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(54) **A fuel manifold preferably of plastics material adapted to supply fuel to the injectors of an internal combustion engine fuel injection device.**

(57) The manifold is formed by a first tubular element (5) adapted to define the casing of the manifold which is provided with a fuel inlet connector (7) and a fuel outlet connector (8) and an attachment flange (9) for a pressure regulator (1) adapted to maintain substantially constant the pressure within the interior of the manifold; the manifold further includes a second tubular element (12) disposed within the interior of the first, one end (13) of which is adapted to be connected to a discharge connector (4) from the pressure regulator and a second end (14) of which is adapted to be connected to the outlet connector (8) of the first tubular element; the first and the second tubular element define an annular duct (15) lying between the outer surface of the second and the inner surface of the first element and adapted to supply fuel to the seats of the fuel injectors which are formed on the first element, whilst the second tubular element defines within its interior a discharge duct (18) for fuel from the pressure regulator.

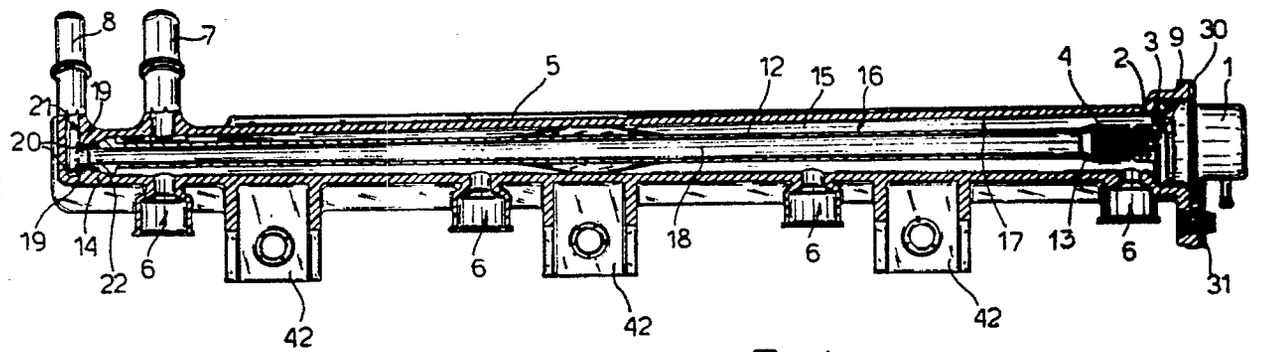

Fig.1

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A FUEL MANIFOLD PREFERABLY OF PLASTICS MATERIAL ADAPTED TO SUPPLY FUEL TO THE INJECTORS OF AN INTERNAL COMBUSTION ENGINE FUEL INJECTION DEVICE

The present invention relates to a fuel manifold utilised in association with fuel supply devices for an internal combustion engine, of the type including electromagnetically actuated fuel injection valves.

As is known, devices of this type normally include a manifold of tubular form which is provided with a plurality of seats for the fuel injection valves and a fuel inlet connection connected to a fuel pipe. Further, such a manifold is normally provided with a further connector which is connected via a suitable pipe to a pressure regulator the function of which is to maintain the fuel pressure in the manifold substantially constant. When this pressure exceeds a predetermined value a part of the fuel is discharged from the interior of the manifold towards a discharge opening with which the pressure regulator is provided, in such a way as appropriately to reduce the pressure within the manifold.

The pressure regulator is therefore provided with a fuel inlet connector adapted to be connected to the manifold outlet connector as indicated above, and also with an outlet connector which is adapted to be connected, via a further pipe, to the fuel reservoir.

Fuel manifolds of the type briefly described have several disadvantages. First of all, they are the cause of a rather high pressure drop because of the length of the ducts which connect the manifold to the pressure regulator and because of the form and type of connections which are necessary to achieve the connections themselves; these pressure drops detrimentally affect the operation of the fuel injection valves.

Moreover, it is possible also for leakages to occur in the region where the manifold is connected to the pressure regulator and to the various pipe sections, therefore rendering the supply device of low reliability.

Finally, it has a rather complex constructional arrangement and large dimensions which make it unsuitable for certain applications; in fact, the various components of the device, and in particular the manifold and the pressure regulator, must be separately connected to the engine block and these must be connected together hydraulically by means of the first-mentioned pipe sections.

The object of the present invention is that of providing a pressure regulator of the type first indicated, by means of which it is possible to eliminate the disadvantages which have been described and which, therefore, will not experience a substantial pressure drop in the fuel passage, and to completely eliminate the regions in which leakage could take place, and give rise to a very compact constructional arrangement adapted therefore to be utilised in applications of any type.

