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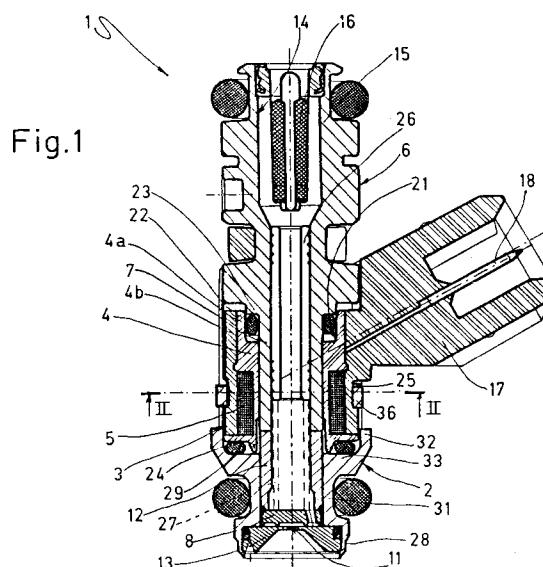
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**I-10121 Torino (IT)**(54) **An electromagnetically operated fuel metering and atomising valve.**

(57) The valve includes a tubular casing (2), an electromagnet (3) defined by a tubular former (4) and an electrical winding (5), a tubular body (6), a portion (7) of which constitutes the core of the magnetic circuit defined in the valve, a movable valve shutter member (8) controlling the flow of fuel through an injection orifice (11) and a tubular armature (12) attracted by the portion (7) of the body (6) when the electromagnet (3) is excited and thereby determining the stroke of the valve shutter member (8). The main characteristic of the valve lies in the fact that it includes an axial interlock between the casing (2) and the former (4), this interlock having at least of a tongue (36) formed in the casing (2) and engaging a groove (25) in the former (4)

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The present invention relates to an electromagnetically actuated fuel metering and atomising valve, intended to be fitted to the fuel supply device of an internal combustion engine.

As is known, valves of the above type include a man body internally housing an annular electromagnet, a core and a movable valve shutter element. The electromagnet consists of a support former and an electrical winding.

A main disadvantage lies in the fact that the former and the main body are not directly fixed to each other, but are fixed indirectly by connection between the various fixed components of the valve. It is clear that clearances may exist between the former and the main body, which clearances could increase over time making the position of the electrical winding unstable relative to the axial air gap of the magnetic circuit defined in the valve. It is clear that this instability affects the axial component of the magnetic force controlling the stroke of the valve shutter element, meaning that for each similar command to the electromagnet the time taken for the valve shutter member to complete its stroke could be different. In addition, this clearance could compromise the fluid-tight seal of the valve as the seals would age prematurely as a result of the extra stress (vibration of the various elements) to which they were subjected.

The object of the present invention is to provide an electromagnetically operated fuel metering and atomising valve free from the above disadvantages, that is to say one provided with a system which prevents clearances from forming and at the same time provides a reliable fluid-tight seal.

Further objects and advantages of the present invention will become apparent from the description which follows.

An electromagnetically operated fuel metering and atomising valve manufactured according to the present invention and intended to be fitted in the fuel supply device of an internal combustion engine, includes:

a tubular casing housing the lower portion of the said valve;

an electromagnet consisting of a tubular former and an electrical winding mounted in an annular seat formed within the interior of the said former;

a tubular body with a lower portion made of ferromagnetic material to form the core of a magnetic circuit defined in the said valve;

a movable valve shutter member operable to control the passage of fuel through an injection orifice;

a movable tubular armature attracted by the said lower portion of the said body when the electromagnet is excited and supporting the said valve shutter member;

a plate in which the injection orifice is formed;

and

a fuel inlet opening defined in the said body; characterised in that it includes an axial interlock between the said casing and the said former, this interlock having at least of a tongue formed in the said casing and a cavity formed in the said former and engaged by the said tongue.

