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

(57) A valve comprising a body (1) housing a core (2) and an electromagnet (3); and an injection nozzle (4) secured to the body (1) and housing an axially-sliding plunger (7) controlling fuel passage through an injection orifice (8) in the nozzle (4). The plunger (7) is fitted integral with an anchor (9) attracted by the core (2), and is guided by at least one guide ring (17s) housed inside an axial hole (6) in the nozzle (4) and locked between a shoulder on the nozzle (4) and a lock coupling (22) force-fitted inside the axial hole (6).

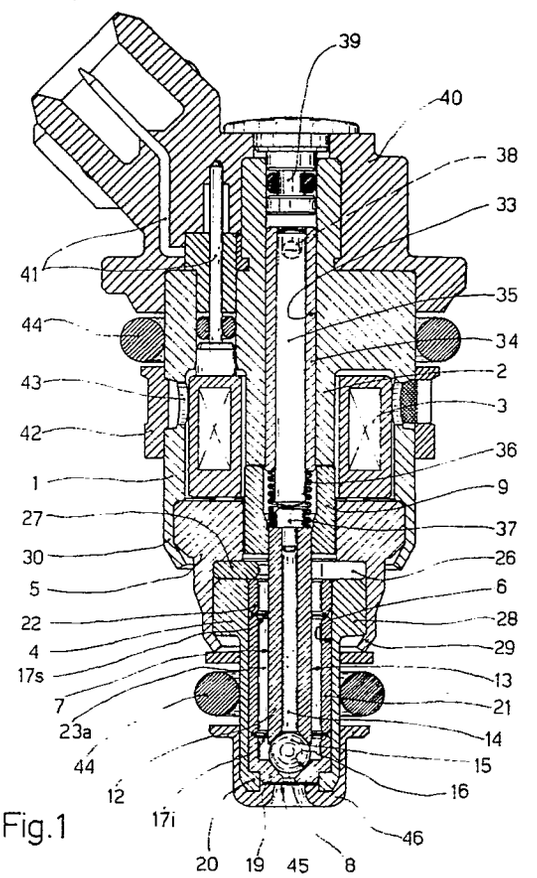


Fig.1

EP 0 450 654 A1

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

Valves of the aforementioned type substantially comprise a body housing a core and an electromagnet; and a nozzle secured to the body and having an axial hole housing an axially-sliding plunger designed to move between a closed position, wherein it cuts off fuel supply through an injection orifice formed in the nozzle, and an open position enabling fuel supply through said orifice. The plunger is fitted integral with an anchor attracted by the core when the electromagnet is energized, for opening the injection orifice.

The plunger is of elongated shape and, to ensure correct displacement in relation to the nozzle, usually presents two annular projections, the outer surface of which mates in sliding manner with the surface of the axial hole on the nozzle housing the plunger. Also, for correctly adjusting the opening stroke of the plunger, provision is usually made for a washer located between the body and the nozzle and acting as a shoulder for a further annular projection on the nozzle.

The plunger is normally maintained in the closed position by a helical spring located between the plunger and a rod housed and secured in a given axial position inside an axial hole on the valve core.

Valves of the aforementioned type present a number of drawbacks.

Foremost of these is that they are fairly complex in design and involve numerous assembly operations.

In fact, for ensuring correct guidance of the plunger inside the axial hole on the nozzle, the surface of the axial hole and those of the two annular projections mating in sliding manner with the same must be machined to a high degree of precision. Also, the design of the plunger is complicated, not only by the above two annular projections, but also by said third annular projection arresting the opening stroke of the plunger.

Moreover, assembly of the valve involves a good deal of checking and adjustment for ensuring correct opening travel and preloading of the plunger. The first is normally achieved by machining at least one of the valve members, usually the nozzle; and the second by axially adjusting the position of the rod resting on the end of the spring holding the plunger in the closed position.

Finally, the response of valves of the aforementioned type is never very high, due to the weight of the plunger, which is a direct consequence of its design and, in particular, said three annular projections.

It is an object of the present invention to provide a fuel metering and atomizing valve of the aforementioned type, designed to overcome the aforementioned drawbacks, i.e. which is straightforward in design, can be assembled easily with no complex machining required, and provides for rapid response.

