

(19)



Europäisches Patentamt
European Patent Office
Office européen des brevets



(11) Publication number:

0 638 720 A1

(12)

EUROPEAN PATENT APPLICATION(21) Application number: **94111906.7**(51) Int. Cl.⁶: **F02M 69/04, F02M 69/08**(22) Date of filing: **29.07.94**(30) Priority: **06.08.93 IT TO930585**(43) Date of publication of application:
15.02.95 Bulletin 95/07(84) Designated Contracting States:
DE ES FR GB(71) Applicant: **WEBER S.r.l.**
Corso Marconi, 20
I-10125 Torino (IT)(72) Inventor: **Armaroli, Massimo**
Via F. Albani 14
40044 Pontecchio Marconi (IT)
Inventor: **Consolini, Roberto**
Via A. Volta 9
40064 Ozzano Emilia (IT)(74) Representative: **Plebani, Rinaldo et al**
c/o Studio Torta,
Via Viotti 9
I-10121 Torino (IT)(54) **Injector with a high atomization capacity, in particular for supplying fuel to motor vehicle engines.**

(57) Injector in which an obturator element (11) controlled by an electromagnetic actuator (7) controls the formation of at least one jet of fuel (15) through an atomization hole (14), characterized in that it is provided with auxiliary atomization means including at least one surface (21) arranged so as to be transversely oblique with respect to the said jet of fuel (15), at a predetermined and relatively large distance from the atomization hole (14) with respect

to the jet diameter, such that the surface (21) is struck by the jet at a predetermined point (22) with an angle of impact other than 0° and 90°, and including moreover a duct (25) for a jet of auxiliary air (23) oriented so as to direct the jet of air (23) against the said oblique surface (21), substantially at the point of impact (22) thereon of the said jet of fuel (15).

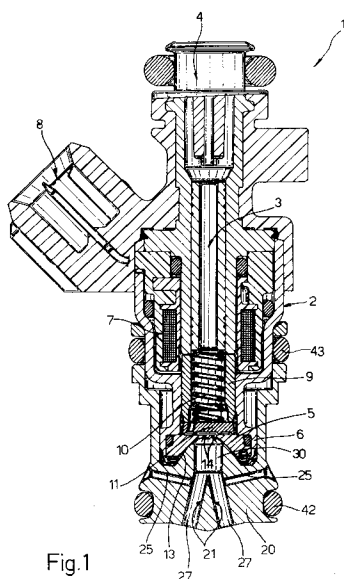


Fig.1

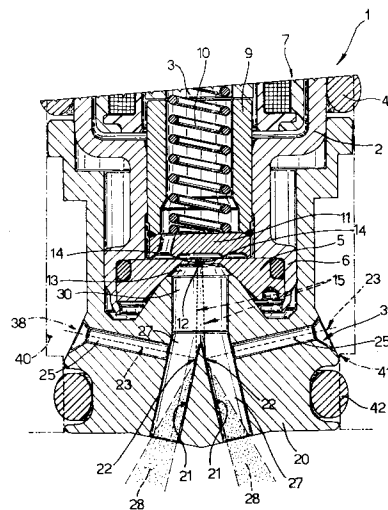


Fig.2

EP 0 638 720 A1

The present invention relates to an electromagnetically controlled fuel injector, in particular for supplying fuel to motor vehicle engines, of the type in which atomization of the injected fuel is obtained partly by effecting injection through one or more atomizer holes formed through a delivery element designed to provide a so-called "thin wall outflow" and partly by the delivery, through the injector, of an auxiliary air flow in addition to the fuel.

Electromagnetic injectors for vehicle engines of the so-called "Pico" type are known, in which the obturator operated by an electromagnetic actuator regulates the outflow of the fuel through holes formed in a portion of a delivery plate or disc defined by a wall of very small thickness, of the order of only a few tenths of a millimetre or less; in this type of injector, atomization of the injected fuel (usually petrol) is achieved by means of the aero- and hydro-dynamic effects which occur, as is well known in rheology, when the outflow of a liquid (the fuel) occurs through a hole formed in a thin wall or through a hole whose length is very small compared to its diameter. In this way, the formation of fuel jets consisting of particles with a diameter of 180 to 200 microns is obtained; in many cases it would preferable, however, to obtain a greater degree of atomization, with the formation of particles of fuel of smaller dimensions, something which is not possible without being obliged to reduce the dimensions of the delivery holes such that there is the risk of blockage of the said holes, not to mention the associated problems relating to both the constructional design and premature wear of the holes themselves.