In order better to understand the present invention, a preferred embodiment will now be described purely by way of non-limitative example, with reference to the appended drawings, in which:

Figure 1 is a sectioned elevation of a valve according to the principles of the present invention;

Figure 2 is a section taken on the line II-II of Figure 1;

Figure 3 is an exploded section of some of the components of the valve of Figure 1; and

Figure 4 is a section of a component of the valve of Figure 1.

With reference to Figure 1, a magnetically actuated fuel metering and atomising valve, generally indicated 1, is intended to be fitted in the fuel supply device of an internal combustion engine.

The valve 1 comprises:

a main body 2 forming a tubular casing for the lower part of the valve;

an electromagnet 3 defined by a tubular former 4 and an electrical winding 5 mounted in an annular seat within the former 4;

a tubular body 6 a lower portion of which is made of ferromagnetic material so as to form the core of a magnetic circuit defined in the valve 1;

a movable valve shutter member 8 operable to control the passage of fuel through an injection orifice 11;

a movable tubular armature 12 attracted by the portion 7 when the electromagnet 3 is excited and supporting the valve shutter member 8;

a plate 13 with the injection orifice 11 formed therein;

a fuel inlet 14 formed in an upper portion 15 of the body 6; and

a filter 16 fitted in the inlet 14.

With reference to Figures 1 and 3, the former 4 is constituted by two tubular parts 4a and 4b, securely fixed one within the other and made of plastics material, defining within them the seat for the winding 5. A body 17 extends obliquely upwards from an upper area of the outermost section 4b and constitutes an electrical connector as it houses blade-like pins 18 through which the winding 5 is supplied. A wall 19 extends upwardly from an upper area of the section 4b, in a position diametrically opposite the body 17. An annular recess 21 is formed in the inner surface of the upper end of the inner part 4a of the former 4 to house an annular seal 22 which is compressed

radially by the portion 7 of the body 6. The seat for the seal 22 is closed at the top by an annular shoulder 23 formed in the body 6.

The part 4a of the former 4 has an annular base wall from which an annular pressure foot 24 extends downwardly. Diametrically opposite, two small part-annular grooves 25 are formed in the outer surface of the part 4b. In particular, one groove 25 is formed just beneath the lower end of the wall 19 and the other groove 25 is formed just beneath the lower end of the body 17.

With reference to Figure 1, the portion 7 of the body 6 is installed within the former 4 and contains an annular pin 26 the function of which is to engage against a coil spring 27 arranged fitted between the pin 26 and the valve shutter member 8 which is defined by a small plate.

With reference to Figures 1, 3 and 4, the body 2 comprises:

a lower portion 28 housing the plate 13;

a central portion 31 having a smaller internal diameter than the portion 28 and within which the armature 12 and the valve shutter member 8 are slidable; and

an upper portion 32 having a larger internal diameter than the portion 31 so as to define an annular wall 33 between the two.

The former 4 is housed in the portion 32, and the annular base wall of the part 4a of the former 4 and the wall 33 define between them an annular seat in which is fitted an annular seal 29 which is compressed axially by the part 4a. The seat for the seal 29 is closed on the inside by the annular foot 24.

With reference to Figures 3 and 4, two diametrically opposite notches 34 having longitudinal axes parallel to a longitudinal axis X of the body 2 are formed in the portion 32 of this body. Under the bottom wall of each notch 34, a through-slot is formed in the portion 32 which defines a tongue 36 with the bottom wall of the notch 34. It must be pointed out that in Figures 3 and 4 the body 2 is illustrated prior to the assembly of the valve 1.

In use, the seal 29 is first placed on the wall 33 then the former 4 is fitted into the portion 32 of the body 2, taking care to orientate the former 4 in such a way that the wall 19 and the body 17 are in correspondence with a respective notch 34. The former 4 is then pressed against the wall 33 so as to compress the seal 29 in such a way that the tongues 36 are moved into correspondence with respective grooves 25.

