(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 112 700 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
04.01.2017 Bulletin 2017/01

(51) Int Cl.:
F15C 1/00 *(2006.01)* ***F02M 59/46*** *(2006.01)*
F02M 37/00 *(2006.01)*

(21) Application number: **16177181.1**

(22) Date of filing: **30.06.2016**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD

(30) Priority: **03.07.2015 GB 201511665**

(71) Applicant: **Delphi International Operations Luxembourg S.à r.l.**
4940 Bascharage (LU)

(72) Inventor: **MCHATTIE, James**
Bean, Kent DA2 8AL (GB)

(74) Representative: **Delphi France SAS**
Patent Department
22, avenue des Nations
CS 65059 Villepinte
95972 Roissy CDG Cedex (FR)

(54) VALVE

(57) A valve section comprising a first portion (4) and a second portion (6), and a valve assembly comprising a first portion (4) and a plurality of second portions (6), wherein a fluid pathway comprising curved surfaces, provided on a bore of the second portions and/or on a protruding part of the first portion, provide switch backs to alter the pressure of fluid such as fuel flowing in either direction through the valve, and in an alternative embodiment, a valve section comprising a venturi provided by a narrow drilling.

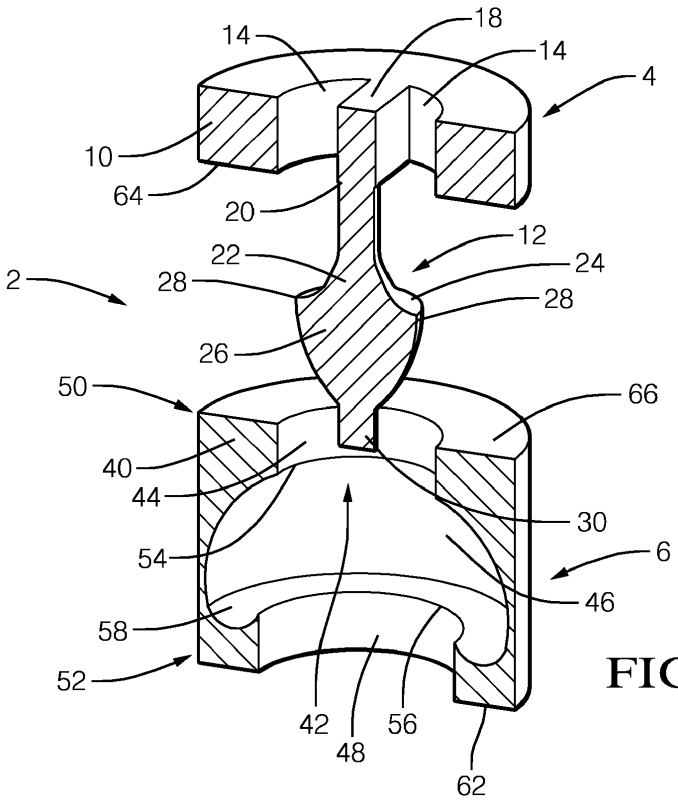

FIG. 1

EP 3 112 700 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to fluid valve, for example a fuel valve for use in a pump assembly of a diesel engine.

BACKGROUND OF THE INVENTION

[0002] High pressure diesel fuel pumps inherently create complex flows, often shuttling and with pulsating pressure.

[0003] In many situations it is advantageous to control these flows, in order to protect other system components from the damage of reverse flow or the increase in pressure that reverse flow will create.

[0004] Examples of currently known valves, used to eliminate reverse flow, are poppet valves and ball valve. However these prior art valves have moving parts, and this incurs durability and cost penalties, and also often requires a method of actuation and/or timing.

[0005] A further known valve, as described in US patent application US1329559A (Tesla), comprises a single-piece valve having a maze of switch-backs, allowing almost free flow in one direction, whilst encouraging the formation of eddies in the opposite direction. By creating eddies, the flow is disrupted, accordingly causing a slowing of subsequent flow. This results in a partial fluid-lock effect, which hinders flow considerably.

[0006] The Tesla valve has limited flexibility due to the single-piece design.

SUMMARY OF THE INVENTION

[0007] It is an object of the present invention to provide an improved valve system which at least mitigates the problems of the prior art valves discussed above.

[0008] Accordingly the present invention provides, in a first aspect, a valve section according to claim 1.

[0009] The protruding part of the valve may have an outer profile which comprises curved surfaces. Additionally or alternatively, the bore of the or each second valve portion may comprise a curved profile.

[0010] Furthermore, the bore of the or each second valve portion may further comprise a curved recess.

[0011] In one embodiment, the valve comprises a single valve section, comprising one second valve portion, wherein an underside face of the first valve portion abuts an upper end face of the second valve portion.

[0012] In a further aspect, the present invention comprises a valve assembly comprising a plurality of second valve portions stacked on top of one another; wherein an underside face of the first valve portion abuts an upper end face of an uppermost second valve portion; and wherein an underside end face of the uppermost second valve portion abuts an upper end face of a further second valve portion.

[0013] In the valve assembly, the protruding part of the first valve portion may extend through the bores of all second valve portions.

[0014] Preferably, the valve has a cylindrical outer profile.

[0015] The present invention also comprises a method of assembling a valve assembly, the method comprising:

stacking the second valve portions on top of one another; and

subsequently, locating the first valve portion on top of the uppermost second valve portion.

[0016] In an alternative embodiment, the present invention comprises a valve comprising a valve section body and a central section; the valve body section comprising a first portion, a second portion, and a mid-portion provided between the first portion and the second portion; wherein a fluid flow path is enabled around the central section and between the central section and the valve section body; wherein the flow path comprises a first flow path section of substantially uniform cross-sectional area, provided in the first portion, a second flow path section of substantially uniform cross-sectional area, provided in the second portion, and a flow path of varying cross-sectional area, provided in the mid-portion; and wherein the flow path in the mid-portion is split between a venturi provided by a drilling, and a main mid-portion flow path, and wherein the flow path in the mid-portion is also split by a fork.

[0017] The valve may comprise a valve section, or may comprises a valve assembly comprising a plurality of valve sections.