In order to improve atomization of the jets of fuel produced by means of injectors it is also known, for example from German Patent No. 4103918, to obtain mixing of the jet of fuel with a jet of auxiliary air prior to actual injection of the fuel into the combustion chamber (or induction manifold) of the engine.

The results obtained hitherto, however, have not been entirely satisfactory; furthermore, in the case of the aforementioned German patent, atomization of the jet is obtained also by dividing up the said jet into two separate jets by means of impact against an edge, something which causes rapid wear of the atomizer device and, therefore, reduces the life of the injector.

The aim of the invention is to provide a fuel injector capable of achieving a high degree of atomization of the injected fuel whilst avoiding the risks of premature wear and/or blockage of the injection holes. A further aim of the invention is to provide an injector which is able to provide a more or less greater degree of atomization by means of the simple addition or replacement of a small number of inexpensive constructional components.

According to the invention, therefore, a high-capacity atomization injector is provided, in particular for supplying fuel to motor vehicle engines, of the type comprising an electromagnetic actuator, a delivery element provided with at least one atomization hole, and an obturator element operated by the said electromagnetic actuator so as to control the formation of at least one jet of fuel through the said atomization hole, characterized in that it is provided with auxiliary atomization means comprising: at least one surface arranged so as to be transversely oblique with respect to the said jet of fuel, at a predetermined and relatively large distance from the atomization hole with respect to the jet diameter, such that the surface is struck by the jet at a predetermined point; and means for delivering a jet of auxiliary air oriented so as to direct the jet of air against the said oblique surface, substantially at the point of impact thereon of the said jet of fuel.

This results, in a known manner, in the formation beforehand of one or more jets of atomized fuel which is then further atomized by means which are arranged downstream of the hole(s) for delivery of the jet(s) of fuel and which may therefore be absent or present without influencing operation of that part of the injector located upstream of them. The means used, moreover, consisting of an impact surface for the jet(s) of fuel and of a converging jet of air, ensure a high degree of atomization, but without subjecting the components to excessive wear.

Preferably, the said auxiliary atomization means are all contained in a cap mounted removably on the outside of the injector casing, in the region of and axially projecting from one end of the latter provided with atomization hole(s) and the associated delivery element.

In this way, by simply providing, on the casing of a currently known and already manufactured injector, snap-engagement fastening means for the said cap, it is possible to convert a conventional injector into an injector according to the invention. The injector according to the invention, then, by simply removing or mounting the cap which, since it does not have moving parts, is a very low-cost part, is able to provide a varying performance without requiring further modification of the more costly parts such as the actuator or obturator.

Further characteristic features and advantages of the invention will emerge clearly from the description, which follows, of a non-limiting example of embodiment thereof, with reference to the accompanying drawings, in which:

Figure 1 is an elevation view of an injector provided in accordance with the invention, sectioned longitudinally along the axis of the injector itself; and

Figure 2 illustrates, on a larger scale and in section, a detail of the injection end of the injector according to Figure 1.

With reference to Figures 1 and 2, a fuel injector is denoted in its entirety by 1, said injector, which is intended in particular for supplying fuel to motor vehicle engines, comprising a casing 2 of the known type inside which there is defined a fuel supply duct 3 connected to a known attachment union 4 extending outside the casing 2, in line with the latter; the duct 3 ends in the region of a fuel delivery element 5 defined by a disc mounted fluid-tightly, in a known manner, so as to close off a bottom end 6 of the casing 2 opposite the union 4 which defines conversely the top end of the casing itself; the latter has a substantially cylindrical symmetry in accordance with which the duct 3, union 4 and disc 5 are arranged in a substantially coaxial manner.

The casing 2 has accommodated inside it an electromagnetic actuator 7 of the known type arranged coaxially in a ring around the duct 3 and operated and powered via a known electric socket 8 which is arranged on the outside of the casing 2 in the vicinity and on one side of the union 4. The actuator 7 is formed by a ferromagnetic armature 9 which is designed to be displaced axially against the action of an opposition spring 10 by operation of the electromagnetic actuator 7 and to which there is integrally fixed, by means of welding in the case in question, an obturator element 11 defined by a metal disc arranged facing and parallel with the disc 5 defining the aforementioned delivery element.

