zylinder (6), der eine Druckkammer (5) bildet;
   einem Kolben (7), der verschiebbar in diesem Zylinder (6) angebracht ist;
   einem inneren Joch (8), das an dem äußeren Umfang des Zylinders (6) befestigt ist; und
   einem Spulenkörper (21), der zum Umgeben des inneren Jochs (8) angeordnet ist und um den eine Magnetspule (11), die den Kolben (7) anregt, gewickelt ist,

   dadurch gekennzeichnet, dass ein Kraftstoffzirkulationskanal (22) an der Außenseite des Zylinders (6) entlang der Längsrichtung des Zylinders (6) gebildet ist und die entgegengesetzten Endbereiche dieses Kraftstoffzirkulationskanals (22) in der Nähe der entgegengesetzten Endbereiche des Zylinders (6) in der Längsrichtung des Zylinders (6) in das Innere des Kraftstofftanks (1) münden.

2. Tankinterne elektromagnetische Kraftstoffpumpe (2, 20) nach Anspruch 1, bei der der Kraftstoffzirkulationskanal (22) durch eine Nut (23) gebildet ist, die in der Innenfläche des Spulenkörpers (21) entlang der Längsrichtung des Spulenkörpers (21) ausgebildet ist.

3. Tankinterne elektromagnetische Kraftstoffpumpe (2, 20) nach Anspruch 2, bei der eine Vielzahl der Nuten (23) in festgelegten Intervallen um die Axiallinie des Spulenkörpers (21) ausgebildet ist.

4. Tankinterne elektromagnetische Kraftstoffpumpe (2, 20) nach Anspruch 1, bei der ein Kragen zwischen dem Spulenkörper (21) und dem inneren Joch (8) angeordnet ist und der Kraftstoffzirkulationskanal (22) in dem Kragen ausgebildet ist.

5. Tankinterne elektromagnetische Kraftstoffpumpe (2, 20) nach einem der Ansprüche 1 bis 4,
   bei der das innere Joch (8) in der Längsrichtung des Zylinders (6) in zwei Teile unterteilt ist und diese Teile in einem festgelegten Abstand in der Längsrichtung des Zylinders (6) angeordnet sind, so dass ein Bereich des Zylinders (6) zu dem Kraftstoffzirkulationskanal (22) offen ist.

Revendications

1. Pompe à carburant (2, 20) en réservoir à commande électromagnétique disposée à l'intérieur d'un réservoir (1) de carburant, comprenant :

   un cylindre (6) qui constitue une chambre (5) de pressurisation ;
   un piston (7) qui est monté à l'intérieur de ce cylindre (6) avec possibilité de glissement ;
   un étrier intérieur (8) qui est fixé à la circonférence extérieure dudit cylindre (6) ; et
   une bobine (21) qui est disposée de manière à entourer ledit étrier intérieur (8), et autour de laquelle est enroulée une bobine de solénoïde (11) qui excite ledit piston (7) ;

   caractérisée en ce que
   un passage (22) de circulation de carburant est formé sur l'extérieur dudit cylindre (6) selon la direction longitudinale du cylindre (6), et les parties d'extrémité opposées dudit cylindre (6) de ce passage (22) de circulation de carburant s'ouvrent dans l'intérieur dudit réservoir (1) de carburant dans le voisinage des parties d'extrémité opposées dudit cylindre (6) dans la direction longitudinale du cylindre (6).

2. Pompe à carburant (2, 20) en réservoir à commande électromagnétique selon la revendication 1, dans laquelle ledit passage (22) de circulation de carburant est constitué par une rainure (23) qui est ménagée dans la surface intérieure de ladite bobine (21) selon la direction longitudinale de ladite bobine (21).

3. Pompe à carburant (2, 20) en réservoir à commande électromagnétique selon la revendication 2, dans laquelle une pluralité desdites rainures (23) est ména-

gée à des intervalles spécifiés autour de la ligne axiale de ladite bobine (21).