[0018] The present invention provides a valve section and a valve assembly which require no moving parts. Accordingly, the present invention avoids the durability and cost penalties encountered with moving-part prior art valves, and also avoid the necessity for a method of actuation and/or timing required for such prior art valve embodiments.

[0019] The present invention also provides a modular cartridge system, which is more package-friendly than the prior valve embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] The present invention is now described by way of example with reference to the accompanying Figures in which:

Figure 1 is an expanded isometric view of a valve section in accordance with a first embodiment of the present invention in cross-section;

Figure 2 is an isometric view of the valve section of Figure 1 in an assembled state;

Figure 3 is an isometric view of the valve section of

Figure 1 in the assembled state;

Figure 4 is an isometric view of a stacked valve assembly in accordance with the present invention;

Figure 5 is a longitudinal cross-sectional view of a valve section in accordance with a further embodiment of the present invention;

Figures 6 and 7 are axial cross-sectional views of the valve section of Figure 5;

Figure 8 is a cross-sectional view of a flow path provided by the valve section of Figure 5; and

Figure 9 is cross-sectional view of a valve assembly in accordance with the further embodiment of Figures 5 to 8.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0021] Referring to the Figures, the present invention comprises a valve, comprising either a valve portion, or a valve assembly.

[0022] Referring to Figures 1 to 3, a first embodiment of the present invention comprises a valve comprising a valve section 2, comprising a first valve portion 4 and a second valve portion 6.

[0023] The first valve portion 4 comprises an annular end portion 10, and a protruding part 12. The end portion 10 has a central section which comprises cut-outs 14, and a bridge section 18, which connects the protruding part 12 to the end portion 10.

[0024] The second valve portion 6 comprises an elongated cylindrical member 40, which is provided with a bore 42.

[0025] To assemble the valve section 2, the protruding part 12 of the first valve portion 4 is inserted into the bore 42 of the second valve section 4, until an underside face 64 of the end portion 10 of the first valve portion 4 abuts an upper end face 66 of the cylindrical member 40 of the second valve portion 6.

[0026] The outer diameter of the end portion 10 of the first valve portion 4 is equal to that of the cylindrical member 40, such that the assembled valve section 2 comprises an elongate cylindrical component. A fluid pathway is enabled through the valve section 2 via the cut-outs 14 provided in the end portion 10 of the first valve section 4, and the bore 42 of the second valve section 6. The fluid pathway is therefore provide between the protruding part 12 and the bore 42.

[0027] The behaviour of fluid passing through the fluid pathway is affected by the varying cross-sectional form of the fluid pathway, which is determined by the external form of the protruding part 12, and by the form of the bore 42, and in particular by curved surfaces of the protruding part 12 and the bore 42, as explained in greater detail below.

[0028] Moving from top to bottom in the orientation of Figures 1 to 3, the protruding part 12 comprises a first, cylindrical portion 20 which extends away from the bridge section 18. A second portion 22, extending from the first portion 20, has a curved outer profile, which increases non-linearly in diameter moving away from the first portion 20, such that an outer surface 24 of the second portion 22 is curved. A third portion 26 extending from the second portion 22 has a maximum diameter, at a junction 28 with the second portion 22, which is equal to a maximum diameter of the second portion 22 at the junction 28. Moving away from the second portion 22, the third portion 26 decreases non-linearly in diameter such that an outer surface 28 of the third portion 26 is also curved. A fourth portion 30 extending from the third portion 26 is cylindrical, having a diameter which is equal to a minimum of the third portion 26.

[0029] The bore 42 comprises a first section 44, a second section 46, and a third section 48. The first section 44 and the third section 48 are provided towards a first end 50 and second end 52 of the second valve portion 6 respectively, wherein the first end 50 is proximate to, and the second end 52 remote from, the first valve portion 4.

[0030] The second section 46 of the bore 42 is located between the first section 44 and the third section 48. At a junction 54 with the first section 44, the second section 46 has a diameter which is equal to that of the first section 44. At a junction with the third section 48, the second section 46 has a diameter which is equal to that of the third section 48.

[0031] Moving from the junction 54 with the first section 44, to a junction 56 with the third section 48, the second section 48 initially increases non-linearly in diameter, and subsequently forms a curved recess 58, adjacent the third section 48. The profile of the second section 46 is therefore curved.

[0032] In use of the valve section 2, fluid flowing through the valve section 2, initially through the first valve portion 4 and subsequently through the second valve portion 6, i.e. in either a free direction (indicated by arrow A in Figures 2 and 3), or a restrictive direction (indicated by arrow B in Figures 2 and 3), is guided by the curved outer surfaces of the protruding part 12 of the first valve portion 4, and by the curved profile of the second section 46 of the bore 42 of the second valve portion 6. The recess 58 provides a hair-pin turn in the fluid pathway, which provides a switch-back effect. As a result of following the hair-pin turn provided by the curved recess 58, fluid flow around this point is disrupted. Specifically, the flow is either hindered, or reversed.

[0033] The disruption of the fluid flow in the region of the recess 58 causes a slowing of approaching fluid flow, and a valve effect is thereby achieved.

[0034] Referring to Figure 4, a valve comprising a valve assembly 100 can be formed by stacking a plurality of second valve portions 6 on top of each other, i.e. such

that an upper end face 66 of one second valve portion 6 abuts an underside end face 62 of a further second valve portion 6. After the plurality of second valve portions 6 have been stacked on top of one another, a single first valve portion 4 is provided on the top of the stacked second valve portions 6, such that the underside face 64 of the first valve portion 4 abuts the upper end face 66 of the uppermost second valve portion 6 of the stack.

[0035] In the stacked valve assembly, the protruding part 12 of the first valve portion 4 may be elongated (with respect to that illustrated in Figures 1 to 3), and may be of sufficient length to protrude through the bores 42 of all second valve portions 6 in the stack. The elongated protruding part 12 may comprises a repeated series of the profile of the protruding part 12 illustrated in Figures 1 to 3, such that the profile of the fluid pathway of the valve portion 2 of Figure 1 is repeated throughout the stacked valve assembly.