According to the present invention, there is provided an electromagnetic fuel metering and atomizing valve for an internal combustion engine fuel supply device, comprising:

a body housing a core and an electromagnet; and

a nozzle secured to said body and having an axial hole housing a plunger designed to move between a closed position, wherein it closes at least one fuel injection orifice in said nozzle, and an open position wherein said orifice is open, said plunger being fitted integral with an anchor attracted by said core when said electro-magnet is energized; characterised by the fact that it comprises:

at least one guide ring housed in said axial hole in said nozzle and engaged in sliding manner by an outer surface portion of said plunger, said ring being housed inside said axial hole with a predetermined radial clearance, and resting on a shoulder of said nozzle; and a lock coupling force-fitted inside said axial hole in said nozzle and designed to lock said ring on said nozzle in a position wherein the axis of said plunger substantially coincides with the axis of said nozzle.

The valve according to the present invention will be described, by way of example, with reference to the accompanying drawings, in which:

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

Fig.2 shows a detail of the Fig.1 section;

Fig.3 shows a detail, similar to that of Fig.2, of a further embodiment of the valve according to the present invention;

Fig.4 shows a plan view of a ring on the valve according to the present invention.

The valve according to the present invention substantially comprises a body 1 housing a core 2 and an electromagnet 3; and an injection nozzle 4 secured to body 1 via the interposition of a bush 5. Core 2 may conveniently be formed in one piece with body 1, as in the embodiment shown.

Nozzle 4 presents an axial hole 6 housing a plunger 7 designed to move between a closed position (Fig.1) wherein the injection orifice 8 of nozzle 4 is closed, and an open position wherein said orifice 8 is open. Plunger 7 is fitted integral with an anchor 9 attracted by core 2 when electromagnet 3 is energized.

Plunger 7 substantially comprises a rod 12 defined by a cylindrical outer surface 13 and having an axial hole 14; and a ball 15 welded to the bottom end of rod 12. Ball 15 is conveniently housed in a conical seat on rod 12 and rests in a seat 16 coaxial with injection orifice 8.

The valve also comprises at least one guide ring 17s housed inside axial hole 6 in nozzle 4 and engaged in sliding manner by the outer cylindrical surface 13 of rod 12. In the embodiment shown, provision is conveniently made for two guide rings 17s and 17i, the lower one of which (17i) rests in an annular seat (Fig.1) of a bush 19 in which injection orifice 8 is formed and which rests on a shoulder 20 of nozzle 4. Ring 17i supports a tubular spacer 21 in turn supporting ring 17s higher up. The outside dimensions of both bush 19 and spacer 21 are such as to enable smooth insertion inside hole 6 in nozzle 4, so that the outer surfaces of bush 19 and spacer 21 may be said to mate in sliding manner with the inner surface of nozzle 4.

Ring 17s presents a lock coupling 22 force-fitted inside hole 6 in nozzle 4 for locking rings 17s and 17i, spacer 21 and bush 19 to nozzle 4, as described later on.

Though the embodiment shown features two guide rings 17s and 17i, provision may be made for one, located, for example, in the position of ring 17s, and resting, not on spacer 21, but on an annular shoulder formed on nozzle 4. In this case, spacer 21 and bush 19 may be dispensed with, and injection orifice 8 formed directly on nozzle 4. As shown clearly in the Fig.2 detail, both rings 17i and 17s are housed inside hole 6 in nozzle 4 with a predetermined radial clearance "g".

Both rings 17i and 17s also conveniently present holes 23 (Fig.2) enabling fuel passage into the cavity defined between outer surface 13 of rod 12 and the inner surface of bush 19, spacer 21 and lock coupling 22.

A spacer washer 27 with a slot 26 is conveniently provided between bush 5 and nozzle 4, and, as shown clearly in Fig.1, nozzle 4 presents a radial enlargement 28 locked inside a hole in bush 5 by permanently deforming edge 29 of bush 5. Bush 5 in turn is locked on to body 1 by deforming edge 30 of the same.

According to an alternative arrangement shown in detail in Fig.3, at least one of guide rings 17i and 17s is welded to the outer surface 13 of rod 12, in which case, said ring is elastically deformable in the direction of the plunger axis, so as to enable plunger 7 to move from said closed to said open position. Moreover, the guide ring 17i or 17s (or both) welded to rod 12 is conveniently mounted between the annular shoulders defined by bush 19, spacer 21 and coupling 22 with a predetermined axial preload for securing plunger 7 in the closed position.

To increase the axial deformability of rings 17i and 17s, these may conveniently be formed as shown, for example, in Fig.4, wherein they substantially comprise two annular portions 31 and 32 connected by suitably shaped radial arms.

