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(54) Title: AUTOMOTIVE COOLANT DISTRIBUTOR

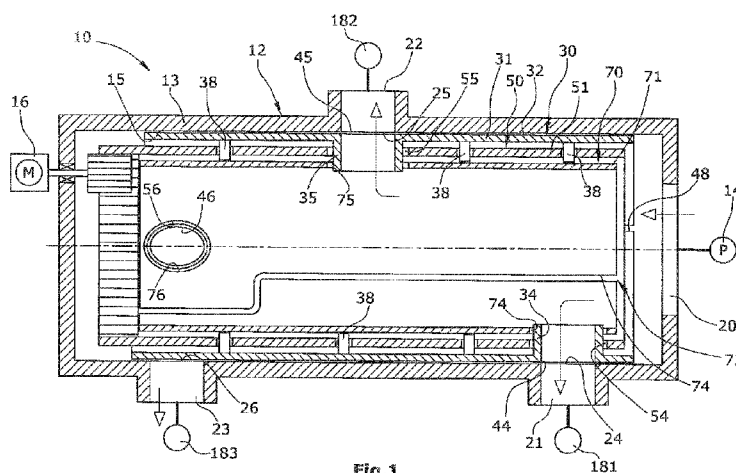


Fig. 1

(57) Abstract: The invention refers to an automotive coolant distributor (10) for selectively distributing a coolant liquid to at least two coolant outlets (21, 22, 23), comprising a distributor housing (12) with a coolant inlet (20) and the at least two distributor outlets (21, 22, 23), and a rotatable and flexible valve element (30) rotatably provided within the distributor housing (12), wherein the distributor housing (12) being provided with at least one radial housing valve opening (24, 25, 26) and the valve element (30) being provided with at least one radial valve element opening (44, 45, 46) which interferes with the radial housing valve opening (24, 25, 26) in a rotational opening position of the valve element (30), the valve element (20) is provided with a separation (48) over the entire axial length of the valve element (30), so that the valve element (30) radially can expand or compress, and the valve element (30) is pretensioned radially outwardly so that the outside surface (32) of the valve element (30) is in sealing contact with the inside surface (15) of the distributor housing (12).



Automotive coolant distributor

The invention refers to an automotive coolant distributor for selectively
5 distributing a coolant liquid to at least two different coolant outlets.

The automotive coolant distributor is used for complex thermal management of the engine and other secondary devices of an automotive vehicle. A typical variation of an automotive coolant distributor is a rotor valve which is provided with a distributor housing with a coolant inlet and
10 at least two distributor outlets. A rotatable valve element is rotatably provided within the distributor housing. The distributor housing is provided with at least two radial housing valve openings and the valve element is also provided with at least two radial valve element openings which interfere with the radial housing valve openings in a rotational opening
15 position of the valve element.

A typical automotive coolant distributor is disclosed in W0 2014/184783 A1. A sensitive issue is the sealing between the static distributor housing and the rotating valve element because the coolant liquid can have an overpressure of up to 1 bar. The sealing is realized by a separate sealing
20 sleeve which is radially shiftable arranged within every socket of the corresponding housing valve opening and which is radially inwardly pretensioned by a pretension spring. Every housing valve opening socket is provided with a separate sealing sleeve.

It is an object of the invention to provide an automotive coolant distributor
25 of the rotor valve type with a simple sealing arrangement.

This object is solved with an automotive coolant distributor with the features of main claim 1.

The automotive coolant distributor according to the invention is of the rotor valve type, and is provided with a distributor housing with a coolant

inlet and at least two coolant outlets. The distributor housing is preferably cylindrical in shape, and preferably most of the coolant outlets and the coolant inlet are provided radially, namely with a radial flow direction through the inlet or outlet. The coolant inlet is preferably provided axially.

5 The distributor housing body is preferably made out of metal, but can also be made out of plastic.

A rotatable and flexible valve element is rotatably provided within the distributor housing. The rotation axis of the valve element defines the axial direction of the coolant distributor. The valve element is preferably
10 cylindrical in shape and is provided with a separation over the entire axial length of the valve element so that the valve element can expand or compress radially. The separation can be provided as a longitudinal slit over the entire axial length of the valve element. As a consequence, the valve element is flexible in radial and/or in circumferential direction so that
15 the outer diameter of the valve element can adapt to the inner diameter of the distributor housing. The valve element is rotated directly or indirectly by a suitable actuator, for example by a small electric motor.

