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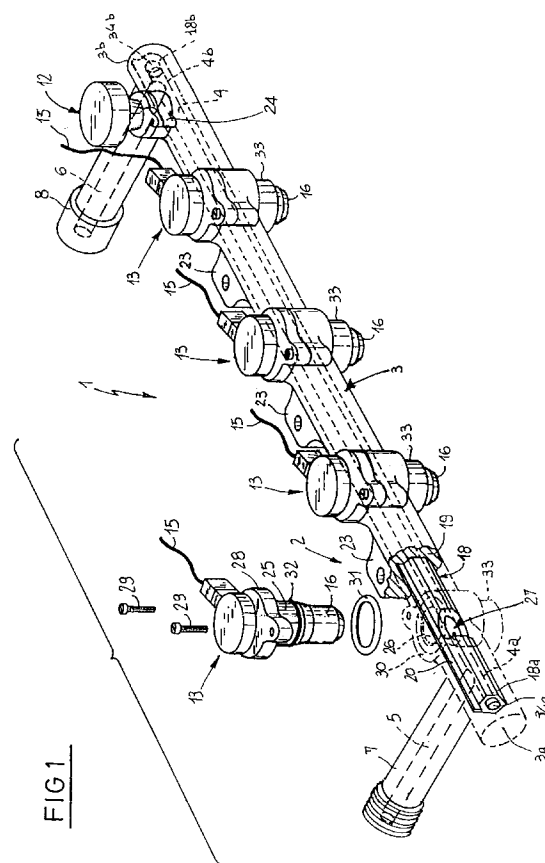
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(54) **Apparatus for dispensing and injecting fuel to cylinders in endothermic engines.**

(57) The described apparatus comprises a dispensing manifold (2) having a main body (3) longitudinally travelled along by a primary tube (4) connected at the ends thereof to an inlet tailpiece (7) and an outlet tailpiece (8) which are in turn connected with a fuel delivery pipe and recirculation pipe, respectively. The primary tube (4) is defined within a tubular core (18) integrally incorporated in a skirt (19) die-cast around the tubular core itself, together with the inlet and outlet tailpieces (7, 8). The main body (3) of the manifold is crossed by substantially cylindrical interconnecting openings (26) each connected to a fuel injector (13) and penetrating the tubular core (18) for connection with the primary tube (4) through outflow ports (27).



The present invention relates to an apparatus for dispensing and injecting fuel to cylinders in endothermic engines, comprising: a dispensing manifold having a main body of elongated configuration, longitudinally travelled along by a primary tube and exhibiting, on opposite sides, an inlet tailpiece and an outlet tailpiece passed through by a first and a second end tube respectively, connected with said primary tube; a plurality of injectors each exhibiting a feed port brought into fluid communication with the primary tube, and a delivery nozzle operatively engaged in a suction tube of an engine for admitting fuel thereto.

It is known that there are different types of endothermic engines, and more particularly internal-combustion positive-displacement engines wherein fuel delivery takes place by means of an apparatus comprising a plurality of injectors each associated with one of the cylinders provided in the engine, governed by an electronic control box controlling the injection of fuel to the cylinders according to a constantly checked metered amount depending on requirements.

Usually injectors are connected to a dispensing manifold, constantly supplying them with fuel from a delivery pipe, fed by a pump. In greater detail, the dispensing manifold is substantially comprised of a main body extending parallelly to the alignment direction of the cylinders longitudinally passed through by a primary tube connected at the opposite ends thereof with an inlet and an outlet tailpiece in turn connected to a fuel delivery pipe and a fuel recirculation pipe, respectively.

Fuel is admitted to the primary tube through the inlet tailpiece and keeps a constant pressure checked by a pressure sensor located close to the outlet tailpiece.

A plurality of branching-off tailpieces projecting sideways from the main body carry out, through respective branching-off tubes, the forwarding to a corresponding injector of part of the fuel admitted to the primary tube. The excess fuel amount admitted to the primary tube will leave the manifold through the outlet tailpiece, and will be subsequently recirculated.

A great number of manifolds of the above type are made substantially by the use of machined tubular elements assembled by welding. In particular, the main body consists of a pipe on which, after appropriate mechanical machinings aiming at achieving side openings in communication with the primary tube defined within the pipe itself, a plurality of collars of tubular sections are welded, being designed to constitute the branching-off tailpieces for connection to the injectors. Connected still by welding to the opposite ends of the pipe forming the main body are the inlet and outlet tailpieces, as well as other possible tailpieces enabling connection of pressure and/or temperature sensors.

The accomplishment of manifolds in the above

described manner involves complicated structural steel works bringing about sophisticated welding techniques of high costs in order to achieve a sufficient reliability and accuracy in the connection between the various parts.

In spite of the foregoing there is however still the risk that, due to the prolonged use of the manifold, in particular under heavy conditions, undesirable micro-crackings may be generated at the welding areas by effect of either microvibrations or mechanical and/or thermal stresses. These microcrackings afford fuel exudations or leakages, which brings about high fire risks.

Also known is the use of manifolds manufactured by means of a moulding process by sand casting.

According to the above process, it is provided that a cylindrical core designed to define said primary tube should be located within a mould provided with a cavity the shape of which matches the outer shape of the manifold. Subsequently, a melt metal is cast by dropping into the cavity of the previously closed mould, which metal will be subsequently solidified as a result of cooling. When solidification is over, concurrently with the withdrawal of the semifinished product from the mould the cylindrical core is removed from the semifinished product itself in order to free the primary tube.

In most cases the semifinished product drawn out of the mould is already provided with the branching-off tailpieces and sometimes the inlet and outlet tailpieces formed at right angles to, and of one piece construction with, the main body. The achievement of the finished manifold will also involve several finishing machinings substantially comprising boring of the different tubes, that is primary, branching-off, inlet and outlet tubes, machining of the ends of the branching-off, inlet and outlet tailpieces and of different seatings for receiving pressure and temperature sensors, as well as fluid-tight sealing of the primary tube at the respective opposite ends in order to isolate it from the surrounding atmosphere.

As a result of the foregoing, manifolds made by sand casting do not require the above described weldings to be carried out, and consequently the related problems can be eliminated. However there is still the possibility of fuel leakages through the fluid-tight seals made at the opposite ends of the primary tube, in that said seals may be damaged after a prolonged use of the manifold.

It has been also found that manufacturing costs for manifolds made by sand casting are greatly increased due to the necessary mechanical finish machinings, being of the greatest importance the fact that the primary tube needs to be bored throughout the whole length thereof in order to eliminate machining allowances and surface unevennesses that could impair the regular fuel flow in the manifold.

Also provided are apparatus in which manifolds

are made by means of several mechanical machinings involving material removal carried out on a semifinished product suitably preformed by a forging operation executed with the aid of a press, on a monolithic metal body made by extrusion or rolling.

The above manufacturing technique for manifolds is sometimes preferred to that involving melting by sand casting, in that the forged semifinished product offers better structural features and can be more easily machined, so that a greater efficiency and accuracy in making said tubes and tailpieces as well as said seatings for the engagement of sensors and/or fastening of the installed manifold can be achieved.

On the other hand it is pointed out that mechanical machinings on the forged product involve the removal of a great amount of material, due to the presence of important machining allowances resulting from the forging process. Therefore, as a result, costs are further increased. In addition and above all, the cost of the finished product is greatly increased by the fact that boring over a great longitudinal extension is needed along the main body of the manifold so as to form the primary tube. This operation involves an important waste of time and the use of particular tools and technologies in that the value of the diameter/length ratio of the bore to be carried out is very low.

