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(54) **Volumetric pump**

(57) Volumetric pump (1) in which a piston (6) is located to slide axially within a seat (3) formed in a valve body (2); the piston (6) defining within the seat (3) a variable volume pumping chamber (8), and the axial ends of the said seat (3) being connected to atmosphere by means of a supply duct (4) and an intake duct (5); the volumetric pump (1) comprises also an intake valve (13) and a discharge valve (14) to regulate respectively the incoming fluid supply and the outgoing fluid supply for the said pumping chamber (8), and an opposing retain-

ing spring (10) to keep the piston (6) in the resting position whereby the pumping chamber volume (8) is minimised, and finally when an electrical current passes through it, a coil able to produce a magnetic field able to induce an axial movement of the piston (6) within the seat (3) to achieve an increase in volume of the said pumping chamber (8); the intake valve (13) being accommodated inside the pumping chamber (8).

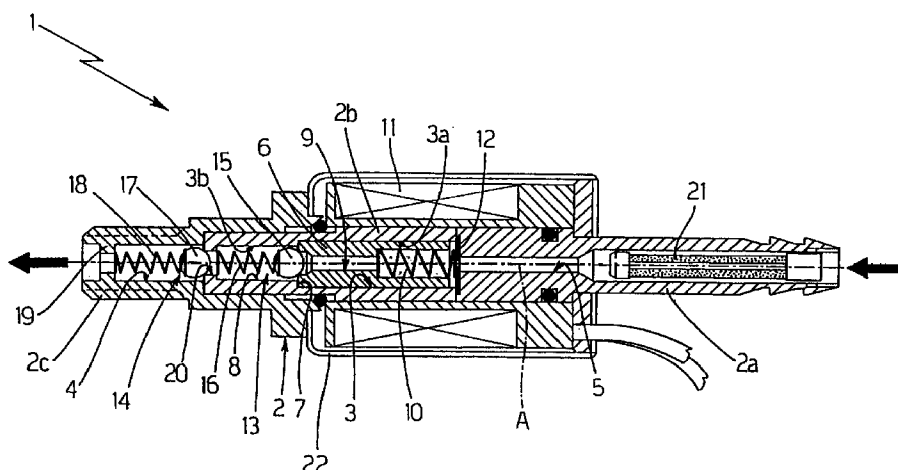


Fig.1

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Description

[0001] The present invention relates to a volumetric pump.

[0002] In particular, the present invention relates to a volumetric pump designed to ensure the circulation of lubricating oil in a two-stroke internal combustion engine of known type; the use to which the details as follow make explicit reference without loss of their general nature thereby.

[0003] As it is known, in two-stroke internal combustion engines the supply of lubricating oil to the engine intake manifold, and to any other part of the engine requiring continuous lubrication, is effectively achieved by volumetric pumps with gears and pistons actuated by the engine shaft.

[0004] Normally such pumps provide a supply proportional to the engine rotation rate, and are frequently able to adjust the supply according to the throttle setting in the engine intake, in such a manner as to maintain at a given level the ratio between lubricating oil sent to the engine intake distributor and the air drawn through the intake distributor itself.

[0005] Unfortunately the oil pumps at present in use are not able to satisfy the requirements contained in the anti-pollution standards shortly to be introduced. In order to come within the limits established for such standards, the two-stroke internal combustion engines must in fact ensure a markedly lower consumption of lubricating oil than at present, and this may only be achieved by the use of oil pumps allowing an extremely accurate setting of the lubricating oil supply circulating within the engine. In the present volumetric pumps such a control would only be achieved by reducing to a few microns the coupling tolerances of the various pistons of the pump; such a reduction would only be achieved by means of complex production processes which would greatly increase the final production costs.

[0006] A possible solution to the problem of anti-pollution standards about to be introduced, could be provided by the use of electro-magnetically operated volumetric pumps now widely used elsewhere in manufacture.

[0007] Referring to U.S.3250219, such pumps generally comprise a valve-like body of essentially cylindrical form, and a ferromagnetic material piston installed to slide axially within a cylindrical seat formed in the valve-like body. The two axial ends of the cylindrical seat are in communication with atmosphere by way of two connecting ducts which extend inside the valve-like body, coaxially with the longitudinal axis of the valve-like body; while the two variable-volume chambers in which the piston subdivides the cylindrical seat, are in communication together through an axial duct formed in the body of the piston.