The distributor housing is provided with at least two radial housing valve openings and the valve element is provided with at least two radial valve
20 element openings which interfere with the radial housing valve openings in a rotational opening position of the valve element. Since more than one radial housing valve opening and more than one corresponding valve element opening are provided, more than one rotational opening position of the valve element can exist, in which none, one, numerous or all radial
25 valve element openings are radially in-line with the corresponding radial housing valve openings. The coolant liquid can be selectively directed to a plurality of distributor outlets dependent on the thermal needs of the connected devices.

The valve element is pretensioned radially outwardly so that the outside
30 surface of the valve element is always in sealing contact with the inside surface of the distributor housing. The pretensioning of the valve element

can be realized with different means and in different manners. However, the pretensioning can be realized for substantially the complete valve element or for some areas only, and is in particular realized in the areas around the valve element openings. As a result, only one single
5 pretensioning means is necessary to provide a sufficient and reliable sealing quality between the inner surface of the distributor housing and the outer surface of the valve element. The pretensioning means can be constructed relatively simple so that a cost-effective sealing arrangement for all distributor outlets can be provided.

10 Preferably, a separate spring element is provided for pretensioning the valve element radially outwardly. The spring element is provided co-rotatably with the valve element. The spring element is pretensioned radially outwardly and is in radial contact with the valve element to push the valve element radially to the outside against the inside surface of the
15 distributor housing. The radial contact can be realized as several punctual contacts, as several line contacts and/or as a plane contact. The contacts can in particular be concentrated at the opening areas and edges of the valve element openings. Since the spring element is provided separately from the valve element, both bodies can be optimized for their respective
20 function, namely providing a suitable material combination for good sealing and good frictional quality, and providing good long term spring quality.

Preferably, the spring element is defined by a metal sheet spring made out of a spring metal material. Preferably, the spring element is provided
25 separately from the valve element and is arranged radially inwardly of the valve element.

According to a preferred embodiment, the spring element is provided with a separation over the entire axial length of the spring element. The separation can be realized as a slit over the entire axial length of the
30 spring element. The separation allows the spring element to radially expand or compress so that the spring element can adapt to a

considerable variation of the diameter of the inside surface of the distributor housing.

Preferably, the valve element is made out of plastic. The plastic body guarantees - in combination with a metal distributor housing - a low frictional coefficient so that only relatively low actuation forces are necessary to rotate the valve element within the distributor housing. The valve element made out of plastic can have a relatively complex form and can be produced cost-effectively. The plastic valve element is also relatively flexible and adaptable so that a good sealing quality is realized.

According to a preferred embodiment of the invention, a separate and stiff valve support element can be provided which is stiffer than the valve element and is co-rotatably fixed to the valve element. The separate stiff valve support element is basically for transferring the rotational forces from an actuation means which directly actuates the valve support element to the valve element which is in direct mechanical contact with the valve support element. The valve support element can be a basically cylindrical and stiff body, for example made out of metal. The valve support element preferably transfers the rotational forces to the valve element over the entire axial length of the valve element so that no toroidal forces appear in the flexible valve element so that the flexible valve element is not twisted. In other words, the valve support element is specialized for transferring the rotational forces from the actuation means to the valve element. The valve support element is preferably provided radially between the valve element and the spring element.

According to an alternative embodiment, the spring element is integrated into the valve element. The spring element can, for example, be provided within the valve element. The valve element can be injection molded around the spring element. The valve element preferably is made out of plastic and the spring element is preferably made out of a spring metal sheet. By integrating the spring element into the valve element, a relatively compact arrangement is realized.

Preferably, the spring element and/or the valve element are provided with radial protrusions to thereby provide numerous support points. Preferably, the radial protrusions are integral part of the valve element, in particular, if the valve element is made out of plastic. The radial protrusions
5 punctually transfer the radial forces directed outwardly from the spring element to the valve element.

According to a preferred embodiment, the spring element is provided with a radial spring element opening being radially in-line with the corresponding valve element opening so that the coolant liquid can radially
10 flow through the spring element opening to the valve element opening. As a consequence, the fluidic resistance of this arrangement is relatively low.