In the non-limiting example shown, relating to an improved twinjet type injector for use with engines having 4 valves per cylinder, the delivery element 5 is of the "thin wall" type since it is provided with a central circular portion 12 (Figure 2) with a smaller thickness compared to that of the disc 5 as a whole, defined as the end wall of a frustoconical cavity 13 formed in the disc 5 on the opposite side to the obturator 11, i.e. on the outside of the casing 2. The thin wall defined by the portion 12 has, passing through it, at least one pair of atomization holes 14, of the known type, of relatively short length compared to the diameter, opening of which for a predetermined duration is controlled by an axial sliding movement of the obturator 11, in turn operated by the movement of the armature 9. When the actuator 7 is de-energised, the obturator disc 11 is kept by the spring 10 in fluid-tight contact with the disc 5, thus hydraulically isolating the holes 14 from the duct 3; conversely, when the actuator 7 is energised, the disc 11 is moved away from contact with the disc 5, thereby establishing hydraulic communication between the holes 14 and the duct 3 into which

pressurised fuel is supplied through the union 4.

Thus, by energising the actuator 7 for the aforementioned predetermined duration, it is possible to control the formation through each hole 14 of a corresponding jet of atomized fuel which is projected through the end 6 of the casing 2; in the case in question, the use of a pair of opposite holes 14 (or of several pairs of holes 14 arranged in a known manner in a ring, symmetrically on opposite sides with respect to the axis of the injector 1 and with their axes suitably oriented) results in the formation of two jets 15 which are not parallel with each other (in the example shown they are slightly divergent), but which in any case are oriented in a mainly axial direction with respect to the direction of sliding of the obturator 11.

According to the invention, the injector 1 comprises moreover auxiliary atomization means for each jet 15, which are formed in an atomizer element 20 arranged immediately downstream, with respect to the direction of delivery of the jets 15, of the delivery element 5, in axial abutment against the latter, on the opposite side to the obturator disc 11. According to a preferred embodiment of the invention, this atomizer element 20 is defined by a cap which is separate from the casing 2 and mounted externally on the casing 2, coaxially with respect to the latter and in the region of the end 6, axially projecting from the end 6 itself; for example, the cap 20 is provided with snap-engagement fastening means (which are known and not shown) cooperating with corresponding means provided on the casing 2, so as to be able to fix the cap 20 on the latter in a removable manner.

With particular reference to Figure 2, the auxiliary atomization means of each jet 15 provided on the element 20 comprise at least one surface 21 arranged so as to be transversely oblique with respect to the jet of fuel 15, at a predetermined and relatively large distance from the atomization hole 14 with respect to the diameter of the jet 15, such that the surface 21 is struck by the jet 15 at a predetermined point 22; and means for delivering a jet of auxiliary air 23 oriented so as to direct the jet of air 23 against the oblique surface 21, substantially at the point of impact 22 thereon of the corresponding jet of fuel 15. In particular, delivery of the jet of auxiliary air 23 for each jet 15 of fuel is effected by means a respective hole 25 formed so as to pass through the cap 20 in a radial direction, at a predetermined distance in the axial direction from the end 6 of the casing 2.

According to that illustrated in Figure 2, each surface 21 designed to receive the impact of a jet 15 is formed internally in the cap 20, inside a duct 27 for delivering a highly atomized jet 28 of fuel and air; in fact, inside each duct 27 there emerges laterally a corresponding radial hole 25 for a jet of

auxiliary air 23 and the holes 23 are oriented obliquely with respect to the axis of symmetry of the casing 2 and in particular converge towards the latter in the direction of delivery of the fuel; furthermore, each surface 21 is arranged so as to be struck by the jet of fuel 15 with an angle of impact other than 0° and 90° and in particular, between these values.

In the example shown of a twinjet injector, inside the cap 20 and in line with the casing 2 there is provided a substantially cylindrical chamber 30 of predetermined dimensions formed in the atomizer element 20 immediately downstream of the atomizer element 5; the atomization holes 14 emerge inside the chamber 30 and, on the opposite side, there extends a pair of ducts 27 formed so as to pass through the atomizer element 20 and arranged so as to diverge from one another in the delivery direction of the jets 15 of fuel; the ducts 27 are delimited with respect to each other by respective lateral intrados surfaces which define two opposite impact surfaces 22 arranged obliquely with respect to the jets 15 supplied from the atomizer holes 14 of the delivery element 5 and in such a way as to be able to intercept the said jets at the points 22; the radial holes 25 are formed so as to pass on opposite sides through the atomizer element 20, each of them emerging laterally inside a respective duct 27 opposite a respective lateral intrados surface 21 of the latter.