In addition a very careful washing of the machined piece must be carried out in order to eliminate the great amount of metal fragments present at the inside thereof as a result of boring and other mechanical machinings.

The above cleansing operations are made particularly difficult since said metal fragments, above all as far as rather malleable materials such as aluminum-based alloys normally used in this field are concerned, tend to get wedged in the machined piece.

It is also noted that the primary tube made by boring will always and inevitably emerge to the outside by at least one of its ends. The fluid-tight seal made on said end in this case too will represent a point of possible escape of fuel to the outside of the manifold.

Finally, it should be pointed out that in all manifolds of the known type, the presence of several points of possible fuel escape makes it necessary to carry out particular test on the individual pieces for checking tightness of the same before their commercialization, by means of sophisticated technologies involving the use of ionizing gases which will bring about additional costs.

Under this situation, the main object of the present invention is to solve the problems of the known art by providing an apparatus offering an improved use reliability, capable of eliminating any possibilities of exudation and leakage of fuel from the manifold, and also requiring a greatly reduced amount of material and reduced machining time, which will obviously bring about important savings on the costs of the feed apparatus as a whole.

The foregoing and still further objects that will become more apparent from the following description are substantially attained by an apparatus for dispensing and injecting fuel to cylinders in endothermic engines, characterized in that the main body of the dispensing manifold comprises: a tubular core internally defining the primary tube and exhibiting a lower length than the overall length of the main body; an outer skirt completely covering the tubular core so as to hermetically isolate it from the surrounding, atmosphere; said injectors being connected with the primary tube by respective interconnecting openings, of substantially cylindrical configuration, each of which extends in the outer skirt and at least partly penetrates the tubular core, so as to define therein at least one outflow port bringing the primary tube into fluid communication with the feed port exhibited by one of said injectors.

Further features and advantages will be better understood from the detailed description of some preferred embodiments of an apparatus for dispensing and injecting fuel to cylinders in endothermic engines in accordance with the invention, given hereinafter by way of non-limiting example with reference to the accompanying drawings, in which:

- Fig. 1 is a partly exploded and cut away perspective view showing an apparatus in accordance with one embodiment of the invention;
- Fig. 2 is a partly exploded and cut away perspective view showing a second embodiment of the apparatus in question;
- Fig. 3 shows a detail of Fig. 1 to an enlarged scale;
- Fig. 4 is a sectional view detailing the connection between the primary tube and the first end tube in the solution of Figs 1 and 3;
- Fig. 5 is a diagrammatic sectional view taken along a plane perpendicular to the axis of the manifold main body shown in Fig. 1 emphasizing the engagement of one of the injectors into a respective one of the interconnecting openings provided in the manifold;
- Fig. 6 is a partly exploded and cut away perspective view from bottom of a third embodiment of the present invention;
- Fig. 7 is a partly exploded and cut away perspective view from bottom of a fourth embodiment of the apparatus in question;
- Fig. 8 shows a detail of Fig. 6 to an enlarged scale;
- Fig. 9 is a diagrammatic sectional view taken along a plane perpendicular to the axis of the manifold main body shown in Fig. 6, emphasizing a possible connection between one of the branching-off tailpieces and an injector operatively engaged with a suction tube of an engine;
- Fig. 10 is a sectional view similar to that shown

in Fig. 9 and representing a different solution for connecting the branching-off tailpiece and the injector.

Referring to the drawings, an apparatus for dispensing and injecting fuel to cylinders in endothermic engines in accordance with the present invention has been generally identified by reference numeral 1.

For the sake of clarity, in the following description corresponding parts in the four different embodiments shown in the accompanying drawings have been allocated the same reference numerals.

In a manner known per se, apparatus 1 essentially comprises a dispensing manifold 2 having a main body 3 designed to be fastened close to the head of an engine, at a appropriate location.

The main body 3 is longitudinally crossed by a primary tube 4 exhibiting first and second ends 4a, 4b connected with a first and a second end duct, 5 and 6 respectively. Such end ducts 5, 6 are respectively formed within an inlet tailpiece 7 and an outlet tailpiece 8, integral with the main body 3 and preferably directed at right angles thereto.

The inlet tailpiece 7 is adapted to be sealingly connected in a conventional manner with a delivery pipe 10 (only shown in Figs. 2 and 7) that, in known manner, is constantly supplied with fuel under pressure drawn from a tank by a pump (both not shown as known and conventional).

The outlet tailpiece 8 is in turn sealingly connected with a recirculation pipe 11 (Figs. 2 and 8) through which excess fuel admitted to the manifold 2 is sent back to said tank.

A variable amount of fuel is sent to the recirculation pipe 11, being controlled by a conventional pressure-adjusting device 12 that, by reducing the fuel passage towards the outlet tailpiece 8 and/or acting upon the fuel pump, keeps fuel in the primary tube 4 to a given feed pressure value.

Still in known manner, apparatus 1 further comprises a plurality of injectors 13 (not shown in Figs. 6, 7 and 8) distributed along the main body 3 of the manifold 2 spaced apart a given distance from each other and each exhibiting a feed port 14 arranged to be connected with the primary tube 4 so as to admit fuel to the injector. Injectors 13, not described in detail as made in known and conventional manner, are connected to an electronic control box, not shown as known per se, by means of cables. The control box drives the injectors in operation such as to cause the sequential delivery of the fuel, at a controlled metering amount, via respective delivery nozzles 16 operatively engaged to respective suction tubes 17 (Figs 5, 9 and 10) each connected to one of the cylinders of an engine. In figs. 5, 9 and 10 arrow "A" shows the direction of the air flow sucked into the engine.

In accordance with the present invention, the main body 3 is advantageously comprised of a tubular core 18 defining said primary tube 4 at the inside

thereof and is integrally incorporated into and covered by an outer skirt 19 die-cast around the core itself.

Advantageously, during the die-casting for making the outer skirt 19 also the inlet and outlet tailpieces 7 and 8 are produced, which are therefore of one piece construction with the skirt itself.

Referring to the skirt die-casting, carried out together with the accomplishment of the inlet and outlet tailpieces 7 and 8, it has been found that the best results can be achieved through the use of a technique known in the art as "squeeze casting". However, other types of die-casting processes can be used too, as well as injection moulding methods involving the use of composite and/or technological polymer-based materials.

During the die-casting or injection moulding operations, also attachment brackets 23 may be manufactured, if necessary, advantageously of one piece construction with the skirt 19, so as to enable the manifold to be mounted to the appropriate engine, as well as seatings 24 designed to accommodate the pressure adjusting device 12 and/or heat sensors and others.

Preferably, the tubular core 18 consists of an extruded metal section member exhibiting a polygonal outer profile seen in cross section. In addition, the core 18 can be advantageously provided with at least one locating wing 20. The locating wing 20, also by virtue of the polygonal section of the tubular core 18, enables the tubular core to be strongly anchored to the inside of the skirt 19 and can also offer holding and/or locating seatings (not shown), which will enable the tubular core 18 to be easily handled and positioned within a mould in which the skirt die-casting will be carried out during the manufacturing operations.

It should be noted that the tubular core 18 has a lower length than the main body 3 taken as a whole, so that the respective ends 18a, 18b are suitably spaced apart from the ends 3a, 3b of the main body 3, towards the inside of the skirt 19.