[0036] In the stacked valve assembly 100, the effect slowing effect which each valve portion 2 has on fluid flow is cumulative, i.e. a chain of switch-backs created by the stack increases the valve effect.

[0037] The present invention provides a valve and a valve assembly which has no moving parts. Furthermore, as the outer profiles of the valve section 2, and the stacked valve assembly 100, are cylindrical, the valve section 2 or assembly 100 can be inserted into a simple drilling.

[0038] The present invention can be used to prevent reverse flow from a digital inlet valve from reaching an inlet of a diesel fuel pump. This allows greater control of fuel flow, and therefore a more stabilised inlet pressure / pressure at fuel filter.

[0039] The profiles of the curved sections of the fluid pathway provided by the present invention, i.e. the radii and angles of the protruding part 12 and the bore 42, can be selected for optimum performance of the valve portion 2 or assembly 100.

[0040] Figure 5 is a longitudinal cross-sectional view of a valve in accordance with a further embodiment of the present invention.

[0041] Figure 6 is an axial cross-sectional view of the further embodiment taken at section 6-6 as indicated on Figure 5, i.e. through a restricted section 204 of the valve section 302.

[0042] Figure 7 is an axial cross-sectional view of the further embodiment taken at section 7-7 as indicated on Figure 5, i.e. taken at an end 214 of a narrow drilling 202 of the valve section 302.

[0043] The alternative valve comprises a valve section 302, formed of a valve section body 304 and a central section 312, wherein a fluid flow path 200 is enabled around the central section 312, i.e. between the valve section body 304 and the central section 312.

[0044] The valve section body comprises a first portion 306, a second portion 308, and a mid-portion 310 provided between the first and second portions 306, 308.

[0045] Figure 6 is an axial cross-sectional view of the further embodiment taken at section 6-6 as indicated on Figure 5, i.e. through a restricted flow path section 204 provided in the mid-portion 310 of the valve section 302.

[0046] Figure 7 is an axial cross-sectional view of the further embodiment taken at section 7-7 as indicated on Figure 5, i.e. taken at an end 214 of a narrow drilling 202 provided in the mid-portion 310 of the valve section 302.

[0047] Figure 8 is a cross-sectional view of a section of the fluid flow path 200 enabled by the alternative valve of Figure 5.

[0048] Referring to Figure 5, a first flow path section 206 of substantially uniform cross-section area is enabled in the first portion 306 of the valve section body 304. A second flow path section 308 of substantially cross-sectional area is enabled in the second portion 308 of the valve section body 304. A flow path of varying cross-sectional area, including the restricted flow path section 204, is enabled in the mid-portion 310 of the valve section body 304.

[0049] In the further embodiment of Figures 5 to 8, a switch-back effect is provided by the narrow drilling 202, which becomes a funnel for a venturi. The flow path in the mid-portion 310 is therefore split between a main mid-portion flow path 216, and a flow path through the drilling 202, such that fluid may flow through either the main mid-portion flow path 216, and/or through the drilling 202, as described below.

[0050] In a free direction (i.e. in the direction of arrow F, from right to left in the orientation of Figures 5 and 8), flow having an initial high pressure in the first flow path section 206 provided in the first valve body section 306, avoids the drilling 202, and passes through the main mid-portion flow path 216 and the restricted section 204. Fluid pressure is caused to drop within the restricted section 204. Pressure is quickly regained as the flow path widens from the restricted section 204 to the second flow path section 208 provided in the second portion 308 of the valve body 304.

[0051] In a restrictive direction (i.e. in the direction of arrow R, from left to right in the orientation of Figures 5 and 8), the flow increases in velocity (and therefore decreases in pressure) in the restricted section 204, and as a result, fluid is pulled through the narrow drilling 202 by a venturi effect.

[0052] Fuel continues from left to right and is split by a fork 210 provided in the mid-portion 310 of the valve section body 304. Some of the fluid flow is thereby stopped, and creates and area 212 of high pressure which the narrow drilling 202 feeds off. As flow in the narrow drilling 202 has low pressure at the end 214 remote from the high pressure area 212 one end and high pressure at the other, the drilling 202 is fed with fuel, raising the pressure of flow (and the quantity of fluid in the volume of the drilling 202). Once the flow reaches an area where it can slow down, it requires more volume and this slows it further.

[0053] In the free direction, fluid pressure changes (from right to left) from high pressure to mid-high pres-

sure. In the restrictive direction, fluid pressure changes (from left to right) from high pressure to low pressure, as energy has been taken from the system.

[0054] A plurality of valve sections 302 may be stacked together to form a valve assembly 400 as illustrated in Figure 9. In this stacked embodiment, the effect of pressure change (in either the free or restrictive direction) is increased.

REFERENCES

First embodiment

[0055]

valve section 2
first valve portion 4
second valve portion 6
annular end portion 10
protruding part 12
cut-outs 14
bridge section 18
protruding part first portion 20
protruding part second portion 22
protruding part second potion outer surface 24
protruding part third portion 26
section / third portion junction 28
third portion outer surface 28
protruding part fourth portion 30
second valve portion cylindrical member 40
second valve portion bore 42
bore first section 44
bore second section 46
bore third section 48
second valve potion first end 50
second valve potion second end 52
first / second bore portion junction 54
second / third bore potion junction 56
recess 58
second valve portion underside end face 62
first valve portion underside face 64
cylindrical member upper end face 66
valve assembly 100
restrictive flow direction arrow A
free flow direction arrow B

Second embodiment

fluid flow path 200
narrow drilling 202
restricted flow path section 204
flow path section 206
flow path section 208
fork 210
high pressure area 212
narrow drilling end 214
main mid-portion flow path 216
valve section 302
valve section body 304
valve section body first portion 306
valve section body second portion 308
valve section body mid-portion 310
central portion 312
valve assembly 400

Claims

1. A valve (2, 100) comprising a first valve portion (4) part and at least one second valve portion (6);
the first valve portion (4) comprising an end portion (10) from which a protruding (12) part extends into a bore (42) of the or each second valve portion (6);
wherein a fluid pathway is through the first valve portion (4) and the or all second valve potions (6);
wherein the fluid pathway has a varying cross-sectional form" wherein the protruding part (12) has an outer profile which comprises curved surfaces (24, 28)"
wherein the bore (42) of the or each second valve portion (6) comprises a curved profile (46),
wherein the bore (42) of the or each second valve portion (6) further comprises a curved recess (58)

2. A valve (2) as claimed in claim 1, comprising one second valve portion (6), wherein an underside face (64) of the first valve portion (4) abuts an upper end face (66) of the second valve portion (6).

