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(54) Compact electromagnetic fuel metering and atomizing valve for an internal combustion engine fuel supply device.

(57) A valve comprising an axially-sliding plunger controlling fuel supply through an injection orifice and controlled by an electromagnet; characterised by the fact that it comprises a sleeve (1) of ferromagnetic material fitted with a spool (2) of plastic material injection molded on to the outer surface (3) of the sleeve (1); a winding (5) of electrically-conductive wire defining the electromagnet and formed on the spool (2); and an enclosure (6) of plastic material containing ferromagnetic material, enclosing and forming a single unit (7) with the sleeve (1), the spool (2) and the winding (5), and formed by injection molding the aforementioned plastic material.

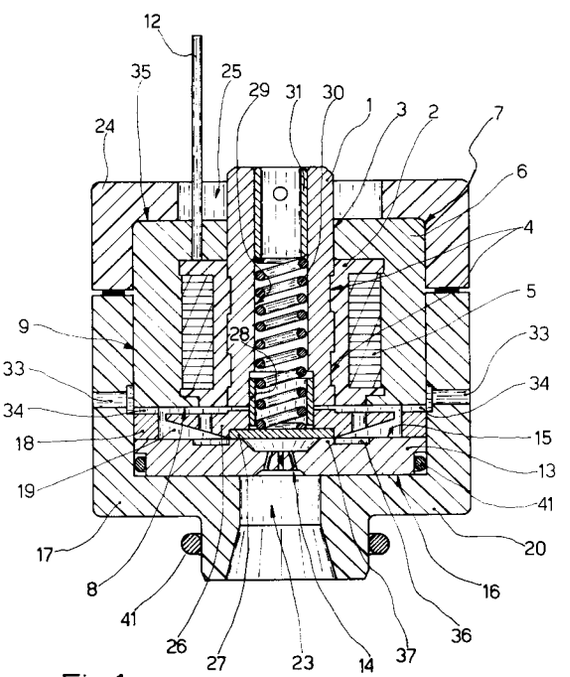

Fig.1

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The present invention relates to an electromagnetic fuel metering and atomizing valve for an internal combustion engine fuel supply device.

Known valves of the aforementioned type substantially comprise a body defined by a lateral surface comprising a number of cylindrical surface portions of different diameters and the bottom end of which is fitted with a substantially cylindrical injection nozzle having at least one fuel injection orifice.

An elongated plunger slides inside an axial cavity in the nozzle and a hole in the body, and the body houses a ferromagnetic core and an excitation coil for producing a magnetic flux in the core, the body and an anchor fitted to the top end of the plunger, so as to attract the anchor to the core and so control displacement of the plunger for opening the injection orifice. The plunger is normally kept in the closed position by a spring, the ends of which rest on respective shoulders on the plunger and core.

A major drawback of known valves of the type briefly described above lies in the large size, particularly lengthwise, of the valves, which are difficult to fit on to engines with limited valve seating space.

What is more, due to the large number and the design of the component parts involved, such valves are highly complex, expensive to produce, and must be assembled and operated with care.

It is an object of the present invention to provide an electromagnetic fuel metering and atomizing valve of the aforementioned type, designed to overcome the aforementioned drawbacks typically associated with known valves.

A first object of the present invention is therefore to provide a fairly compact valve, particularly lengthwise, enabling troublefree fitment on engines with limited valve seating space.

A further object of the present invention is to provide a valve of extremely straightforward design, comprising a small number of component parts, and enabling fast, troublefree assembly.

According to the present invention, there is provided an electromagnetic fuel metering and atomizing valve for an internal combustion engine fuel supply device, said valve substantially comprising an axially-sliding plunger for controlling fuel passage through at least one injection orifice and activated by an electromagnet; characterised by the fact that it comprises:

a ferromagnetic sleeve fitted with a plastic spool injection molded on to the outer surface of said sleeve; a winding of electrically-conductive wire coated with insulating material, defining said electromagnet, and formed on said spool;

an enclosure of plastic material containing ferromagnetic material, said enclosure enclosing and forming a single unit with said sleeve, said spool and said winding, and being formed by injection molding said plastic material.

