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(54) Exhaust gas recirculation valve

(57) An exhaust gas recirculation valve (10) for an engine comprises a valve body (12) having a valve passage (14) therein for exhaust gases. A valve seat (20) is arranged in the valve passage (14) and a closing element (22) is associated therewith. A valve shaft (24) is attached at one end to the closing element (22) and extends out of the passage (14) through a shaft aperture (26) to be coupled at its other end to actuating means. Protecting means (36) are provided around the valve shaft (24) in the valve passage (14) and designed so as to deviate exhaust gases travelling along the valve shaft (24) in such a way as not to directly impinge onto the shaft (24) in the vicinity of the shaft aperture (26).

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Description

FIELD OF THE INVENTION

[0001] The present invention generally relates to an exhaust gas recirculation valve.

BACKGROUND OF THE INVENTION

[0002] In internal combustion engines, exhaust gas recirculation (EGR) valves are used to regulate the proportion of exhaust gas that is recirculated into the intake air manifold.

[0003] An EGR valve typically comprises a valve body having a valve passage therein. The valve passage has an inlet for communication with an exhaust duct of the engine and an outlet for communication with an intake manifold. A valve seat is provided in the valve passage and a closing element is associated with the valve seat. A valve shaft is attached at one end to the closing element and extends out of the valve passage through a shaft aperture located in a wall of the valve passage, generally on the downstream side of the valve. Outside the valve passage, the valve shaft is slideably received in a guide bushing mounted in the valve body, which allows actuation of the valve shaft along its longitudinal axis. Furthermore, the shaft is coupled at its end remote from the closing element to actuating means. Actuation of the shaft allows moving the closing element between a closed position, wherein it rests on the valve seat, and any open position off the valve seat.

[0004] A known problem of such an EGR valve is the accumulation of soot and other particles contained in the exhaust gas (generally referred to as coking) in the vicinity of the shaft aperture. Indeed, part of the exhaust gases flow along the shaft and thus reach the shaft aperture region in the valve body, where they impinge with high velocity on the shaft, aperture walls and the guide bushing. Hence, coking deposits form in the area of the shaft opening and in the clearance between valve shaft and the valve aperture and/or between the valve shaft and the guide bushing. This leads to a degradation of performance of the EGR valve, in particular since the coking deposits tend to stick the valve shaft to the guide bushing and/or the valve body, and may even cause blocking of the valve shaft.

OBJECT OF THE INVENTION

[0005] The object of the present invention is to provide an improved EGR valve, which does not present the above-described problem. This object is achieved by an EGR valve as claimed in claim 1.

SUMMARY OF THE INVENTION

[0006] The EGR valve according to the present invention comprises a valve body with a valve passage therein for exhaust gases, the valve passage having an inlet for communication with an exhaust duct of an engine and an outlet for communication with an intake manifold of the engine. A valve seat is arranged in the valve passage and has an associated closing element. A valve shaft is attached at one end to the closing element and extends out of the valve passage through a shaft aperture in a wall of the valve passage to be coupled at its other end to actuating means. The valve shaft is slideably mounted in the valve body so as to allow moving the closing element between a closed position, wherein it rests on the valve seat, and an open position off the valve seat.

[0007] According to the invention, protecting means are provided around the valve shaft in the valve passage and designed so as to deviate exhaust gases travelling along the valve shaft in such a way as not to directly impinge onto the valve shaft in the vicinity of said shaft aperture.

[0008] The protecting means thus prevent soot particle flows from reaching the shaft aperture area, to avoid the coking of this area, critical for the operation of the valve. In particular, the protecting means allow to avoid the formation of soot deposits at the clearance between the shaft and shaft aperture and/or between the shaft and its bearing in the valve body. As coking problems in the vicinity of the shaft aperture can be prevented, the present EGR valve exhibits an improved robustness and controllability.

[0009] Advantageously, the protecting means is further designed to deviate the exhaust gases towards the passage outlet. This allows reducing the pressure drop through the valve, which also means an improvement of flow conditions for a given pressure drop.

[0010] The valve shaft is preferably slideably mounted in a guide bushing arranged in the valve body and aligned with the shaft aperture. Such a guide bushing may have one end next to the shaft aperture or may be arranged further inside the valve body.

[0011] In a first embodiment, the protecting means comprise an annular disc fitted onto the valve shaft and extending substantially perpendicularly thereto. This is a cheap, simple and easy to implement embodiment, that allows to deviate the exhaust gases away from the shaft aperture and towards the outlet. The fixing of the annular disc may be carried

out in various ways. Preferably, the annular disc is fixed against a shoulder on the shaft by means of a fixing washer (e.g. a starlock washer).