3. A valve (100) as claimed in claim 1, comprising a valve assembly (100);
the valve assembly (100) comprising a plurality of second valve portions (6) stacked on top of one another;
wherein an underside face (64) of the first valve portion (4) abuts an upper end face (66) of an uppermost second valve portion (6);
and wherein an underside end face (62) of the uppermost second valve portion (6) abuts an upper end face (66) of a further second valve portion (6).

4. A valve (100) as claimed in claim 3 wherein the protruding part (12) of the first valve portion (4) extends through the bores (42) of all second valve portions (6).

5. A valve (2, 100) as claimed in any one of the preceding claims wherein the valve has a cylindrical outer profile.

6. A method of assembling a valve (100) in accordance with claim 3 or claim 4 comprising:

stacking the second valve portions (6) on top of one another; and
subsequently, locating the first valve portion (4) on top of the uppermost second valve portion (4).

7. A valve (302, 400) comprising a valve section body (304) and a central section (312);
the valve body section (304) comprising a first portion (306), a second portion (308), and a mid-portion (310) provided between the first portion (306) and the second portion (308);
wherein a fluid flow path (200) is enabled around the central section (312) and between the central section (312) and the valve section body (304);
wherein the flow path (200) comprises a first flow path section (206) of substantially uniform cross-sectional area, provided in the first portion (306), a second flow path section (208) of substantially uniform cross-sectional area, provided in the second portion (308), and a flow path of varying cross-sectional area, provided in the mid-portion (310);
and wherein the flow path in the mid-portion (310) is split between a venturi provided by a drilling (202), and a main mid-portion flow path (216), and wherein the flow path in the mid-portion (310) is also split by a fork (210).

8. A valve (302) as claimed in claim 7 comprising a valve section (302).

9. A valve (400) as claimed in claim 7 comprising a valve assembly (400), the valve assembly comprising a plurality of valve sections (302).

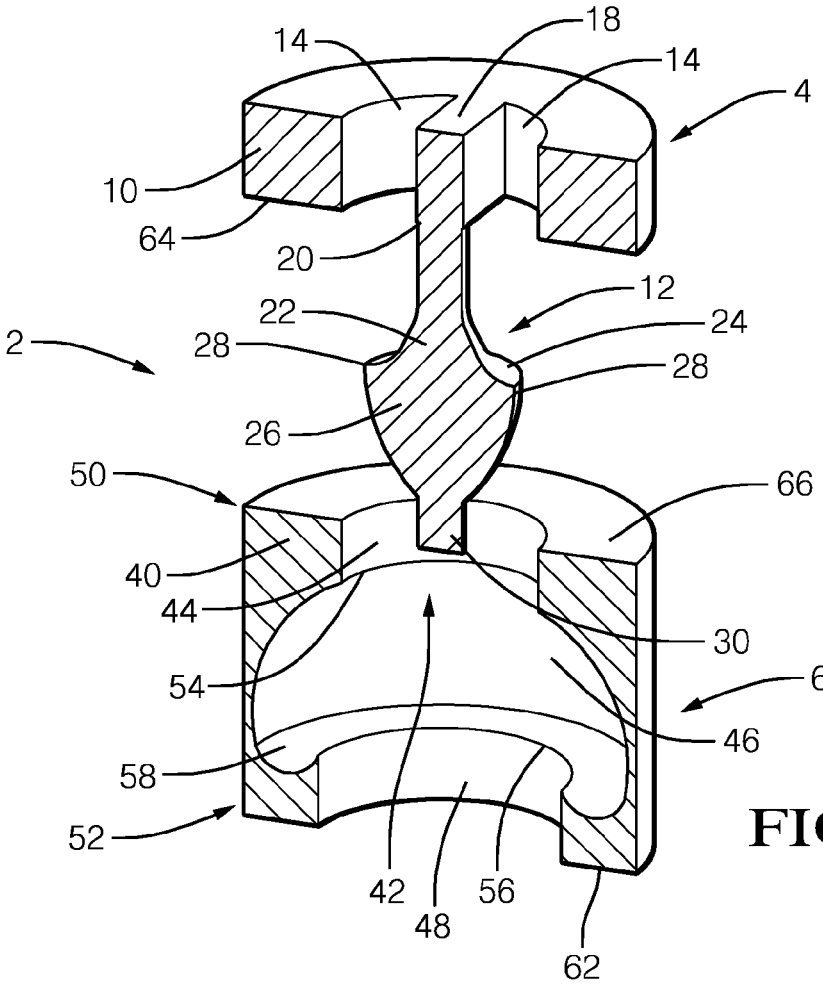
18
14
14
4
10
64
20
12
22
24
2
28
28
26
50
66
40
44
30
6
54
46
58
52
42
56
48
62