The core 18 is therefore completely separated from the surrounding atmosphere, due to the presence of the skirt 19 integrally surrounding it.

In the embodiments shown in Figs. 1, 3, 4, 6 and 8, the first and second end tubes 5, 6 are formed directly within the inlet and outlet tailpieces 7 and 8, by boring for example, and cross the tubular core 18 perpendicularly, so that they are brought into communication with the primary tube 4. In this case the ends 18a, 18b of the tubular core 18 are provided with respective closing elements 34a, 34b, formed with added welding material for example, the function of which is substantially to prevent the melted material from entering the primary tube 4 during the skirt and inlet and outlet tailpiece manufacturing process.

In the embodiment shown in Figs. 2 and 7 provi-

sion is made for a first and a second tubular extension 21, 22 departing from the opposite ends 18a, 18b of the tubular core 18, said extensions being incorporated in the inlet and outlet tailpieces 7 and 8 respectively, in order to define the first and second end tubes 5 and 6 thereof. In fact, said inlet and outlet tailpieces 7, 8 are die-cast around the respective first and second tubular extensions 21, 22 simultaneously with the formation of the skirt 19 around the tubular core 18.

In the embodiments shown in Figs. 2 and 7 provision is also made for the first and second tubular extensions 21, 22 to be of one piece construction with the tubular core 18 and joined to the opposite ends 18a, 18b thereof at respective bending areas. In this manner, the tubular core 18 and respective extensions 21, 22 can be made by merely cutting to size and bending the above mentioned extruded section member.

In accordance with another embodiment the tubular extensions 21, 22 may be made separately from the tubular core 18 and fastened to the respective ends 18a, 18b of said core by weldings, threaded connections or others. Advantageously weldings or threaded connections joining the extensions 21, 22 to the tubular core 18 will be at all events incorporated into the die-cast material forming the skirt 19 and/or the inlet and outlet tailpieces 7 and 8, thus eliminating any risks of fuel leakage.

In accordance with another feature of the present invention, a plurality of interconnecting openings 26 of a substantially cylindrical configuration is provided along the main body 3, each of them being formed across the skirt 19 and penetrating the tubular core 18 at least partly so as to intersect the primary tube 4 in order to define at least one fuel-outflow port 27. Each outflow port 27 puts the primary tube 4 into fluid communication with one of the injectors 13, via the respective interconnecting opening 26. To this end, in the embodiments shown in Figs. 1 to 5, each injector 13 exhibits a cylindrical body 25 to be directly engaged with the corresponding interconnecting opening 26. In greater detail, each injector 13 is provided with an anchoring flange 28 perimetrically projecting therefrom, to be fixedly engaged, by threaded elements 29 or the like, to a locating surface 30 formed on the skirt 19, at the interconnecting opening 26. When the injector 13 is properly fitted and fastened to the opening 26, the corresponding feed port 14 located sideways on the cylindrical body 25 breasts the outflow port 27 afforded by the tubular core 18. Thus a fluid communication between the primary tube 4 and injector 13 is achieved.

First and second seal rings 31, 32 located at opposite positions with reference to the outflow and feed ports, 27 and 14 respectively, act between the skirt 19 and the anchoring flange 28 and, respectively, between one inner wall of the interconnecting opening 26 and the cylindrical body 25 of the injector

13, in order to ensure the hermetic sealing of the interconnecting opening with respect to the surrounding atmosphere. The delivery nozzle 16 of the injector 13 faces the respective suction pipe 17 through a collar 33 projecting coaxially with respect to the interconnecting opening 26.

On the contrary, in the embodiments shown in Figs. 6 to 10, the interconnecting openings 26 are connected to the injectors 13 by respective branching-off tailpieces 35 distributed along the main body 3 spaced apart a given distance from each other, each of them being longitudinally crossed by a branching-off tube 36 (Figs. 9, 10) arranged to bring the primary tube 4 into communication with the feed port 14 (not shown) of the corresponding injector 13. Each of the branching-off tailpieces 35 is fastened to the skirt 19 by threaded elements 37a acting across a connecting flange 37 carried by the branching-off tailpiece. The flange 37 sealingly engages, upon interposition of a seal ring 38 or similar means, on the locating surface 30 formed on the skirt 19. As shown in Fig. 9, the connection of each branching-off tailpiece 35 with the corresponding injector 13 can be carried out through the interposition of a flexible tubular element 39 of known type, the opposite ends 39a, 39b of which are sealingly engaged with one free end 35a of the branching-off tailpiece 35 and one connecting portion 13a incorporating the feed port 14 of the injector 13, respectively.

In another embodiment shown in Fig. 10, the free end 35a of each branching-off tailpiece 35 is directly and sealingly engaged with the connecting portion 13a of the injector 13.

Advantageously, the interconnecting openings 26 can be already present on the raw semifinished product coming from the above specified die-casting process. In this semifinished product the tubular core 18 will extend at the inside of the interconnecting openings 26 and, for the achievement of the outflow ports 27, will undergo an appropriate material removal following boring operations carried out on the openings themselves formed during one of the subsequent working steps of the product.

In the same manner as above, one or more cavities may also be formed on the skirt 19, to be combined with corresponding outflow ports in order to enable the pressure adjusting device 12 and/or other sensors to be sealingly connected with the primary tube 4.

The present invention achieves important advantages.

Firstly, the apparatus in question, as compared to the known art, completely eliminates any risks of fire resulting from possible fuel leakages through crackings produced in weldments directly exposed to the atmosphere.

A drastic reduction in the possibilities of fuel escape is also achieved due to the absence in the pri-

mary tube of unnecessary openings towards the atmosphere which openings in the known art needed to be closed by adding welding material or otherwise. In fact in the apparatus in question the primary tube extends exclusively within the tubular core and is in communication with the outer part of the manifold exclusively at the inlet and outlet tailpieces, where connection between pipes takes place with the aid of known seal means, widely tested and of great reliability.

Referring to the embodiments shown in Figs. 1 and 6 the engagement of the individual injectors directly in the main body of the manifold eliminates connection between injectors and manifolds which were used in the known art. This expedient further increases the apparatus reliability as regards possibilities of fuel leakages.

The use of the tubular core for defining the main tube has also eliminated the necessity of carrying out perforations along the whole extension of the main body, which brings about time savings in workings and, as a result, reduced costs of the finished product.

Obviously the apparatus is not considered limited to the embodiments chosen for purposes of illustration and includes all changes and modifications which do not constitute a departure from the true scope of this invention as claimed in the following claims.

Claims

1. An apparatus for dispensing and injecting fuel to cylinders in endothermic engines, comprising:
 - a dispensing manifold (2) having a main body (3) of elongated configuration, longitudinally travelled along by a primary tube (4) and exhibiting, on opposite sides, an inlet tailpiece (7) and an outlet tailpiece (8) passed through by a first and a second end tube (5, 6) respectively, connected with said primary tube (4);
 - a plurality of injectors (13) each exhibiting a feed port (14) brought into fluid communication with the primary tube (4), and a delivery nozzle (16) operatively engaged in a suction tube (17) of an engine for admitting fuel thereto,
 characterized in that the main body (3) of the dispensing manifold (2) comprises:
 - a tubular core (18) internally defining the primary tube (4) and exhibiting a lower length than the overall length of the main body (3);
 - an outer skirt (19) completely covering the tubular core (18) so as to hermetically isolate it from the surrounding atmosphere;

said injectors (13) being connected with the primary tube (4) by respective interconnecting openings (26), of substantially cylindrical configuration, each of which extends in the outer skirt (19) and at least partly penetrates the tubular core (18), so as to define therein at least one outflow port (27) bringing the primary tube (4) into fluid communication with the feed port (14) exhibited by one of said injectors (13).