Preferably, the valve element is provided with an opening neck at the opening edge of the valve element opening. The opening neck is orientated radially inwardly. Preferably, the opening neck defines a support
15 structure for the spring element to transfer radial spring forces and/or to transfer circumferential forces as a tappet so that the spring element is reliably co-rotated with the valve element.

According to a preferred embodiment, the opening neck is provided with a lateral neck opening opening to an intermediate space between the valve
20 element and the spring element. The spring element can be provided as a closed and opening-free body at the circumferential cylindrical body. The fluidic connection from the distributor interior to the valve element opening is realized by the lateral neck opening. The direction "lateral" refers to the flow direction through the valve element opening.

25 Several embodiments of the invention are described with reference to the enclosed drawings, wherein

figure 1 shows a longitudinal section of an automotive coolant distributor in accordance with a first embodiment of the invention,

figure 2 shows, in principle, a cross section of the automotive coolant
30 distributor of figure 1,

figure 3 shows enlarged part of the automotive coolant distributor of figure 1,

figure 4 shows a cross-section of a second embodiment of an automotive coolant distributor,

5 figure 5 shows an enlarged part of the automotive coolant distributor of figure 4 in longitudinal section,

figure 6 shows a cross-section of a third embodiment of an automotive coolant distributor, and

figure 7 shows a cross-section of a forth embodiment of an automotive
10 coolant distributor.

Figures 1 to 3 show an automotive coolant distributor 10 for distributing a coolant liquid coming from a coolant liquid pump 14 to three different devices 181, 182, 183 which can be, for example, an internal combustion engine which is liquid-cooled, a heat exchanger of an automotive heating
15 circuit, and another secondary device which needs to be cooled, for example a cooled turbocharger or a heat exchanger of an exhaust recirculation path.

The automotive coolant distributor 10 is of the rotor type and is provided with a static distributor housing 12 defined by a metal distributor housing
20 body 13 which is substantially cylindrical in shape. The distributor housing 12 is provided with an axial distributor inlet 20 and three radial distributor outlets 21, 22, 23 for the coolant liquid. The three radial distributor outlets 21, 22, 23 are fluidically connected with corresponding housing valve openings 24, 25, 26 at the inner cylindrical surface 15 of the distributor
25 housing body 13.

Three separate and substantially cylindrical rotating elements are provided with in the distributor housing 12, namely a rotatable and flexible plastic valve element 30, a co-rotating metal valve support element 50 and a co-rotating spring element 70 made out of a metal sheet.

The valve element 30 is defined by a plastic valve element body 31 which is provided with a separation 48 over the entire axial length of the valve element body 31 so that the valve element body 31 radially can expand or compress. The separation 48 is realized as a longitudinal slit which extends over the entire longitudinal length of the valve element body 31. The valve element 30 is pretensioned radially outwardly by the spring element 70 so that the outside surface 32 of the valve element 30 is always in sealing contact with the inside surface 15 of the distributor housing body 13. The valve element 30 is completely open at both longitudinal ends and is provided with three valve body openings 44, 45, 46 which interfere with the radial housing valve openings 24, 25, 26 in different rotational opening positions of the valve element 30. In the valve element position shown in figure 1, two distributor outlets 21, 22 are open and the third distributor outlet 23 is closed because the corresponding two valve body openings 44, 45 are radially in-line with the corresponding two housing valve openings 24, 25, whereas the third valve body opening 46 is radially not in-line with the corresponding third housing valve opening 26. The valve element body 31 is provided with numerous radial protrusions 38 which extend radially invalidly from the cylindrical part of the plastic valve element body 31.

The valve support element 50 is defined by a stiff metal valve support element body 51 arranged radially inside the valve element 30. The valve support element body 51 is completely cylindrical and is not provided with a longitudinal slit. The valve support element body 51 is provided with several protrusion openings 60 through which the radial protrusions 38 protrude radially inwardly. The protrusions 38 and the corresponding protrusion openings 60 define a rotational coupling of the valve support element 50 with the valve body 30. The valve support element 50 is actuated by an actuator 16 which is, in the present embodiment, an electric motor. The actuator 16 can rotate the valve support element 50

and the co-rotating valve body 30 to selectively open and close the distributor outlets 21, 22, 23 as required.

