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I-10121 Torino (IT)(54) **An air-assisted single jet injector.**

(57) An air-assisted single jet injector (1) in which a valve shutter (11) actuated by an electromagnetic actuator (7) controls the formation of jets of fuel through atomisation orifices (15) formed in a delivery element (5) downstream of which an auxiliary atomisation chamber (21) is arranged, defined internally at least in part by a frusto-conical surface (24b) into which open radial holes (25) for the induction of an auxiliary air flow having respective axes perpendicular to the surface (24b).

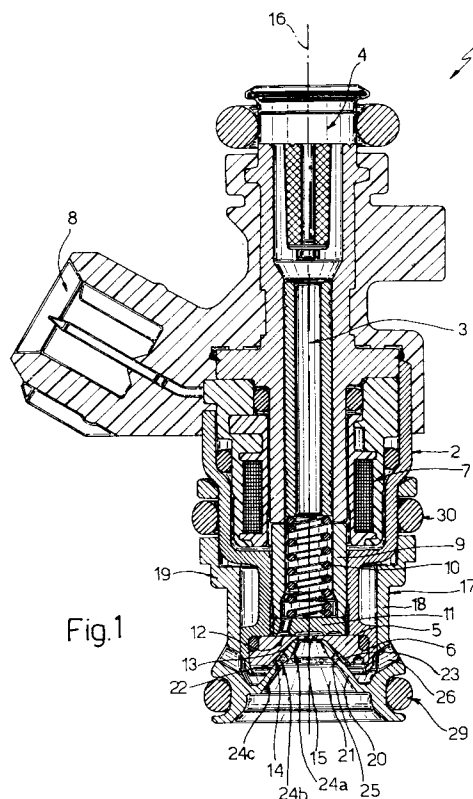


Fig.1

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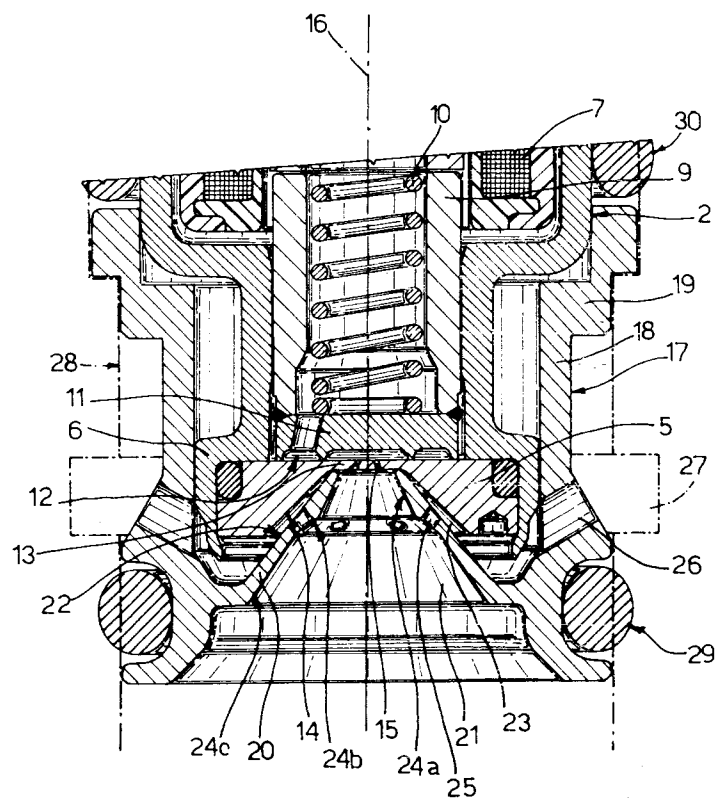


Fig. 2

The present invention relates to an electromagnetically controlled fuel injector, of the air-assisted single jet type, for the fuel supply of a motor vehicle engine.

In particular, the present invention relates to a "Pico" type injector, operable to atomise the fuel by injecting it through a delivery element which can produce a flow through a thin wall.

Electromagnetic fuel injectors for vehicle engines are known in which fuel injection is regulated by an electromagnetic actuator which controls the movement of a valve shutter which controls the formation of jets of fuel through atomisation orifices in a delivery element. By causing the fuel to flow through the orifices, the length of which is far smaller than their respective diameter, aerohydrodynamic effects on the liquid occur to atomise it, reducing it to very small droplets. By decreasing the thickness of the wall of the delivery element to a dimension of the order of tenths of a millimetre, it is possible to obtain droplets having a diameter of 180-200 micrometres. It is difficult to obtain a more forceful atomisation as any further reduction in the thickness of the wall would involve manufacturing problems and problems with clogging and excessive wear of the orifices. Devices are known in the art for improving fuel atomisation, in which the atomised fuel jet is mixed with an auxiliary air flow before being injected into the combustion chamber.