FIG. 1

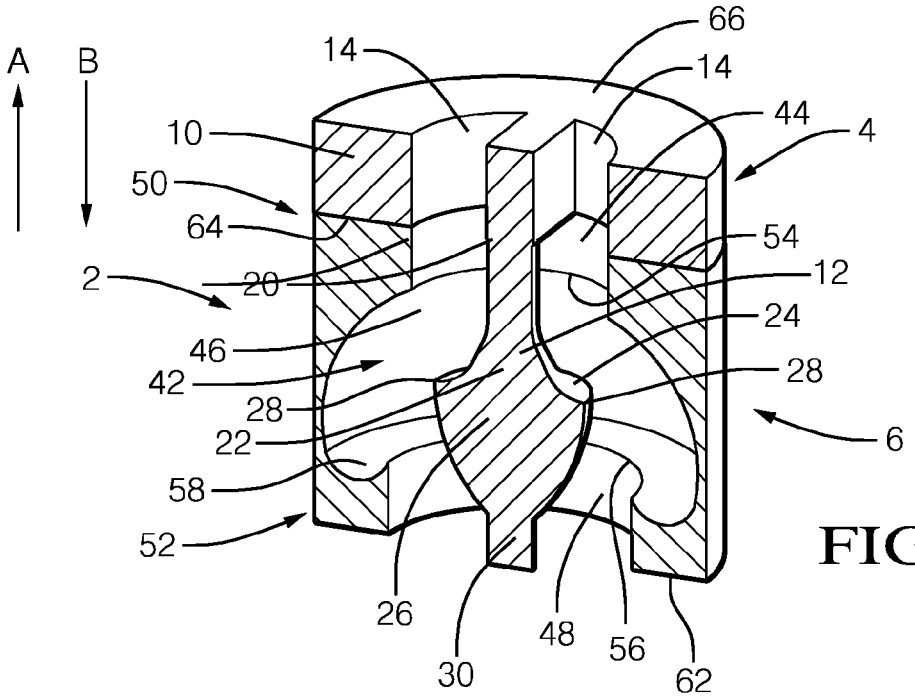
A
B
66
14
14
44
10
4
50
64
54
2
20
12
24
46
42
28
28
22
6
58
52
26
30
48
56
62