Core 2 (Fig.1) presents an axial hole 33 coaxial with plunger 7 and housing a tubular element 34 in turn housing a rod 35. A helical spring 36 is provided between tubular element 34 and rod 12 of plunger 7, for securing plunger 7 in the closed position. Rod 35 provides for arresting rod 12 when plunger 7 is in the open position, for which purpose, hole 14 on rod 12 is fitted with a pin 37 designed to rest against the end of rod 35.

Tubular element 34 is housed in sliding manner inside hole 33, and in turn houses sliding rod 35. Core 2 presents at least a radial hole 38 (outlined by the dotted line in Fig.1) enabling insertion of a tool for permanently deforming portions of tubular element 34 and rod 35 and so locking the same on to core 2 as described later on.

The top end of hole 33 is conveniently closed by a cap 39, and body 1 presents a cap 40 conveniently made of hot-deformable material and housing rheophores 41 for supplying current to electromagnet 3.

Finally, the valve presents an annular filter 42 in the vicinity of fuel inlet holes 43; and two sealing rings 44 enabling troublefree seating of the valve.

Downstream from injection orifice 8, provision is conveniently made for a plate 45 having small-diameter holes and locked on to nozzle 4 by a cap 46.

The valve according to the present invention operates as follows.

Fuel is fed into the valve through holes 43 and, through the cavities defined between the surfaces of the various valve components (Fig.1), in particular, through slot 26 in washer 27, fills the cavity 23a between rod 12, bush 19, spacer 21 and coupling 22. When electromagnet 3 is energized, anchor 9 is attracted by core 2, against the action of spring 36, so as to raise rod 12 and open injection orifice 8. As it is raised, rod 12 is guided by rings 17i and 17s, the inner surface of which mates in sliding manner with the outer surface 13 of rod 12.

On reaching the top limit position, plunger 7 is arrested by pin 37 engaging the end of rod 35, and a residual axial clearance (air gap), depending on the thickness of washer 27, is left between anchor 9 and core 2.

Even if one or both of guide rings 17i and 17s are welded to rod 12, as shown in the Fig.3 embodiment, axial travel of rod 12 is still permitted by virtue of rings 17i and 17s deforming axially like a pair of springs. For achieving a high degree of axial deformability, rings 17i and 17s may be formed as shown, for example, in Fig.4.

As already stated, when welded to rod 12 and appropriately preloaded, rings 17i and 17s provide for sufficient axial force for securing plunger 7 in the closed position shown in Fig.1, in the same way as helical spring 36.

The means provided for ensuring correct axial guidance of rod 12 enable accurate positioning of the same, when assembling the valve, as follows.

First of all, an assembly is formed consisting of nozzle 4, bush 19, spacer 21 and lock coupling 22, upon completion of which rod 12 is perfectly coaxial with nozzle 4. In fact, for forming said assembly, bush 19, spacer 21, rings 17i and 17s and rod 12 are fitted inside hole 6 on nozzle 4, in the exact finished valve position. A centering tool of any type (not shown) is then used for securing the top end of rod 12 in such a position that the axis of rod 12 coincides with that of nozzle 4. At this point, lock coupling 22 may be inserted, with a given radial pressure, inside hole 6, so as to contact upper ring 17s and exert a given axial pressure on ring 17s and the members housed inside hole 6 of nozzle 4.

Rings 17i and 17s are thus locked firmly in the correct position wherein rod 12 and nozzle 4 are perfectly coaxial. The assembly so formed may then be fitted on to the valve.

The valve according to the present invention provides for fast, troublefree adjustment of the upstroke of plunger 7 and the preload on spring 36, by simply inserting a tool inside hole 33 in core 2, for axially displacing, as required, tubular element 34 in relation to core 2 and rod 35 in relation to tubular element 34. When set to the required axial position, tubular element 34 and rod 35 are locked by permanently deforming a portion of the same using a tool inserted inside at least one of radial holes 38.

The valve according to the present invention is therefore extremely straightforward in design, and provides for accurate guidance of plunger 7 in relation to nozzle 4, and high-speed response due to the straightforward design and light weight of plunger 7.

What is more, it provides for fast, troublefree adjustment of the upstroke of plunger 7 and the preload on spring 36.