However, the atomisation effect obtained with these injectors is not very powerful and in addition their structure means that they have a rather short working life, since they generally wear quickly.

The object of the present invention is to provide a fuel injector that is free from the disadvantages of the prior art, gives a fine atomisation of the fuel and is easily produced simply by modifying the structure of prior art injectors, adding or replacing a small number of inexpensive parts.

The invention thus provides an injector with a powerful atomisation capacity, in particular for the fuel supply of a motor vehicle engine, of the type including: an electromagnetic actuator; a delivery element with at least one atomisation orifice; a valve shutter controlled by the said electromagnetic actuator to control the formation of at least one jet of fuel through the said atomisation orifice; a casing which is symmetrical about an axis and houses the said electromagnetic actuator, the said delivery element and the said valve shutter; and auxiliary atomisation means disposed immediately downstream of the delivery element and including: a chamber at least partly defined internally by a frusto-conical surface and into which the said atomisation orifice opens; and at least one substantially radial hole opening at one end into the side of the said chamber and communicating at the other

with means for introducing an auxiliary air flow; characterised in that the said substantially radial hole has an axis perpendicular to the said surface of the said chamber.

Further characteristics and advantages of the invention will become apparent from the following description of two non-limitative embodiments with reference to the appended drawings, in which:

Figure 1 is an elevation of a first preferred embodiment of the present invention, sectioned longitudinally along the axis of the injector;

Figure 2 shows, on an enlarged scale and in section, a detail of the injection end of the injector of Figure 1;

Figure 3 shows, on an enlarged scale and in section, a detail of the injection end of a second preferred embodiment of the present invention; and

Figure 4 is a view from below of the injector of Figure 3.

With reference to Figures 1 and 2, a fuel injector, particularly for the fuel supply of a motor vehicle engine, is generally indicated 1 and includes a casing 2 of known type defining internally a fuel supply duct 3 connected to a known attachment element 4 extending outside the casing 2 along the same axis; the duct 3 ends at a fuel delivery element defined by a disc 5 mounted in known manner so as to be fluid-tight and closing the lower end 6 of the casing 2, opposite the attachment element 4 which forms the upper end of the casing 2; the symmetry of this casing 2 is substantially cylindrical meaning that the duct 3, the attachment element 4 and the disc 5 are substantially coaxial.

An electromagnetic actuator of known type is housed in the casing 2, arranged coaxially in a ring round the duct 3 and controlled and supplied by means of a known electrical connector element 8 arranged outside the casing 2, near to and to one side of the attachment element 4. The actuator 7 also includes a ferromagnetic armature 9 operable to be moved axially, against the action of a biasing spring, by the electromagnetic actuator 7 and to which, in the embodiment shown, is welded a valve shutter 11 defined by a metal disc facing and parallel to the disc 5 defining the delivery element. Conveniently, annular projections 12 are formed in the surface of the valve shutter 11 facing the disc 5.

In the non-limitative example illustrated, the delivery element is of the "thin wall" type in that the disc 5 has a circular central portion 13 (Figure 2) which is thinner than the peripheral wall of the disc 5; this circular portion 13 constitutes the base of a frusto-conical cavity 14 formed in the disc 5 on the side opposite the valve shutter 11, that is towards the outside of the casing 2. Six atomising

orifices 15, of known type, relatively shallow in relation to their diameter, are formed in the thin wall defined by the portion 13 and their opening, for a predetermined time, is controlled by an axially sliding movement of the valve shutter 11, controlled in turn by the movement of the armature 9. Although six atomisation orifices 15 are provided in the embodiment described and illustrated, any number whatsoever may be employed although this would preferably be from four to six. When the actuator 7 is de-energised, the valve shutter 11 is held in fluid-tight contact against the disc 5 by the spring 10, thus hydraulically isolating the orifices 15 from the duct 3; on the other hand when the actuator 7 is energised, the valve shutter 11 is moved away from contact with the disc 5, putting the orifices 15 in hydraulic communication with the duct 3, through which fuel is fed under pressure through the attachment element 4.