FIG. 2

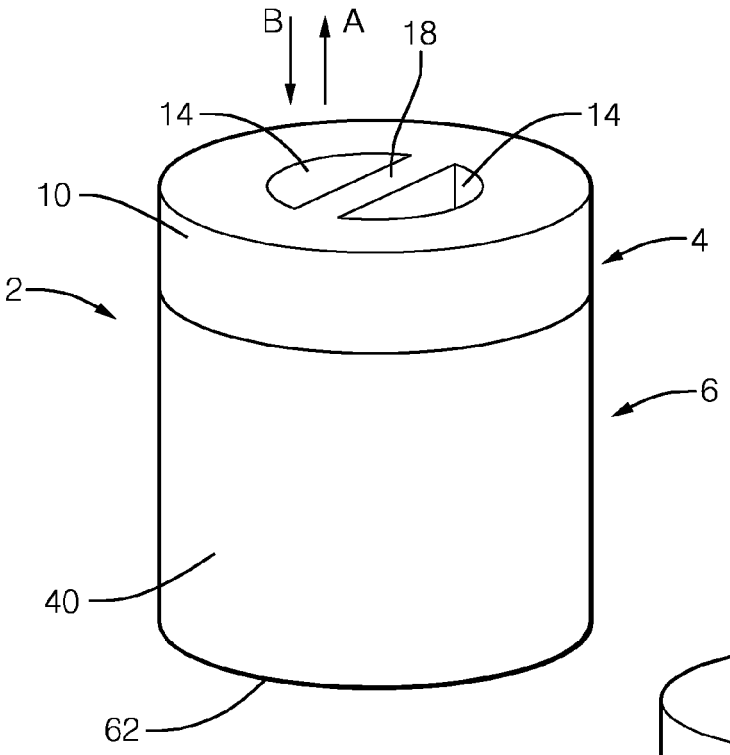

FIG. 3

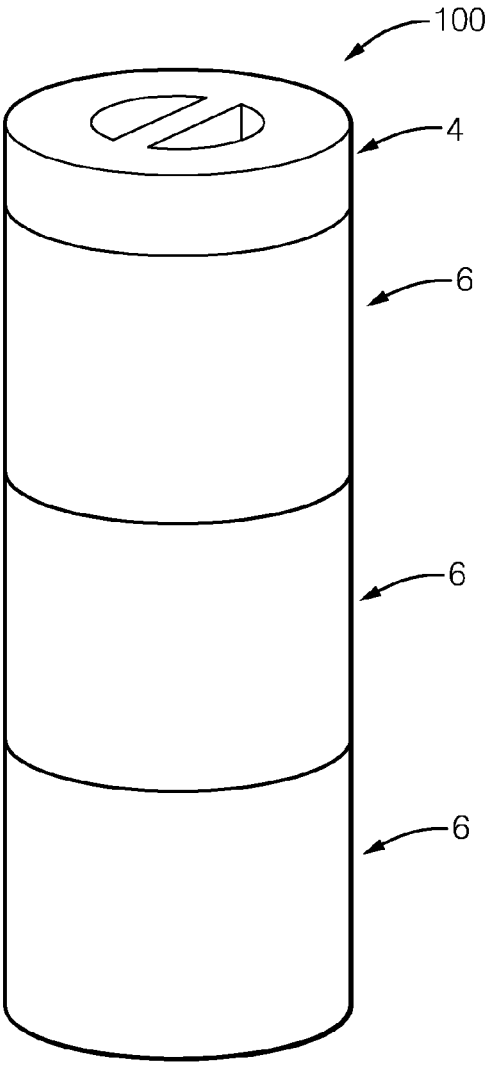

FIG. 4

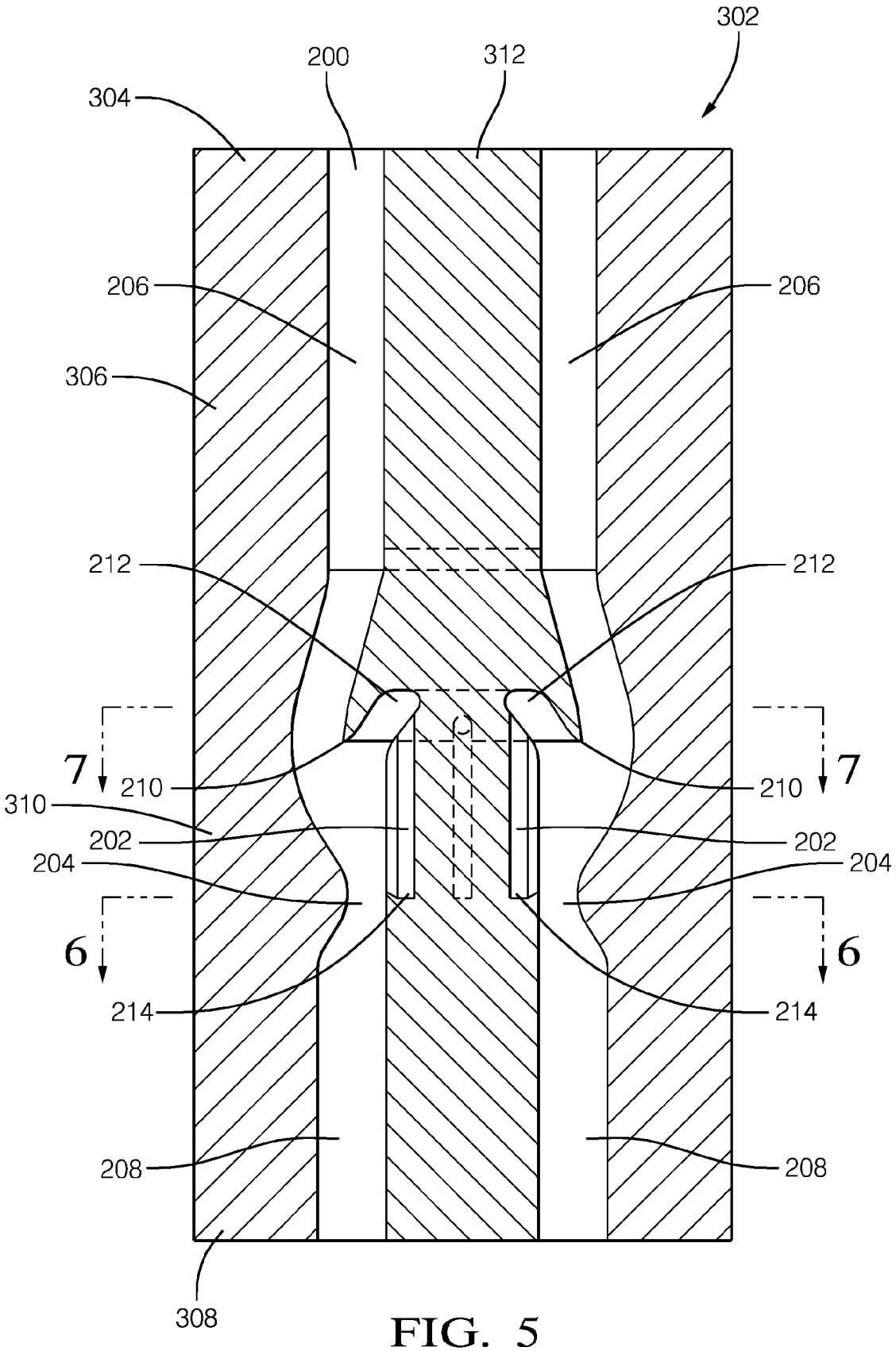
302
200
312
304
206
206
306
212
212
7
7
210
210
310
202
202
204
204
6
6
214
214
208
208
308