In this way (Figure 2), the jets 15 of fuel are intercepted and re-atomized, being mixed with the jets of air 23, by the static action of the surfaces 21, giving rise to two divergent jets 28 of fuel and air, where the particles of fuel are atomized to dimensions well below 180 microns and even to dimensions of the order of about 50 microns. The auxiliary air necessary for operation of the injector 1 may be taken in a known manner, not illustrated for the sake of simplicity, from the induction manifold of the engine and conveyed into the holes 25 by means of suitable ducts; in the case in question the radial holes 25 are connected on the outside of the atomizer element 20 to a manifold 38 defined by respective bevels or chamfers 39 formed on the external lateral surface of the element 20 in line with the holes 25 for facilitating (inviting) entry of the air into the latter, and by a corresponding annular chamber 40 formed in the case in question inside a seat 41 for the injector 1, in which the latter is mounted in fluid-tight manner by means of a seal 42 mounted on the cap 20 and a second seal 43 mounted around the casing 2, so that the bevels 39 are kept facing the chamber 40; the latter is in turn connected, in a manner not illustrated for the sake of simplicity, via ducts formed in the cylinder head, to the induction manifold of the engine itself.

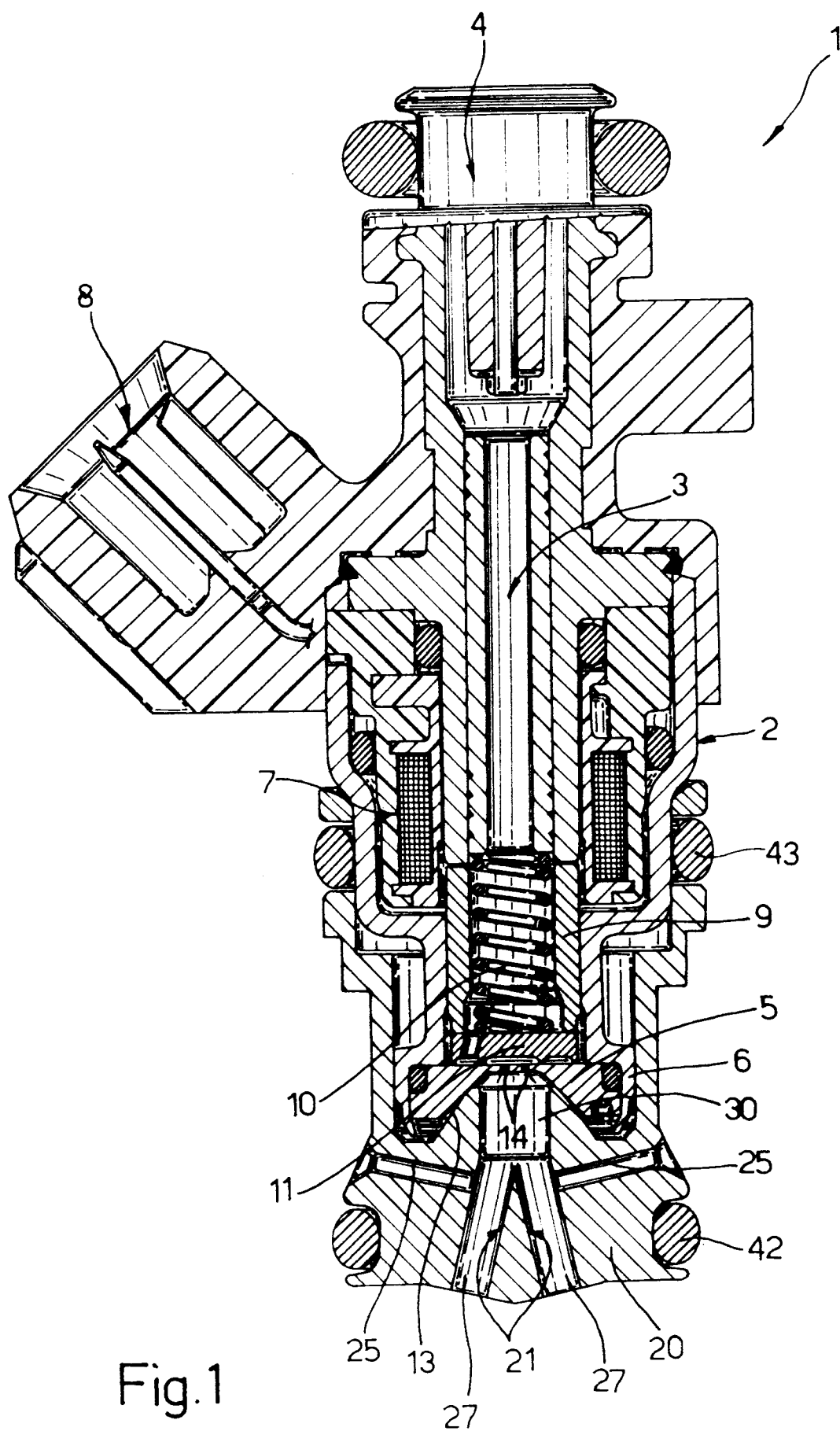
According to a possible variation, not shown for the sake of simplicity, the manifold 38 may on the other hand be formed as one piece with the injector 1, for example inside the cap 20, and be connected to the induction manifold of the engine via a flexible pipe. In any case, the manifold 38 receives during use a flow of auxiliary air of suitable throughput supplied from the induction manifold and directs it inside the holes 25 so as to create the directed jets of air 23 which help form highly atomized jets 28 of fuel which emerge eventually from the injector 1 and are conveyed to the engine via the ducts 27.