In this way, by energising the actuator 7 for a predetermined period of time, a jet of atomised fuel is formed by each orifice 15 and projected through the lower end 6 of the casing 2; by using six orifices 15 (Figure 4) arranged symmetrically about an axis of symmetry 16 of the injector 1 with their axes at a small predetermined angle to the aforesaid axis of symmetry, six jets of fuel are formed which are slightly divergent but directed along a predominantly axial direction relative to the direction of movement of the valve shutter 11.

According to the present invention, the injector 1 also includes an auxiliary atomisation element arranged immediately downstream of the delivery element in the sense of delivery of the fuel jets, fitted axially over it from the opposite side from the valve shutter 11.

According to the preferred embodiments of the invention described and illustrated here, this auxiliary atomisation element is defined by a cap 17 independent of but mounted on the outside of the casing 2 and projecting from the end 6 thereof. For example, the cap 17 may be provided with snap engagement means (known and therefore not shown) cooperating with corresponding means on the casing 2, so it may be removably fixed thereto.

With particular reference to Figure 2, the cap 17 includes a tubular portion 18 with a circular appendage 19 operable to fix the cap to the casing 2.

The cap 17 has a frusto-conical wall 20 defining a central delivery duct constituted by a chamber 21 of predetermined dimensions; the free end of the frusto-conical wall 20 is inserted into the cavity 14 of the disc 5, as shown in Figure 2; the wall 20 is defined externally by a conical surface 22 having a smaller cone angle than the cavity 14 so that when the cap 17 is mounted on the casing 2 the free end of the wall 20 forms a fluid-tight seal

against the central portion 13 of the disc 5, and an annular cavity 23 is formed between the conical surface 22 of this wall and that of the cavity 14.

The wall 20 is defined internally by a succession of different frusto-conical surfaces 24a, 24b, 24c.

Radial holes 25 passing through the wall 20 to deliver an auxiliary air flow open laterally into the chamber 21. In the preferred embodiment described here, there are six radial holes 25 arranged symmetrically in a ring about the axis 16 of the casing 2 at a predetermined axial distance from the delivery element. The radial holes 25 are orientated so as to direct respective jets of auxiliary air towards a point of interception of the fuel jets, this also being situated at a predetermined axial distance from the delivery element. In particular, the radial holes 25 are inclined obliquely to the axis of symmetry 16 of the casing 2 so as to be convergent towards this casing, in the fuel delivery direction. The respective axes of the radial holes 25 are perpendicular to the surface 24b of the chamber 21 so that the line of intersection between this surface 24b and the cylindrical surface defining each hole 25 is substantially circular. The radial holes 25, passing through the auxiliary atomiser element have one end opening laterally into the chamber 21 and the opposite end in communication with the annular cavity 23 defined between the disc 5 and the cap 17.

The annular cavity 23 is in communication with ducts 26 which extend substantially-radially through the cap 17 and end, outside of the injector 1, in an auxiliary air manifold contained in a seat 28 of the engine block into which the injector 1 is fitted in a fluid tight manner by a first interposed seal 29 (mounted round the cap 17) and a second seal 30 (mounted round the casing 2).

The manifold 27 is connected in turn, in a manner not illustrated for the sake of simplicity, to the induction manifold of the engine by means of ducts formed in the cylinder head.

In use, the flow of auxiliary air, drawn from the manifold 27 and conveyed to the annular cavity 23 by the ducts 26, is introduced into the chamber 21 through the radial ducts 25 so as to intercept the fuel jets in a predetermined manner, further atomising them so that the fuel droplets are reduced to characteristic dimensions far smaller than those which can be achieved by ordinary atomisation through a thin wall.

The atomising action has been found to be particularly effective if a particular geometric configuration is obtained by:

- conforming the inner surface of the wall 20 of the cap 17, into which the holes 25 open to a conical surface (the surface 24b);

- disposing the axes of these holes 25 perpendicular to this conical surface, that is perpendicular to the generatrices of the surface itself.

Figures 3 and 4 show a second preferred embodiment of the present invention, of which only the characterising elements which distinguish it from the first embodiment will be explained here, it being understood that in the description which follows, reference numerals which have already been used are employed to indicate similar and corresponding parts or components which serve the same purpose.

With particular reference to Figure 3, it is easy to see that in the second preferred embodiment of the present invention the annular cavity 23 is in direct communication with a chamber 23a, situated in an interstitial space substantially between the tubular portion 18 and the appendage 19 of the cap 17 and the casing 2. In particular, the chamber 23a is defined between the inner surface of the tubular portion 18 of the cap 17 and the outer surface of the casing 2. The chamber 23a communicates through a duct 31 with the induction manifold of the engine.