Next a tool is used to deform the tongues 36 towards the axis X so that they tightly engage the respective grooves 25 as shown in Figures 1 and 2. The seal 29, having been preloaded, acts as a spring, urging the former 4 upwards which former is held fixedly by the engagement of the tongues

36 in the grooves 25.

The advantages inherent in the implementation of the present invention are clear from the above description.

In particular, the invention provides a valve which is simple to manufacture and easy to assemble; it can be assembled with the use of automated machinery. The main advantage of the valve according to the present invention lies in having provided axial interlock between the valve casing and the electromagnet. This interlock enables the position of the electrical winding to be kept stable relative to the wall 33 and thus relative to the airgap of the magnetic circuit, this airgap being defined between the portion 7 of the body 6 and the armature 2.

It is clear that the stable position of the electrical winding tends to improve the performance of the magnetic circuit. In addition, it must be emphasised that in addition to its role in providing an axial, and therefore particularly effective, fluid-tight seal, the seal 29 also acts as an axial spring, maintaining constant the pressure of the bottom of the grooves 25 against the lower edge of the tongues 36. The locking system between the casing and the electromagnet enables the size of the valve 1 to be kept compact.

It is finally clear that modifications and variations may be made to the valve 1 as described and illustrated here without thereby departing from the protective scope of the present invention.

In particular, the interlocking system between the casing and the electromagnet may also be applied to valves which provide for the fuel to enter a central area. In addition, this locking system may be made differently from the way described above. In particular, there may be a different number of tongues and these may have different geometric shapes from those described.

## Claims

1. An electromagnetically actuated fuel metering and atomising valve, intended to be fitted in a fuel supply system of an internal combustion engine, comprising:

a tubular casing (2) forming a seat for the lower portion of the said valve;

an electromagnet (3) defined by a tubular former (4) and an electrical winding (5) mounted in an annular seat formed inside the said former (4);

a tubular body (6) with a lower portion (7) made of ferromagnetic material forming the core of a magnetic circuit defined in the said valve;

a movable valve shutter member (8) operable to control the flow of fuel through an

injection orifice (11);

a movable tubular armature (12) attracted by the said lower portion (7) of the said body (6) when the electromagnet (3) is excited and supporting the said valve shutter member (8); 5

a plate (13) with the said injection orifice (11) formed therein; and

a fuel inlet (14) defined in the said body (6); characterised in that it includes an axial interlock between the said casing (2) and the said former (4), this interlock involving at least one tongue (36) formed in the said casing (2) and engaging a groove (25) formed in the said former (4). 10

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2. A valve according to Claim 1, characterised in that engagement of the said tongue (36) in the said groove (25) is defined by a deformation of the tongue (36). 20

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3. A valve according to Claim 2, characterised in that the said casing (2) includes:

a lower portion (28) housing the said plate (13);

a central portion (31) having a smaller inner diameter than that of the said lower portion (28) within which the said armature (12) and the said valve shutter member (8) are slidable; and 25

an upper portion (32) having a greater inner diameter than that of the said central portion (31) so as to define an annular wall (33) between these two; the former (4) being housed within the said upper portion (32). 30

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4. A valve according to Claim 3, characterised in that an annular seat is defined between an annular base wall of the said former and the annular wall (33) of the said casing (2), housing an annular seal (29) which is axially compressed by the said former (4). 40

5. A valve according to Claim 4, characterised in that two small part-annular grooves (25) are formed in the said former (4) in diametrically opposite positions, and in that two diametrically opposite notches (34) are formed in the said upper portion (32) of the said casing (2), with their longitudinal axes parallel to a longitudinal axis (X) of the said casing (2), and in that 50
- in the bottom of each notch (34) a slot is formed through the said upper portion (32) which defines the said tongue (36) with the bottom of a respective notch (34). 55