Claims

1. Injector with high atomization capacity, in particular for supplying fuel to motor vehicle engines, of the type comprising an electromagnetic actuator, a delivery element provided with at least one atomization hole, and an obturator element operated by the said electromagnetic actuator so as to control the formation of at least one jet of fuel through the said atomization hole, characterized in that it is provided with auxiliary atomization means comprising: at least one surface arranged so as to be transversely oblique with respect to the said jet of fuel, at a predetermined and relatively large distance from the atomization hole with respect to the jet diameter, such that the surface is struck by the jet at a predetermined point; and means for delivering a jet of auxiliary air oriented so as to direct the jet of air against the said oblique surface, substantially at the point of impact thereon of the said jet of fuel.
2. Injector according to Claim 1, comprising a casing inside which the said electromagnetic actuator and the said obturator element are accommodated, the latter being mounted so as to slide parallel to an axis of symmetry of the casing and the casing housing moreover, on its end and in a position facing the obturator element, the said delivery element, characterized in that the said auxiliary atomization means are all contained in a cap removably mounted on the outside of the casing, in the region of and axially projecting from said end of the latter.
3. Injector according to Claim 2, characterized in that the said means for delivering the said jet of auxiliary air consist of at least one hole formed so as to pass through the said cap in the radial direction, at a predetermined distance in the axial direction from the said end of the casing.

4. Injector according to Claim 3, characterized in that the said surface arranged so as to be transversely oblique with respect to the jet of fuel is formed internally in the said cap, inside a delivery duct in which there emerges laterally the said radial hole for the jet of auxiliary air; the latter being oriented obliquely with respect to the axis of symmetry of the casing and the said surface being arranged so as to be struck by the jet of fuel with an angle of impact other than 0° and 90° .
5. Injector according to one of the preceding claims, characterized in that the said delivery element comprises at least one pair of atomization holes, opening of which for a predetermined duration is controlled by an axial sliding movement of the said obturator so as to form at least one pair of fuel jets which are not parallel with one another, said jets being nevertheless oriented in a mainly axial direction with respect to sliding of the obturator; and in that the auxiliary atomization means are formed in an atomizer element arranged immediately downstream of the delivery element, in axial abutment against the latter, and comprise: a chamber of predetermined dimensions which is formed inside the atomizer element immediately downstream of the delivery element and in which the said atomization holes emerge; a pair of ducts formed so as to pass through the atomizer element and arranged so as to diverge from one another in the direction of delivery of the fuel jets, from said chamber and on the opposite side to the delivery element, said ducts being delimited with respect to each other by respective lateral intrados surfaces arranged obliquely with respect to the jets of fuel supplied from the atomizer holes of the delivery element and the said surfaces being formed in a position such they are able to intercept the jets of fuel; and at least one pair of opposite radial holes formed so as to pass through the atomizer element, each of them emerging laterally inside a said duct, opposite the respective said lateral intrados surface of the latter, the said radial holes being connected on the outside of the atomizer element to a manifold receiving a flow of auxiliary air.

