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(54) **COMMON RAIL**

(57) A high pressure reservoir (10) adapted to be arranged in a diesel fuel injection system, and comprising an outer forged tubular body in which is inserted a seamless tube, the inner space being defined inside the seamless tube.

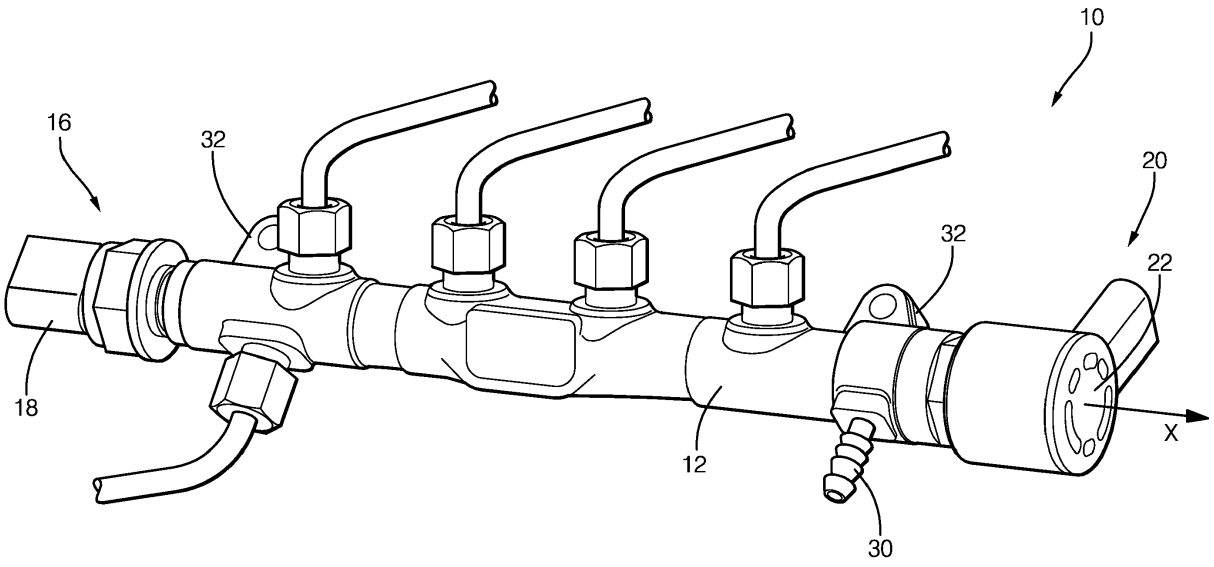

FIG. 1

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Description

TECHNICAL FIELD

[0001] The present invention relates to a high pressure reservoir adapted to be arranged in a fuel injection equipment.

BACKGROUND OF THE INVENTION

[0002] A diesel fuel injection equipment comprises a high pressure reservoir, commonly known as a common rail, wherein is delivered pressurized fuel and wherefrom depart pipes joining fuel injectors that spray, upon command, said pressurized fuel into compression chambers of an internal combustion engine. At both extremities of the rail are typically arranged a pressure sensor and a pressure limiting valve.

[0003] Considering that in use inner pressure fluctuation is important and lasts for very long, , said common rail is a highly stressed component typically manufactured by machining a forged blank. The manufacturing process comprises, in addition to the classical machining operations, autofrettage of the two extremities performed and creating residual compressive stresses acting against the radial stress and enabling longer fatigue cycling.

[0004] Rising required performance lead to further develop the rail.

SUMMARY OF THE INVENTION

[0005] Accordingly, it is an object of the present invention to resolve the above mentioned problems in providing a high pressure reservoir adapted to be arranged in a diesel fuel injection system, the reservoir extending along a main axis from a first end adapted to complementary receive a first device, such as a pressure sensor to, a second end adapted to complementary receive a second device, such as a pressure valve limiter. Said reservoir has a peripheral wall defining an inner space and, being further provided with a plurality of radial protrusions defining radial holes opening in said inner space and adapted to complementary receive inlet and outlet pipes. Advantageously, the reservoir comprises an outer forged tubular body in which is inserted a seamless tube, the inner space being defined inside the seamless tube.

[0006] Also, the seamless tube is press-fitted with interference.

[0007] Also, the opening of any radial channel into the inner space is surrounded by a female sealing face provided in the wall of the seamless tube, said female sealing face being adapted to receive in abutment a complementary male sealing face of an inlet or an outlet pipe.

[0008] More precisely, said female sealing face may be conical.