FIG. 5

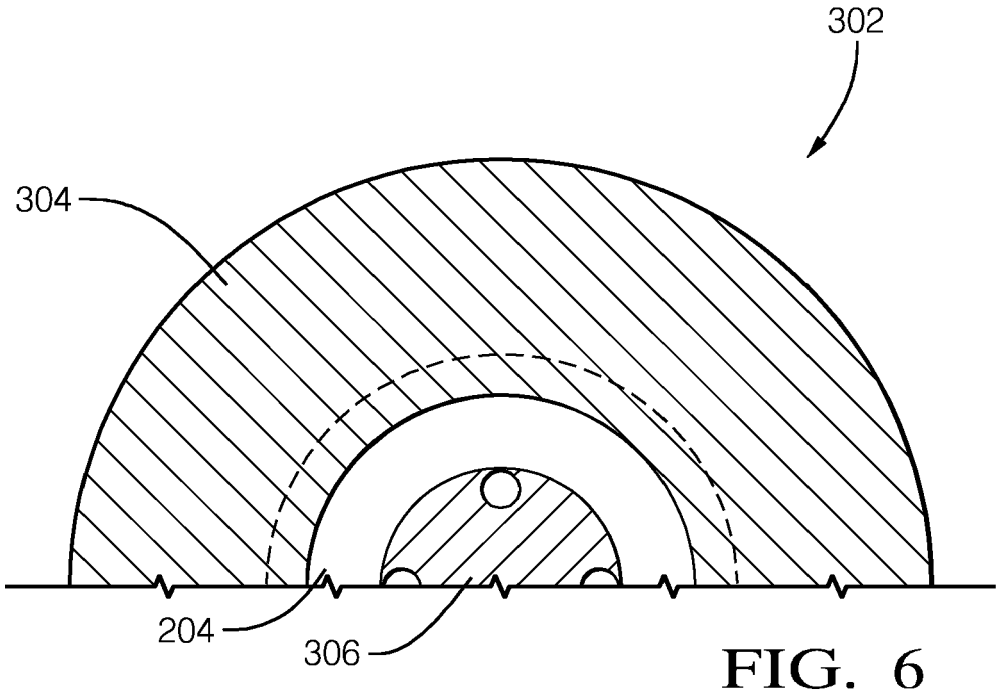

FIG. 6

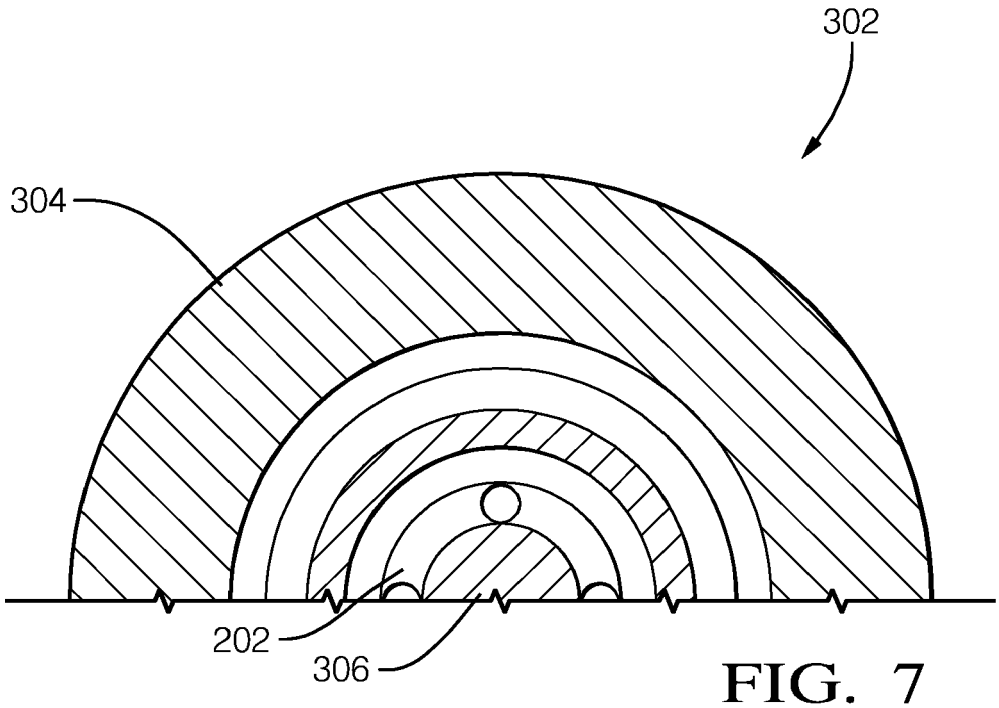

FIG. 7

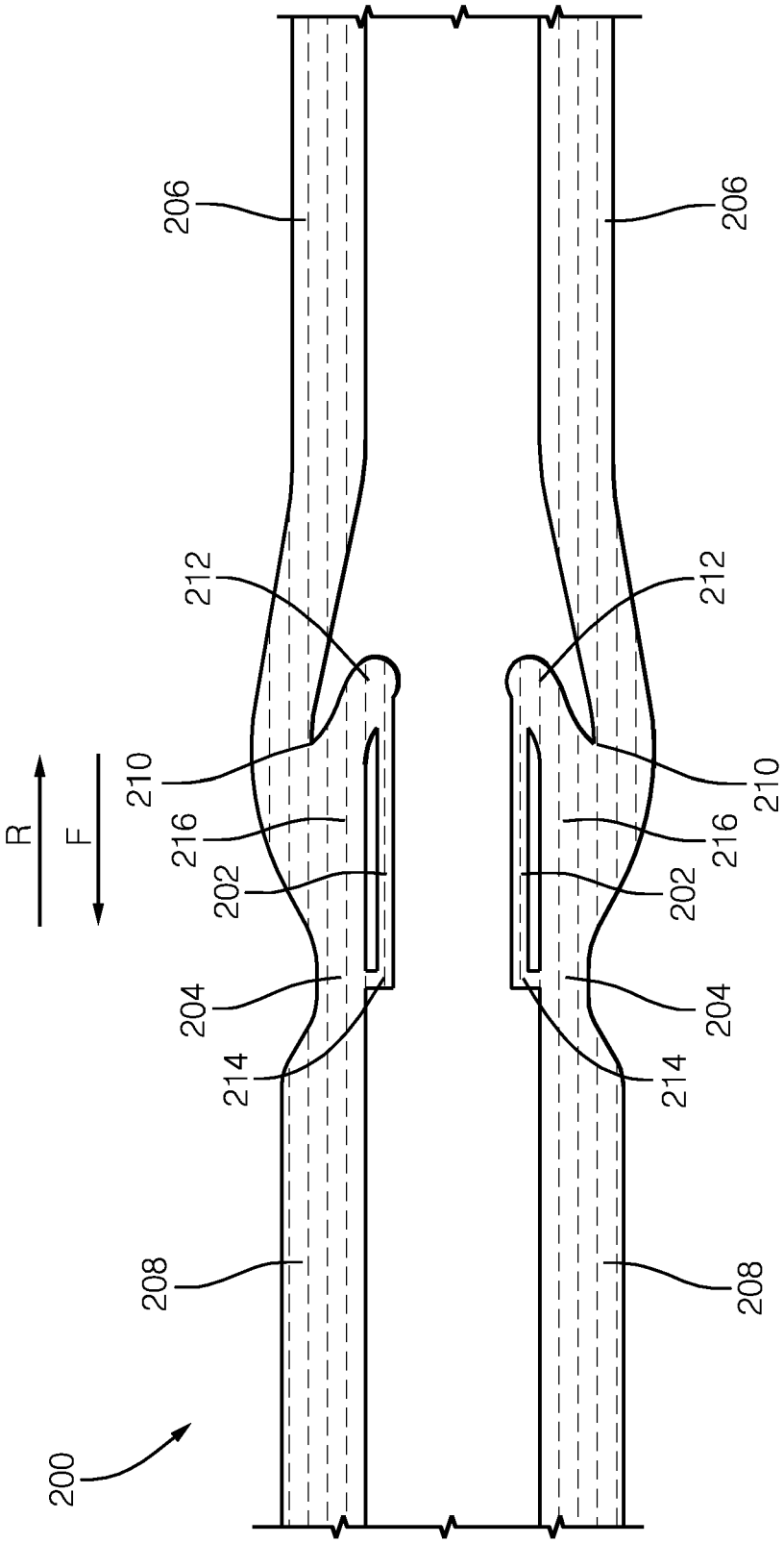
206
206
212
212
210
210
216
216
202
202
204
204
214
214
208
208
200
R
F