These objects are achieved by means of a fuel manifold adapted to supply fuel to the injectors of a fuel injection device of an internal combustion engine, the said device including a pressure regulator which is adapted to maintain the fuel pressure supplied to the said injectors substantially constant and which is provided with a bottom wall in which there is formed a fuel inlet opening and from which projects a fuel discharge connector, characterised by the fact that it comprises:

a first tubular element adapted to define the manifold casing, which is provided with a plurality of seats for housing the said injectors, a fuel inlet connector, a fuel outlet connector and an attachment flange for the said pressure regulator;

a second tubular element disposed within the first, a first end of which is adapted to be connected to the said discharge connector of the said pressure regulator and a second end of which is adapted to be connected to the said outlet connector of the said first tubular element;

the said first and second tubular elements defining an annular duct lying between the outer surface of the second and the inner surface of the first element and adapted to supply fuel to the said seats for the said injectors, and the said first tubular element defining within its interior a fuel discharge duct from the said pressure regulator.

For a better understanding of the structure of the manifold of the present invention a more detailed description of it will now be given by way of example with reference to the attached drawings, in which:

Figure 1 is a longitudinal section of the manifold of the invention;

Figure 2 is a detail on an enlarged scale of the section of Figure 1;

Figure 3 is a section of the detail of Figure 2 taken on the line III-III;

Figure 4 is another detail of the section of the regulator of Figure 1;

Figure 5 is a partially sectioned side view of a first tubular element which forms part of the regulator of the invention;

Figure 6 is a section of the tubular element of Figure 5 taken on the line III-III;

Figure 7 is another section of the tubular element of Figure 5 taken on the line VII-VII;

Figure 8 is a partially sectioned side view of a second tubular element which forms part of the

device of the invention;

Figure 9 is a detail on an enlarged scale of the tubular element of Figure 8;

Figure 10 is a side view from the right hand end of the element of Figure 8;

Figure 11 is a longitudinal section of the end section of the element of Figure 8;

Figure 12 is a view from the left hand end of the element of Figure 8;

Figure 13 is an end view of the manifold of Figure 1; and

Figure 14 is a fork which forms part of the manifold of the invention.

The fuel manifold of the invention can form part of a fuel supply device for an internal combustion engine of the type in which the fuel is supplied by means of electromagnetically actuated injectors. This device includes a pressure regulator which is adapted to maintain substantially constant the fuel pressure supplied to injectors of known type; conveniently this pressure regulator is of the type such as that shown in Figure 1, in which it has been indicated with the reference numeral 1, comprising a bottom wall 2 in which is formed a fuel inlet opening 3 and from which projects a fuel discharge connector 4. A pressure regulator of this type is described in Italian Patent application No 68 054-A/88 filed 25 November 1988 by the same applicant and entitled: "A pressure regulator device for the fuel circuit of a supply installation of an internal combustion engine".

The fuel manifold of the invention substantially comprises a first tubular element 5 adapted to define the manifold casing which is provided with a plurality of seats 6 for housing fuel injection valves (not shown). This tubular element is further provided with an inlet connector 7 and an outlet connector 8 for the fuel, as well as an attachment flange 9 for the pressure regulator 1. The manifold further includes a second tubular element 12 disposed within the first, one end 13 of which is adapted to be connected to the discharge connector 4 of the pressure regulator 1 and the other end 14 of which is adapted to be connected to the outlet connector 8 of the tubular element 5.

The two tubular elements 5 and 12 therefore define an annular duct 15 which lies between the outer surface 16 of the element 12 and the inner surface 17 of the element 5 and which is arranged to supply fuel to the seats 6 of the injection valves; the tubular element 12 defines within it a fuel discharge duct 18 for fuel from the pressure regulator 1 being discharged.

According to the invention the end 14 of the tubular element 12 is sealingly snap-engaged to the outlet connector 8 of the tubular element 5. For this purpose the tubular element 12 includes at least one resiliently deformable tongue 19 (Figure 2), preferably a pair of such tongues, which project from the end 14 and is or are provided with a stop tooth 20 adapted to snap against a corresponding shoulder 21. This end conveniently includes a conical section 22 adapted to cooperate with a corresponding seat 23 of the tubular element 5, as well as a cylindrical section 24 which lies between the tongues 19 and the conical section 22 and is adapted to couple into a corresponding hole 25 of the element 5; a sealing ring 26 is interposed between the cylindrical section 24 and a corresponding annular seat formed on the tubular element 5.

The fuel inlet connector 7 and fuel outlet connector 8 project laterally from one end of the element 5 as is clearly seen in the drawings; in particular the outlet connector 8 is provided with a opening 27 which opens into the hole 25 in which the cylindrical section 24 of the element 12 is coupled; moreover the teeth 20 of the resiliently deformable tongues 19 are adapted to snap against the surface 21 of the hole itself, which therefore constitutes the shoulder for the said teeth.