[0008] The electromagnetically-actuated volumetric pumps also comprise an opposition spring, which is located inside one of the two variable-volume chambers

of which the piston subdivides the cylindrical seat, in such a manner as to minimise the volume of the chamber not occupied by the spring; and a coil of electrically conductor material, which when an electrical current passes through, is able to generate a magnetic field able to oppose the force of the opposing spring, and to axially move the piston in such a way as to maximise the volume of the variable-volume chamber not containing the spring. The said chamber defines the pumping chamber of the volumetric pump.

[0009] The aforementioned electromagnetically-actuated volumetric pumps are finally provided with an intake valve located along the axial duct formed in the body of the piston, and with a supply valve located along the duct which connects the pumping chamber, or the variable-volume chamber not containing the opposition spring, directly to atmosphere.

[0010] Unfortunately, the electromagnetically-actuated volumetric pumps described above have the great disadvantage that their scope of utilisation is insufficiently extensive to allow justifiable use in two-stroke internal combustion engines.

[0011] In particular, such pumps do not provide on discharge a sufficiently high capacity to satisfy the oil requirements of the internal combustion engine running at high speeds. This is mainly due to the fact that the overall piston weight is too great to allow axial movements sufficiently allowing hourly capacities compatible with those required for two-stroke internal combustion engines.

[0012] Furthermore, for the electromagnetically-actuated volumetric pumps described above (please see U.S.patent 3 250 219) the intake and supply valves are normally made of flexible plastic material, which owing to distortion, are unable to ensure the constant volume of the pumping chamber throughout the whole range of use of the pump.

[0013] The purpose of the present invention is to provide an electro-magnetically actuated volumetric pump able to ensure a extremely precise control of the oil capacity throughout the whole range of use of an internal combustion engine, with relatively low production costs.

[0014] According to the present invention a volumetric pump is designed having a valve-like body, and at least a piston mounted to slide axially within a seat formed in the valve-like body itself the said seat being in communication with atmosphere by way of a supply duct and an intake duct, and the said piston defining on the inside of the said seat at least a variable-volume pumping chamber; the volumetric pumps also comprising flexible means able to retain the said piston in a rest position in which it minimises the volume of the said pumping chamber, a coil of electrically conductive material able to produce, on being supplied with a magnetic field able to axially displace the piston inside the said seat to produce a volume variation of the said pumping chamber, and at least an intake valve and a discharge valve able

to regulate the fluid flow respectively on entry and on discharge from the said seat; the said volumetric pump being characterised by the fact that the said intake valve is located inside the pumping chamber and is not carried by the said piston.

[0015] The present invention is now described with reference to the appended drawings, which illustrate a non-restrictive operating example thereof wherein:

Figure 1 is a sectional view of a volumetric pump designed according to the terms of the present invention;

Figures 2 and 3 are sectional views of a number of variations of the volumetric pump illustrated in Figure 1.

[0016] With reference to Figure 1, reference number 1 indicates the whole of a volumetric pump assembly able to be used, preferably though not necessarily, to circulate the lubricating oil in a two-stroke internal combustion engine.

[0017] The volumetric pump 1 comprises a valve-like body 2 of essentially cylindrical form, which extends coaxially with a longitudinal axis A, and has internally a seat 3 which extends preferably, though not necessarily, coaxially with axis A, and a pair of ducts 4 and 5 able to bring into communication the two axial ends of the seat 3 itself with atmosphere. The volumetric pump 1 also comprises a piston 6 made of ferromagnetic material, which is located axially mobile within the seat 3 formed in the valve-like body 2, and defines inside the seat 3 itself a variable volume pumping chamber 8. Obviously the connection between the piston 6 and the seat 3 has a fluid-proof seal.

[0018] The duct 4 communicates directly with the chamber 8, and defines the volumetric pump supply duct 1, whereas duct 5 communicates with the seat 3 of the opposing part of the chamber 8 in relation to the piston 6, and defines the intake duct of the volumetric pump 1.