A non-limiting embodiment of the present invention will be described by way of example with reference to the accompanying drawings, in which:

Fig.1 shows an axial section of the valve according to the present invention;

Fig.s 2 and 3 show axial sections of the bottom portion of a further two embodiments differing slightly from that of Fig.1.

The valve according to the present invention substantially comprises a ferromagnetic sleeve 1 fitted and forming a single unit with a plastic spool 2 conveniently injection molded directly on to outer surface 3 of sleeve 1. For this purpose, annular grooves 4 may conveniently be formed in known manner on surface 3, and sleeve 1 used as an insert inside the mold of spool 2 according to known injection molding techniques.

The valve also comprises a winding 5 of electrically-conductive wire coated with insulating material, defining an annular electromagnet, and formed by winding a given number of turns of said wire on to spool 2.

The valve also comprises an enclosure 6 made of plastic material containing ferromagnetic material, and enclosing and forming a single unit 7 (Fig.1) with sleeve 1, spool 2 and winding 5. Enclosure 6 is formed by injection molding said plastic material on to said unit comprising sleeve 1, spool 2 and winding 5.

Unit 7 is defined at the bottom by a flat surface 8, and enclosure 6 laterally by a substantially cylindrical surface 9. As shown in Fig.1, the ends 12 of the wires of winding 5 are fitted through both spool 2 and enclosure 6, and come out through the upper surface of enclosure 6.

The valve comprises at least one round plate 13 having at least one injection orifice 14 (in the Fig.1 embodiment, several orifices are provided). Plate 13 is defined at the top and bottom by respective flat surfaces 15 and 16 substantially parallel to flat surface 8 of unit 7, and laterally by a cylindrical surface substantially coinciding with cylindrical surface 9 externally defining enclosure 6.

A cup-shaped housing 17 houses plate 13, unit 7 and an annular spacer 18 inserted between plate 13 and unit 7 so as to define a chamber 19 of predetermined size.

Injection orifices 14 come out inside a hole 23 in bottom wall 20 of housing 17, which presents a top cover 24, the top wall of which presents a hole 25 housing the top end of sleeve 1 as shown in Fig.1. The valve also comprises a disk-shaped anchor 26 housed in and moving axially inside chamber 19, and fitted with a disk 27 resting on top surface 15 of plate 13 and defining the valve plung-

er. Though usually made of metal, anchor 26 and disk 27 may be made of any permeable material. e.g. soft material, in which case, they are formed in one piece and chromium-plated to produce a surface hardness sufficient to withstand working stress. For the same purpose, the end surface of sleeve 1 facing anchor 26 may also conveniently be chromium-plated.

An end portion of hole 29 in sleeve 1 is fitted with an annular element 28, which fits inside a hole in anchor 26 for guiding axial slide of the same. Anchor 26 is thrust against plate 13 by a helical spring 30 housed inside hole 29 in sleeve 1 and inside annular element 28. The ends of spring 30 conveniently rest respectively on disk 27 and on a shoulder formed by a tube 31 force-fitted inside hole 29.

The lateral wall of housing 17 presents at least one radial hole 33, and spacer 18 presents at least one slot 34 communicating with chamber 19 and radial hole 33, so as to form a fuel supply duct to chamber 19. Provision is conveniently made for two diametrically-opposed radial holes 33 and slots 34, so as to form two ducts for supplying and draining fuel to and from chamber 19.

As shown in Fig.1, the inner surface of bottom wall 20 of housing 17 is flat for supporting the flat bottom surface 16 of plate 13, and the cylindrical inner surface of the lateral wall of housing 17 substantially mates with the outer surface 9 of enclosure 6.

Substantially the same applies to cover 24, the inner surfaces of which mate with both the top surface 35 and the lateral surface 9 of enclosure 6.

Top surface 15 of plate 13 conveniently presents an annular recess 36 defining a corresponding annular projection 37 for seating disk 27.

In the Fig.3 embodiment, disk 27 presents a substantially spherical bottom surface 38 mating with a spherical surface portion formed on plate 13.

In the Fig.2 embodiment, in addition to plate 13, which in this case presents an axial hole 39 instead of injection orifices, provision is made between plate 13 and bottom wall 20 of housing 17 for a thin plate 40 in which injection orifices 14 are formed.