Each tooth 20, as can be seen from Figure 3, is delimited laterally and above by curved surfaces which are adapted to cooperate with the surface 21 of the opening 27 of the outlet connector 8, in such a way that when the tubular element 12 is made to rotate axially with respect to the tubular element 5 the teeth 20 are released from the surface 21 by deforming the tongues 19 resiliently to allow the tubular element 12 to be separated from the other element 5: the position in which the teeth 20 are found at the end of this operation is shown in broken outline in Figure 3. Conveniently the tubular element 12 is provided with grip means, generally indicated 28 (Figure 4) which can be constituted by simply radial teeth formed on the end 13 of the element 12 and which are adapted to control the rotation of the element to cause the release of the teeth 20 in the manner described above. The pressure regulator, as is clearly seen in Figure 4, includes an attachment collar 30 adapted to contact the flange 9 of the tubular element 5; to connect the pressure regulator to the tubular element 5 a fork 31 is utilised comprising a pair of arms 32 (Figure 14) of substantially C-shape and adapted to engage the collar 9 that is clearly seen in Figure 4; the fork is further provided with a pair of teeth projecting radially inwardly of the fork, indicated 33 (Figure 14), which are positioned in such a way as to engage on the inner surface 34 of the flange 9 when the fork contacts the collar 30. This fork is then provided with at least one hole 35 for a fixing screw 36 to fix the fork to the flange and consequently to lock the pressure regulator 1 with respect to the tubular element 5.

The end 14 of the tubular element 12 has a

cylindrical seat 37 (Figure 4) adapted to house the end of the discharge connector 4 of the pressure regulator 1. Further, the tubular element 5 has a cylindrical seat 38 formed close to the flange 9 and between this and the casing 39 of the pressure regulator there is interposed a sealing ring 14. Similarly, between the discharge connector 4 and the seat 37 there is interposed another sealing ring 41.

The tubular element 5 then has an attachment flange 42 provided with holes adapted to allow the connection of the manifold to the engine block.

The two tubular elements 5 and 12 are conveniently made of a synthetic material, preferably a thermoplastic material by utilising the usual forming technology for injection moulding. Although each of these elements is formed with the members and parts which have been described above it has a very simple form and requires for its construction a mould of non-complex structure; in particular, because of the shape and arrangement of the various parts and the manner with which these are connected together, the tubular elements 5 and 12 have no over square corners and therefore can easily be produced by injection moulding at high production speeds and low costs.

The manifold described operates in the same manner as usual in manifolds of the same type; the fuel under pressure is supplied from the inlet connector 7 and therefore to the interior of the annular duct 15 defined between the tubular element 12 and the tubular element 5; from this duct fuel is supplied directly to the injection valve seats 6. Simultaneously the fuel from the duct 15 passes through the hole 3 in the bottom wall 2 of the pressure regulator 1 to the interior of the regulator itself: when the fuel pressure within the duct 15 exceeds a predetermined value a part of this fuel is discharged, in a known way, from the pressure regulator through the discharge connector 4 into the discharge duct 18 defined within the tubular element 12 and by this discharge duct, through the discharge connector 8.

As is seen, the manifold of the invention has a very simple structure, is compact and of small dimensions and lends itself therefore to be utilised in association with a fuel supply device intended for any type of application. The pressure drop which occurs during movement of fuel within the manifold itself is very low because of the short length of the various duct sections which connect the members of the regulator itself and because of the form of these ducts: consequently the speed of response of the injection valves which are supplied by the manifold is very high. Further, the manifold has a very high reliability because the risk of leakages between the various parts of the manifold is avoided: in fact, the joints formed between the various parts are very secure and have a perfect seal.

It is apparent that the shape and arrangement of the various parts of the manifold of the invention which has been described can have modifications and variations introduced thereto without departing from the ambit of the invention.

Claims

1. A fuel manifold adapted to supply fuel to the injectors of a fuel injection device of an internal combustion engine, the said device including a pressure regulator (1) which is adapted to maintain substantially constant the fuel pressure supplied to the said fuel injectors and which is provided with a bottom wall (2) in which is formed a fuel inlet (3) and from which projects a fuel discharge connector 4 for discharging fuel from the manifold itself, characterised by the fact that it comprises:
a first tubular element (5) adapted to define the manifold casing, which is provided with a plurality of seats (6) for housing the said fuel injectors, a fuel inlet connector (7) and a fuel outlet connector (8) and an attachment flange (9) for the said pressure regulator;
a second tubular element (12) disposed within the first and one end (13) of which is adapted to be connected to the said discharge connector (4) of the said pressure regulator and a second end (14) of which is adapted to be connected to the said fuel outlet connector (4) of the said first tubular element;
the said first and second tubular elements (5, 12) defining an annular duct (15) lying between the outer surface (16) of the second and the inner surface (17) of the first element and adapted to supply fuel to the said seats (6) for the said fuel injectors, and the said second tubular element (12) defining within its interior a fuel discharge duct (18) from the said pressure regulator.