2. An apparatus according to claim 1, characterized in that said outer skirt (19) and inlet and outlet tailpieces (7, 8) are of one piece construction, being die-cast around said tubular core (18).
3. An apparatus according to claim 2, characterized in that said inlet and outlet tailpieces (7, 8) are directed substantially at right angles to the main body (3).
4. An apparatus according to claim 1, characterized in that each of said first and second end tubes (5, 6) crosses the tubular core (18) perpendicularly, so as to be brought into communication with the primary tube (4), said tubular core (18) being provided, at the opposite ends (18a, 18b) thereof, with closing elements (34a, 34b) for the primary tube (4).
5. An apparatus according to claim 4, characterized in that departing from the opposite ends (18a, 18b) of said tubular core (18) is a first and a second tubular extension (21, 22) respectively, said extensions being incorporated in said inlet and outlet tailpieces (7, 8) respectively, in order to define the first and second end tubes (5, 6) thereof.
6. An apparatus according to claim 5, characterized in that said first and second tubular extensions (21, 22) are of one piece construction with said tubular core (18) and are connected to the opposite ends (18a, 18b) of said core at respective bending areas.
7. An apparatus according to claim 5, characterized in that said first and second tubular extensions (21, 22) are connected to the opposite ends (18a, 18b) of the tubular core (18) by respective weldments that are integrally incorporated in the outer skirt (19) of the main body (3) and hermetically isolated from the surrounding atmosphere.
8. An apparatus according to claim 5, characterized in that said first and second tubular extensions (21, 22) are connected to the opposite ends of the tubular core (18) by respective threaded connections which are integrally incorporated in the outer skirt (19) of the main body (3) and hermetically

isolated from the surrounding atmosphere.

9. An apparatus according to claim 1, characterized in that the outer skirt (19) is made of a material die-cast around the tubular core (18). 5
10. An apparatus according to claim 1, characterized in that said tubular core (18) exhibits at least one anchoring side wing (20) incorporated within the main body (3). 10
11. An apparatus according to claim 1, characterized in that said tubular core (19) is made of an extruded section member. 15
12. An apparatus according to claim 1, characterized in that said core (18) in cross-sectional view has a substantially polygonal profile.
13. An apparatus according to claim 1, characterized in that each of said injectors (13) is directly and sealingly engaged in one of said interconnecting openings (26). 20
14. An apparatus according to claim 13, characterized in that in each injector (13) the respective feed port (14) is located sideways. 25
15. An apparatus according to claim 14, characterized in that each injector (13) has a cylindrical body (25) fitted in coaxial relation in the corresponding interconnecting opening (26) and provided with an anchoring flange (28) fastened to a locating surface (30) formed on said skirt (19), upon interposition of a first seal ring (31), a second seal ring (32) being inserted between said cylindrical body and an inner wall of the interconnecting opening (26), on the opposite side to the first seal ring (31), so that the feed port (14) is interposed between the first and second seal rings (31, 32). 30 35 40
16. An apparatus according to claim 1, characterized in that it further comprises a plurality of branching-off tailpieces (35) distributed along the main body (3), each of them being longitudinally crossed by a branching-off tube (36) communicating with one of said interconnecting openings (26) in order to bring the primary tube (4) into communication with the corresponding fuel injector (13). 45 50
17. An apparatus according to claim 16, characterized in that each of said branching-off tailpieces (35) sealingly engaged to the skirt (19) of the main body (3) at the respective interconnecting opening (26) is operatively connected with the respective injector (13) by a flexible tubular ele-

ment (39).

18. An apparatus according to claim 16, characterized in that each of said branching-off tailpieces (35) is sealingly fastened to the skirt (19) of the main body (3) at the respective interconnecting opening (26) and is directly and sealingly engaged to the respective injector (13) on the opposite side to the main body (3).