[0012] In a second embodiment, the protecting means is a cup-shaped element with a central bore, and the cup-shaped element it is fitted onto the valve shaft through the central bore and has its concavity facing the shaft aperture. This cup-shaped element can be blocked against a shoulder of the shaft by means of a fixing washer.

[0013] The annular disc or the cup-shaped element are advantageously positioned on the valve shaft in such a way as to provide their effect in any operating position of the shaft within the valve. In the case where opening of the valve is done by moving the valve shaft further into the passage, the annular disc, respectively the cup-shaped element, will be arranged so as to be proximate of the shaft aperture when the valve is closed (closing element resting on the valve seat).

[0014] In a third embodiment, the protecting means comprise a first tubular element that protrudes from the valve aperture into the valve passage so as to surround the valve shaft. A second tubular element has one end attached either to the closing member or to the shaft and extends towards the valve aperture. The dimensions of the first and second tubes are chosen in such a way that the first and second tubular elements fit into each other in an overlapping manner in any operating condition of the valve. Hence, the shaft is enclosed by the protecting means at least in the region of the shaft aperture. In this connection, the inner diameter of the first tubular element is advantageously designed to serve as guide bushing for the shaft in the passage. Furthermore, the first tubular element is preferably integral with the guide bushing.

[0015] In connection with the third embodiment, the second tubular element may advantageously be provided about its end opposite the closing member with a deflecting flange designed to direct the exhaust gases toward the outlet.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] The present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

FIG.1: is a partial section view through a first embodiment of an EGR valve according to the present invention;

FIG.2: is a partial section view through a second embodiment of an EGR valve;

FIG.3: is a partial section view through a third embodiment of an EGR valve;

FIG.4: is a partial section view through a fourth embodiment of an EGR valve;

FIG.5: is a partial section view through a fifth embodiment of an EGR valve.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

[0017] Five different embodiments of an EGR valve are shown in section in the Figures; however the upper part of the valve shaft and of the body on this side is not shown.

[0018] Fig.1 shows a partial section view through a first embodiment of an EGR valve 10 in accordance with the present invention. The EGR valve 10 includes a valve body 12 with a valve passage 14 therein, the valve passage 14 having an inlet 16 for communication with an exhaust duct of an engine and an outlet 18 for communication with an intake manifold of the engine. The EGR valve 10 comprises a valve seat 20 in the passage 14 and an associated closing element 22. A valve shaft 24 is attached to the closing element 22 and extends out of the passage 14 through a shaft aperture 26 in a wall of the passage 14. The valve shaft 24 is mounted in the valve body 12 in such a way as to be slideable along its longitudinal axis 28. At its opposite end (not shown), the valve shaft 24 is coupled to an actuating mechanism (not shown). Such an actuating mechanism may e.g. be an actuator with an electric motor, that is mounted on the valve body 10.

[0019] The closing element 22 has a peripheral sealing surface 30 that cooperates with the valve seat 20 in order to sealingly close the valve passage 14. Operation of the valve 10 is performed through actuation of the valve shaft 24 along its axis 26 by means of the actuator. In the present embodiment, the design of the valve seat 20 and associated closing element 22 is such that opening of the valve 10 requires moving the closing member 22 towards the inlet 16. Accordingly, when moving the shaft 24 in the downward direction, the closing element 22 is removed from the valve seat and the passage 14 opens, allowing exhaust gas to flow in the direction of arrow 32. Closure of the valve 10 is then obtained by moving the valve shaft 24 in the opposite direction to bring the closing member 24 back onto its seat 20.

[0020] As can be seen, the shaft 24 is supported in a guide bushing 34 outside the valve passage 14. The guide bushing 34 is mounted in the valve body 12 and has one end next to the shaft aperture 28. The shaft aperture 28 is

thus on the downward side of the valve 10.

[0021] It will be appreciated that the present EGR valve 10 comprises protecting means provided around the valve shaft 24 in the passage 14 and designed to deviate exhaust gases travelling along said valve shaft 24 in such a way as not to impinge directly on the valve shaft 24 in the vicinity of the shaft aperture 26.

[0022] In the present embodiment, the protecting means preferably takes the form of an annular disc 36, e.g. made of steel. As can be seen, the annular disc 36 is fitted onto the shaft 24 and is fixed between a shoulder 38 on the shaft and a starlock washer 40 (a fixing washer having prongs on its inner periphery that grip the shaft tightly, locking the washer in place with initial tension). However, the annular disc 36 may be fixed to the shaft 24 in a variety of ways, e. g. by using soldering, a nut, etc.

[0023] The position of the deflecting annular disc 36 on the shaft 24 is chosen in such a way that, in any position that the shaft 24 may take during operation of the valve 10, part of the exhaust gases are deviated away from the shaft aperture 26 area. This avoids that exhaust gases travelling along the shaft 24 directly reach the area of the shaft aperture 26, thereby preventing coking at the interface between the valve shaft 24 and the bushing 34 or the aperture 26. Furthermore, this annular disc 36, proves advantageous in that it deviates part of the exhaust gases towards the passage outlet 18, thereby reducing the pressure drop through the valve 10.