When secured as described to rod 12, rings 17i and 17s provide for effectively improving the closing action of plunger 7, thus enabling the use of a small-size spring 36. Finally, by virtue of the elastic closing force of plunger 7 being, in this case, provided partly by rings 17i and 17s and partly by spring 36, preload adjustment of spring 36 is simplified by enabling spring 36 to be employed solely for fine adjustment purposes.

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 and illustrated 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, comprising:
a body (1) housing a core (2) and an electromagnet (3); and
a nozzle (4) secured to said body (1) and having an axial hole (6) housing a plunger (7) designed to move between a closed position, wherein it closes at least one fuel injection orifice (8) in said nozzle (4), and an open position wherein said orifice (8) is open, said plunger (7) being fitted integral with an anchor (9) attracted by said core (2) when said electromagnet (3) is energized; characterised by the fact that it comprises:
at least one guide ring (17s) housed in said axial hole (6) in said nozzle (4) and engaged in sliding manner by an outer surface portion (13) of said plunger (7), said ring (17s) being housed inside said axial hole (6) with a predetermined radial clearance, and resting on a shoulder of said nozzle (4); and
a lock coupling (22) force-fitted inside said axial hole (6) in said nozzle (4) and designed to lock said ring (17s) on said nozzle (4) in a position wherein the axis of said plunger (7) substantially coincides with the axis of said nozzle (4).

2. A valve as claimed in Claim 1, characterised by the fact that it comprises two said guide rings (17s, 17i), a first (17i) resting on a first shoulder of said nozzle (4), and a second (17s) resting on a tubular spacer (21) between said rings (17s, 17i); said lock coupling (22) resting on said second ring (17s).

3. A valve as claimed in Claim 2, characterised by the fact that said first shoulder consists of a bush (19) housed in said axial hole (6) in said nozzle (4) and having a seat (16) supporting said plunger (7).

4. A valve as claimed in one of the foregoing Claims, characterised by the fact that at least one of said guide rings (17i, 17s) is welded to said outer surface portion (13) of said plunger (7), and is elastically deformable in the direction of the axis of said plunger (7) for enabling flexible displacement of said plunger (7) from said closed position to said open position.

5. A valve as claimed in Claim 4, characterised by the fact that said guide ring (17i, 17s) is mounted between said shoulder and said lock coupling (22) and is so preloaded axially as to produce sufficient axial force for normally

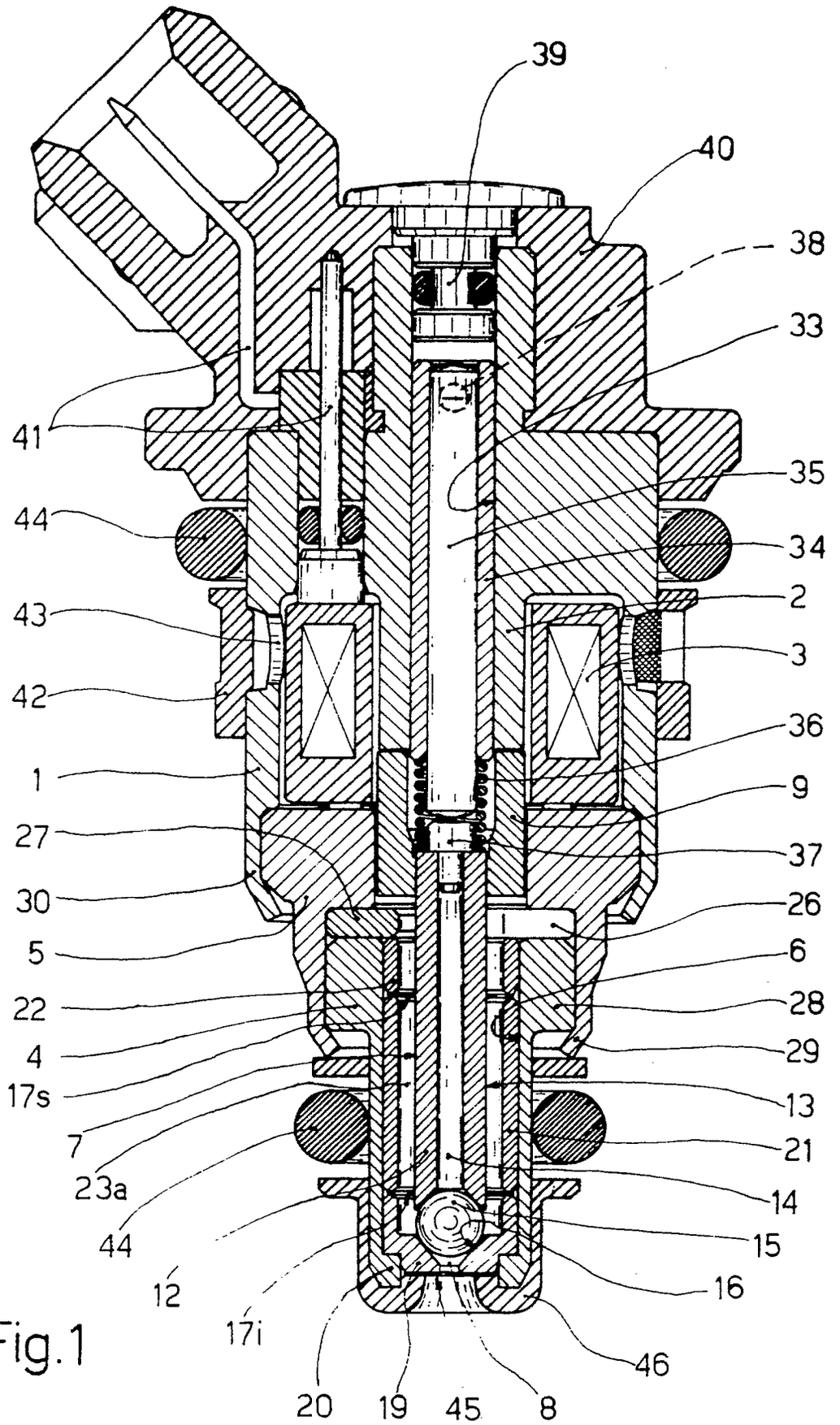
maintaining said plunger (7) in said closed position.