[0019] In the example illustrated here, in particular ducts 4 and 5 extend coaxially with the axis A running in opposition to the seat 3 in such a way that each ends correspondingly in a respective end of the valve-like body 2. Such ends are designed in such a way as to allow coupling to pipework in which the lubricating oil circulates.

[0020] However the piston 6 has a passing hole 9, which extends coaxially with the axis A along the whole length of the piston 6 itself, in such a way as to ensure the communication of the chamber 8 with the duct 5.

[0021] The volumetric pump 1 finally comprises a retaining spring 10 able to retain the piston 6 in a rest position in which, the piston 6 minimises the volume of the chamber 8, and a coil 11 made of electrically conducting material placed coaxially with axis A, on the outside of the valve-like body 2. The said coil 11 is able to generate when energised with electricity, a magnetic

field and is located on the valve-like body 2 in such a manner that the magnetic field produced thereby causes an axial movement of the piston 6 so as to displace the piston 6 itself from the rest position, thus increasing the volume of chamber 8. Obviously, the said displacement yes place against the action of spring 10.

[0022] In the example as illustrated, in particular the seat 3 is sub-divided in two portions 3a and 3b of differing diameter, the piston 6 being mounted to slide within portion 3a of greater diameter, whereas the chamber 8 comprises the portion 3b of the seat 3 and as is more clearly explained below, part of the portion 3a when it reaches its maximum volume. The spring (70) on the other hand is located coaxially with the axis A inside the portion 3a of the part opposing the chamber 8 in relation to the piston 6 and presents a first end bearing against the piston 6 and a second end bearing against the bottom of the seat 3, in such a manner as to maintain the piston 6 bearing against the shoulder 7 connecting portions 3a and 3b of the seat 3 one to the other, or in the rest position.

[0023] Meeting the axial end of the seat 3 where the spring 10 is bearing, or meets the inlet to duct 5, the volumetric pump 1 also has a disc 12 with a calibrated centre hole, which is located coaxially with the axis A in such a way as to present the calibrated hole aligned with the duct 5.

[0024] The volumetric pump 1 also includes an intake valve 13 able to regulate the access of lubrication oil to the inside of the chamber 8, and a discharge valve 14 able to regulate the exit of the lubricating oil from the chamber 8. The intake valve 13 is located inside the chamber 8, to coincide with the passing hole 9 of the piston 6, whereas the discharge valve 14 is located in the duct 4 immediately downstream from the chamber 8.

[0025] In the example illustrated here, in particular, the valve 13 has a plug 15 located axially sliding inside the chamber 8, and an opposing spring 16 located inside the chamber 8 coaxially with axis A, with a first end bearing against the plug 15 and a second end bearing against the wall of the valve-like body 2, in such a manner as to maintain the plug 15 bearing on the piston 6 in such a way as to prevent with a fluid-sealing means the ingress from the passing hole 9.

[0026] The valve 14 comprises instead a plug 17 located axially sliding inside the duct 4, and an opposing spring 18 located inside the duct 4 coaxially with the axis A, with a first end bearing against the plug 17 and a second end bearing against an annular shoulder 19 located inside the duct 5, in such a way as to keep the plug 17 bearing against a contraction 20 located at inlet of duct 5.

[0027] In the example shown here, both the plug 15 as well as the plug 17 consist of a metallic material spherically-formed body.

[0028] Finally the volumetric pump 1 is preferably though not necessarily, fitted with a filter component 21

installed inside the duct 5.

[0029] With reference to Figure 1, to facilitate the assembly of the volumetric pump 1, the valve body 2 consists of three cylindrical portions, respectively referenced 2a, 2b, 2c, in line along axis A, and made integral with each other by an external shell 22 which extends coaxially to axis A to protect the coil 11. In the case in point, the duct 5 is achieved inside the cylindrical portion 2a, the seat 3 is achieved inside the cylindrical portion 2b, whereas the duct 4 is achieved inside the cylindrical portion 2c.

[0030] Other structural solutions are obviously possible to facilitate the assembly of the tubular body 2.

[0031] Operation of the volumetric pump 1 is now described assuming that the pump is located along a lubricating oil circulation duct.

