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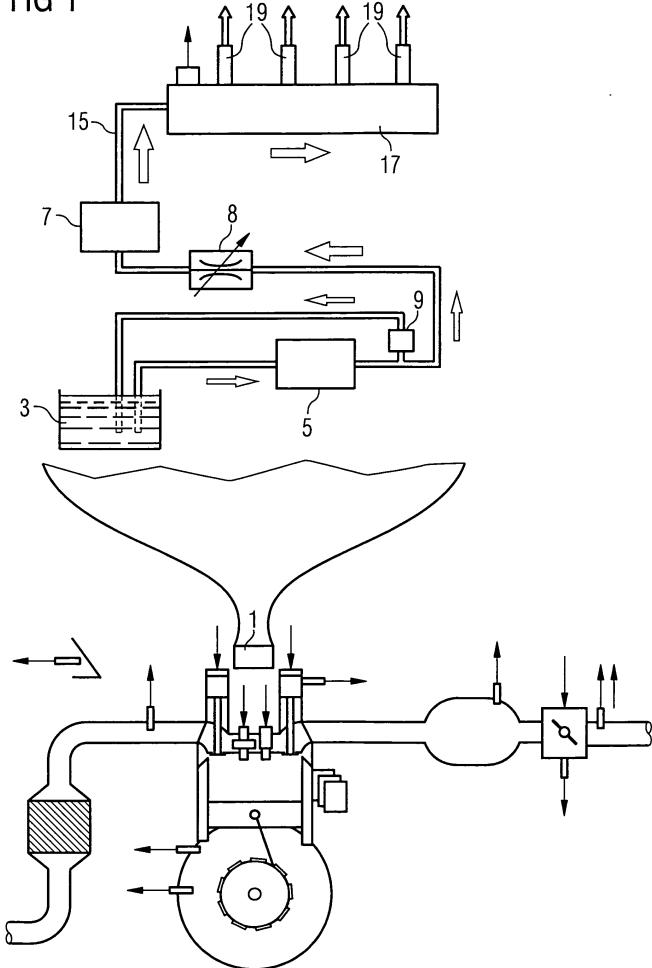
Remarks:

Amended claims in accordance with Rule 86 (2)
EPC.

(54) Fuel-rail and method for manufacturing a fuel-rail

(57) A fuel-rail (17) comprises a one piece formed hollow body (25), which has a rectangular cross-section and turns into a circular cross-section in an area (31, 33) of at least one axial end (27, 29) of the hollow body (25).

FIG 1



Description

[0001] The invention relates to a fuel-rail and a method for manufacturing a fuel-rail, in particular a fuel-rail for an internal combustion engine.

[0002] Internal combustion engines are more and more frequently equipped with injection valves, that are arranged inside a cylinder head and that inject the fuel directly into the combustion chamber of the cylinders of the internal combustion engine. Such fuel injection valves need to be supplied with fuel under high pressure in order to ensure a very fine atomization of the fuel in the combustion chamber. A very fine atomization of the fuel in the combustion chamber helps to reduce the emissions of the internal combustion engine. For that purpose fuel in the gasoline internal combustion engine is supplied with fuel under a pressure of up to 200 Bars.

[0003] In order to keep pressure fluctuations during the operation of the internal combustion engine at a very low level, internal combustion engines are supplied with a fuel accumulator, to which the injection valves are connected and which has a relatively large volume. Such a fuel accumulator is often referred to as a common rail. It may also be called a fuel-rail.

[0004] Known fuel-rails comprise a hollow body, which in the case of gasoline internal combustion engines is often formed with a rectangular cross-section. The hollow body has recesses, where connectors for the fuel injection valves are arranged. These connectors can best be tightly fitted into the recess, if the recess is formed in a planar surface. The rectangular hollow bodies have such planar surfaces and are therefore well-suited for that purpose and often need no additional treatment for making the surface planar. The connection of the hollow body to a supply, that supplies the fuel from a fuel tank via a low and/or high pressure fuel pump, needs to be tight and needs to withstand the high pressures. This supply is often connected at one axial end of the hollow body. On the other end of the hollow body a fuel pressure sensor or a fuel-pressure regulator valve may need to be installed.