4. Pompe à carburant (2, 20) en réservoir à commande électromagnétique selon la revendication 1, dans laquelle un collier est disposé entre ladite bobine (21) et ledit étrier intérieur (8), et ledit passage (22) de circulation de carburant est formé dans ce collier.

5. Pompe à carburant (2, 20) en réservoir à commande électromagnétique selon l'une quelconque des revendications 1 à 4, dans laquelle ledit étrier intérieur (8) est divisé en deux parties dans la direction longitudinale dudit cylindre (6), et ces parties sont disposées selon un espacement spécifié dans la direction longitudinale dudit cylindre (6), de sorte qu'une partie dudit cylindre est exposée audit passage (22) de circulation de carburant.

FIG.1

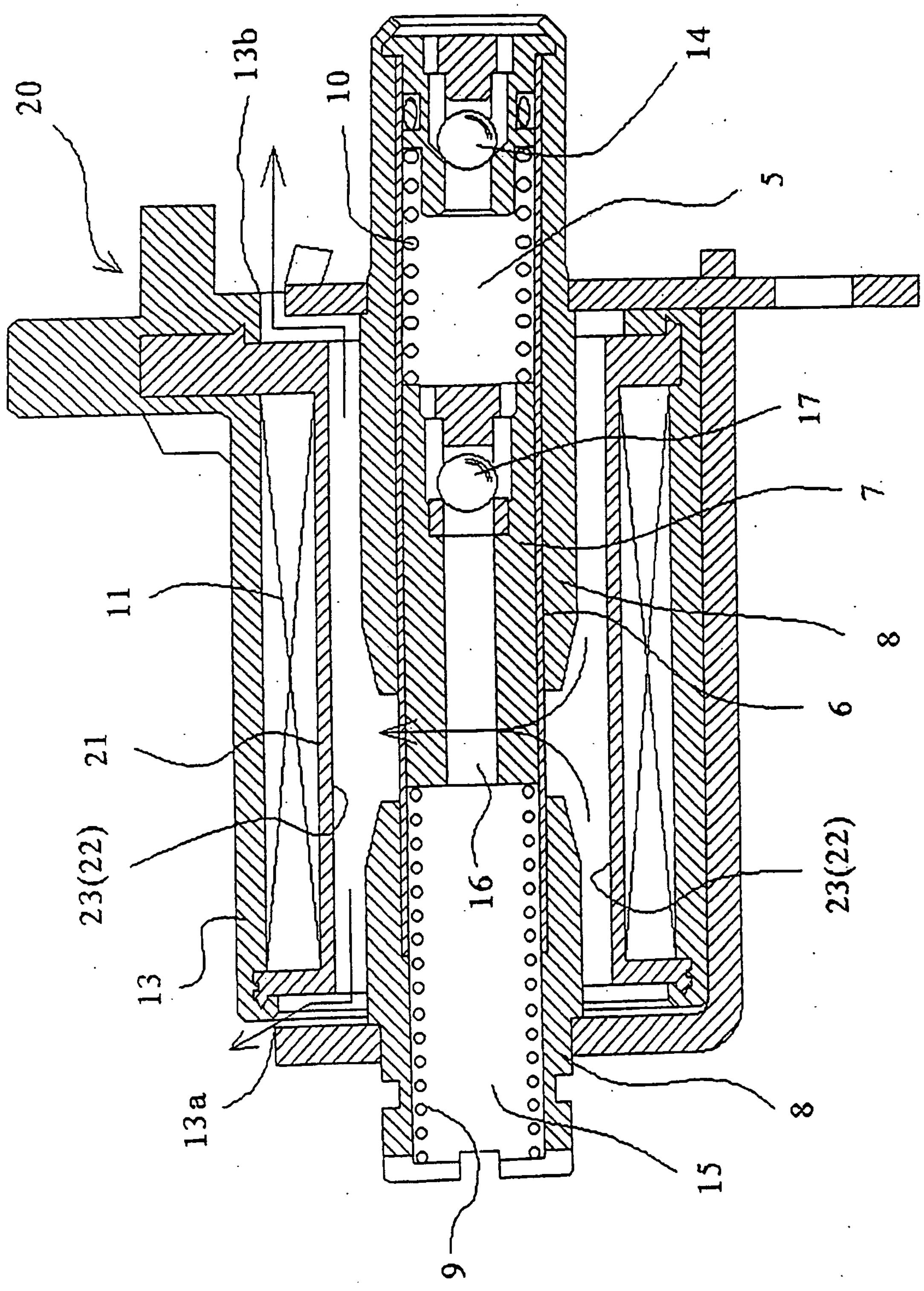


FIG.2

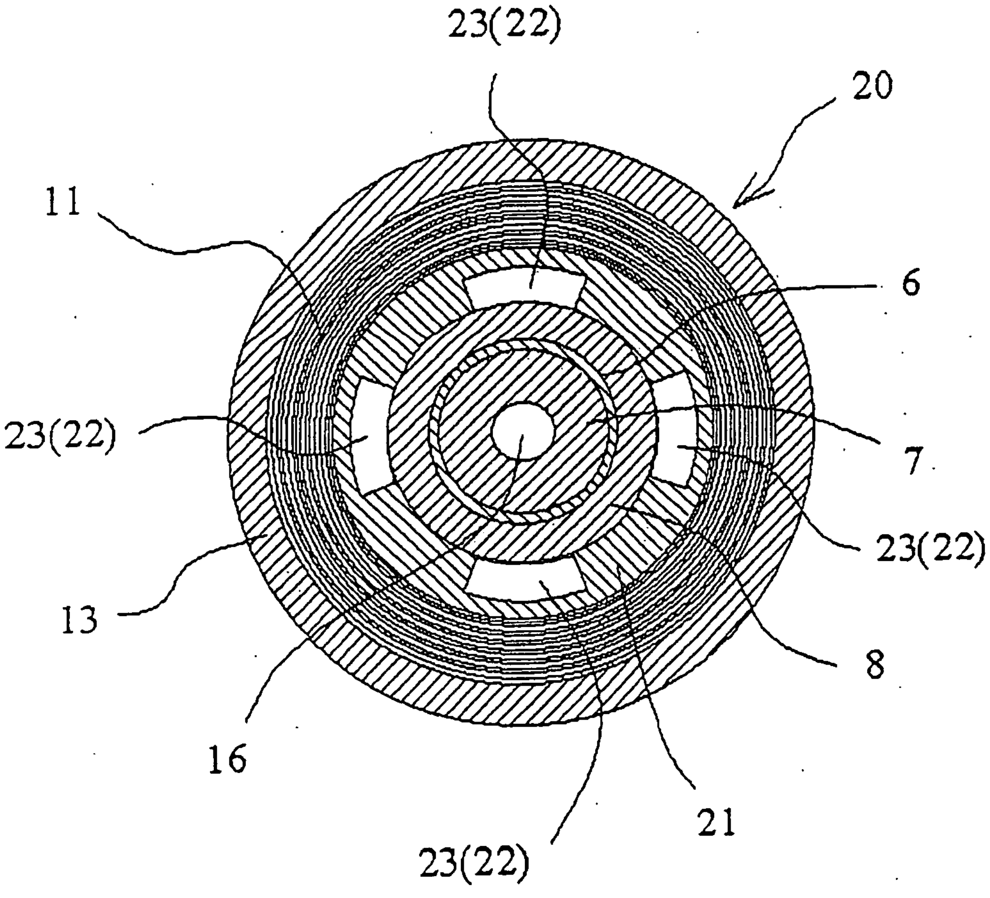
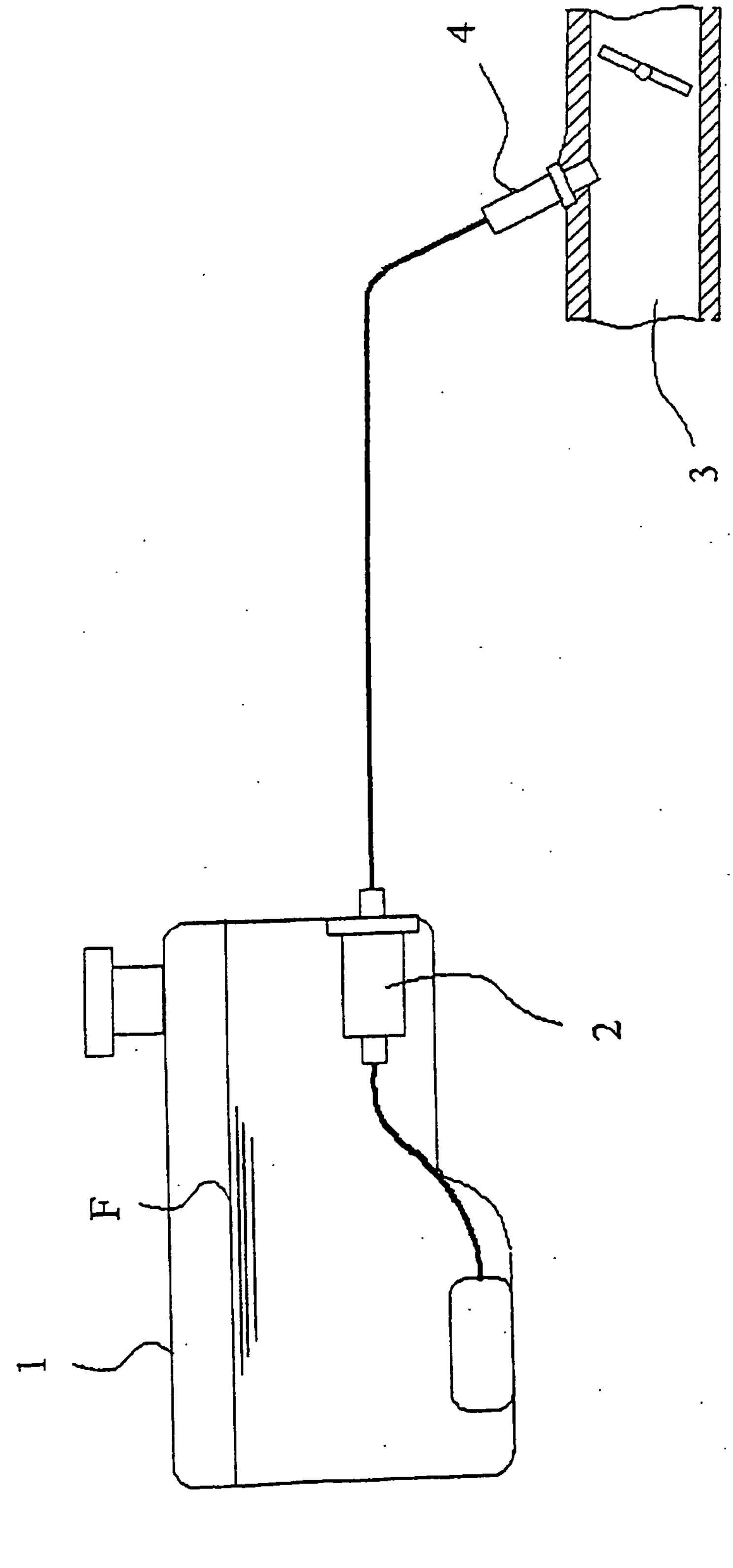