[0032] In service, when the coil 11 is energised with electricity, the magnetic field produced thereby causes the axial displacement of the piston 6 and consequent increase in the volume of chamber 8.

[0033] During the displacement of the piston 6, the opposing spring 16 nevertheless does not manage to keep the plug 15 bearing against piston 6, owing either to the inertia of the plug 15 or to the discharging lubricating oil forced through the passing hole (9). The lubricating oil occupying the portion 3a of the seat 3 together with the piston 6, in fact will discharge more easily through the passing hole (9) formed in the piston 6 than through the calibrated hole in the disc 12, also facilitated in this by the depression which occurs inside the chamber 8 owing to the rapid increase in volume.

[0034] In view of the whole of the displacement and the volumes involved, when the opposing spring 16 manages to displace the plug 15 to close the entrance to the passing hole 9 of the piston 6, the lubricating oil has already completely filled the chamber 8 which in addition to portion 3b of the seat 3 now also comprises part of portion 3a of the seat 3 itself.

[0035] When the magnetic field ceases, that is when no more electricity passes into the coil 11, the retaining spring 10 returns the piston 6 into the rest position, thus rapidly reducing the volume of the chamber 8. Nevertheless since the lubricating oil is incompressible, the excess part of the lubricating oil discharges from the chamber 8 through the duct 4, thereby displacing the plug 17.

[0036] When all the excess lubricating oil has discharged, the opposing spring 18 ensures the return of the plug 17 to bear against the throttle 20 produced at the point of inlet of the duct 5.

[0037] It will be obvious that the capacity of the volumetric pump 1 is a function of the frequency with which the piston 6 is displaced inside the seat 3, that is to say of the frequency with which an electric current is made to pass through the coil 11.

[0038] According to a variation not shown here, the piston 6 is made of permanent magnet material.

[0039] According to the variation illustrated in Figure

2, the piston 6 is double acting, and defines inside its seat two variable volume pumping chambers 9 complementary to each other. Each chamber 8 is connected with atmosphere through a supply duct 4 which extends coaxial with the axis A, and has an intake valve 13 and a discharge valve 14, whereas the intake duct 5 is in common communication with both chambers 9, and extends inside the valve-like body 2 perpendicularly to the axis A, along an appendix of the valve body 2 which in turn extends perpendicularly to axis A. In that case the duct 5 faces a branch 9a of the passing hole 9 which extends in the piston 6 perpendicularly to axis A, and the disc 12 is located along the duct 5, immediately upstream from the seat 3.

[0040] According to the variation illustrated in Figure 3, the valve body 2 presents two seats 3 each of which is actuated in a sliding manner by a respective piston 6, which defines a pumping chamber 8. In a similar way as the previous variation, each chamber 8 is connected to atmosphere through a supply duct 4 which extends coaxial to the axis A, and is provided with its own intake valve 13 and its own discharge valve 14. In that case the intake duct 5 is in communication with both seats 3, and a terminal portion thereof extends into the valve body 2 coaxially to the axis A, along an appendix in the valve body 2 which extends in turn, perpendicularly to axis A.

[0041] The advantages of the volumetric pump 1 described above and as shown are evident: the absence of the intake valve 13 on the piston allows a drastic reduction in its weight with a considerable increase in maximum capacity of the pump related to solutions at present adopted.

[0042] A further advantage derives from the fact that the plug 15 for valve 13 cannot be deformed so that the volume of the chamber 8 is constant in whatsoever operating condition. The volumetric pump 1 can thus be transformed into a metering arrangement always able to provide the same volume of oil under pressure on each electrical current impulse.

[0043] Other advantages of the volumetric pump 1 are its extremely simple construction, with a limited number of component parts in relative movement, and the fact that it allows direct piloting from an electronic central unit which, by varying the frequency of the supply to the coil 11, it is possible to control in real time and with extreme precision the capacity thus provided.

[0044] Finally it is clear that modifications and variations may be made to the volumetric pump 1 described and illustrated herein without thereby exceeding the scope of the present invention.