FIG. 8

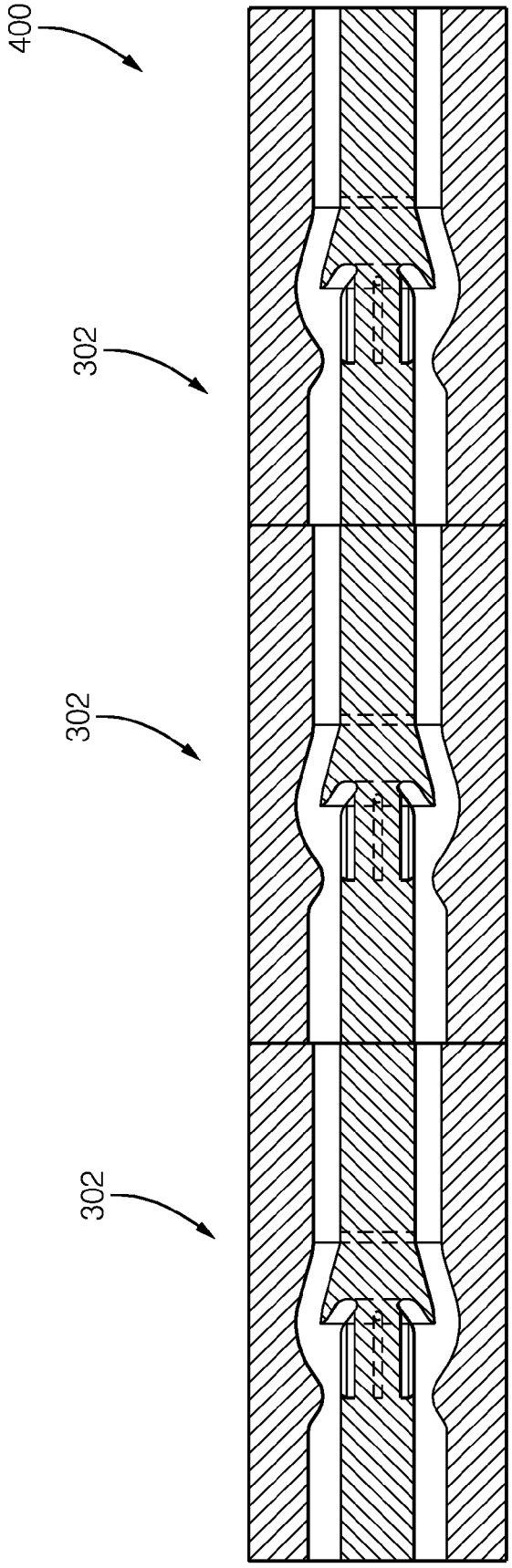

FIG. 9

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 16 17 7181

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	US 2004/134550 A1 (TREUSCH CHRISTOPHER JOHN [US] ET AL) 15 July 2004 (2004-07-15)	1,2,5	INV. F15C1/00 F02M59/46 F02M37/00
A	* figure 6 *	3,4,6	

X	EP 2 811 145 A1 (TOYOTA MOTOR CO LTD [JP]) 10 December 2014 (2014-12-10)	1	
A	* figures 2A,2B,2E *	7	

X	US 2011/036408 A1 (DESAI ASHVIN D [US]) 17 February 2011 (2011-02-17)	1,2	
A	* figures *	3,4,6	

X	US 2 618 925 A (WISLICENUS GEORGE F) 25 November 1952 (1952-11-25)	1,5	
A	* figures *	7-9	

X	US 2011/139453 A1 (SCHULTZ ROGER L [US] ET AL) 16 June 2011 (2011-06-16)	1,5	
A	* figures 11-13 *	7-9	

X	US 2014/151062 A1 (STEPHENSON STANLEY V [US] ET AL) 5 June 2014 (2014-06-05)	1,5	TECHNICAL FIELDS SEARCHED (IPC)
A	* figures 4-6 *	7-9	F15C F02M

X	US 3 543 781 A (KENTFIELD JOHN A C) 1 December 1970 (1970-12-01)	1	
A	* abstract; figures 6,7 *	7-9	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	19 October 2016	Landriscina, V

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 03.82 (P04C01)

Europäisches Patentamt
European Patent Office
Office européen des brevets

Application Number
EP 16 17 7181

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing claims for which payment was due.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☒ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☐ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

☐ The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).

Europäisches Patentamt
European Patent Office
Office européen des brevets

LACK OF UNITY OF INVENTION
SHEET B

Application Number
EP 16 17 7181

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-9

   Valve according to claim 1, method according to claim 6 for assembling a valve and valve according to claim 7

1.1. claims: 1-6

   Valve according to claim 1 and method according to claim 6 of assembling a valve

1.2. claims: 7-9

   Valve according to claim 7

Please note that all inventions mentioned under item 1, although not necessarily linked by a common inventive concept, could be searched without effort justifying an additional fee.

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 16 17 7181

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.

19-10-2016

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2004134550 A1	15-07-2004	DE 102004001214 A1	29-07-2004
		GB 2397341 A	21-07-2004
		US 2004134550 A1	15-07-2004
EP 2811145 A1	10-12-2014	CN 104081036 A	01-10-2014
		EP 2811145 A1	10-12-2014
		JP 5673864 B2	18-02-2015
		JP WO2013114606 A1	11-05-2015
		KR 20140110038 A	16-09-2014
		RU 2014131890 A	27-03-2016
		US 2014366963 A1	18-12-2014
		WO 2013114606 A1	08-08-2013
US 2011036408 A1	17-02-2011	CN 101994861 A	30-03-2011
		US 2011036408 A1	17-02-2011
US 2618925 A	25-11-1952	NONE	
US 2011139453 A1	16-06-2011	AU 2010328400 A1	21-06-2012
		BR 112012013850 A2	10-05-2016
		CA 2782343 A1	16-06-2011
		CN 102725478 A	10-10-2012
		CO 6501126 A2	15-08-2012
		DK 2510187 T3	27-01-2014
		EC SP12011960 A	31-07-2012
		EP 2510187 A2	17-10-2012
		RU 2012122630 A	20-01-2014
		SG 181544 A1	30-07-2012
		US 2011139453 A1	16-06-2011
		WO 2011071830 A2	16-06-2011
US 2014151062 A1	05-06-2014	NONE	
US 3543781 A	01-12-1970	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 1329559 A **[0005]**