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Fig.2

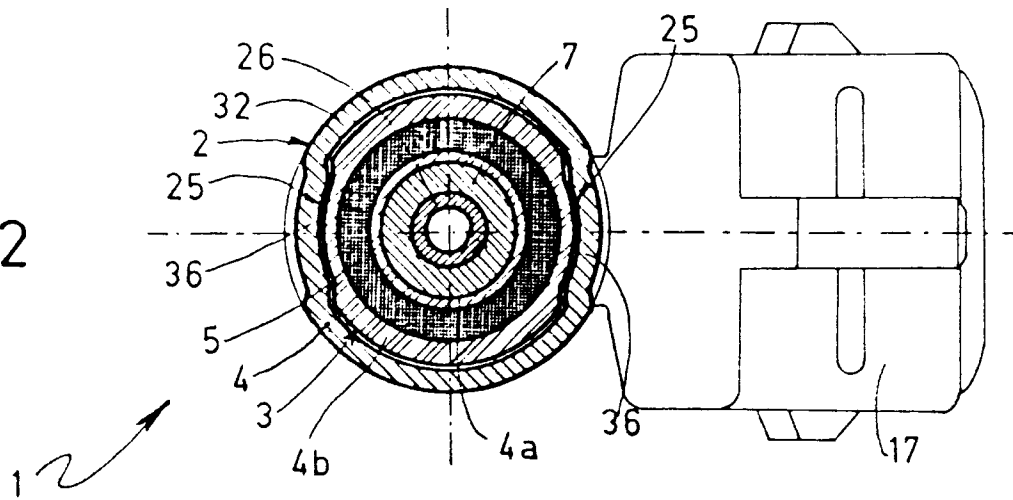
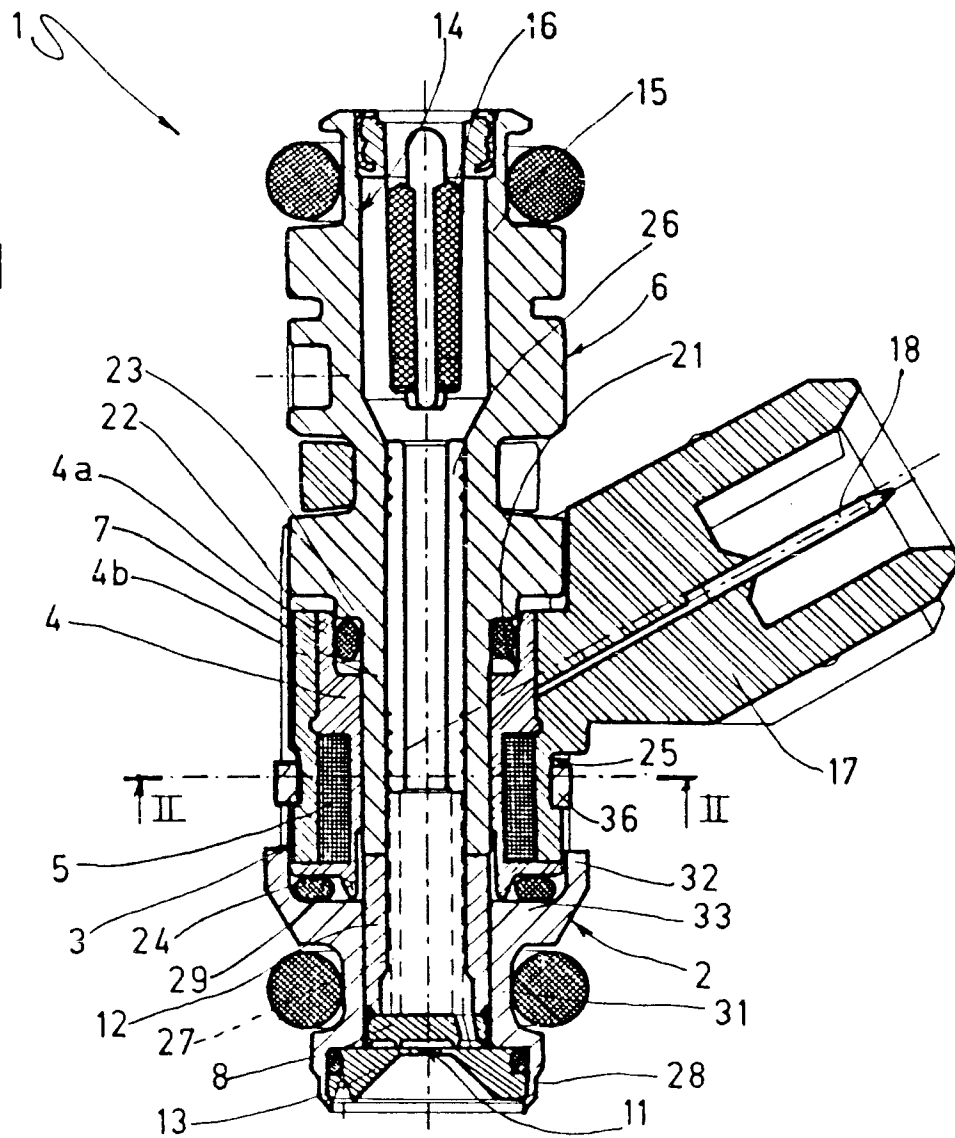