[0024] It is to be further noted that the inclination of the valve passage downstream of the valve seat with regard to the passage upstream of the valve seat is favourable to the flow of the exhaust gas.

[0025] Turning now to Fig.2, another embodiment of an EGR valve 110 is shown. It comprises a valve body 112 with a valve passage 114 extending between an inlet 116 and an outlet, the outlet section of the passage 114 being indicated by reference sign 118. A valve seat 120 is provided in the valve passage 114 and has an associated closing element 122. A valve shaft 124 is attached to the closing element 122 and extends out of the passage 114 through a shaft aperture 126 in a wall of the passage 114. The valve shaft 124 is mounted in the valve body 112 in such a way as to be slideable along its longitudinal axis 128. At its opposite end (not shown), the valve shaft 124 is coupled to an actuating mechanism (not shown).

[0026] Actuating the valve shaft 124 along its longitudinal axis allows moving the closing element 122 between its valve seat 120 and any open position, so as to regulate the flow of exhaust gas through the passage 114.

[0027] The valve shaft 124 is mounted in a guide bushing 130 arranged in the valve body 112. As can be seen, the shaft aperture 126 is at the end of a holder portion 132 that protrudes into the passage 114.

[0028] It will be appreciated that this EGR valve 110 is provided around its valve shaft 124 with a cup-shaped element 134 acting as protecting means. The cup-shaped element 134 has a central bore 136 through which it is fitted onto the valve shaft 124, and has its concavity facing the holder portion 132. The cup-shaped element 134 bears on one side against a shoulder 138 on the shaft 124 and is fixed thereto by means of a starlock washer 140.

[0029] This provides an improved protection of the shaft aperture 126 area when compared to the embodiment of Fig.1. Indeed, when the closing element 122 is slightly off its seat 120, the cup-shaped element 134 encloses the holder portion 132 due to its side walls extending towards the holder portion 132, thereby preventing any flow of exhaust gas in the vicinity of the shaft aperture 126.

[0030] It will be understood that dimensions and position of the annular disc 36 of Fig.1 and of the cup-shaped element 134 of Fig.2 can be adapted to the configuration of the valve passage, in order to provide the desired protecting and deviating effects.

[0031] A third embodiment of an EGR valve 210 is shown in Fig.3. It comprises a valve body 212 with a valve passage 214 extending between an inlet 216 and an outlet, the outlet section of the passage 214 being indicated by reference sign 218. A valve seat 220 is provided in the valve passage 214 and has an associated closing element 222. A valve shaft 224 is attached to the closing element 222 and extends out of the passage 214 through a shaft aperture 226 in a wall of the passage 214. The valve shaft 224 is mounted in the valve body 212 in such a way as to be slideable along its longitudinal axis 228. At its opposite end (not shown), the valve shaft 224 is coupled to an actuating mechanism (not shown).

[0032] Actuating the valve shaft 224 along its longitudinal axis 228 allows moving the closing element between its valve seat 220 and any open position, so as to regulate the flow of exhaust gas through the passage 214.

[0033] The valve shaft 224 is mounted in a guide bushing 230 arranged in the valve body 212. As can be seen, the shaft aperture 226 is at the end of a holder portion 232 that protudes into the passage 214.

[0034] It will be appreciated that in the present embodiment, the protecting means includes a first tubular element 234 that protrudes from the shaft aperture 226 into the passage 214 so as to enclose the valve shaft. This first tubular element 234 is preferably cylindrical and integral with the guide bushing 230, and has an inner diameter equivalent to that of the guide bushing 230 to further guide the valve shaft 224 in the passage 214.

[0035] Furthermore, the protecting means comprises a second tubular element 236 attached to the closing element 222. The second tubular element 236 encloses the valve shaft 224 and extends towards the shaft aperture 226. The diameters of the first and second tubular elements 234 and 236 are chosen in such a way that the first cylindrical part 234 fits into the second part 236. Furthermore, their length are chosen in such a way that the second tubular element

236 at least in part overlaps the first tubular element 234 in any operating position of the shaft 224 in the valve 210.

Turning now to Fig.4, a fourth embodiment of an EGR valve 310 is shown. For the sake of simplicity, the description of the structural elements similar or equivalent to that of the embodiment of Fig.3 will not be repeated herein, and are indicated by reference numbers increased by one hundred. It will be appreciated that, the second tubular element 336 is further provided with a deflecting flange 338 at its end opposite the closing member 322. This deflecting flange 338 allows deviating the exhaust gas towards the outlet 218, thereby improving the flow conditions through the passage 314 by reducing the pressure drop.