2. A manifold according to Claim 1, characterised by the fact that the said first (5) and second (12) tubular elements are made of plastics material.

3. A manifold according to Claim 1, characterised by the fact that the said second end (14) of the said second tubular element (12) is sealingly connected and snap-engaged to the said outlet connector (8) of the said first tubular element (5).

4. A manifold according to Claim 3, characterised by the fact that the said second end (14) of the said second tubular element (12) includes at least one resiliently deformable tongue (19) projecting axially from the said second end (14) and provided with a stop tooth (20) adapted to snap-engage against a corresponding shoulder (21) of the said first tubular element (5).

5. A manifold according to Claim 3 or Claim 4, characterised by the fact that the said second end (14) of the said second tubular element includes a conical section (22) adapted to cooperate with a corresponding conical seat of the said first tubular element (5) and a cylindrical section (24) lying between the said tongue (19) and the said conical section (22) and adapted to engage with a corresponding hole (25) of the said first tubular element, a sealing ring (26) being interposed between the said cylindrical section (24) and a corresponding annular seat of the said first tubular element.

6. A manifold according to any preceding Claim, characterised by the fact that the said fuel inlet connector (7) and fuel outlet connector (8) of the said first tubular element (5) project laterally from one end of the element itself, the said outlet connector (8) being provided with an outlet opening (27) which opens into the said opening (25) of the said first tubular element in which the said cylindrical section of the said second tubular element is coupled, and the said tooth (20) of the said resiliently deformable tongue (19) being adapted to snap-engage against the surface (21) of the said outlet opening (27) of the said outlet connector.

7. A manifold according to Claim 6, characterised by the fact that each of the said teeth (20) is delimited laterally and above by curved surfaces adapted to cooperate with the said surface (27) of the said outlet opening of the said outlet connector, in such a way that when this is caused to turn axially with respect to the said first tubular element (5) the said teeth (20) are released from the surface of the outlet opening (27) by deforming the said tongues (19) resiliently to allow the second tubular element (12) to be separated from the first five.

8. A manifold according to Claim 7, characterised by the fact that the said second tubular element (12) is provided with grip means (28) formed on the said first end (13) and adapted to control rotation of the element to cause release of the said teeth (20) from the surface of the said outlet opening (27) of the outlet connector of the first tubular element.

9. A manifold according to any preceding Claim, in which the said pressure regulator (1) includes an attachment collar (30) adapted to engage on the said attachment flange (9) of the said first tubular element, characterised by the fact that it includes a fork (31) provided with a pair of substantially C-shape arms (32) adapted to engage on the said collar (30) and provided with a pair of teeth (33) projecting radially inwardly of the fork and position in such a way as to engage on a surface (34) of the said flange when the said fork engages on the said collar, and the said fork being provided with at least one hole (35) for a fixing screw (36) for fixing the fork to the flange to secure the pressure regulator by the fork to the said tubular element.

10. A manifold according to any preceding Claim, characterised by the fact that the said first end (13) of the said second tubular element (12) has a cylindrical seat (37) for the said outlet connector (4) of the said pressure regulator and the said first tubular element (5) has a cylindrical seat (38) formed close to the flange, adapted to house the body of the said pressure regulator, between the said outlet connector (4) and the associated seat (37) and between the said body of the pressure regulator and the said seat (38) there being interposed a sealing ring.