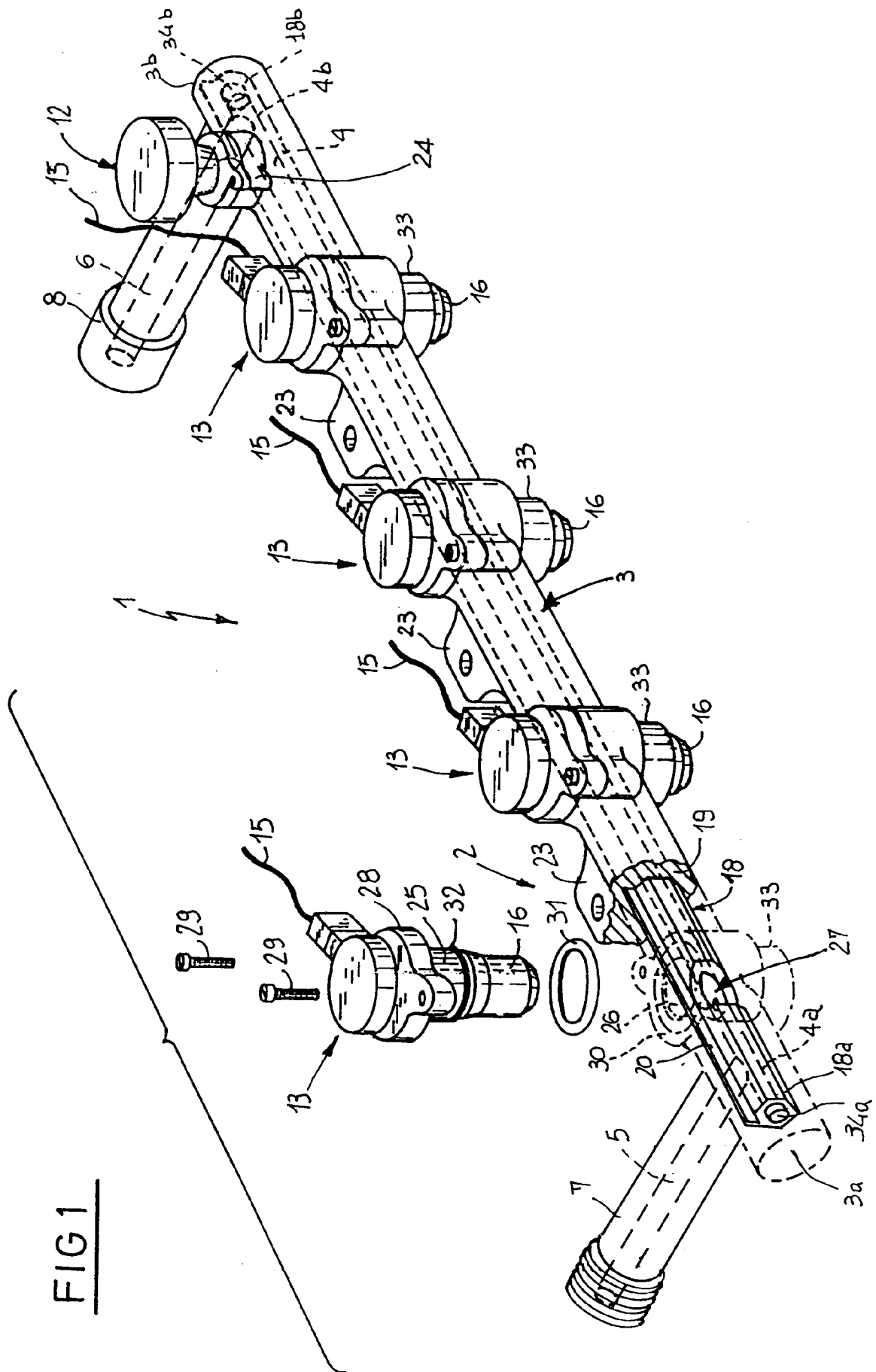


FIG 1

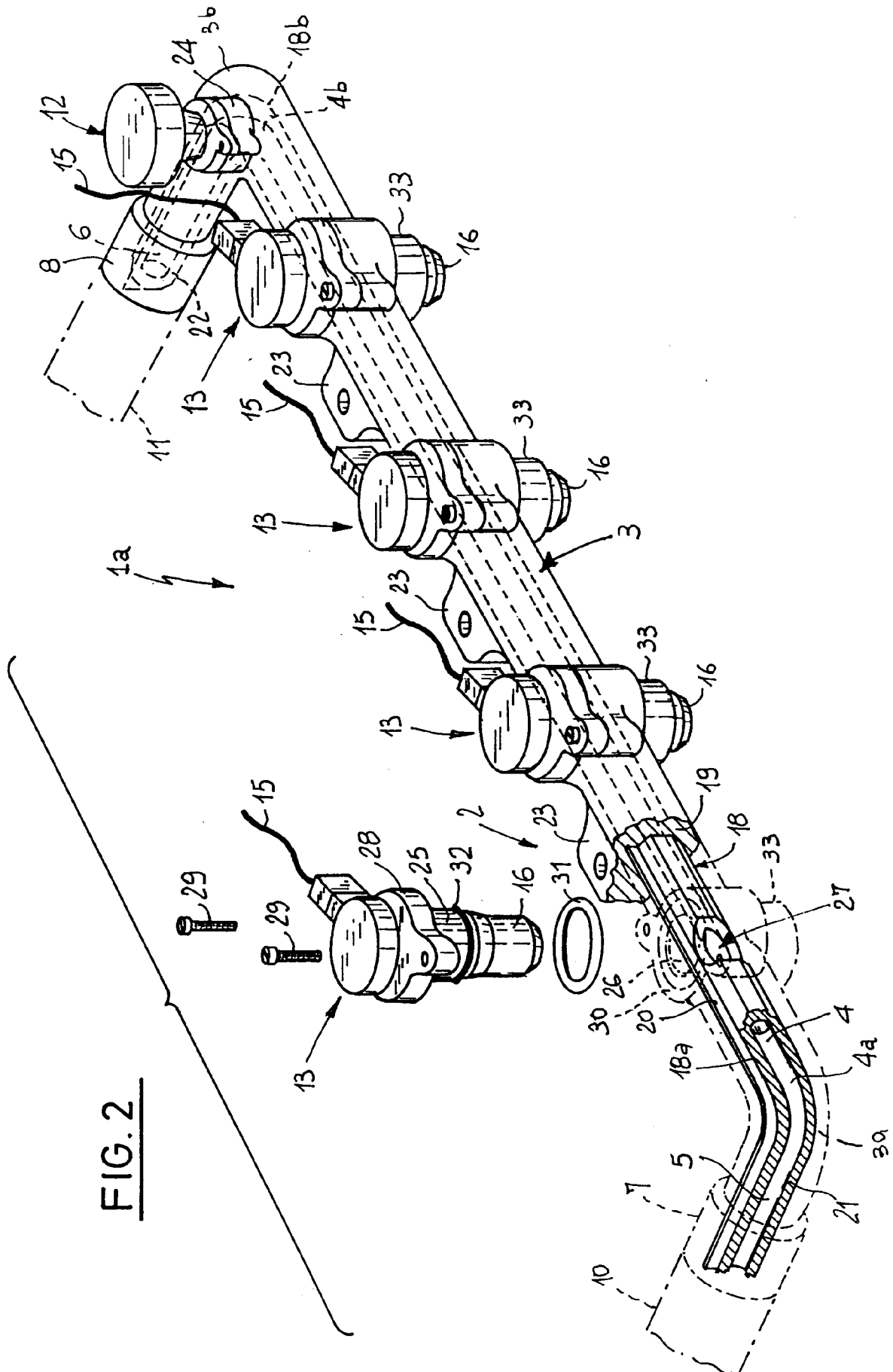