Fig.1



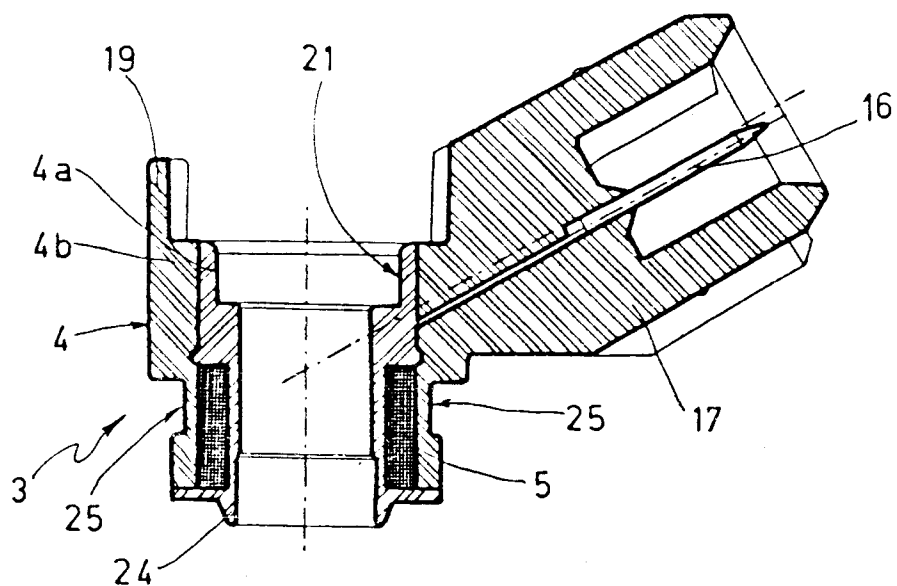
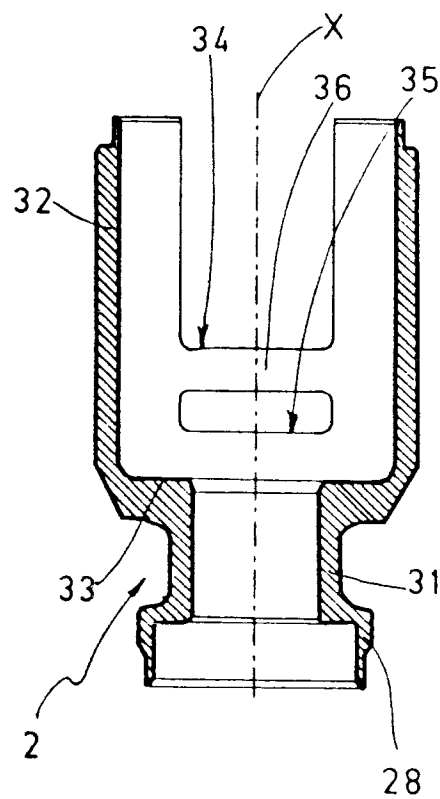
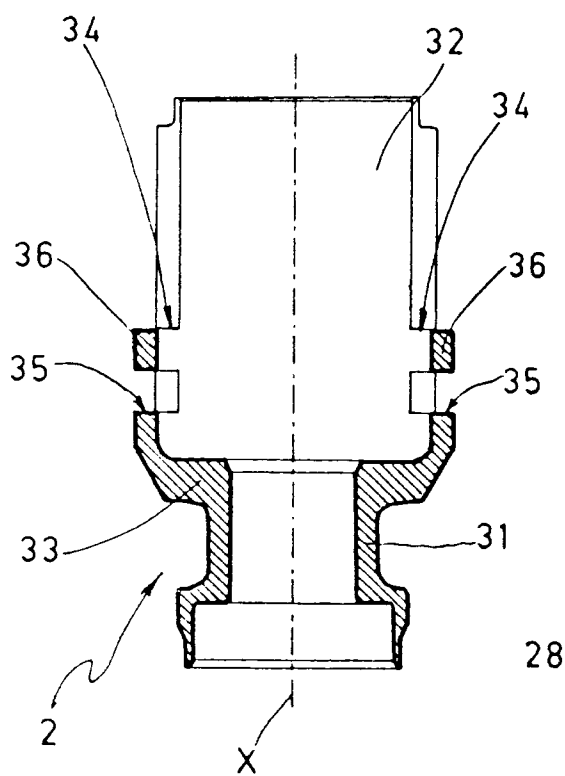