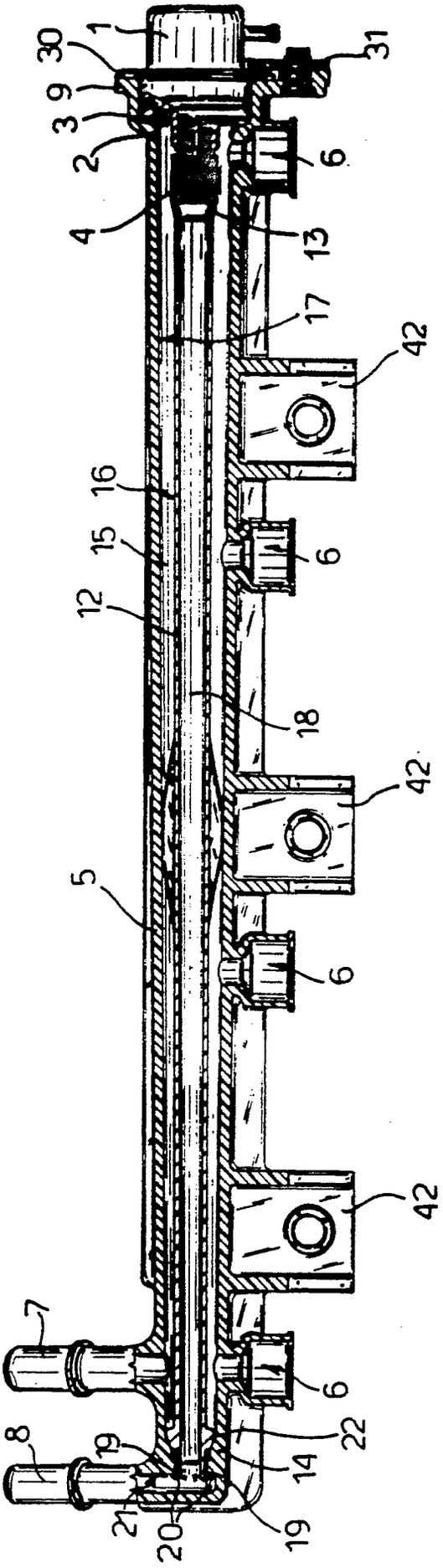

Fig.1

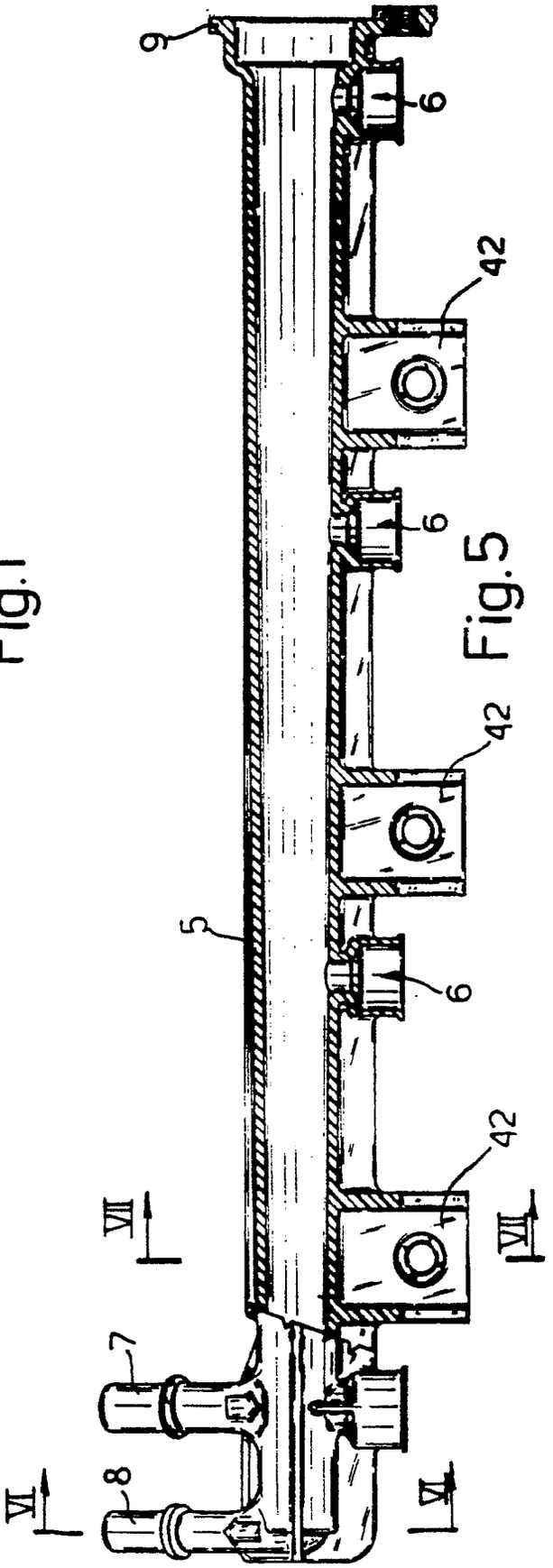

Fig.5

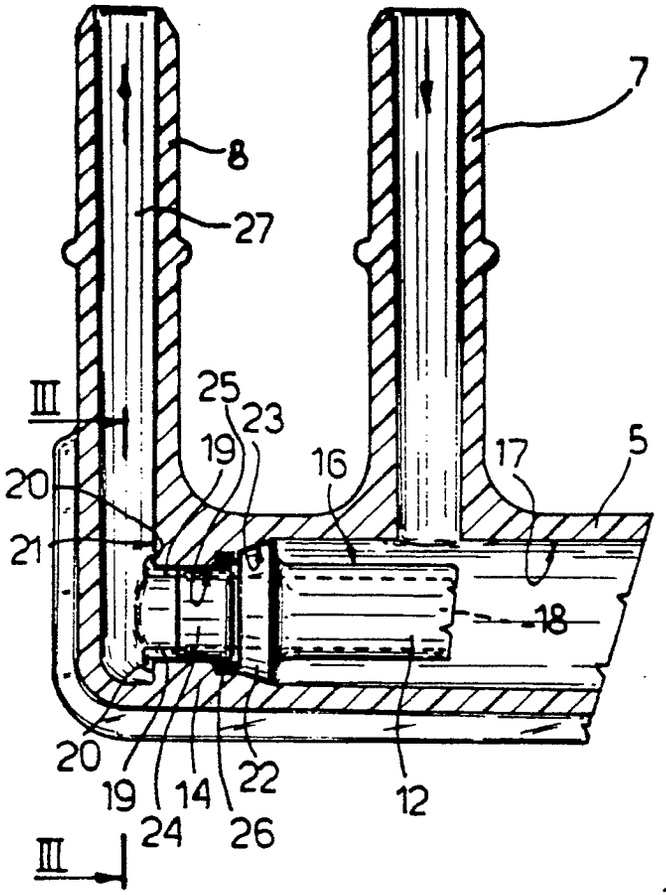

Fig. 2

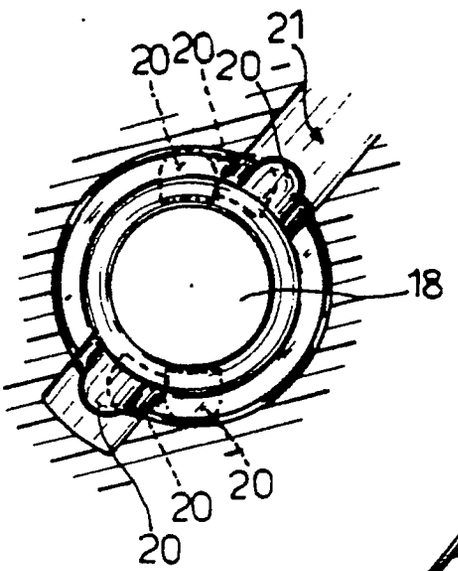

Fig. 3

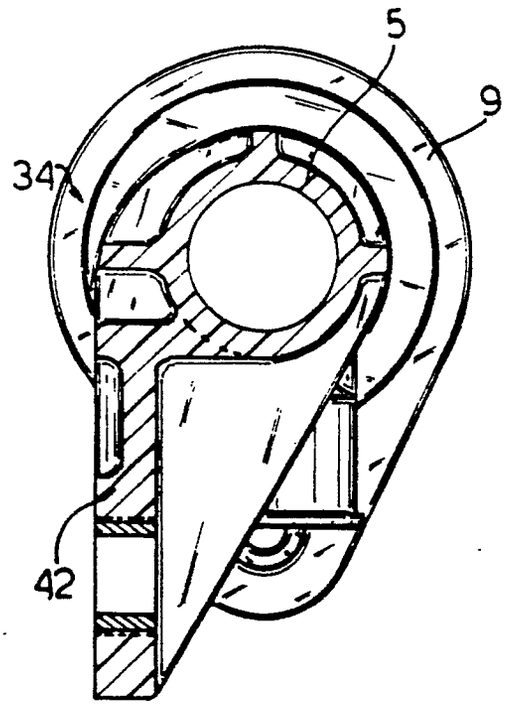

Fig. 7

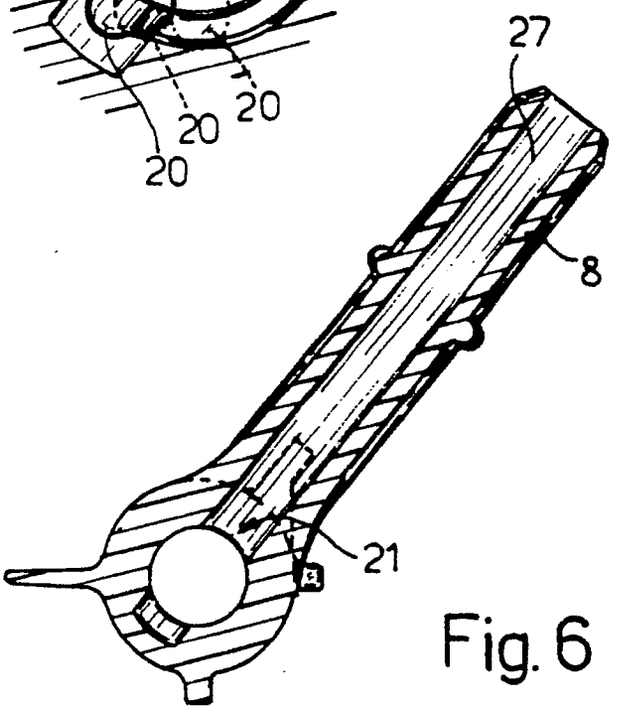

Fig. 6

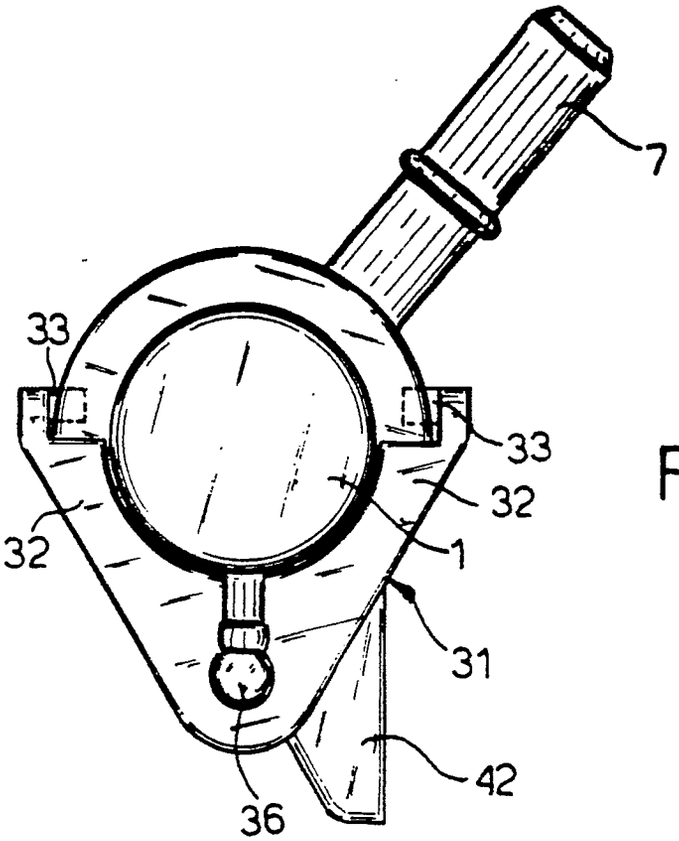

Fig. 13

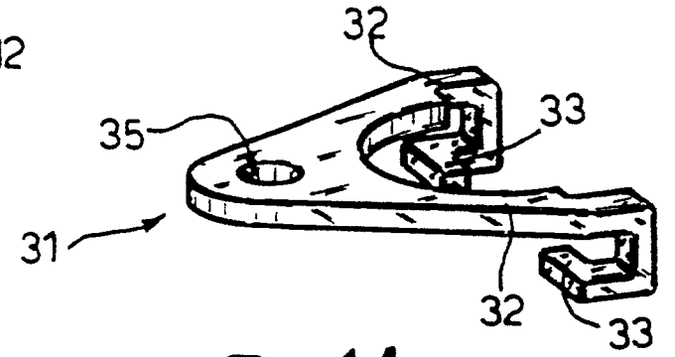