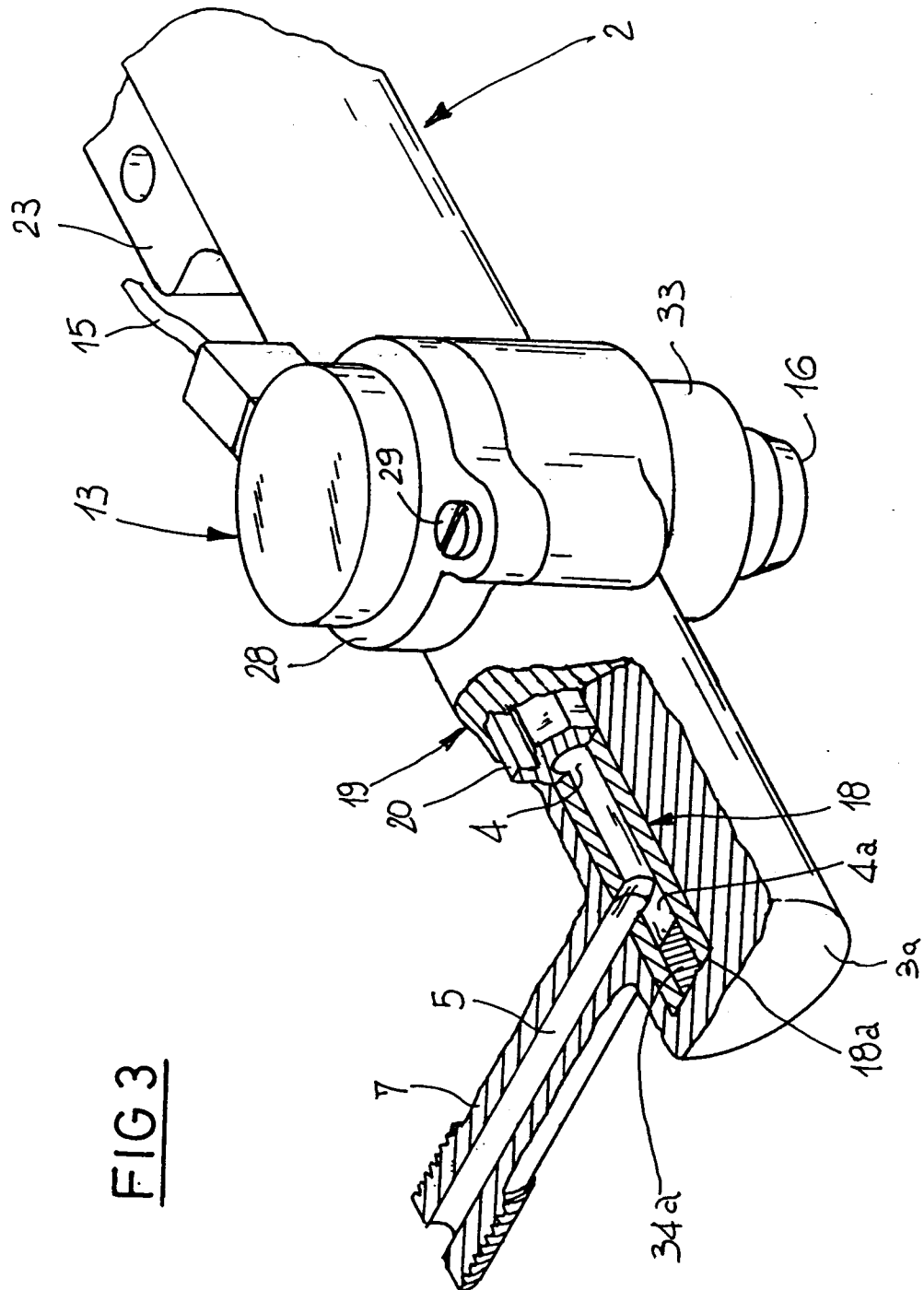
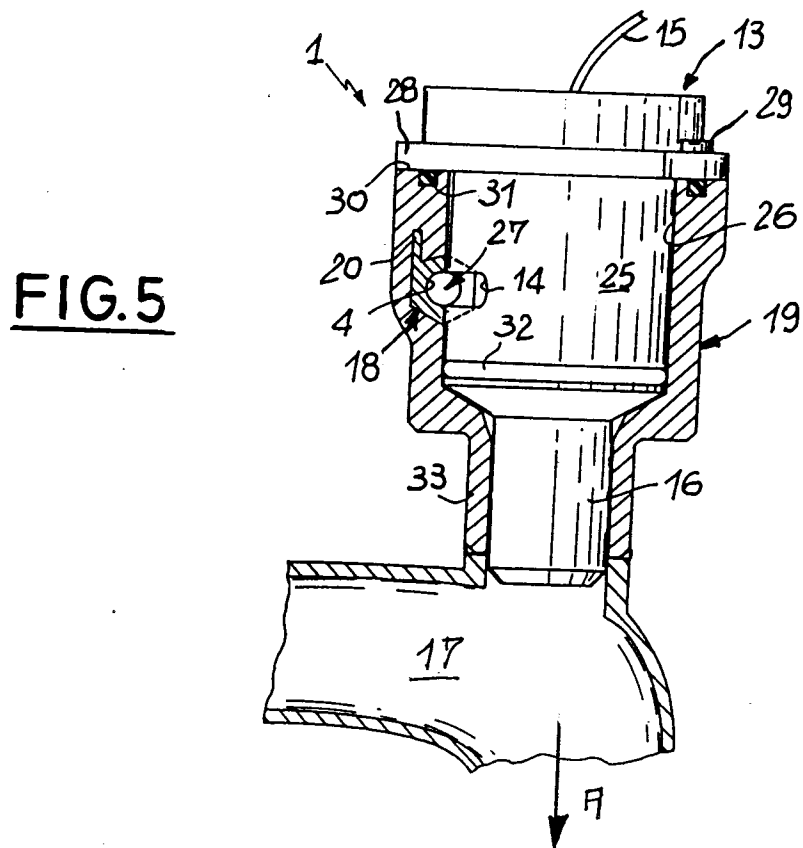
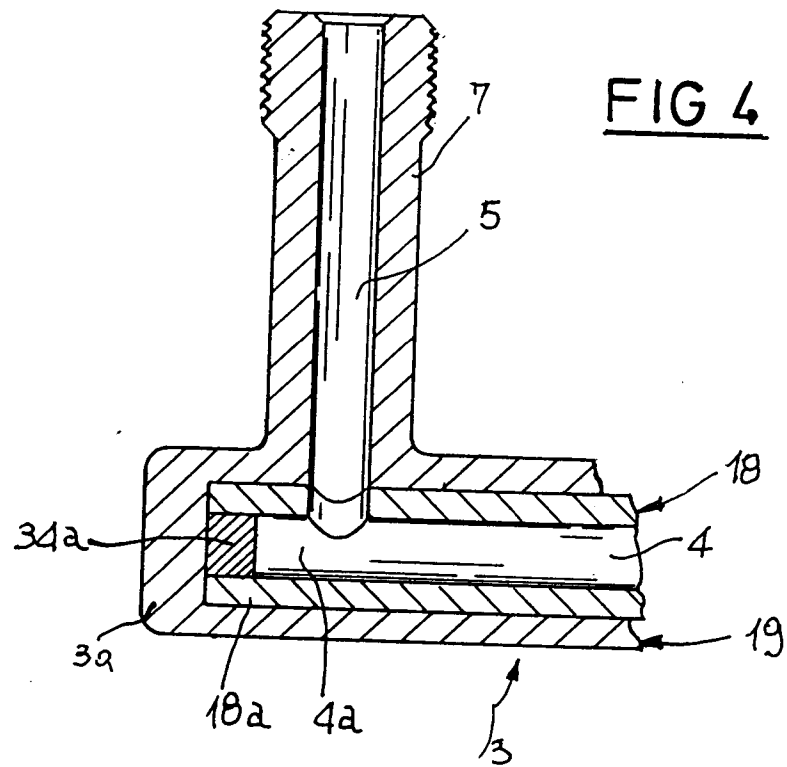