6. A valve as claimed in one of the foregoing Claims, characterised by the fact that said plunger (7) comprises a rod (12) defined by a cylindrical outer surface (13) and having an axial hole (14); and a ball (15) welded to one end of said rod (12) and resting in said seat (16).

7. A valve as claimed in one of the foregoing Claims, wherein said core (2) presents an axial hole (33) coaxial with said plunger (7); characterised by the fact that said hole (33) houses a tubular element (34) in turn housing a rod (35); a spring (36) being provided between said tubular element (34) and said rod (12) of said plunger (7), for securing said plunger (7) in said closed position; and said rod (35) providing for arresting said rod (12) when said plunger (7) is in said open position.

8. A valve as claimed in Claim 7, characterised by the fact that said tubular element (34) is housed in sliding manner inside said hole (33) in said core (2), and said rod (35) is housed in sliding manner inside said tubular element (34); said core (2) presenting at least one radial hole (38) communicating with said axial hole (33) and enabling insertion of a tool for permanently deforming portions of said tubular element (34) and said rod (35), for locking the same on to said core (2).

9. A valve as claimed in one of the foregoing Claims, characterised by the fact that a spacer washer (27) is provided. between said nozzle (4) and said body (1).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22
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Fig.1

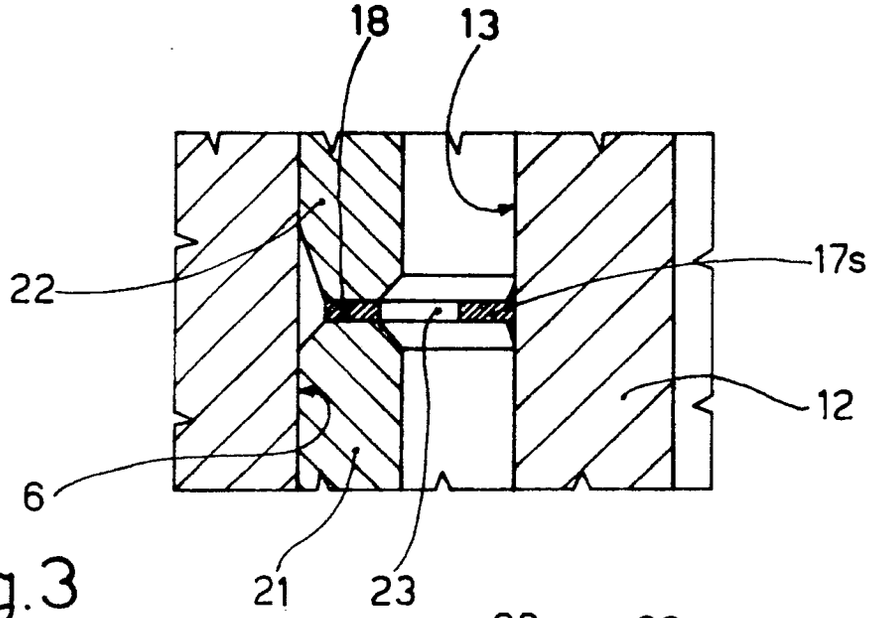

Fig.3

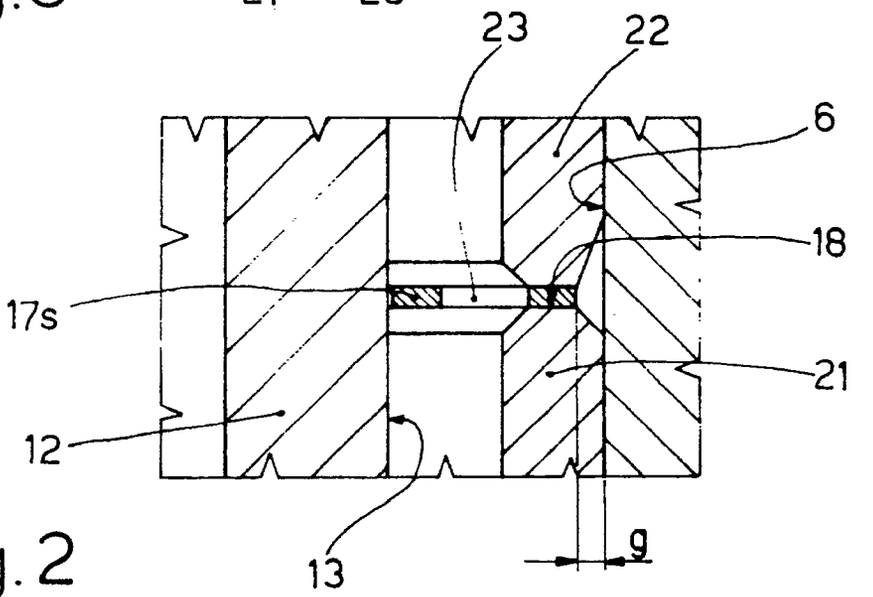

Fig.2

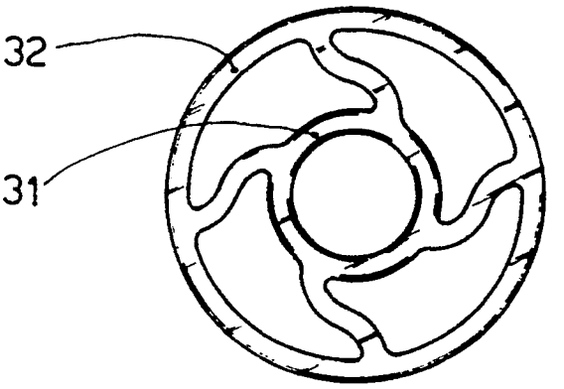

Fig.4

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EUROPEAN SEARCH REPORT

Application Number

EP 91 10 5441

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	DE-A-3 120 160 (BOSCH) * The whole document *	1,6,9	F 02 M 51/06 F 02 M 61/12
Y		2,3,4,7,8	
Y	DE-A-3 905 992 (MESENICH) * Column 10, line 31 - column 11, line 19; figure 4 *	2,3	
Y	FR-A-1 553 610 (BOSCH) * The whole document *	4	
Y	US-A-2 356 577 (FUSCALDO) * The whole document *	7	
Y	EP-A-0 312 708 (PIERBURG) * Column 3, lines 7-34; figure 1 *	8	
X	DE-A-1 601 395 (BOSCH) * The whole document *	1,4	
Y		7	
A		5	
Y	GB-A-1 019 013 (ROOSA) * The whole document *	7	TECHNICAL FIELDS SEARCHED (Int. Cl.5) F 02 M
A	GB-A-1 085 093 (BRYCE BERGER) * The whole document *	1,2	
A	DE-B-1 263 396 (PHILIPS) * The whole document *	1,4,5	
A	GB-A-2 192 427 (PIERBURG) * The whole document *	7,8	

The present search report has been drawn up for all claims

Place of search	Date of completion of search	Examiner
The Hague	22 July 91	VAN ZOEST A.P.

CATEGORY OF CITED DOCUMENTS

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