The valve element 30 is also provided with three opening necks 34, 35, 36 protruding radially inwardly from the opening edges of the valve element
5 openings 44, 45, 46. The opening necks 34, 35, 36 protrude through corresponding openings 54, 55, 56 of the valve support element body 51.

The spring element 70 is defined by a spring element body 71 which is made of a metal sheet spring material. The spring element 70 is provided with a separation 72 over the entire axial length of the spring element
10 body 71 and is pretensioned radially outwardly. The separation 72 is defined by a separation slit 74 which basically axially extends over the entire axial length of the spring element body 71 but is not necessarily completely orientated axially, as can be seen in figure 1. The spring element 70 is provided with three radial spring element openings 74, 75,
15 76 which are always in-line with the corresponding valve element openings 44, 45, 46. The opening necks 34, 35, 36 also protrude through the corresponding spring element openings 74, 75, 76 to thereby guarantee, that the spring element 70 is always co-rotating with the valve element 30.

20 Figures 4 and 5 show a second embodiment of the automotive coolant distributor 10'. In this embodiment, the opening necks 35' are protruding through the corresponding opening 55 but are not protruding through the spring element 70. The corresponding spring element opening 75' has an inner diameter which is similar or equal to the inner diameter of the
25 opening neck 35' so that the spring element 70 radially supports and pushes the opening neck 35' radially outwardly. As a consequence, in particular the sealing quality around the housing valve opening 25 is high.

The opening neck 35' is provided with a lateral neck opening 81 opening to an intermediate space 86 between the valve element 30 and the spring
30 element 70.

Figures 6 show a third embodiment of the automotive coolant distributor 10". In this embodiment, no separate valve support element is provided. The valve rotor is defined by the valve element 30" and the spring element 70". The actuator directly actuates the valve element 30".

- 5 Figure 7 shows a fourth embodiment of the automotive coolant distributor 10"". The spring body 70"" is integrated into the valve body 30"". No separate valve support element is provided. The valve body 30"" is directly actuated by the actuator.

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CLAIMS

- 5 1. An automotive coolant distributor (10) for selectively distributing a coolant liquid to at least two coolant outlets (21,22,23), comprising a distributor housing (12) with a coolant inlet (20) and the at least two distributor outlets (21,22,23), and
- 10 a rotatable and flexible valve element (30) rotatably provided within the distributor housing (12), wherein
- the distributor housing (12) being provided with at least two radial housing valve openings (24,25,26) corresponding with the distributor outlets (21,22,23),
- 15 the valve element (30) being provided with at least two radial valve element openings (44,45,46) which interfere with the radial housing valve openings (24,25,26) in a rotational opening position of the valve element (30),
- the valve element (30) is provided with a separation (48) over the entire axial length of the valve element (30), so that the
- 20 valve element (30) radially can expand or compress, and
- the valve element (30) is pretensioned radially outwardly so that the outside surface (32) of the valve element (30) is in sealing contact with the inside surface (15) of the distributor housing (12).
- 25
2. The automotive coolant distributor (10) of claim 1, wherein a separate spring element (70) is provided, the spring element (70) being provided co-rotatably with the valve element (30), being pretensioned radially outwardly and being in radial contact with the

valve element (30) to radially push the valve element (30) to the outside against the inside surface (15) of the distributor housing (12).

- 5 3. The automotive coolant distributor (10) of claim 2, wherein the spring element (70) is a metal sheet spring.
4. The automotive coolant distributor (10) of claim of one of the preceding claims, wherein the spring element (70) is provided with a
10 separation (72) over the entire axial length of the spring element (70).
5. The automotive coolant distributor (10) of one of the preceding claims, wherein the valve element (30) is made out of plastic.
15
6. The automotive coolant distributor (10) of one of the preceding claims, wherein a separate stiff valve support element (50) is provided which is stiffer than the valve element (30) and is co-rotatably fixed to the valve element (30).
20
7. The automotive coolant distributor (10''') of one of the preceding claims, wherein the spring element (70''') is integrated into the valve element (30''').
- 25 8. The automotive coolant distributor (10) of one of the preceding claims 1 to 6, wherein the spring element (70) is provided separately from the valve element (30) and is arranged radially inwardly of the valve element (30).