55



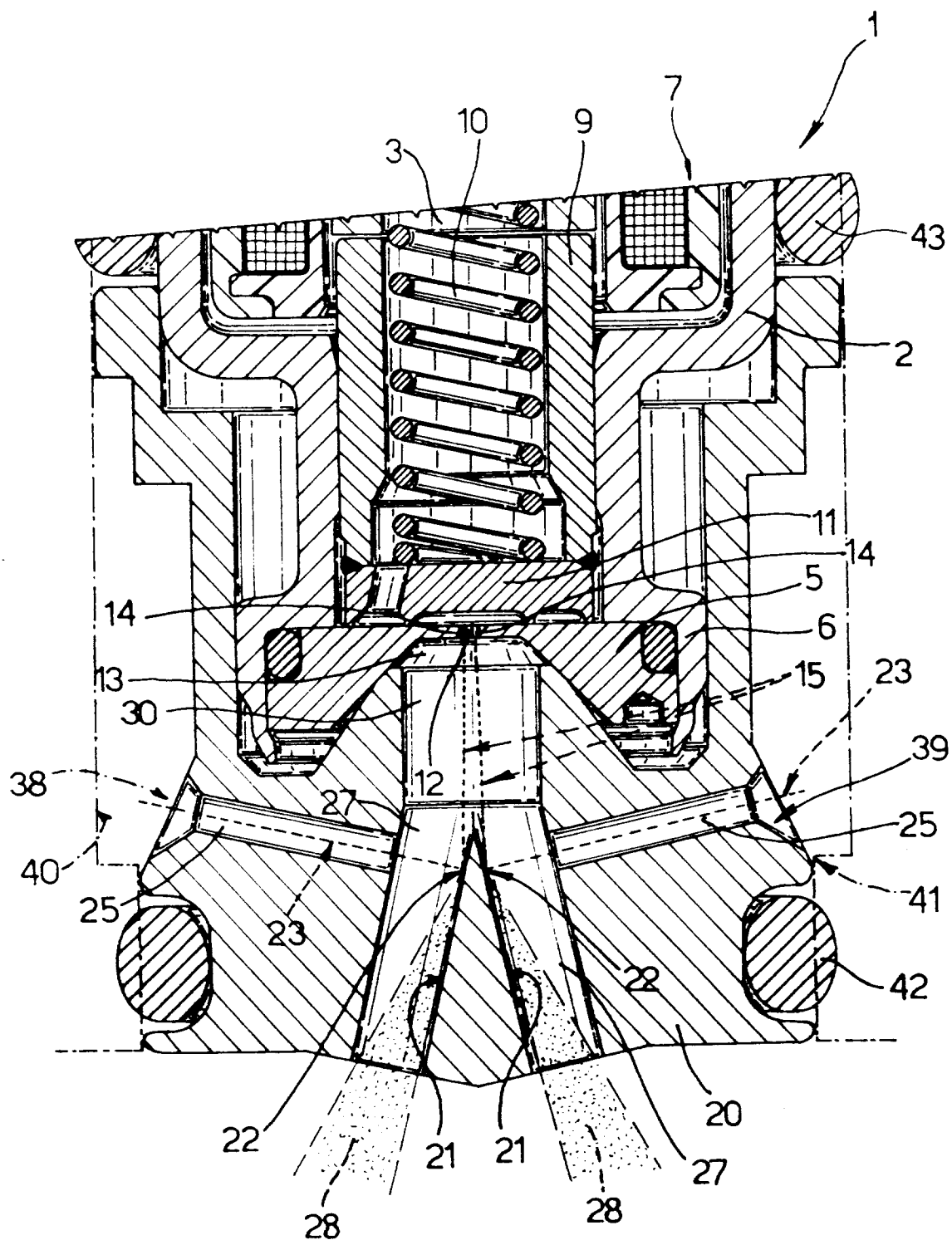


Fig.2



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 94 11 1906

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	US-A-5 224 458 (T. OKADA ET AL.) * column 2, line 56 - column 4, line 53; figures 1,2 * ---	1-5	F02M69/04 F02M69/08
P,X	WO-A-94 02736 (M. NAMIKI ET AL.) Abstract * figure 7 * ---	1-5	
D,X A	DE-A-41 03 918 (AISAN KOGYO K.K.) * column 2, line 24 - column 4, line 54; figures 1,2 * ---	1-4 5	
X	US-A-4 982 716 (K. TAKEDA ET AL.) * column 5, line 9 - column 7, line 66; figures 1-5 * ---	1-4	
A	DE-A-42 09 154 (HITACHI LTD.) * column 14, line 11 - line 32; figure 22 * -----	1-5	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			F02M
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 7 October 1994	Examiner Hakhverdi, M
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	