FIG.3



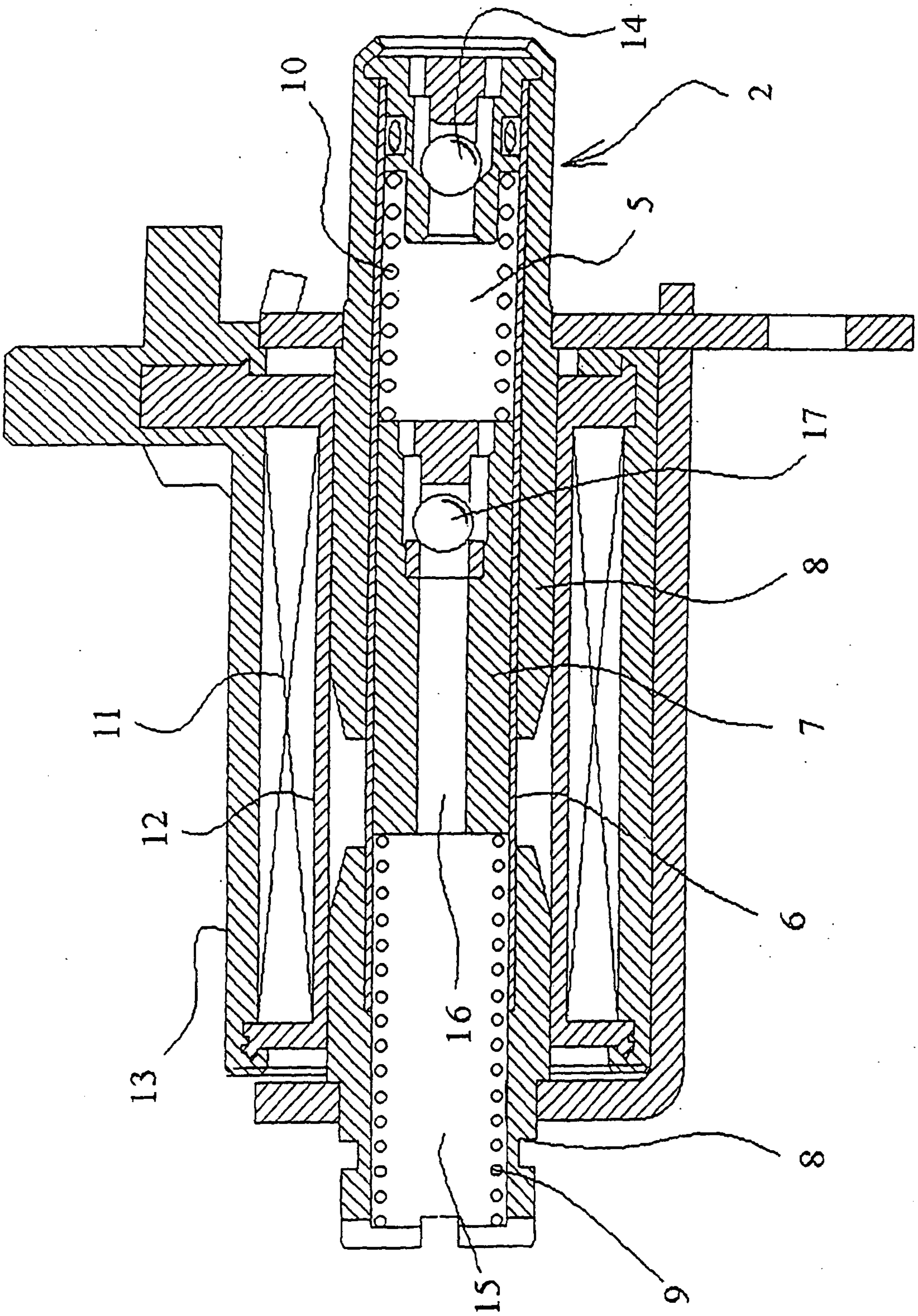


FIG.4