Claims

1. Volumetric pump (1) comprising a valve-like body (2), and at least a piston (6) mounted axially sliding inside a seat (3) formed within the valve-like body (2); the said seat (3) being in communication with atmosphere by way of a supply duct (4) and an

intake duct (5), and the said piston (6) defining inside the said seat (3) at least a variable-volume pumping chamber (8); the volumetric pump (1) also comprising flexible means (10) able to retain the said piston (6) in the resting position in which it minimises the volume of the said pumping chamber (8), a coil (11) of electrically conductive material which when energised is able to provide a magnetic field allowing the axial movement of the piston (6) inside the said seat (3) to produce a variation in the volume of the said pumping chamber (8), and at least an intake valve (13) and a discharge valve (14) able to regulate respectively the incoming and outgoing flow of fluid from the said seat (3), the said volumetric pump (1) being characterised in that the said intake valve (13) is not carried by the piston (6) and is located inside the pumping chamber (8).

2. Volumetric pump according to claim 1, characterised in that the said supply duct (4) directly connects the said pumping chamber (8) with atmosphere; the said piston (6) being provided instead with a passing duct (9) able to ensure communication of the pumping chamber (8) with the said intake duct (5).

3. Volumetric pump according to claim 2, characterised in that the said piston (6) subdivides the seat (3) inside the valve-like body (2) into two portions which are connected with atmosphere respectively by means of the supply duct (4) and by means of the intake duct (5); the passing duct (9) in the piston (6) being able to connect together the two portions of the said seat (3).

4. Volumetric pump according to claim 3, characterised in that the said supply duct (4) and intake duct (5) connect with atmosphere the two axial ends of the seat (3) formed inside the said valve-like body.

5. Volumetric pump according to any one of claims 2 to 4, characterised by the fact that the said intake valve (13) comprises a plug (15) axially moving inside the pumping chamber (8), and an opposing spring (16) located inside the pumping chamber (8) with a first end coming to bear against the plug (15) and a second end coming to bear against the wall of the valve-like body (2), in such a manner as to maintain the plug (15) bearing against the piston (6) in such a manner as to engage while maintaining engaged under fluid-sealed conditions the passing duct (9) under fluid-seal conditions the ingress of the passing duct (9) formed within the said piston (6).

6. Volumetric pump according to any one of the previous claims, characterised by the fact that the said supply duct (4) has immediately downstream from

the said pumping chamber (8) a choke means (20), and the said discharge valve (14) comprises a moving plug (17) inside the said supply duct (4), and an opposing spring (18) able to maintain the said plug (17) bearing against the said choke means (20), engaging it under fluid-sealed conditions.

7. Volumetric pump according to any one of the previous claims, characterised in that it comprises along the said intake duct (5) a disc (12) with a central calibrated hole.

8. Volumetric pump according to any one of the previous claims, characterised in that it comprises a filtering component (21) located along the said intake duct (5).

9. Volumetric pump according to any one of the previous claims, characterised in that the said seat (3), the said supply duct (4), the said piston (6) and its passing hole (9), are extended coaxially with a same longitudinal axis (A).

10. Volumetric pump according to claim 9, characterised in that the said valve-like body (2) is of essentially cylindrical shape and extends coaxially with the said longitudinal axis (A).

11. Volumetric pump according to any one of the previous claims, characterised in that the said piston (6) defines on the inside of the said seat (3) two variable-volume pumping chambers (9) complementary to each other; both the said pumping chambers (8) being each directly connected to a respective supply duct (4), and both communicating with a same said intake duct (5) through a passing hole (9) formed in the said piston (6).

12. Volumetric pump according to one or other of claims 1 to 10, characterised in that it comprises two pistons (6) mounted axially sliding each inside a respective seat (3) formed in the said valve-like body (2); the pistons (6) defining respective variable-volume pumping chambers (8) inside the corresponding seats (3).

13. Pump according to one or other of the previous claims, characterised by the fact that the said piston (6) is made of ferromagnetic material.

14. Pump according to one or other of the claims 1 to 12, characterised by the fact that the said piston (6) is made of permanent magnet material.