The duct 31 thus has an end opening in the side of the chamber 23a and an opposite end provided with typical engagement means 32 (Figure 4) for connecting it to a duct, not shown, such as a flexible hose leading from the induction manifold of the engine.

In any case, the operation of this second preferred embodiment is substantially the same as that described for the first embodiment. In this case as well, a flow of auxiliary air is introduced into the chamber 21 through the radial holes 25 so as finely to atomise the fuel jets directed towards the engine from the delivery element.

From the above it is clear that the injector forming the subject of the present invention is capable of causing very fine atomisation of the fuel, without the central portion 13 of the disc 5 needing to be so thin that it is difficult to manufacture and without needing to reduce the atomisation orifices 15 to dimensions that would make them liable to clogging in use. Furthermore, no component of the injector is subjected to conditions which would cause excessive wear.

The possibility of the auxiliary atomisation means being carried by a cap removably fixed to the outside of the casing means that in one simple operation a conventional "Pico" injector may be transformed into an injector according to the present invention without any need for modifications, thus considerably increasing performance for a small increase in cost.

It is clear that modifications and variations may be made to the device described above without

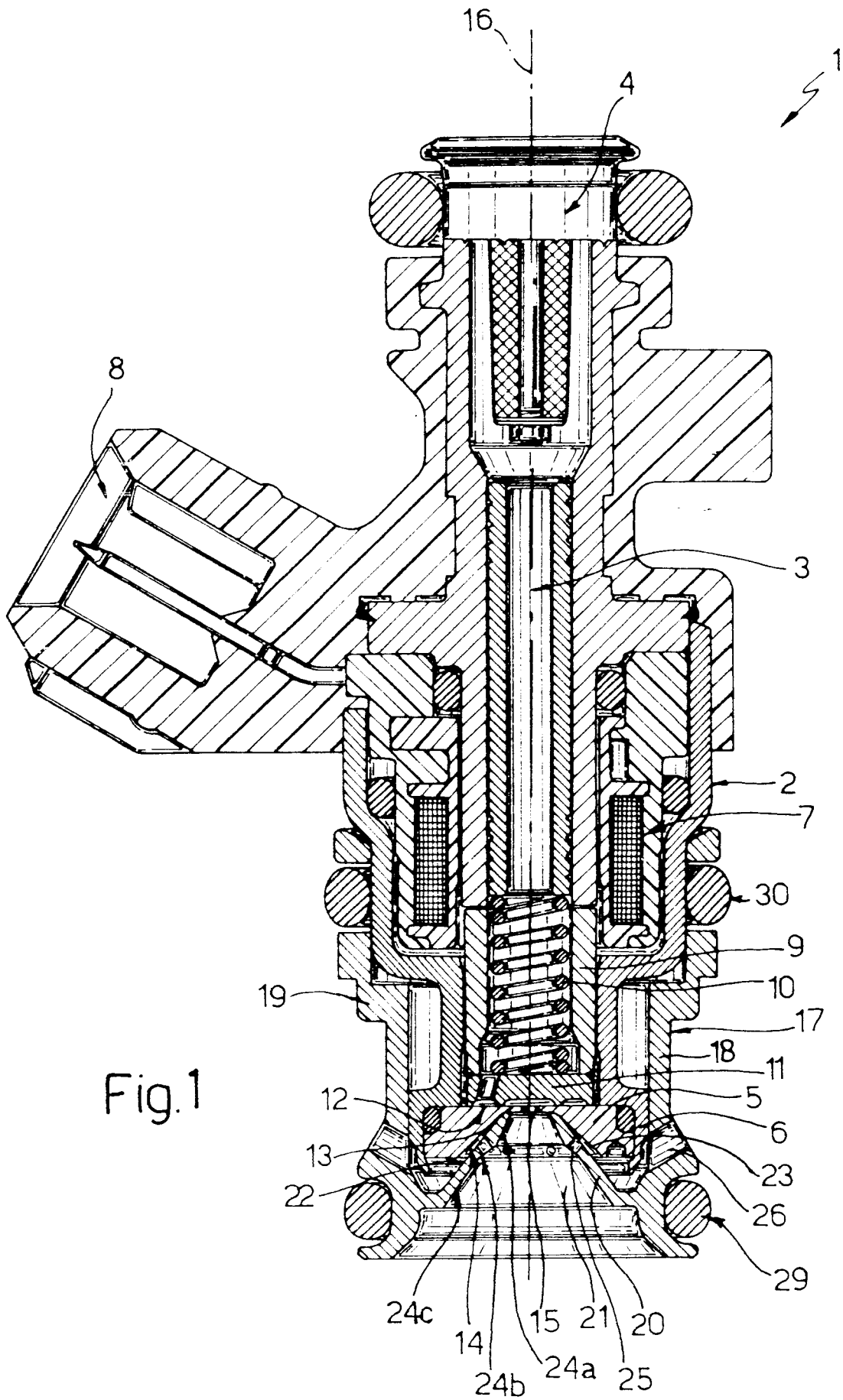
departing thereby from the protective scope of the present invention.