9. The automotive coolant distributor (10) of claim 8, wherein the spring element (50) and/or the valve element (30) are provided with radial protrusions (38) to thereby provide numerous support points.
- 5 10. The automotive coolant distributor (10) of one of the preceding claims, wherein the spring element (70) is provided with a radial spring element opening (74,75,76) being in-line with the corresponding valve element opening (44,45,46).
- 10 11. The automotive coolant distributor (10) of one of the preceding claims, wherein the valve element (30) is provided with an opening neck (34,35,36) at the opening edge of the valve element opening (44,45,46), the neck (34,35,36) being orientated radially inwardly to preferably define a support structure for the spring element (70)
- 15 and/or a circumferential tappet.
12. The automotive coolant distributor (10) of claim 11, wherein the opening neck (34,35,36) is provided with a lateral neck opening (81) opening to an intermediate space (86) between the valve element
- 20 (30) and the spring element (70).

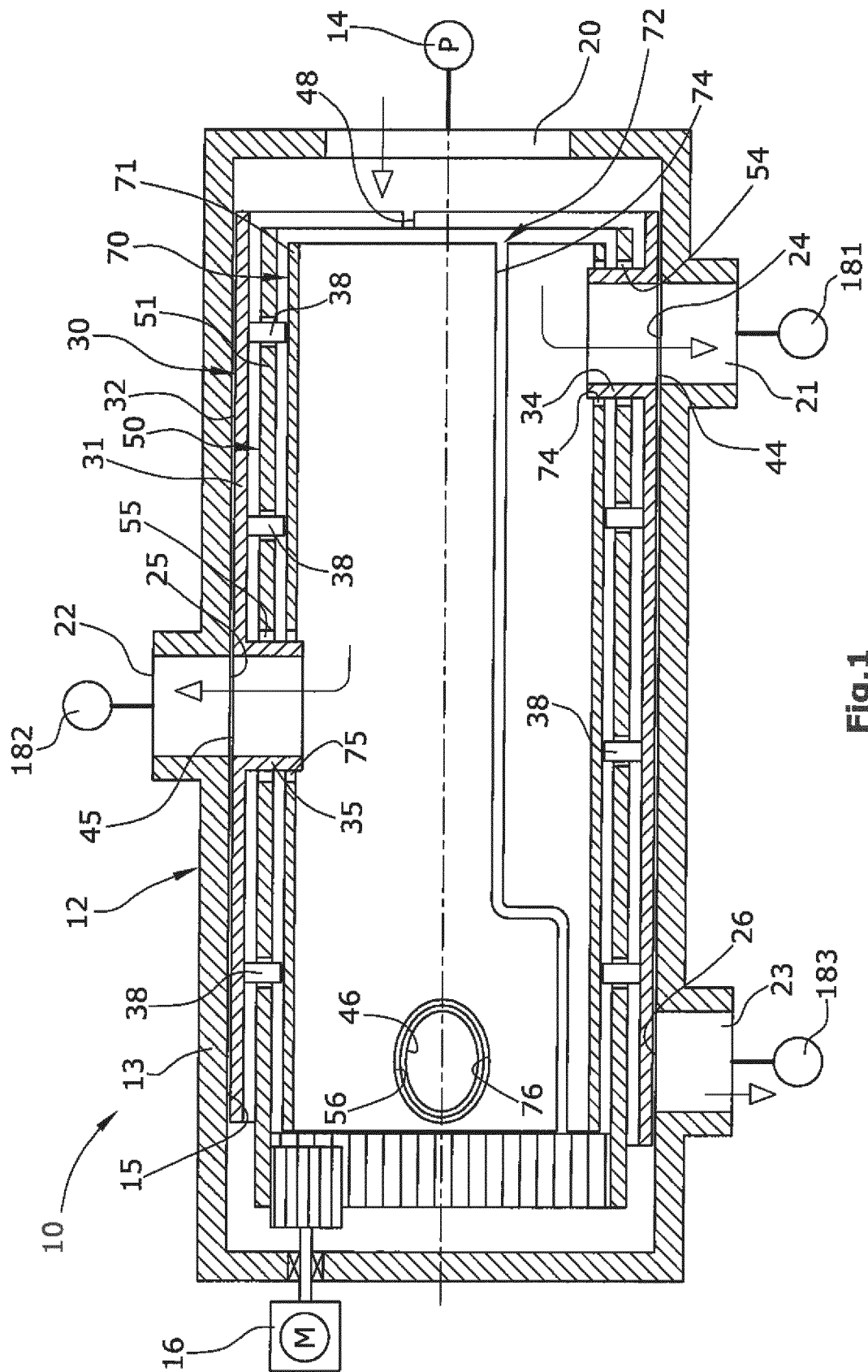


Fig. 1

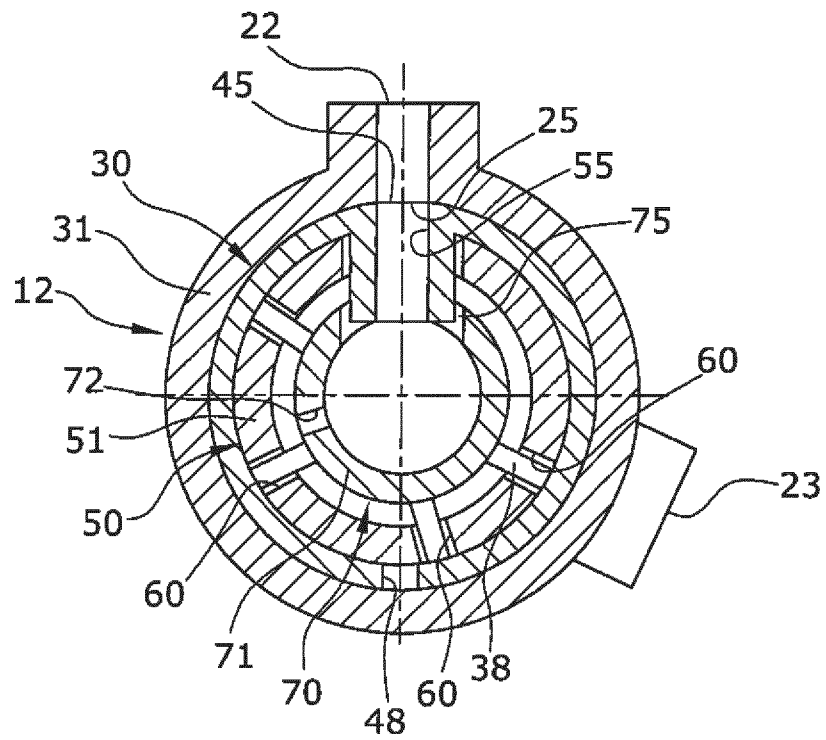