A sealing ring 41 is conveniently inserted between plate 13 (Fig.3) and the lateral wall of housing 17. In the Fig.2 embodiment also, a sealing ring 41 is inserted between plates 13 and 40 and the lateral wall of housing 17.

According to the present invention, housing 17 and cover 24 enclosing all the valve components may be replaced by the walls of a fuel manifold forming part of the vehicle fuel supply device, in which case, the manifold presents appropriate seats defining cavities similar to those formed inside housing 17 and cover 24.

The valve described above operates as follows. When idle, spring 30 maintains disk 27 contacting surface 15 of plate 13, thus cutting off fuel supply from chamber 19 to injection orifices 14. When winding 5 is energized, the magnetic flux produced with enclosure 6, sleeve 1 and anchor 26 draws anchor 26 towards unit 7.

All the above components, in fact, are made of ferromagnetic material, with the exception of enclosure 6, which, though made of plastic, also possesses ferromagnetic properties due to the ferromagnetic filler in the plastic material. The opening stroke of the valve obviously depends on the thickness of spacer 18 defining displacement of anchor 26.

Pressurized fuel is fed through injection orifice 33 to fill chamber 19, from which it is injected through orifices 14 when anchor 26 is detached from plate 13. Any unused fuel flows back through orifice 33 diametrically opposite the inlet orifice.

The valve described above is evidently highly compact, particularly lengthwise, due to integration of spool 2 and sleeve 1, and the ferromagnetic properties of enclosure 6 surrounding sleeve 1, spool 2 and winding 5, which effectively contributes towards producing the magnetic circuit on the valve.

What is more, in place of an injection nozzle, the valve presents injection orifices formed directly on plate 13, while anchor 26 is so designed as to be of minimum length.

Finally, the valve according to the present invention is extremely straightforward in design, due to the small number of component parts and the manner in which these are connected. Spool 2 and enclosure 6, in fact, are so designed as to enable troublefree manufacture and simultaneous connection to sleeve 1, while unit 7, plate 13 and spacer 18 provide for fast, troublefree assembly inside housing 17 with no special positioning required.

To those skilled in the art it will be clear that changes may be made to both the design and arrangement of the component parts of the valve as described herein without, however, departing from the scope of the present invention.

Claims

1. An electromagnetic fuel metering and atomizing valve for an internal combustion engine fuel supply device, said valve substantially comprising an axially-sliding plunger for controlling fuel passage through at least one injection orifice and activated by an electromagnet; characterised by the fact that it comprises:
   a ferromagnetic sleeve (1) fitted with a plastic spool (2) injection molded on to the outer surface (3) of said sleeve (1);

a winding (5) of electrically-conductive wire coated with insulating material, defining said electromagnet, and formed on said spool (2);
an enclosure (6) of plastic material containing ferromagnetic material, said enclosure (6) enclosing and forming a single unit (7) with said sleeve (1), said spool (2) and said winding (5), and being formed by injection molding said plastic material.

2. A valve as claimed in Claim 1, characterised by the fact that, on the side facing said plunger, said unit (7) is defined by a flat surface (8), and said enclosure (6) is defined laterally by a substantially cylindrical surface (9).

3. A valve as claimed in Claim 1 or 2, characterised by the fact that it comprises at least one round plate (13) in which is formed said fuel injection orifice (14); said plate (13) being defined at the top and bottom by respective flat surfaces (15, 16) substantially parallel to said flat surface (8) of said unit (7), and being defined laterally by a cylindrical surface substantially coinciding with said cylindrical surface (9) externally defining said enclosure (6).

4. A valve as claimed in Claim 1 or 2, characterised by the fact that it comprises two round plates (13, 40) contacting each other and defined at the top and bottom by flat surfaces parallel to said flat surface (8) of said unit (7); one of said plates (40) presenting said injection orifices, and the other (13) presenting an axial hole (23) communicating with said injection orifices.

5. A valve as claimed in one of the foregoing Claims, characterised by the fact that it comprises a cup-shaped housing (17) housing said plates (13, 40), said unit (7) and an annular spacer (18) inserted between said plate and said unit, so as to define between the same a chamber (19) of predetermined size; said housing (17) being fitted with and closed by a cover (24).