[0009] The nvention also extends to a method to manufacture a high pressure reservoir as described above. The method comprising the steps of:

a) providing a forged housing comprising a main member having an elongated shape extending along the main axis from a first end to a second end, and having a plurality of radial protrusions extending from said main member;
b) drilling said main member along said main axis in order to create a through axial hole having a predetermined diameter and extending from the first end to the second end; said through hole having a forged peripheral wall of a predetermined thickness;
c) providing a seamless tube with external diameter slightly larger than said predetermined diameter;
d) inserting the seamless tube inside the through hole, said insertion operation being done by press-fitting with interference fit.
e) drilling a through hole in the radial protrusions, the hole having substantially a constant large diameter through the forged housing, and having a reduced diameter through the seamless tube;
f) machining in the thickness of the seamless tube, a tapered sealing face surrounding the opening of the through hole, said sealing face joining the large diameter to the reduced diameter.

[0010] Also, said sealing face machined machined conical.

[0011] The method further comprising the step:

g) machining the first and second ends in order to be able to arranged at each end a first and a second device.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The present invention is now described by way of example with reference to the accompanying drawings in which:

Figure 1 is an isometric view of a high pressure reservoir as per the invention.
Figure 2 is an axial section of a portion of the reservoir of figure 1.
Figure 3 is a magnified are of figure 2.
Figure 4 is a schematic arrangement of an extremity of the reservoir of figure 1.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0013] In reference to the figures is described a high pressure reservoir 10, also known as a common rail 10, adapted to be arranged in a fuel injection equipment of an internal combustion engine. The rail 10 has an elongated body 12 defining, an inner space S surrounded by a peripheral wall 14 and, the rail 10 extends along a main axis X from a first end 16, on the left of the figure, where is arranged a first device 18 which here is a pressure

sensor to, a second end 20, right of the figure where is arranged a second device 22 here a pressure limiter.

[0014] In between said two ends 16, 20, the body 12 is provided with radial protrusions 24 each being centrally pierced and externally threaded so that a nut 26 can sealingly fix a high pressure pipe 28 for either delivering pressurized fuel into the inner space S or, for delivering said pressurized fuel from said inner space S toward fuel injectors.

[0015] In the example embodiment presented on figure 1, the rail 12 is adapted to a four cylinder engine and it is provided with one inlet and four outlets. Other engine types would require another rail with a different number of outlets.

[0016] Furthermore, the rail 12 is provided with a hose connector member 30 adapted to receive a flexible hose of a return line joining a low pressure tank enabling, in use, excess fuel in the rail to flow through said line when the pressure limiter 22 opens. Also, for fixing the rail 12 the body is provided with pierced fixing ears 32, two on the example of figure 1, the rail 12 being fixed via screws engaged through the hole of the fixing ears and tightened onto the engine block.

[0017] As visible on the section of figure 2, the body 12 comprises an outer member 34 and an inner member 36. The outer member 34 is a forged body, made of steel having low mechanical properties relatively to the inner member 36 that is a seamless tube which role is to reinforce the rail structure. The forged body 34 is provided with an axial X through hole 38 in which is press-fitted with interference the inner member reinforcement seamless tube 36.

[0018] As represented on figure 2 and magnified on figure 3, the protrusion 24 is provided with a radial hole 40 extending from the outer face of the protrusion and opening 42 in the inner space S. As shown, through the protrusion, the hole 40 is of constant diameter D40 enabling engagement of the high pressure pipe and, in the vicinity of the opening into the inner space S the section of said hole 40 restricts and is tapered so that a conical sealing face 44 is formed surrounding said opening 42. As visible on figure 3, said conical female sealing face 44 is mainly provided in the thickness of the seamless tube 36. It could be entirely in the thickness of the seamless tube 36.

[0019] Also, at the end of the high pressure pipe is provided an enlarged head portion defining on one side a shoulder joining the main part of the pipe and, on the other side at the very extremity of the pipe, a tapered male sealing face 46. Inside said extremity of the pipe, a restriction 48 to the inner conduit of the pipe is provided. As the head of the pipe is engaged in the radial hole 40, the male sealing face 46 complementary abuts against the female sealing face 44 and, the nut 26 is screwed on a thread externally provided around the protrusion. As the nut 26 is tightened, it generates a force sealingly forcing the male and female sealing faces 44, 46, against each other.