Fig.2

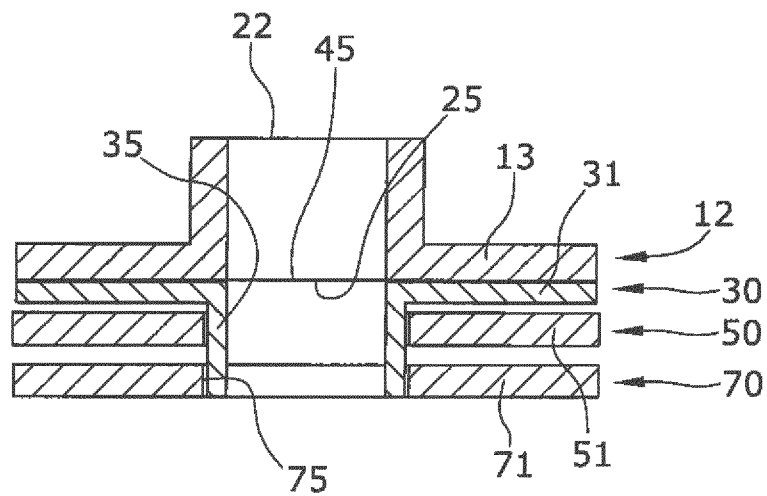


Fig.3

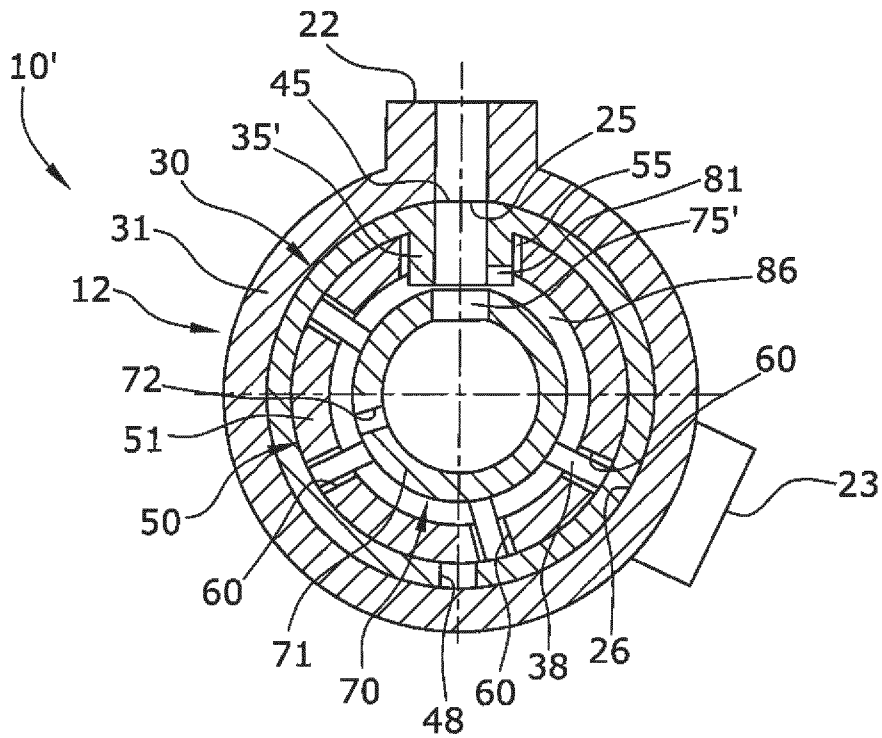


Fig.4

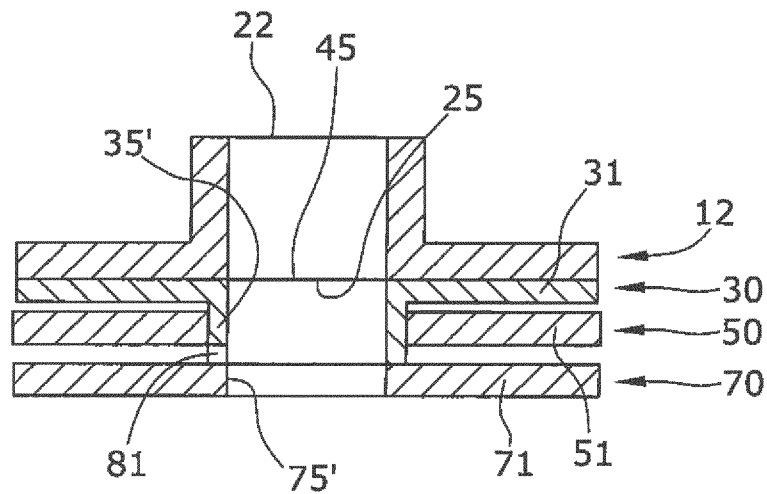


Fig.5

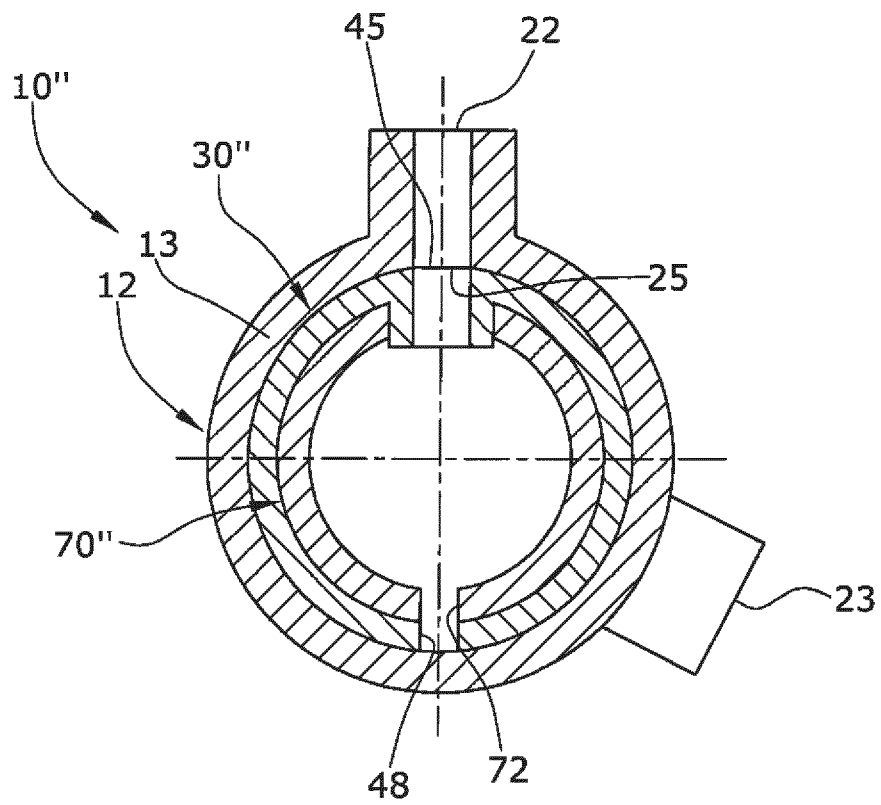


Fig.6

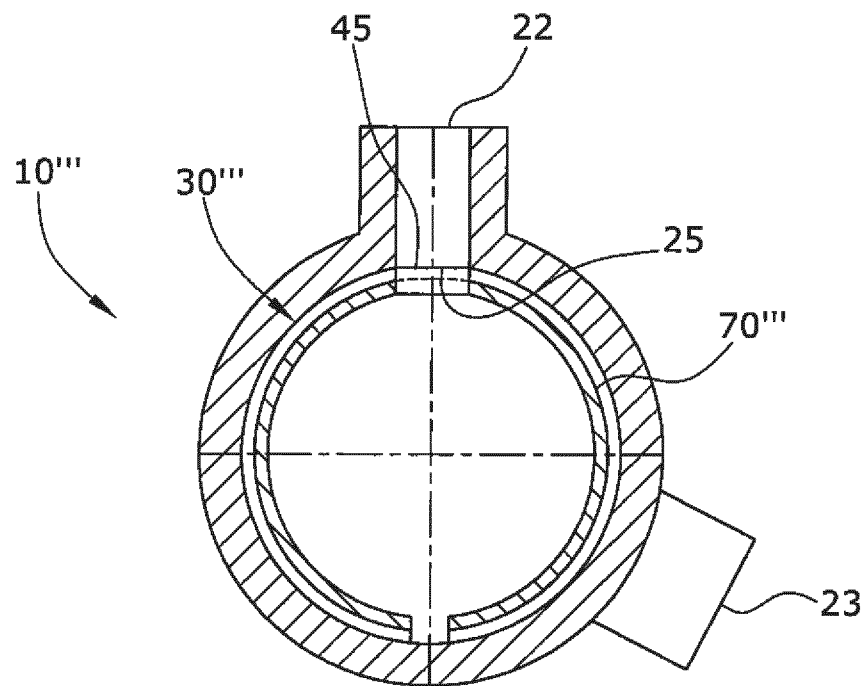


Fig.7

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2016/056042

A. CLASSIFICATION OF SUBJECT MATTER

INV. B60K11/02 F16K11/085
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B60K F16K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2014/184783 A1 (MAGNA POWERTRAIN USA INC [CA]; GREENE DARRELL [CA]) 20 November 2014 (2014-11-20) cited in the application the whole document	1-14
A	US 2014/076438 A1 (SEMMES THOMAS MIDDLETON [US]) 20 March 2014 (2014-03-20) abstract; figure 1	1-14
A	DE 10 2013 008195 A1 (VOLKSWAGEN AG [DE]) 20 November 2014 (2014-11-20) abstract; figure 2	1-14
A	DE 10 2008 030771 A1 (AUDI AG [DE]) 7 January 2010 (2010-01-07) abstract; figure 1	1-14



Further documents are listed in the continuation of Box C.



See patent family annex.

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2016/056042

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