FIG. 2





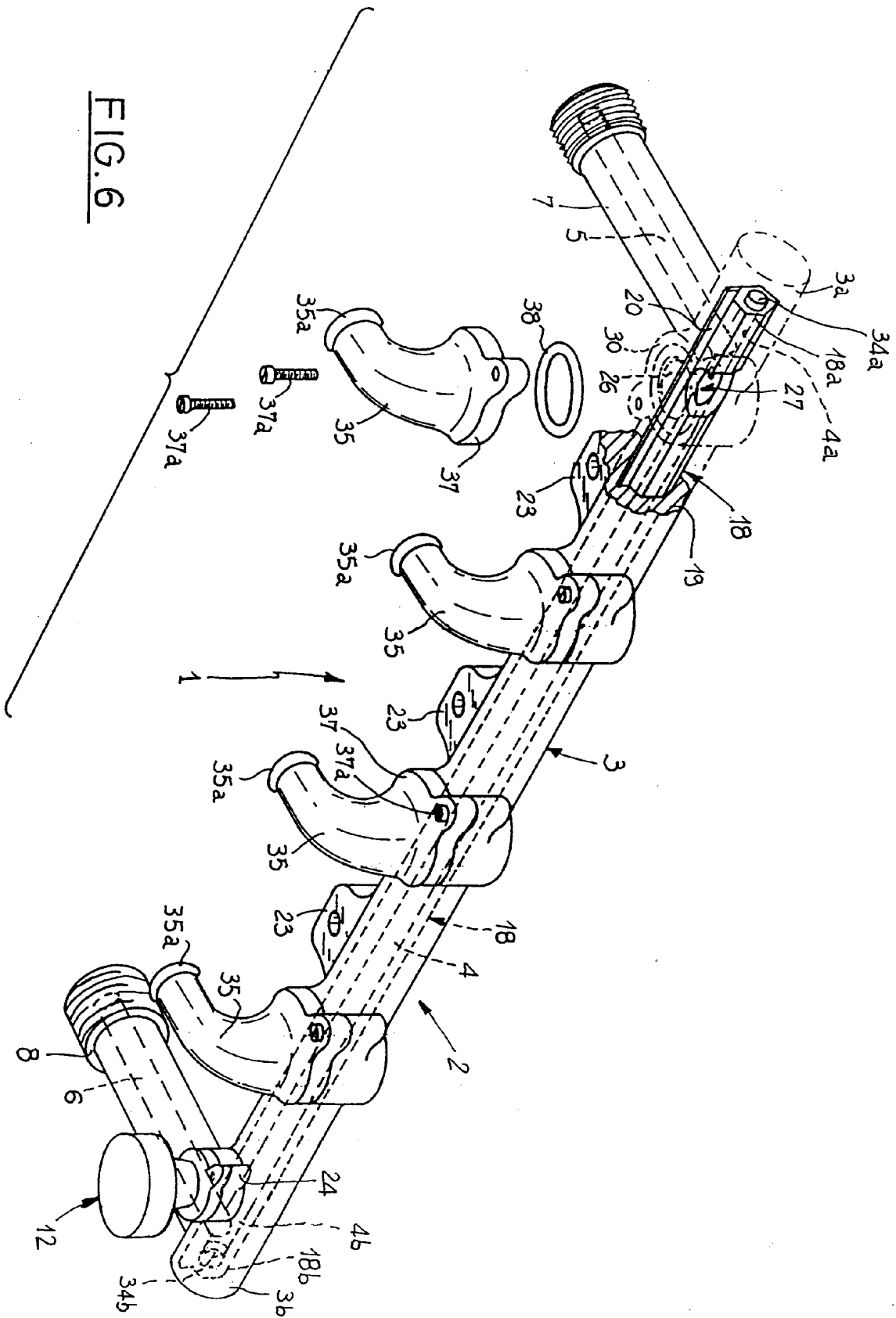
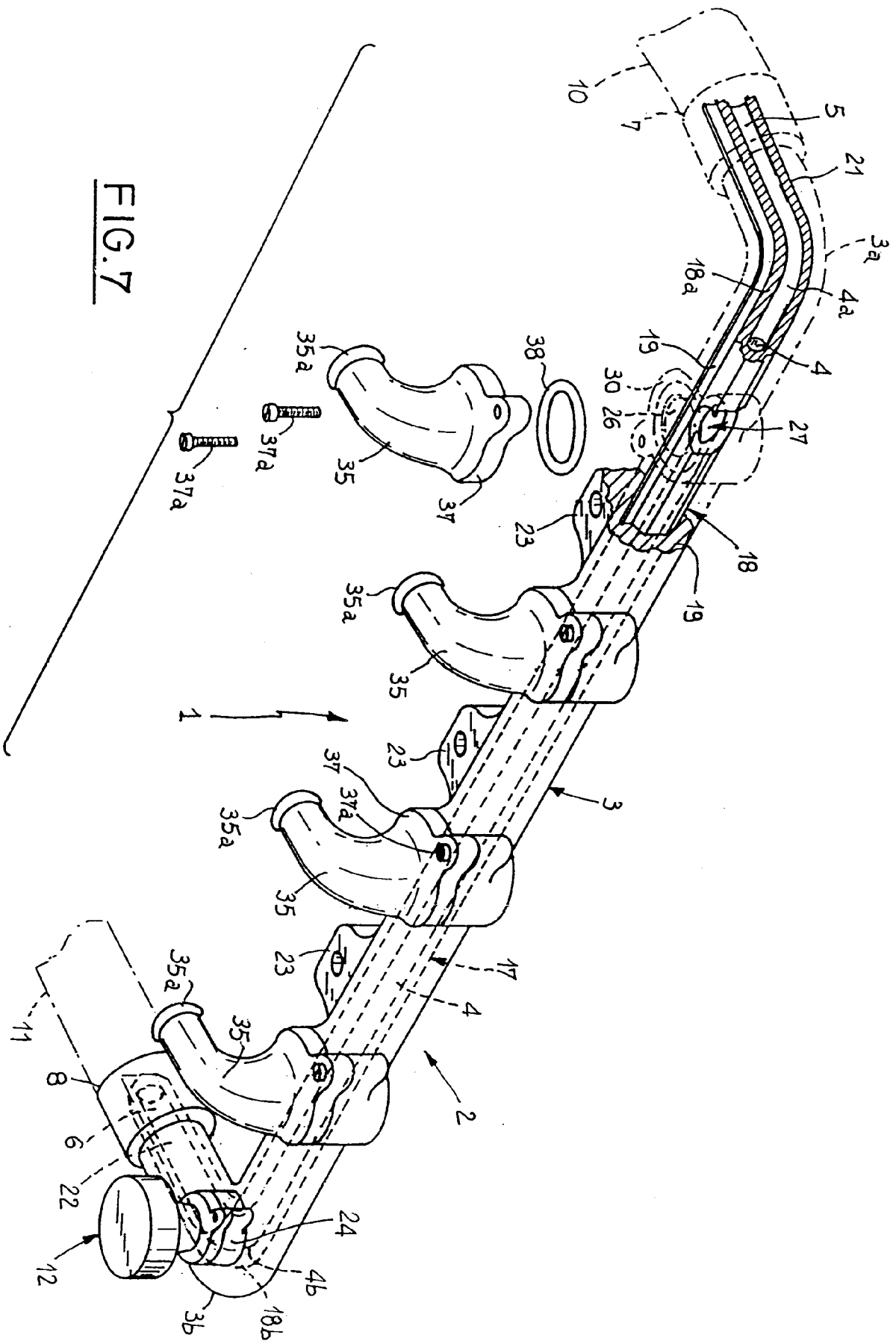
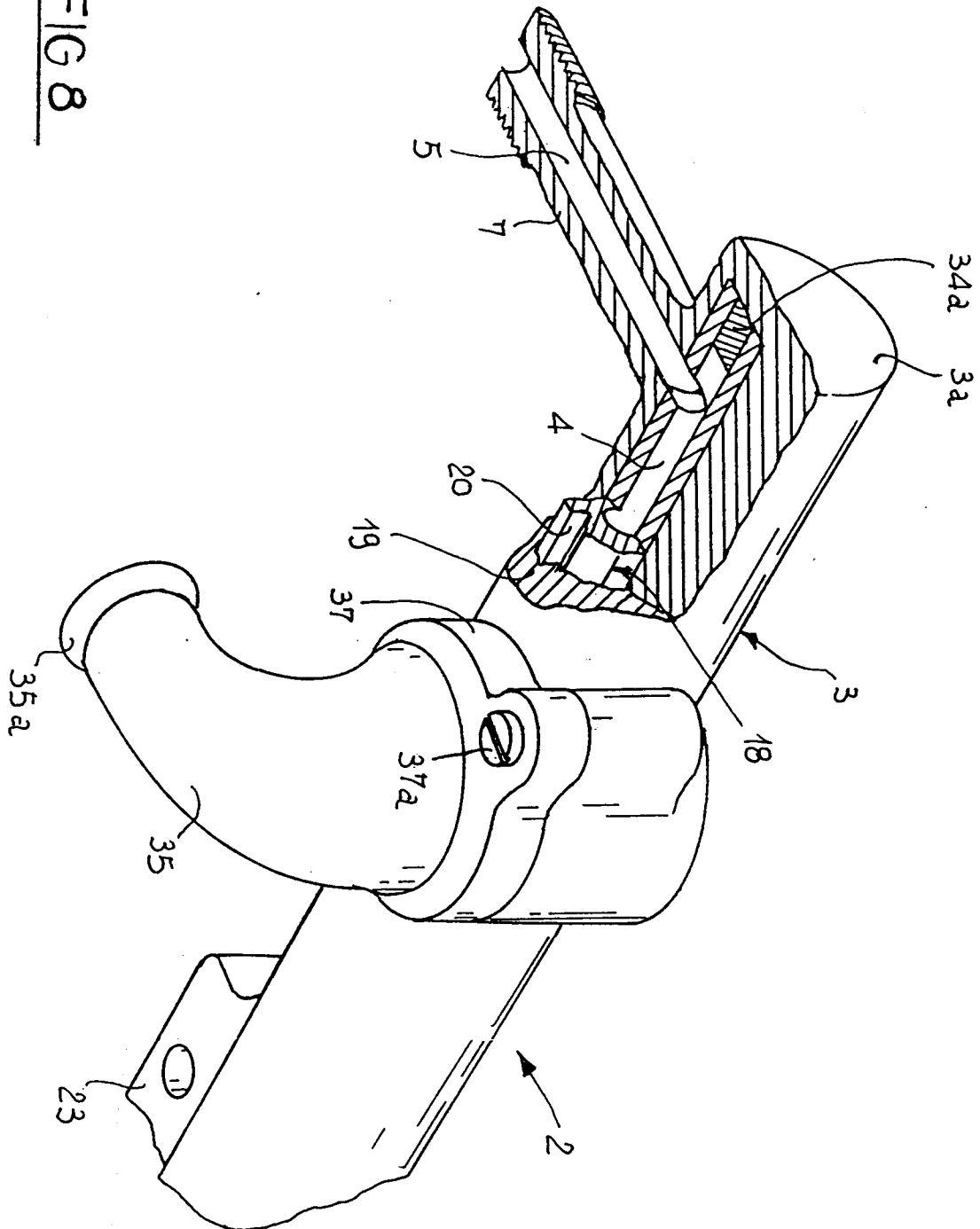