[0005] The object of the invention is to create a fuel-rail and a method for manufacturing a fuel-rail which is simple.

[0006] The object is achieved by the features of the independent claims. Advantageous embodiments of the invention are given in the sub-claims.

[0007] The invention is distinguished by a fuel-rail with a one piece formed hollow body, which has a rectangular cross-section and turns into a circular cross-section in the area of at least one axial end of the hollow body. Such a fuel-rail has the advantage that it can withstand the high pressures because of its geometrical shape needed for high pressure internal combustion engines. It is further very easy to mount connectors for fuel injectors on the planar surfaces of the rectangular cross-section part of the hollow body. In addition to that the circular cross-section formed area is most suited for

connecting further elements. Threads, which ensure a very tight connection of the further elements, can easily be drilled inside the areas of the circular cross-section of the hollow body.

[0008] The method for manufacturing the fuel-rail is distinguished by the step of forming a hollow body, which has a rectangular cross-section, in the area of at least one axial end of the hollow body into a circular cross-section. Rectangular hollow bodies are widely and cheaply available as half-finished goods, which together with the forming process enables to produce a high quality and at the same time a fairly cheap fuel-rail.

[0009] In an advantageous embodiment of the method for manufacturing the fuel-rail the forming is being achieved by a cold forming process, which has the advantage that the hardness of the material stays unchanged.

[0010] Exemplary embodiments of the invention are explained in the following with the aid of schematic drawings. These are as follows:

Figure 1 an internal combustion engine with a fuel-rail and

Figure 2 a detailed representation of the fuel-rail according to Figure 1.

[0011] Elements of the same design and function that occur in different illustrations are identified by the same reference character.

[0012] An internal combustion engine (Figure 1) comprises an inlet manifold, an engine block, a cylinder head, an exhaust manifold and a fuel supply device 1. The fuel supply device 1 comprises a fuel tank 3, which is connected via a first fuel duct with a low pressure fuel pump 5. The output of the low pressure fuel pump 5 is connected to an input to a high pressure fuel pump 7. Connected to the output of the low pressure fuel pump 5 is also a mechanical regulator 9, which is connected on its output side via a further fuel duct with the fuel tank 3. The mechanical regulator 9 is preferably a simple spring-loaded valve in the form of a check valve. The spring constant of the check valve is preferably chosen in a way, that the connection between the low pressure fuel pump 5 and the high pressure fuel pump 7 a given low pressure of, for example, 3 to 6 Bars is not exceeded. The high pressure fuel pump 7 delivers fuel via a supply 15 to a fuel-rail 17. The high pressure fuel pump is in a preferred embodiment driven by a camshaft of the internal combustion engine.

[0013] In the preferred embodiment a final control element 8 is assigned to the high pressure fuel pump 7, that controls the volume flow, which is delivered by the high pressure fuel pump 7.

[0014] Injection valves 19 are connected to the fuel-rail 17 and are preferably located in the cylinder head of the internal combustion engine.

[0015] The fuel-rail (Figure 2) comprises a hollow body 25, which is generally rectangular-shaped in

cross-section. At a first axial end 27 and/or a second axial end 29 the hollow body 25 has an area 31 and/or an area 33, which has a circular cross-section. In the inner or outer wall of the area 31 and/or respectively the area 33 a thread may be drilled, which serves to connect the supply 15 or a fuel pressure sensor 21 or a fuel pressure regulator, which may comprise an electromagnetic actuator. The areas 31 and 33 are best suited for a drilling a thread because of their circular shape.

[0016] Connectors 35 for the fuel injection valves 19 are fitted into recesses of the hollow body 25 which are formed on one of its planar surfaces. The planar surfaces are best suited for establishing a very tight fit of the connectors 35.

[0017] The fuel-rail is manufactured by preferably using a prefabricated metal hollow body of a suitable metal and a wall thickness in order to withstand the pressures, under which the fuel-rail is to be operated. Such rectangular hollow bodies are widely available as half-finished goods and may be cut into the right length. The hollow body which at first has only a rectangular cross-section is formed in at least the area 31 or also the area 33 of at least one axial end into a circular cross-section. This is achieved by a suitable forming process. Preferably a cold forming process is used. Such a cold forming process has the advantage that the hardness of the material stays unchanged.