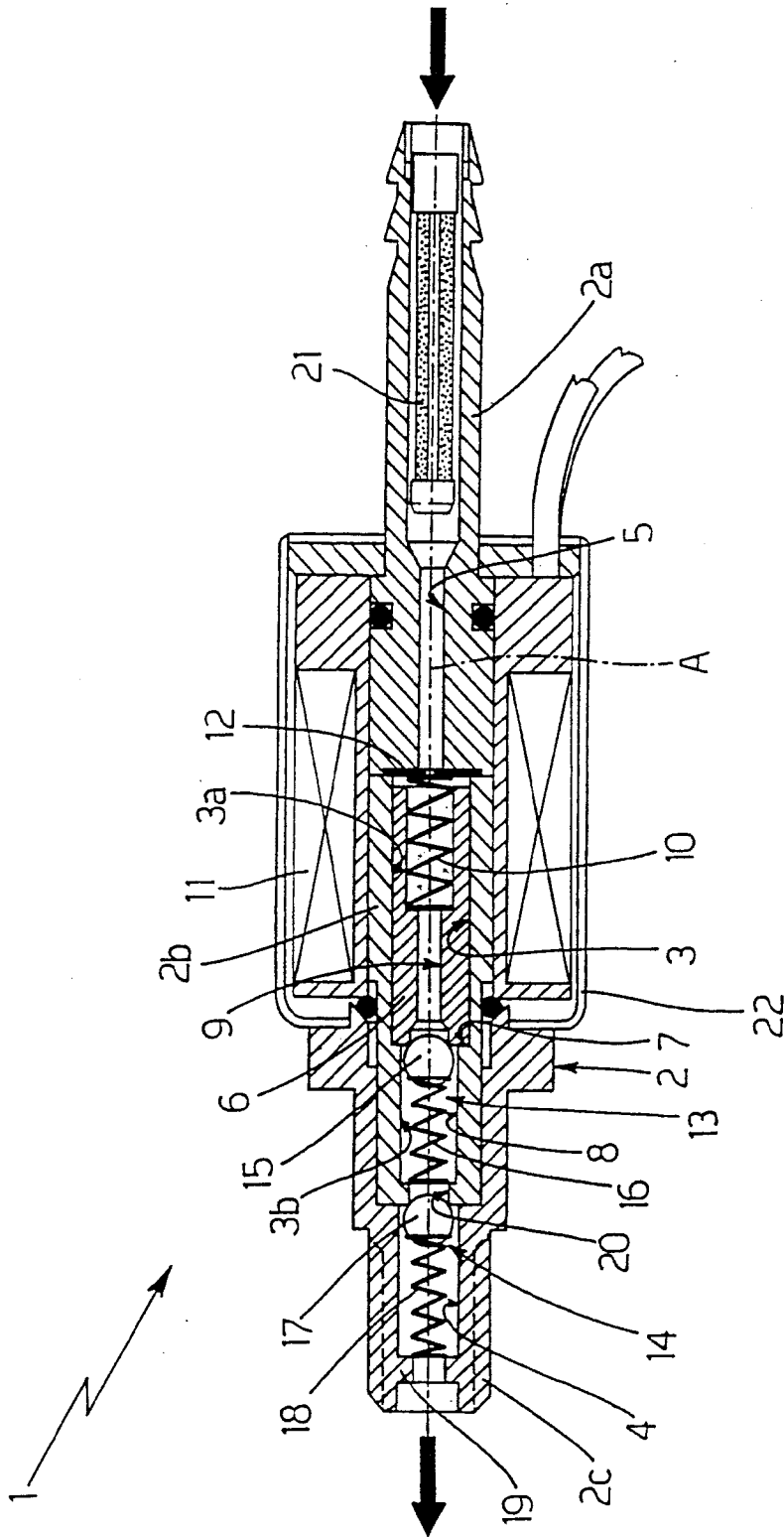


Fig.1

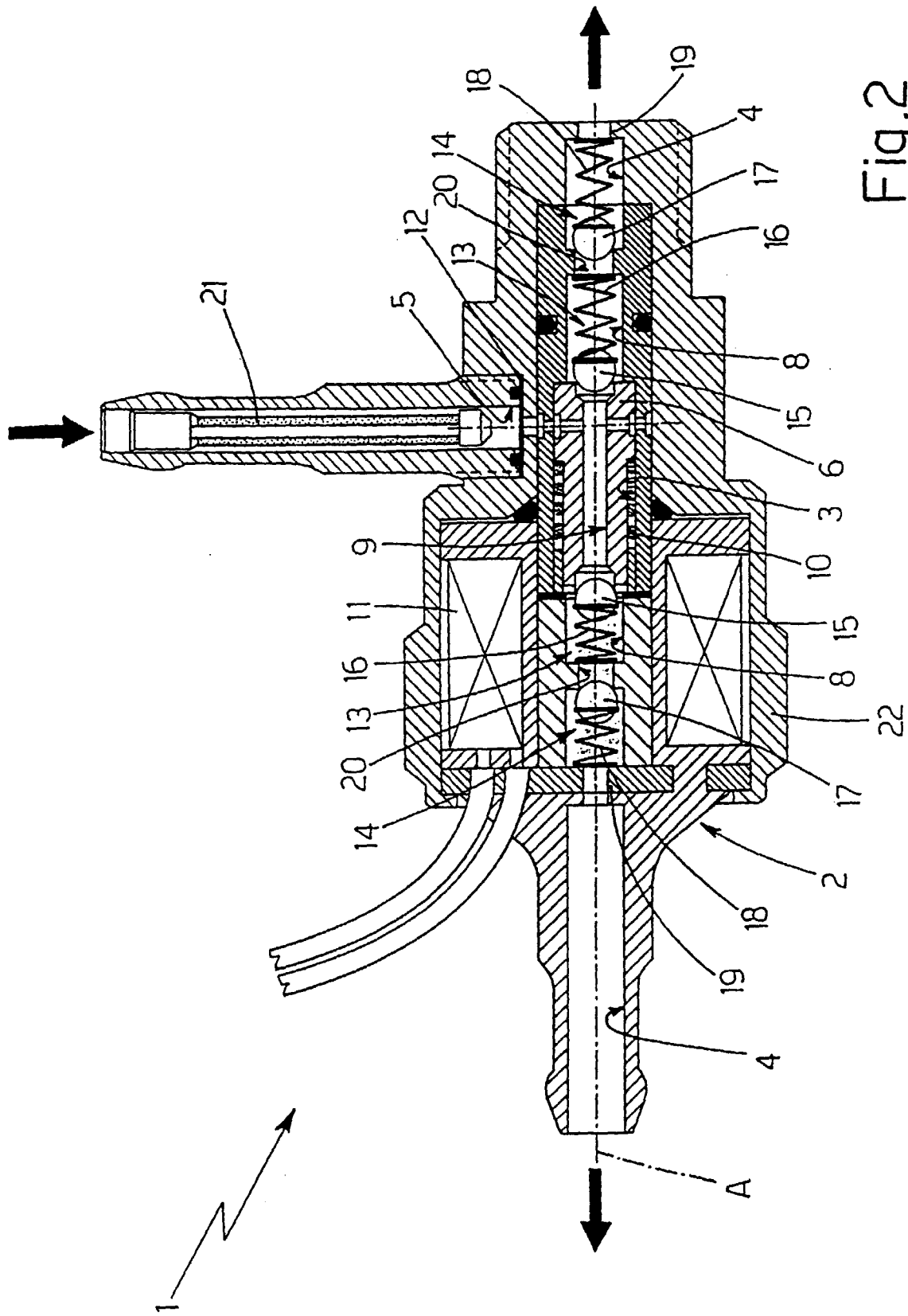


Fig. 2

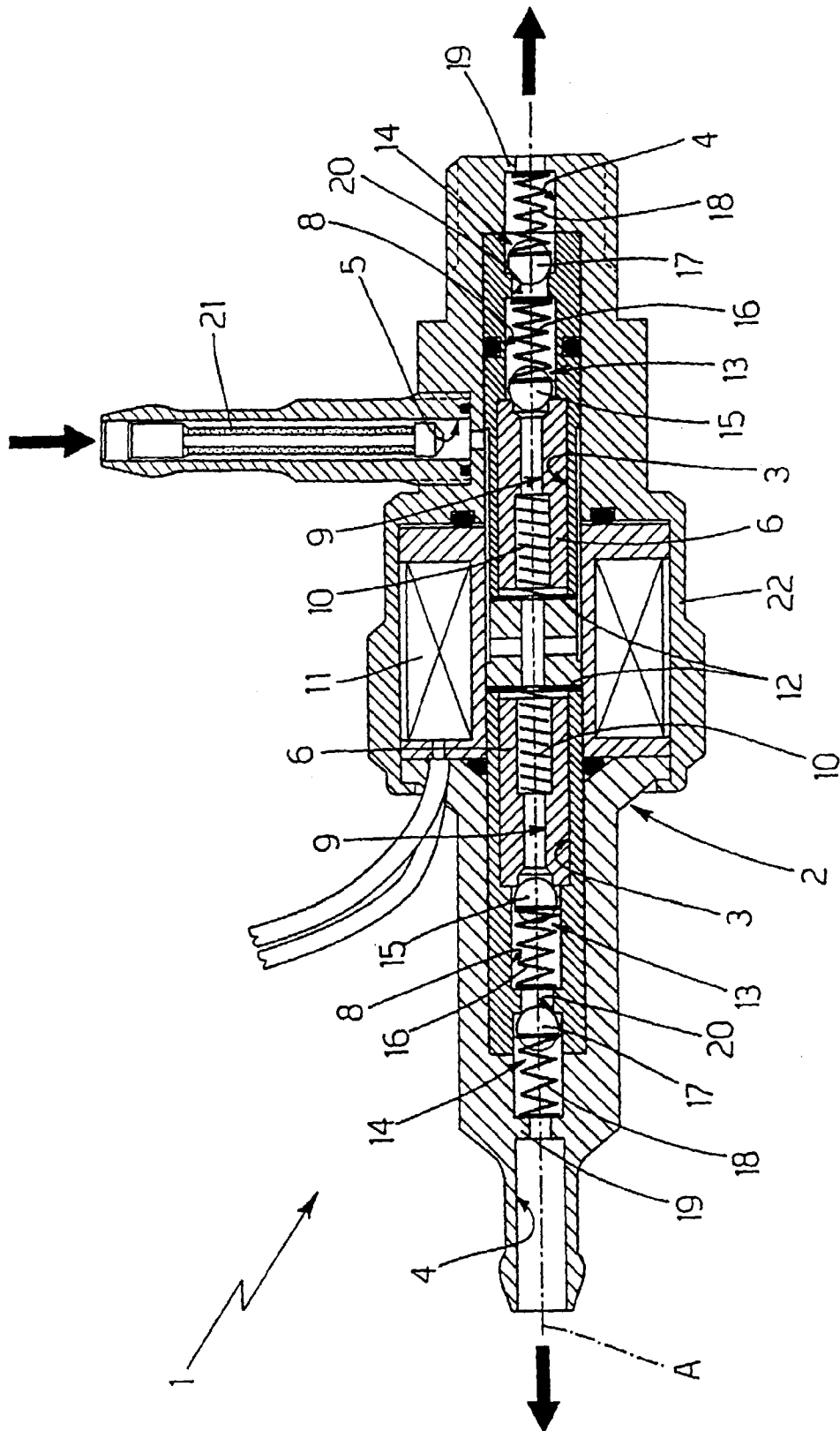


Fig.3



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EUROPEAN SEARCH REPORT

Application Number
EP 99 10 7763

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.6)
X	CH 675 312 A (RUECK & MEIER AG) 14 September 1990 * column 3, line 64 - column 5, line 36; figure 2 *	1-5,9,10	F04B17/04
X	FR 2 465 903 A (ULKA SRL) 27 March 1981 * page 4, line 14 - page 8, line 5; figures 1,2 *	1-5,9,10	
X	EP 0 288 216 A (EATON SA MONACO) 26 October 1988 * the whole document *	1-5,9,10	
A	US 5 567 131 A (MCNAULL MICHAEL H) 22 October 1996 * abstract; figures 5,6 *	1	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			F04B
Place of search		Date of completion of the search	Examiner
THE HAGUE		21 June 1999	Ingelbrecht, P
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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21-06-1999

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