[0020] Conclusive tests have been performed with rail 10 having an overall length of 240mm and an outer diameter of the forged body 34 of 26 mm. The axial through hole 38 had a diameter of 14 mm and the interference press-fit was around 20μm. The seamless tube 36 inner diameter was of 8 mm, the wall thickness of the seamless tube being of 3mm.

[0021] Also, the forged body 34 has a yield strength of 650 MPa and an ultimate strength of 950 MPa while the seamless tube 36 had a yield strength of 1100 MPa and an ultimate strength of 1400 MPa.

[0022] Figure 4 sketches a section of the first end 16 of the rail. As represented, the seamless tube 36 ends before the forged body 34 and, the very portion of the forged body 36 is internally threaded. The pressure sensor 18 which is outwardly threaded is complementary screwed in the forged body 36 and, because of the different behavior of the materials and, of the sealing performance required, a metallic washer 50 is inserted between the end face of the seamless tube and the pressure sensor 18.

[0023] Thanks to this twin-concentric tube configuration the rail 10 is mechanically reinforced and the manufacturing is eased. Indeed, compared to an entirely forged body, the classical operations of autofrettage, the micro-hole machining of the inlet and outlets openings 42 into the inner space S and, the gun drill operation are removed.

[0024] The method of manufacturing 100 the rail comprises the steps of:

- providing 110 the forged body 34;
- drilling 120 in said forged body the axial through hole 38;
- machining 130 both ends of the forged body with required threads and other geometries enabling complementary arrangement of the first and second devices 18, 22;
- threading 140 the outer faces of the radial protrusions 24;
- providing 150 the seamless tube 36;
- inserting 160 with press-fit the seamless tube 36 in the forged body 34;
- radially drilling 170 the protrusions 24 to provide the radial hole 40;
- machining the female sealing faces 44.

LIST OF REFERENCES

[0025]

S	inner space
X	main axis
D40	diameter
10	high pressure reservoir - common rail
12	body
14	peripheral wall

16 first end
18 first device - pressure sensor
20 second end
22 second device - pressure limiter
24 radial protrusions
26 nut
28 high pressure pipe
30 hose connector member
32 fixing ear
34 outer member of the body - forged body
36 inner member of the body - seamless tube
38 axial through hole
40 radial hole
42 opening
44 female sealing face
46 male sealing face
48 restriction
50 washer

100 method
110 providing step
120 drilling step
130 machining step
140 threading step
150 providing step
160 inserting step
170 drilling step
180 machining step

Claims

1. High pressure reservoir (10) adapted to be arranged in a diesel fuel injection system, the reservoir (10) extending along a main axis (X) from a first end (16) adapted to complementary receive a first device (18) such as a pressure sensor to, a second end (20) adapted to complementary receive a second device (22) such as a pressure valve limiter; said reservoir (10) having a peripheral wall defining an inner space (S) and, being further provided with a plurality of radial protrusions (24) defining radial holes opening in said inner space (S) and adapted to complementary receive inlet and outlet pipes, **characterized in that** the reservoir (10) comprises an outer forged tubular body (34) in which is inserted a seamless tube (36), the inner space (S) being defined inside the seamless tube (36).

2. High pressure reservoir (10) as claimed in the preceding claim wherein the seamless tube (36) is press-fitted with interference.

3. High pressure reservoir (10) as claimed in any one of the preceding claims wherein, the opening of any radial channel into the inner space (S) is surrounded by a female sealing face (44) provided in the wall of the seamless tube, said female sealing face (44) being adapted to receive in abutment a complementary male sealing face (46) of an inlet or an outlet pipe.

4. High pressure fuel reservoir (10) as claimed in claim 3 wherein said female sealing face (44) is conical.

5. Method (100) to manufacture a high pressure reservoir (10) as claimed in any one of the preceding claims, the method comprising the steps of:

a) providing (110) a forged housing comprising a main member having an elongated shape extending along the main axis (X) from a first end (16) to a second end (20), and having a plurality of radial protrusions (24) extending from said main member;
b) drilling (120) said main member along said main axis in order to create a through axial hole having a predetermined diameter and extending from the first end to the second end; said through hole having a forged peripheral wall of a predetermined thickness;
c) providing (150) a seamless tube with external diameter slightly larger than said predetermined diameter;
d) inserting (160) the seamless tube inside the through hole, said insertion operation being done by press-fitting with interference fit.

6. Method (100) as claimed in claim 5 further comprising the step:

e) drilling (170) a through hole in the radial protrusions, the hole having substantially a constant large diameter through the forged housing, and having a reduced diameter through the seamless tube.