Fig.3



Fig.4





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## EUROPEAN SEARCH REPORT

Application Number  
EP 94 11 6845

| DOCUMENTS CONSIDERED TO BE RELEVANT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                      |                                                     |                                         |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------|-----------------------------------------|
| Category                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Citation of document with indication, where appropriate, of relevant passages                                                                        | Relevant to claim                                   | CLASSIFICATION OF THE APPLICATION       |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | EP-A-0 536 774 (WEBER)<br>* abstract; figure 1 *<br>---                                                                                              | 1                                                   | F02M61/16<br>F02M51/06                  |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | GB-A-804 116 (C.A.V)<br>* page 2, line 17 - line 49; figures 1,2 *<br>---                                                                            | 1                                                   |                                         |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | PATENT ABSTRACTS OF JAPAN<br>vol. 9, no. 73 (M-368) 3 April 1985<br>& JP-A-59 203 866 (NIPPON DENSO KK) 19<br>November 1984<br>* abstract *<br>----- |                                                     |                                         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                      |                                                     | TECHNICAL FIELDS<br>SEARCHED (Int.CL.6) |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                      |                                                     | F02M                                    |
| The present search report has been drawn up for all claims                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                      |                                                     |                                         |
| Place of search<br>THE HAGUE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                      | Date of completion of the search<br>11 January 1995 | Examiner<br>Sideris, M                  |
| <b>CATEGORY OF CITED DOCUMENTS</b><br>X : particularly relevant if taken alone<br>Y : particularly relevant if combined with another document of the same category<br>A : technological background<br>O : non-written disclosure<br>P : intermediate document<br>T : theory or principle underlying the invention<br>E : earlier patent document, but published on, or after the filing date<br>D : document cited in the application<br>L : document cited for other reasons<br>.....<br>& : member of the same patent family, corresponding document |                                                                                                                                                      |                                                     |                                         |