6. A valve as claimed in one of the foregoing Claims, characterised by the fact that it comprises a disk-shaped, axially-sliding anchor (26) housed inside said chamber (19); said anchor (26) being fitted with a disk (27) resting on said top surface (15) of said plate (13) and defining said plunger.

7. A valve as claimed in Claim 6, characterised by the fact that said anchor (26) presents an axial hole in which is inserted an annular element (28) also inserted inside the hole (29) in said sleeve (1) for guiding axial displacement of said anchor (26); said anchor (26) being maintained contacting said plate (13) by a spring (30) housed in said hole (29) in said sleeve (1) and inside said annular element (28).

8. A valve as claimed in one of the foregoing Claims from 5 to 7, characterised by the fact that said housing (17) presents at least one radial hole (33), and said spacer presents at least one slot (34) communicating with said chamber (19) and said radial hole (33), so as to form a fuel supply duct to said chamber (19).

9. A valve as claimed in one of the foregoing Claims from 5 to 8, characterised by the fact that said housing (17) presents a bottom wall (20) having a flat inner surface supporting said bottom surface (16) of said plate (13), and a cylindrical inner lateral surface substantially mating with said outer surface (9) of said enclosure (6).

10. A valve as claimed in Claim 9, characterised by the fact that said injection orifice (14) comes out inside an axial hole (23) in said bottom wall (20) of said housing (17), and said cover (24) presents an axial hole (25) in which the top end of said sleeve (1) is inserted.

11. A valve as claimed in one of the foregoing Claims, characterised by the fact that said unit (7), said plate (13), said spacer (18) and said anchor (26) are housed in cavities formed in a fuel manifold forming part of said fuel supply device.

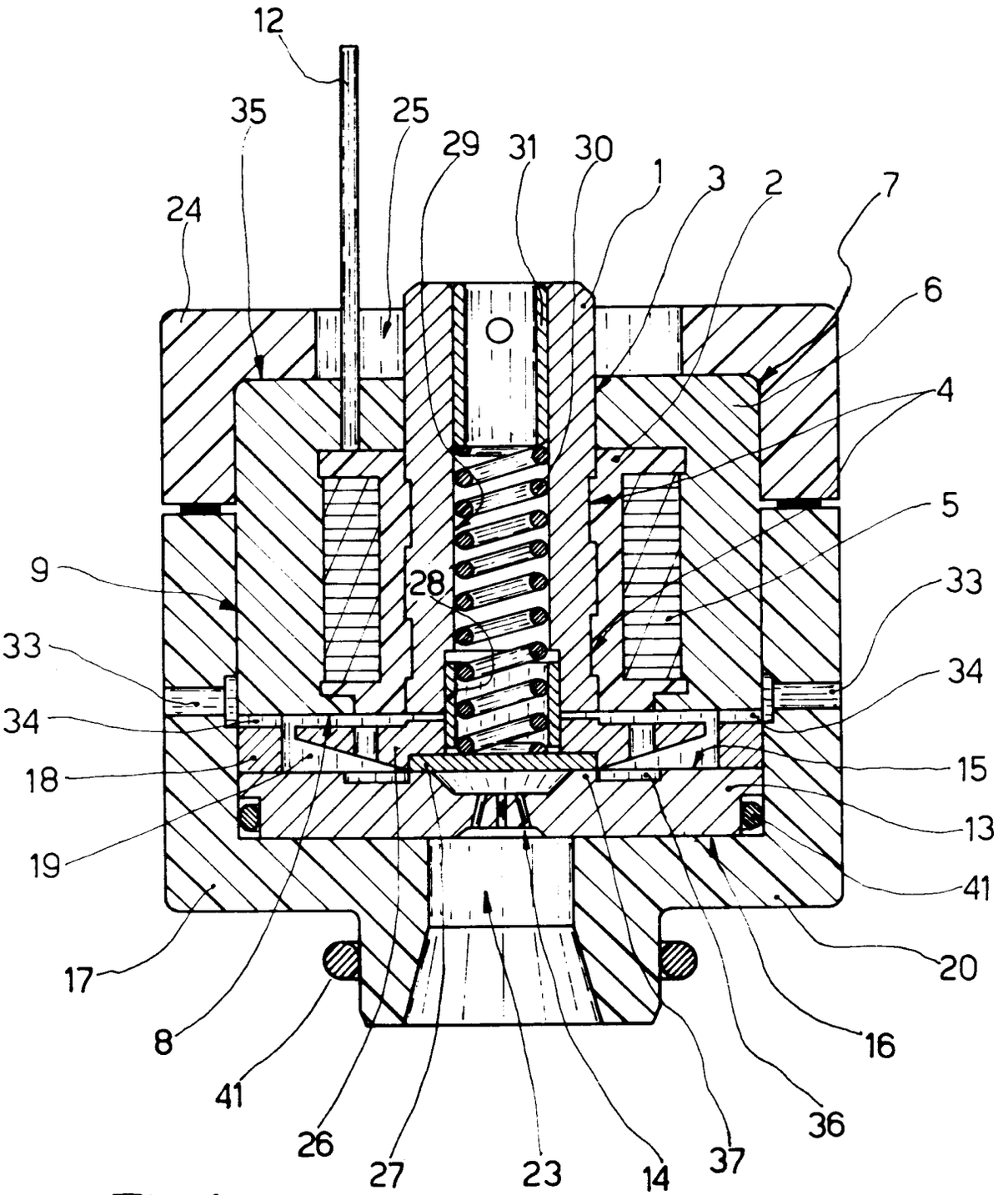
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Fig.1