7. Method (100) as claimed in claim 6 further comprising the step:

f) machining (180) in the thickness of the seamless tube, a tapered sealing face surrounding the opening of the through hole, said sealing face joining the large diameter to the reduced diameter.

8. Method (100) as claimed in claim 7 further where said sealing face is machined conical.

9. Method (100) as claimed in any one of the claims 6 to 8 further comprising the step:

g) machining the first and second ends in order to be able to arranged at each end a first and a second device.

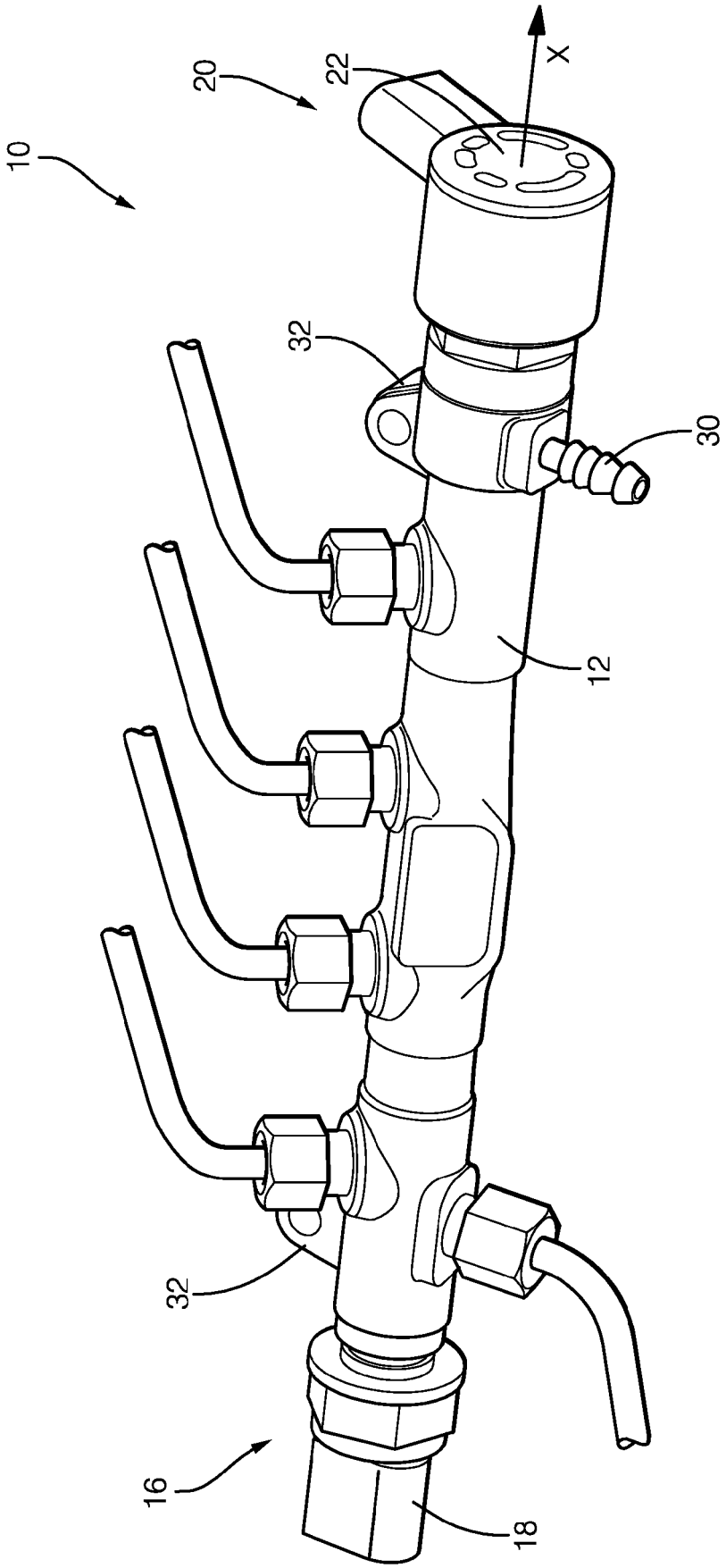

FIG. 1

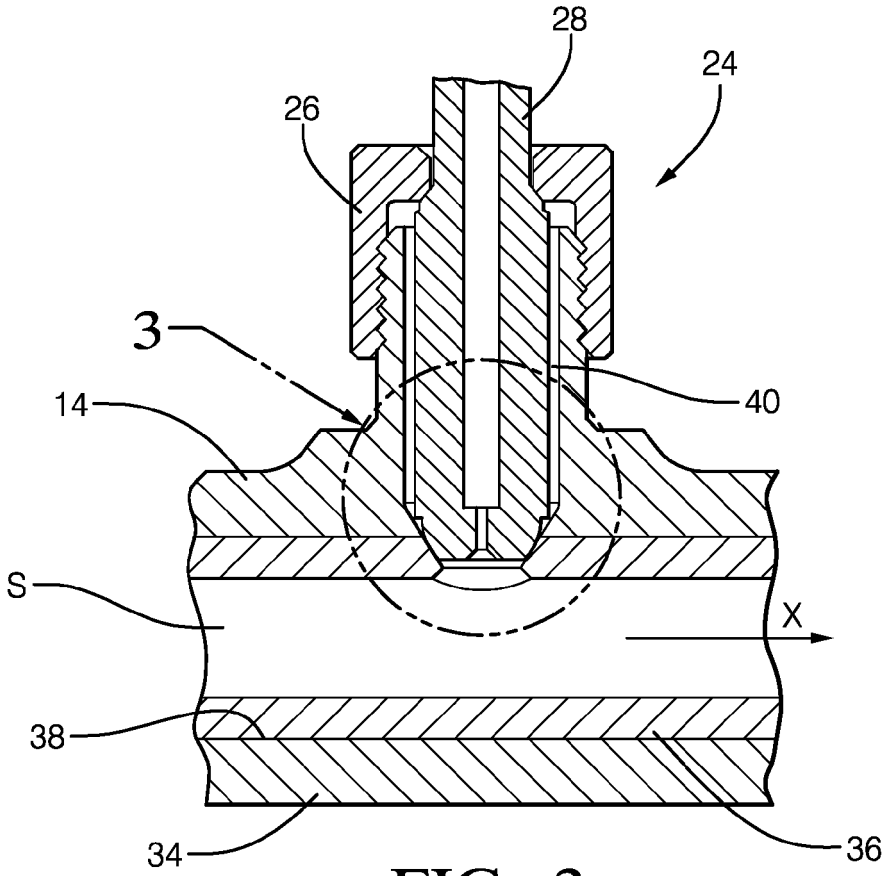

FIG. 2

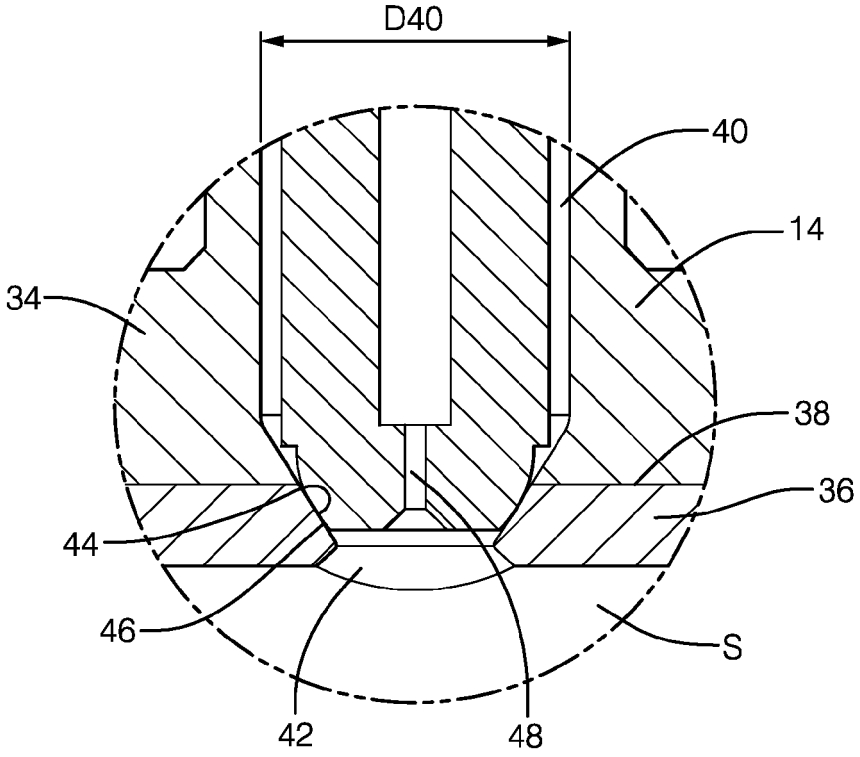

FIG. 3

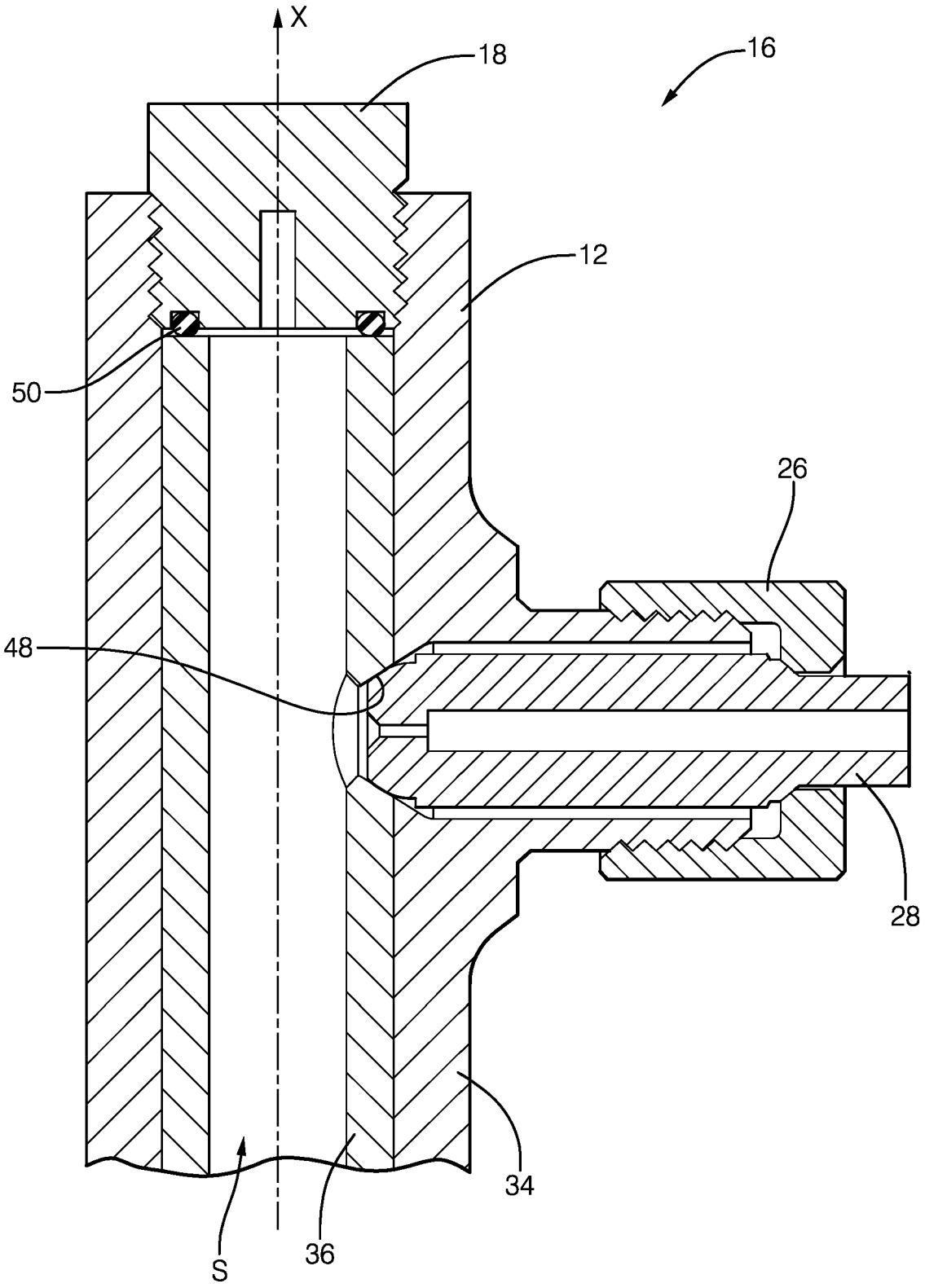

FIG. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 17 17 2586

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	JP 2000 073908 A (DENSO CORP) 7 March 2000 (2000-03-07) * paragraph [0012] - paragraph [0028]; figures 1,2 * * abstract * -----	1,2,5,7, 8 6,9	INV. F02M55/02
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X	DE 103 03 853 A1 (SCHMITTERSYSCO GMBH [DE]) 12 August 2004 (2004-08-12) * paragraph [0008] - paragraph [0029]; figure 1 * * abstract * -----	1,3,4	

TECHNICAL FIELDS SEARCHED (IPC)

F02M

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	14 September 2017	Hermens, Sjoerd

CATEGORY OF CITED DOCUMENTS

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