FIG. 6





F/G 8

FIG 9

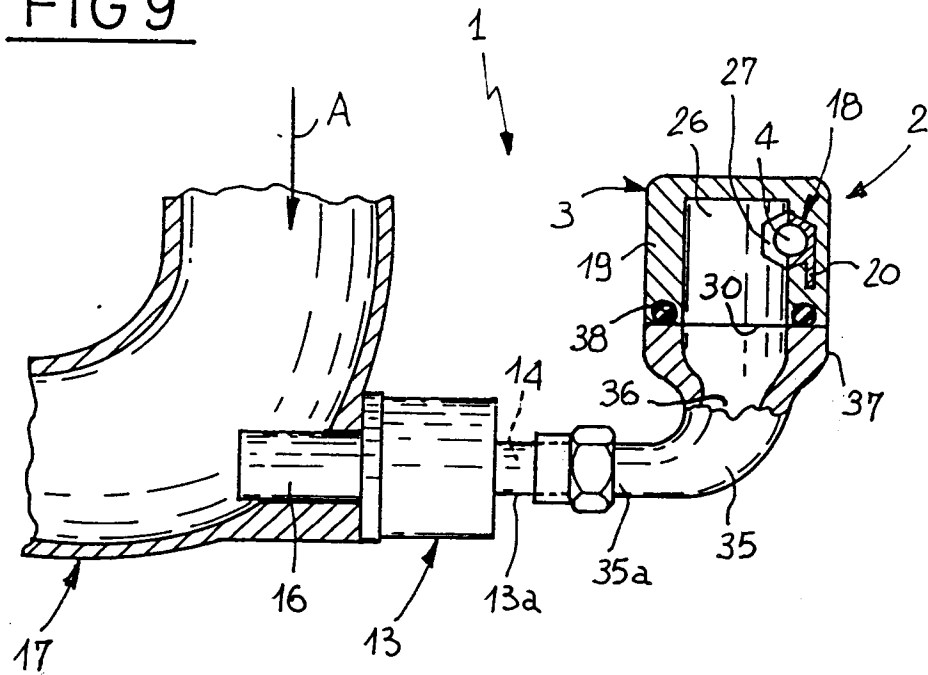
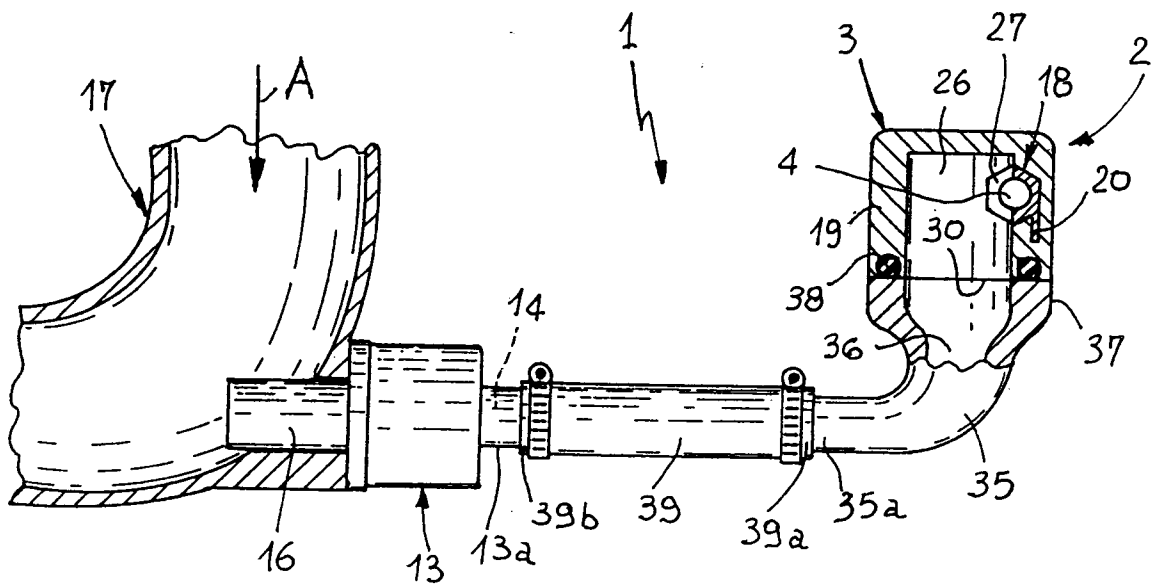


FIG 10





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number

EP 92 83 0511

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	US-A-4 836 246 (LEMP)	1,2,9,13	F02M69/46
Y	* column 2, line 24 - column 4, line 49; figure 7 *	3,14-18	
Y	---		
Y	EP-A-0 132 418 (DE BRUYN)	3	
A	* page 7, line 22 - line 28; figure 1 *	1	
Y	---		
Y	WO-A-9 013 741 (ROBERT BOSCH GMBH)	14,15	F02M
A	* page 4, paragraph 2; figures 2,3 *	1,13	
Y	---		
Y	GB-A-2 024 937 (ROBERT BOSCH GMBH)	16-18	
A	* the whole document *	1	
Y	---		
Y	US-A-4 964 381 (SHIOZAKI)	16,17	F02M
A	* column 4, line 32 - line 48; figures 5,6 *	1	

The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 30 NOVEMBER 1992	Examiner FRIDEN C.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			

EPO FORM 1503 01.92 (P0401)