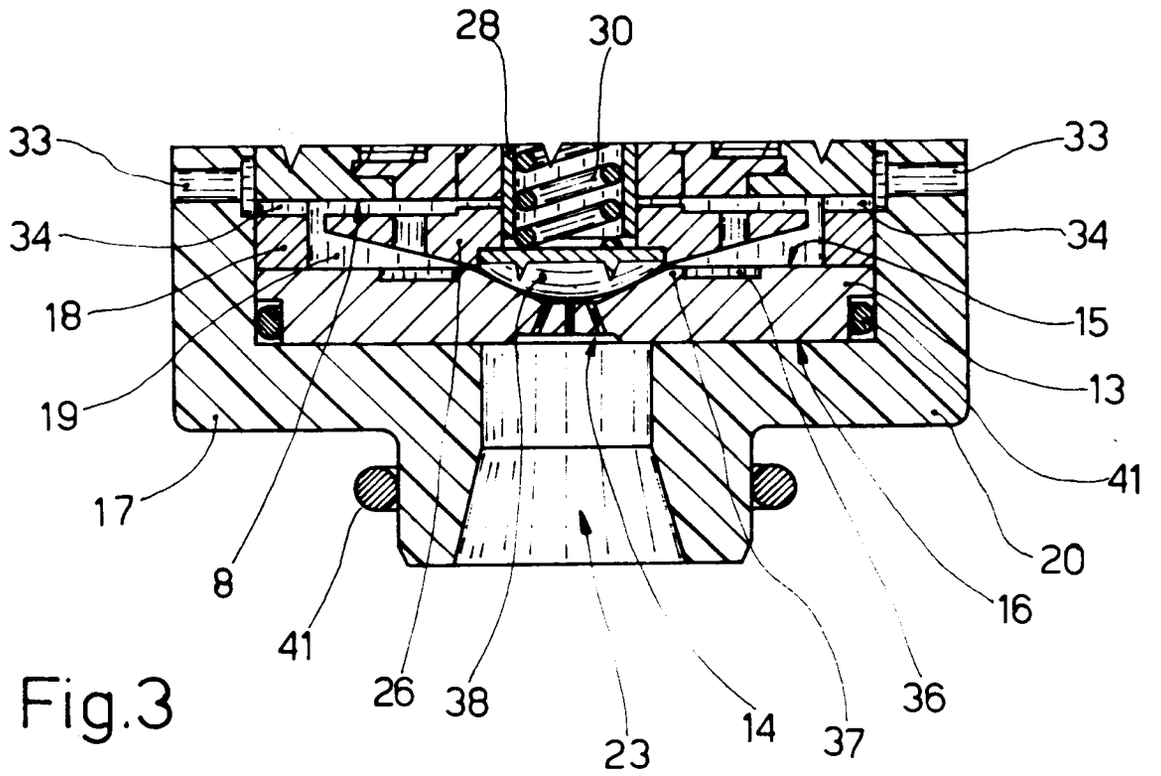
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Fig.3