Claims

1. An injector (1) having a high atomisation capacity, in particular for the fuel supply of a motor vehicle engine, of the type including: an electromagnetic actuator (7); a delivery element (5) with at least one atomisation orifice (15); a valve shutter (11) controlled by the said electromagnetic actuator (7) to control the formation of at least one jet of fuel through the said atomisation orifice (15); a casing (2) which is symmetrical about an axis (16) and houses the said electromagnetic actuator (7), the said delivery element (5) and the said valve shutter (11); and auxiliary atomisation means (17) arranged immediately downstream of the delivery element (5) and including: a chamber (21) at least partly defined internally by a frusto-conical surface (24b) and into which the said atomisation orifice (15) opens; and at least one substantially radial hole (25) opening at one end into the side of the chamber (21) and communicating at the other end with means for introducing an auxiliary air flow; characterised in that the said substantially radial hole (25) has an axis perpendicular to the said surface (24b) of the said chamber (21).
2. An injector (1) according to Claim 1, characterised in that it includes a plurality of atomisation orifices (15) arranged in a predetermined configuration about the said axis of symmetry (16) of the said casing (2), and in that it includes the same number of substantially radial holes (25) as atomisation orifices (15), the said substantially radial holes (25) being arranged about the said axis of symmetry (16) in the same configuration in which the said atomisation orifices (15) are arranged about this axis (16).
3. An injector (1) according to Claim 2, characterised in that there are six said atomisation orifices (15) operable to produce respective jets of fuel having a predominantly axial direction which is slightly divergent from the said axis of symmetry (16) of the said casing (2) in the direction of delivery of the fuel.
4. An injector (1) according to Claim 2 or Claim 3, characterised in that the said substantially radial holes (25) are orientated so as to direct a respective jet of auxiliary air towards a point of interception of the said jet of fuel situated at a predetermined distance from the said atomisa-

tion orifices (15).

5. An injector (1) according to any one of Claims 2, 3 or 4, characterised in that the said substantially radial holes (25) are inclined with respect to the said axis of symmetry (16) of the said casing (2) and are convergent therein in the direction of delivery of the fuel. 5
6. An injector (1) according to any one of the preceding Claims, in which the said valve shutter (11) is slidably mounted parallel to the said axis of symmetry (16) of the said casing (2) and the said casing (2) supports at its lower end (6) the said delivery element (5) in a position facing the said valve shutter (11), characterised in that the said auxiliary atomisation means (17) are carried on a cap (17) removably fixed to the outside of the said casing (2), projecting axially from the lower end (6) thereof. 10 15 20
7. An injector (1) according to Claim 6, in which the said delivery element comprises a disc (5) fixed to the said casing (2) and having a central portion (13) in which the said atomisation orifices (15) are formed and a cavity (14), downstream of the said orifices (15), defined by a first conical surface, characterised in that the said cap (17) includes a tubular portion (18) sealably fixed to a portion of the external surface of the said casing (2) and a frusto-conical wall (20) which can be inserted into the said cavity (14) of the said disc (5) so as to form an air-tight seal between the said wall (20) and the surface of the said cavity (14), the said frusto-conical wall (20) being defined internally by at least one second conical surface and externally by a third conical surface (22) having a smaller cone angle than the said first conical surface so as to define between the said first and third conical surfaces an annular chamber (23) of predetermined dimensions into which flows the auxiliary air, the said substantially radial holes (25) being formed in the said frusto-conical wall (20) to put the said annular chamber (23) in communication with the said chamber (21). 25 30 35 40 45
8. An injector (1) according to Claim 7, characterised in that the said cap (17) includes a series of substantially radial holes (25) formed in the said tubular portion (18) to put the annular chamber (23) in communication with an auxiliary air manifold (27), formed near a seat (28) in the engine block incorporating the injector (1) and in communication with the induction manifold of the engine. 50 55
9. An injector (1) according to Claim 7 or Claim 8, characterised in that the said wall (20) of the said cap (17) is defined internally by a plurality of different conical surfaces (24a, 24b, 24c), the said substantially radial holes (25) opening into one (24) of the said plurality of surfaces.