Fig. 14

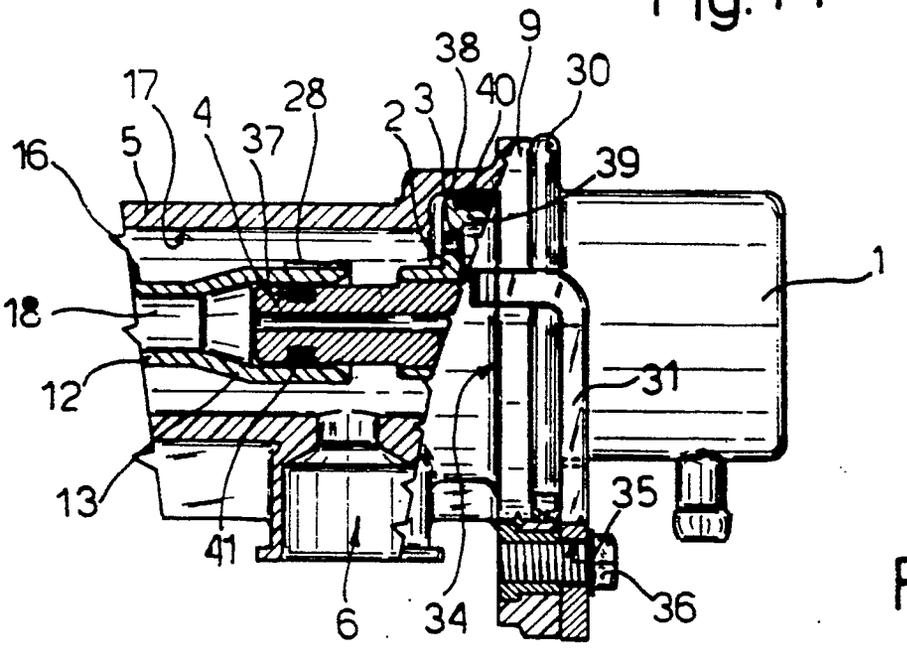

Fig. 4

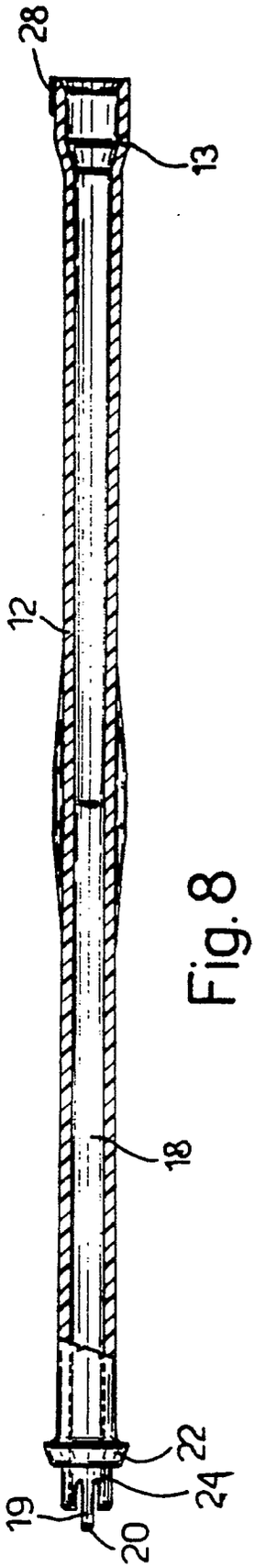

Fig. 8

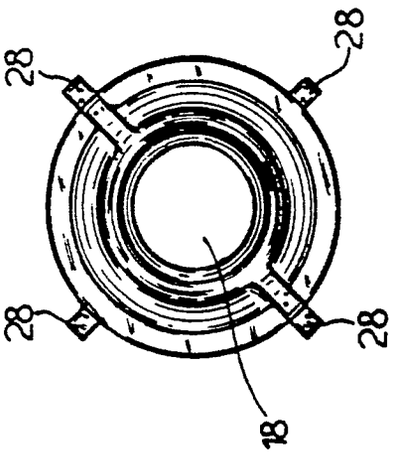

Fig. 10

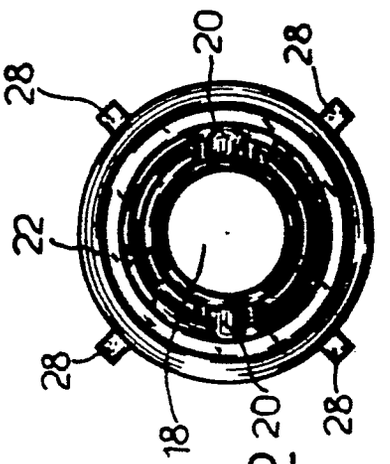

Fig.12

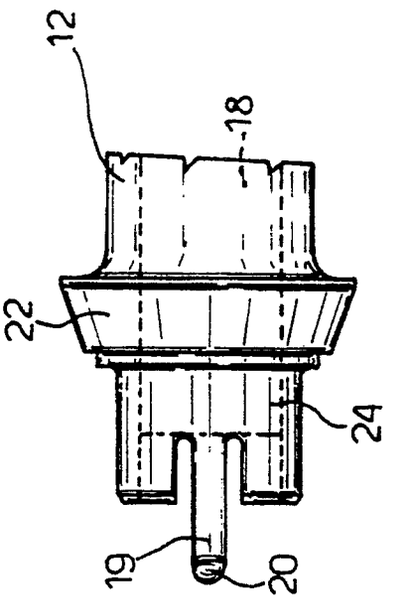

Fig. 9

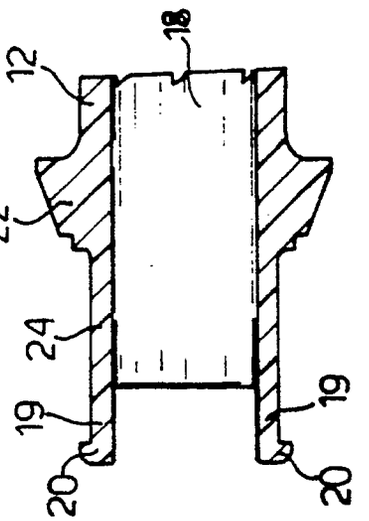

Fig.11

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 90 11 0595

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)
A	US-A-4836246 (LEMP) * column 2, line 24 - column 4, line 64; figures 1-11 *	1-3	F02M55/02
A,P	PATENT ABSTRACTS OF JAPAN vol. 14, no. 29 (M-922)(3972) 19 January 1990, & JP-A-1 267354 (SUZUKI MOTOR CO) 25 October 1989, * the whole document *	1, 3	
A	RESEARCH DISCLOSURE. no. 276, April 1987, NEW YORK,USA, page 195, Eshleman: "27623: Coaxial tube fuel rail." * the whole document *	1, 3	
A	EP-A-0233697 (GENERAL MOTORS CORPORATION)		

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

F02M

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	05 SEPTEMBER 1990	FRIDEN C.M.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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