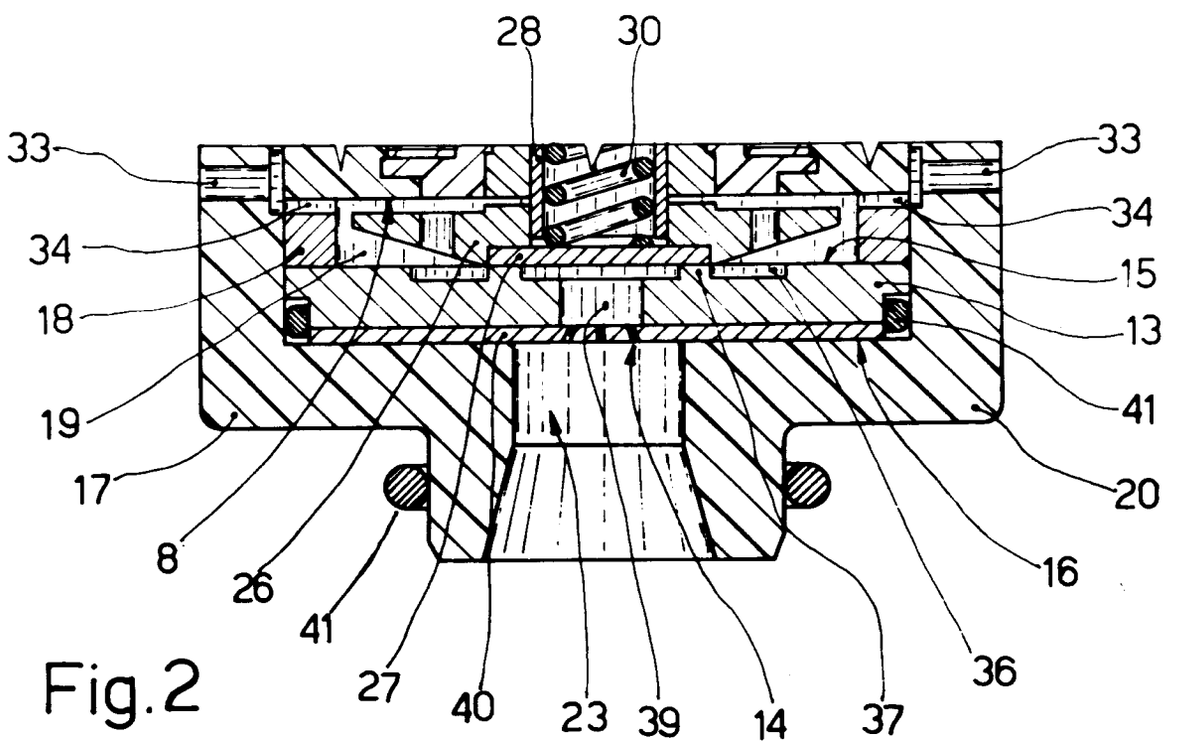
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Fig.2

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EUROPEAN SEARCH REPORT

Application Number

EP 91 11 2264

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.5)
X,Y	EP-A-0 352 444 (BOSCH) * claim 1; figure 1 *	1,2	F 02 M 51/08
Y,A	DE-A-3 520 154 (BOSCH) * column 1, paragraph 3; figure 1 *	2,3,5,6	
A	EP-A-0 144 082 (HITACHI) * figure 1 *	1	
A	GB-A-2 058 466 (BOSCH) * the whole document *	2-6,9,10	
A	GB-A-2 178 483 (LUCAS) * claim 1; figure 3 *	2-3,6,10	
A	DE-A-3 727 342 (BOSCH) * column 4, last paragraph; figures 1-5 *	7,8	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

F 02 M

The present search report has been drawn up for all claims

Place of search	Date of completion of search	Examiner
Berlin	18 November 91	THOMAS C L

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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