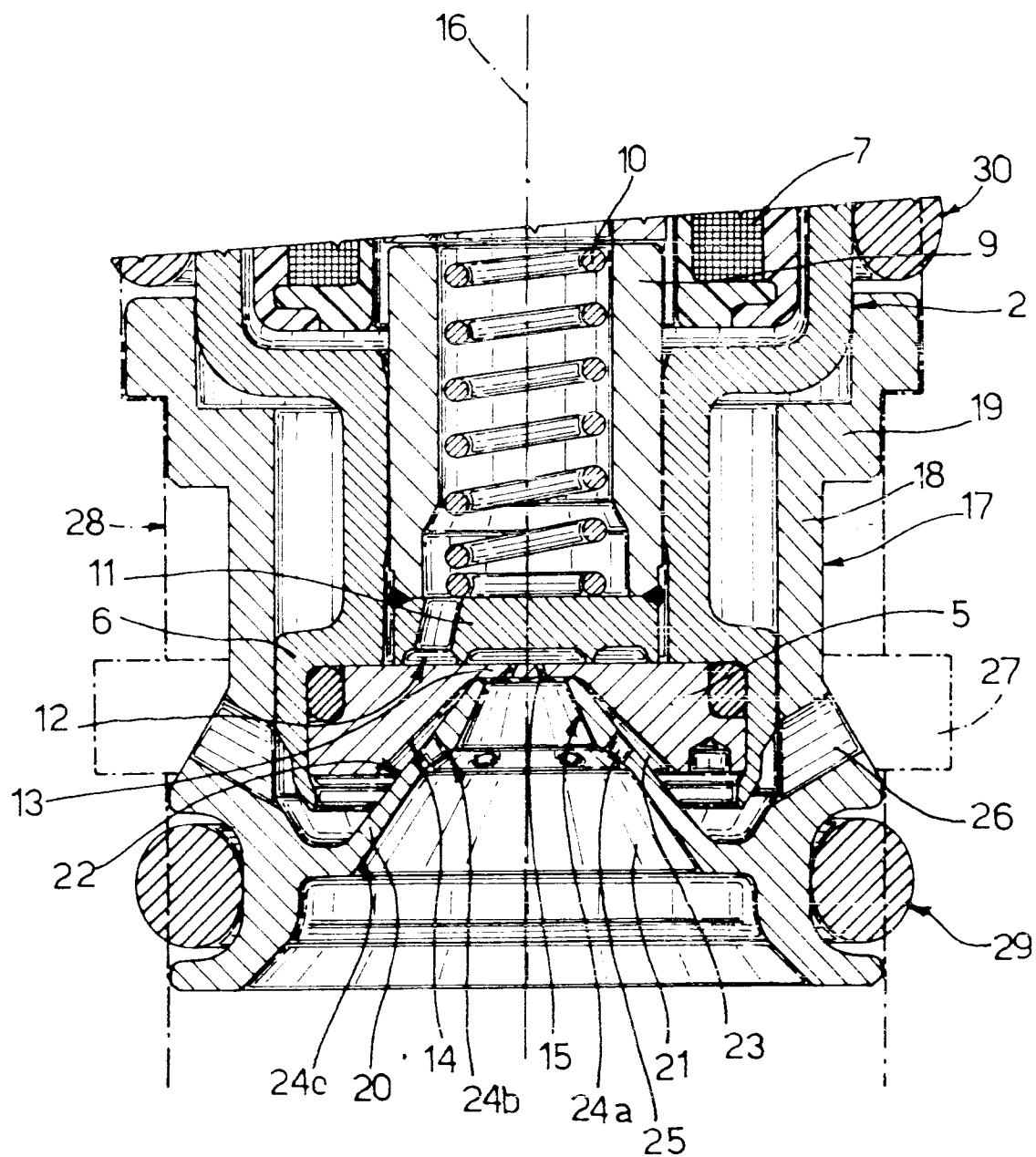
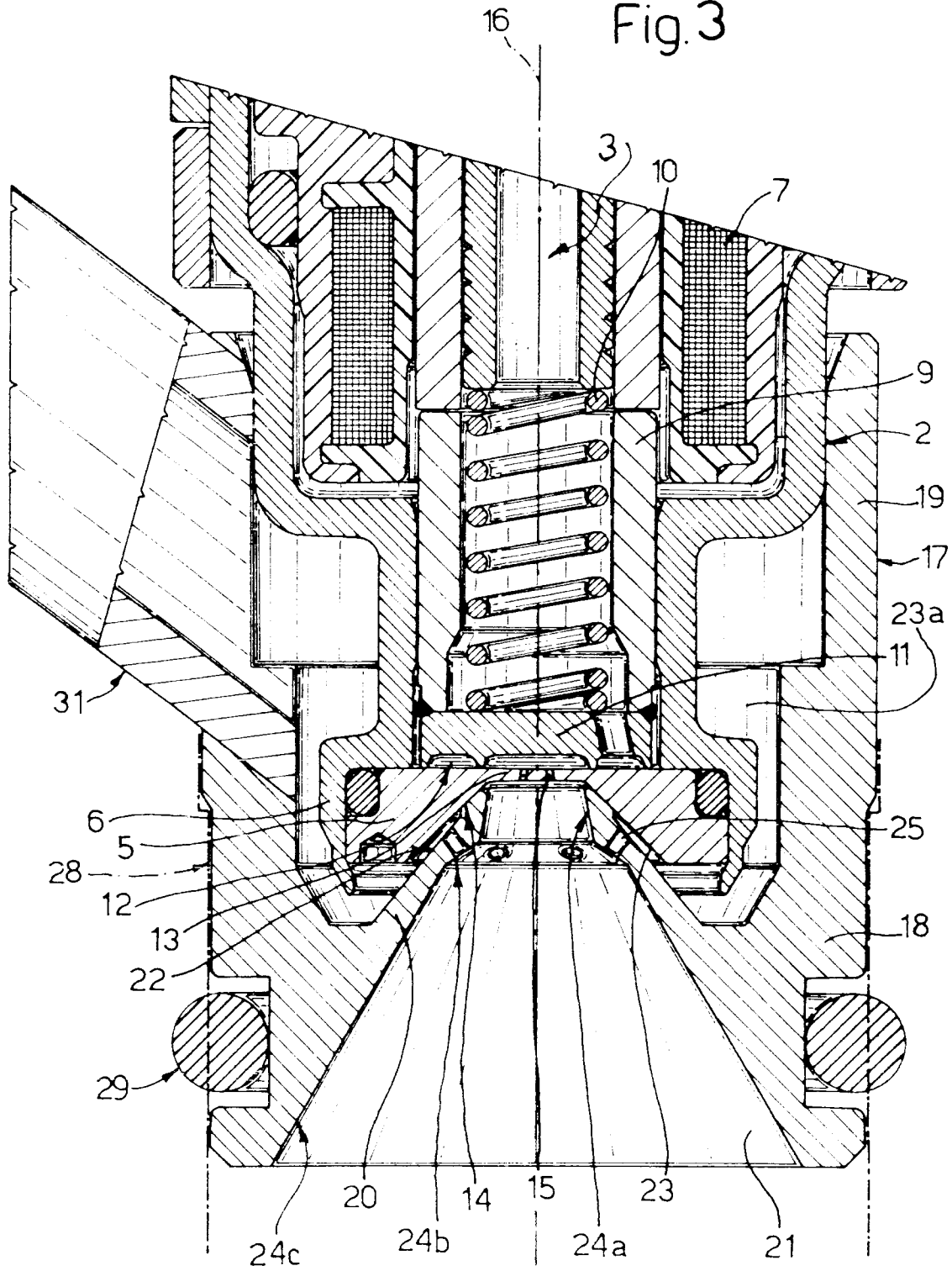
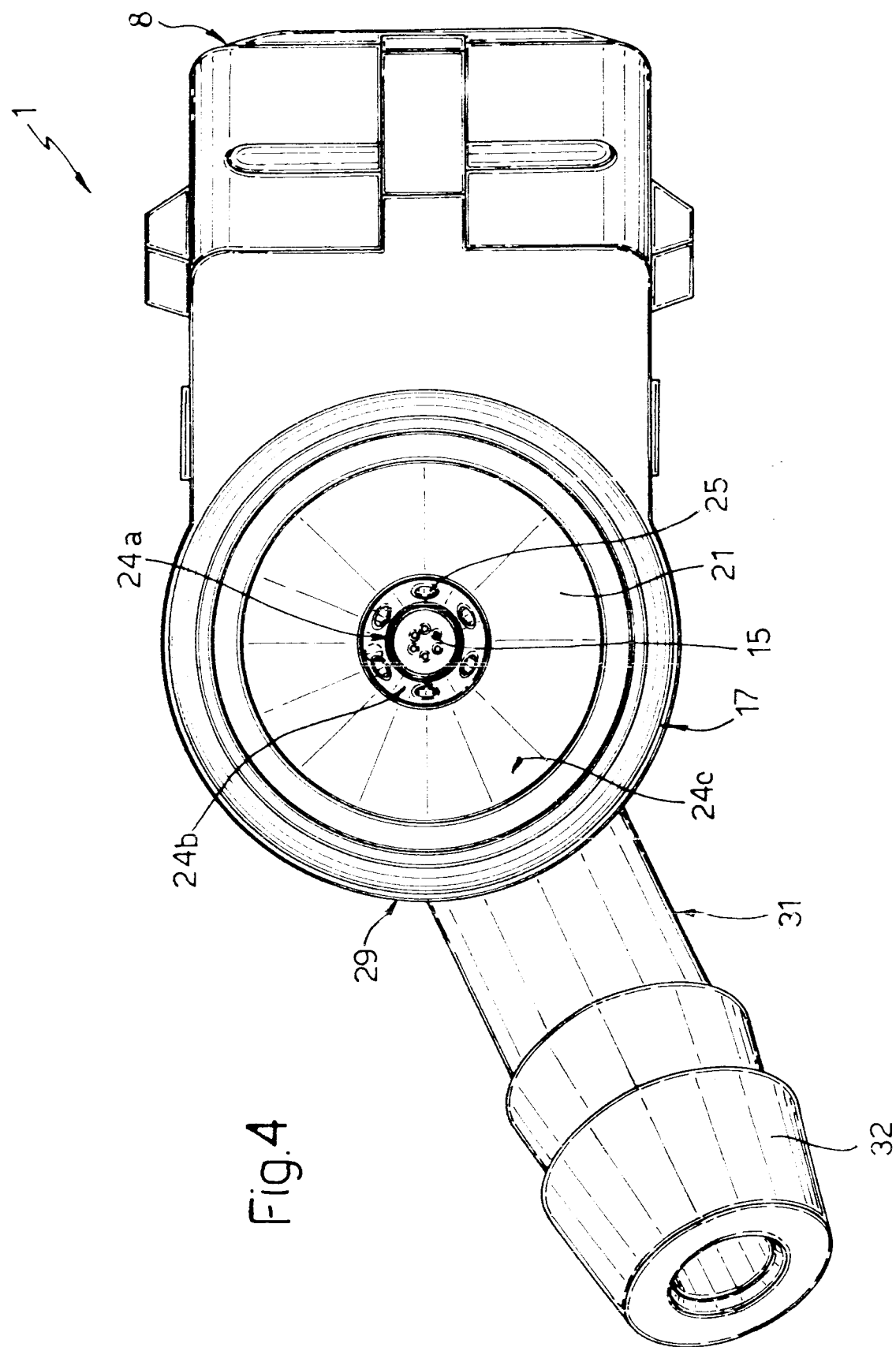


Fig. 2

Fig.3







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EUROPEAN SEARCH REPORT

Application Number
EP 94 11 6846

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	EP-A-0 480 329 (COLTEC INDUSTRIES)	1	F02M69/04
Y	* column 7, line 17 - column 10, line 52; figures 1-3 *	2,4,5	F02M69/08
A	---	6	F02M51/06
Y	PATENT ABSTRACTS OF JAPAN vol. 14, no. 60 (M-931) (4003) 5 February 1990 & JP-A-01 285 657 (JAPAN ELECTRON CONTROL SYST) 16 November 1989 * abstract *	2,4,5	F02M61/18
A	---		
A	DE-A-41 12 853 (BOSCH) * column 2, line 7 - line 58; figure 1 *	1,6,7	
A	---		
A	DE-A-41 19 206 (NISSAN) ---		
A	EP-A-0 515 810 (BOSCH) -----		
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			F02M
Place of search		Date of completion of the search	Examiner
THE HAGUE		23 January 1995	Sideris, M
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