Claims

1. Fuel-rail with a one piece formed hollow body (25), which has a rectangular cross-section and turns into a circular cross-section in an area (31, 33) of at least one axial end (27, 29) of the hollow body (25). 30
2. Method for manufacturing a fuel-rail (17) which includes the step of forming a hollow body (25), which has a rectangular cross-section, in an area (31, 33) of at least one axial end (27, 29) of the hollow body (25) into a circular cross-section. 35
3. Method in accordance with claim 2 with the forming being a cold forming process. 40

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Amended claims in accordance with Rule 86(2) EPC.

1. Fuel-rail with a one piece formed hollow body (25), which has a rectangular cross-section and turns into a circular cross-section in an area (31, 33) of at least one axial end (27, 29) of the hollow body (25), characterized in that an inner or outer wall of said area (31, 33) of at least one axial end (27, 29) is threaded. 50
2. Method for manufacturing a fuel-rail (17) which 55

includes the step of forming a hollow body (25), which has a rectangular cross-section, in an area (31, 33) of at least one axial end (27, 29) of the hollow body (25) into a circular cross-section, characterized in that the step of drilling a thread in an inner or outer wall of said area (31, 33) of at least one axial end (27, 29) is included.

3. Method in accordance with claim 2, characterized in that the forming is a cold forming process.

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FIG 1

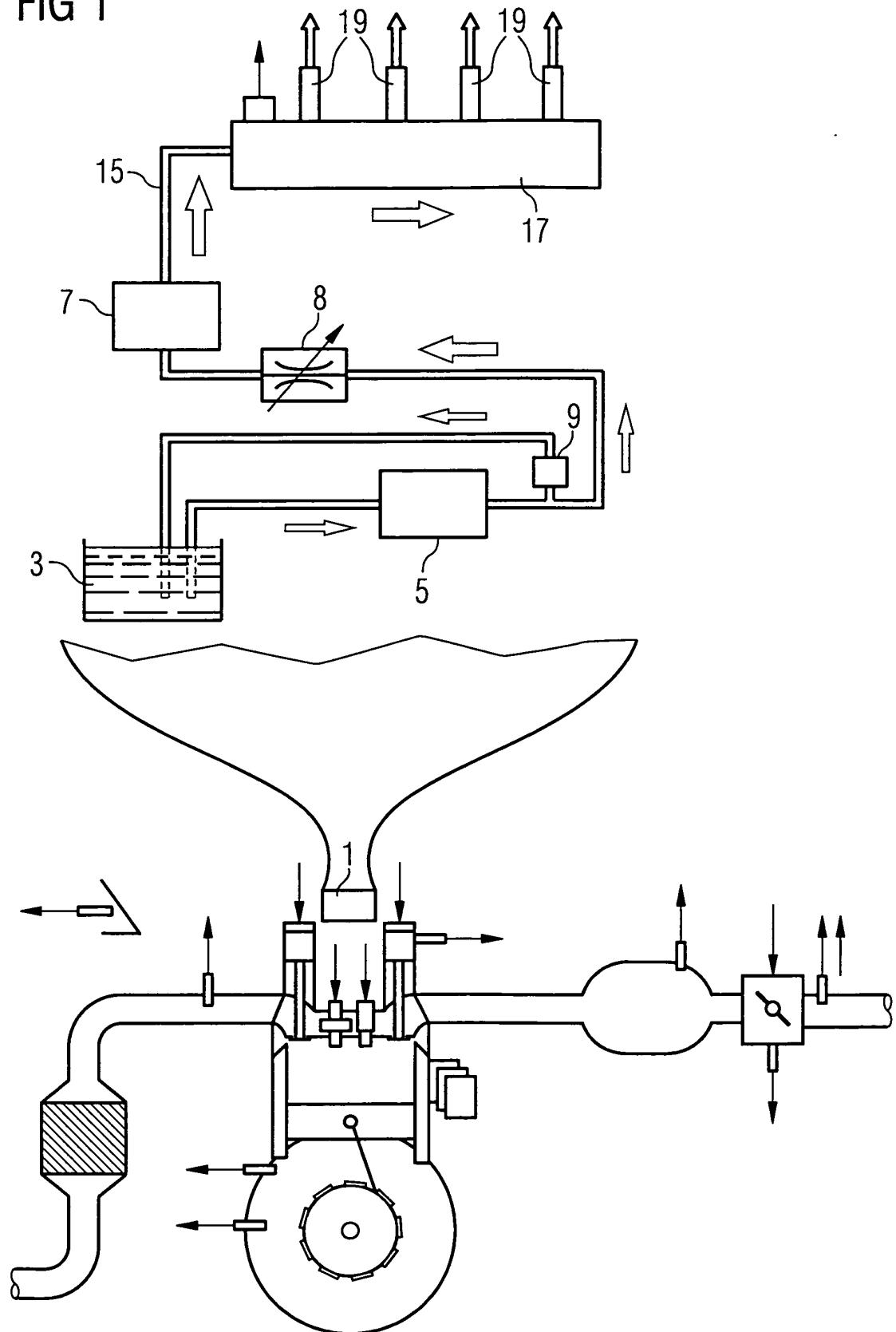
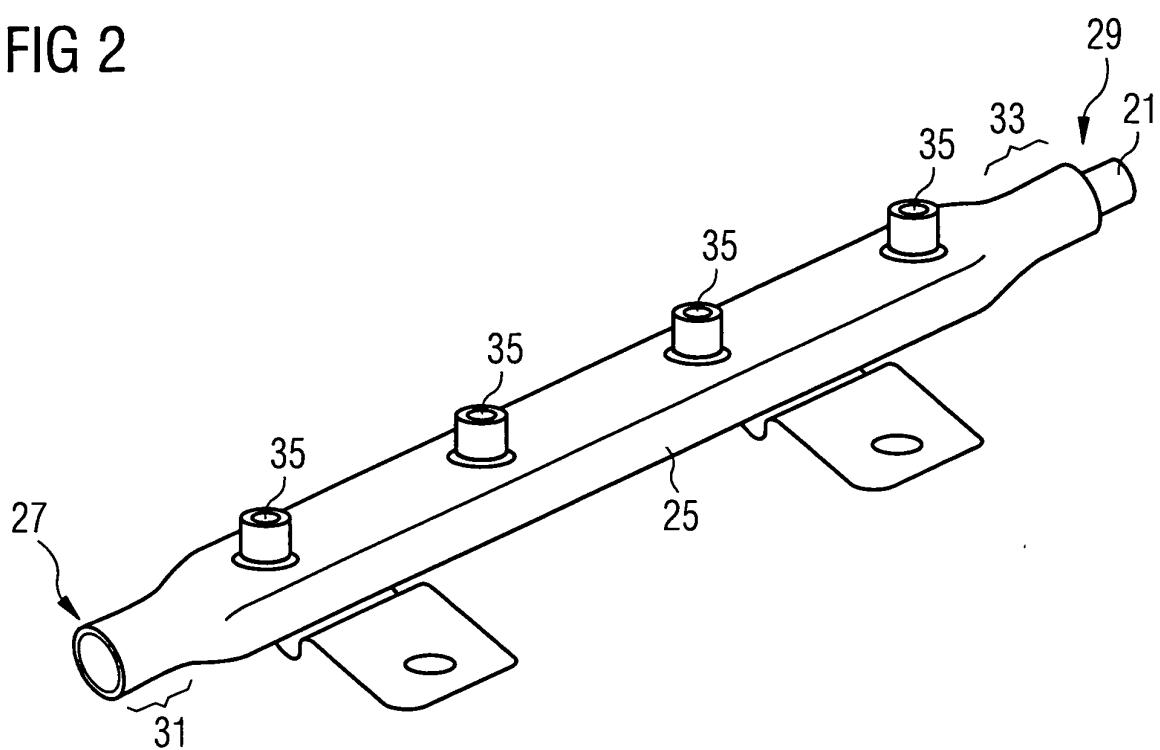


FIG 2





DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
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A	EP 1 318 292 A (DANA CORP) 11 June 2003 (2003-06-11) * the whole document *	1-3	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			F02M
The present search report has been drawn up for all claims			
2	Place of search	Date of completion of the search	Examiner
	Munich	30 March 2004	Wagner, A
CATEGORY OF CITED DOCUMENTS		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	
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			

**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on. The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

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