[0036] Fig.5 shows a fifth embodiment of the present EGR valve. Again, for the sake of simplicity, the description of the structural elements similar or equivalent to that of the embodiment of Fig.3 will not be repeated herein, and are indicated by reference numbers increased by two hundreds. It will be noted that, contrary to the embodiment of Fig.3, the outer, second tubular part 436 is fixed onto the shaft 424. Furthermore, the end of the second tubular element 436 remote from closing element 422 ends by a conical portion 438 so as to deviate exhaust gas flows towards the outlet 418.

[0037] The end of the second tubular part 436 closest to the closing member 422 has a bottom 440 with a bore 442 therein, through which it has been fitted onto the valve shaft 424. The bottom 440 bears against a shoulder 444 on the valve shaft 424 and is blocked thereon by means of a starlock washer 446.

LIST OF REFERENCE SIGNS

[0038]

10, 110, 210, 310, 410	EGR valve	38	shoulder
		40	washer
12, 112, 212, 312, 412	valve body	130, 230	guide bushing
		132, 232	holder portion
14, 114, 214, 314, 414	valve passage	134	cup-shaped element
16, 116, 216, 316,416	inlet	136	central bore
		138	shoulder
18, 118, 218, 318, 418	outlet	140	washer
20, 120, 220, 320, 420	valve seat	230,330,430	guide bushing
		232, 332, 432	holder portion
22, 122, 222, 322, 422	closing element	234, 334, 434	first tubular element
24, 124, 224, 324, 424	valve shaft	236, 336, 436	second tubular element
26, 126, 226, 326, 426	shaft aperture	338, 438	deflecting flange
		440	bottom
28, 128, 228, 328,428	longitudinal axis	442	bore
		444	shoulder
30	sealing surface		
32	flow direction of exhaust gas	446	washer
34	guide bushing		
36	annular disc		

Claims

1. An exhaust gas recirculation valve for an internal combustion engine comprising:

   a valve body having a valve passage therein for exhaust gases, said valve passage having an inlet for communication with an exhaust duct and an outlet for communication with an intake manifold;

   a valve seat in said valve passage ;

   a closing element associated with said valve seat;

   a valve shaft attached at one end to said closing element and extending out of said valve passage through a shaft aperture in a wall of said valve passage to be coupled at its other end to actuating means, wherein said valve shaft is slideably mounted in said valve body so as to allow moving said closing element between a closed position, wherein it rests on said valve seat, and an open position off said valve seat;

   characterised by
   protecting means provided around said valve shaft in said valve passage and designed so as to deviate exhaust gases travelling along said valve shaft in such a way as not to directly impinge onto said shaft in the vicinity of said shaft aperture.

2. The exhaust gas recirculation valve according to claim 1, **characterised in that** said protecting means is further designed to deviate exhaust gases towards said outlet.

3. The exhaust gas recirculation valve according to claim 1 or 2, **characterised in that** said protecting means comprises an annular disc fitted onto said valve shaft and extending substantially perpendicularly thereto.

4. The exhaust gas recirculation valve according to claim 3, **characterised in that** said annular disc is blocked onto a shoulder of said shaft by means of a fixing washer.

5. The exhaust gas recirculation valve according to claim 1 or 2, **characterised in that**
   said protecting means is a cup-shaped element with a central bore;
   said cup-shape part it is fitted onto said valve shaft trough said central bore and has its concavity facing said shaft aperture.

6. The exhaust gas recirculation valve according to claim 5, **characterised in that** said cup-shaped element is blocked against a shoulder by means of a fixing washer.

7. The exhaust gas recirculation valve according to claim 1 or 2, **characterised in that** said protecting means comprises:

   a first tubular element that protrudes from said valve aperture into said valve passage so as to surround said valve shaft; and

   a second tubular element that has one end attached either to said closing member or to said shaft and extends towards said valve aperture;

   wherein the dimensions of said first and second tubes are chosen in such a way that said first and second tubular elements fit into each other in an overlapping manner in any operating condition of the valve.

8. The exhaust gas recirculation valve according to claim 7, **characterised in that** the inner diameter of said first tubular element is designed to serve as guide bushing for the shaft in said passage.

9. The exhaust gas recirculation valve according to claim 7 or 8, **characterised in that** said first tubular element is integral with said guide bushing.

10. The exhaust gas recirculation valve according to claim 7, 8 or 9, **characterised in that** said second tubular element has about its end opposite said closing member a deflecting flange.

11. The exhaust gas recirculation valve according to any one of the preceding claims, **characterised in that** said valve shaft is slideably mounted in a guide bushing arranged in said valve body and aligned with said valve aperture.

12. The exhaust gas recirculation valve according to any one of the preceding claims, **characterised by** an actuator mounted to said valve body and coupled to the end of said valve shaft opposite said closing element.

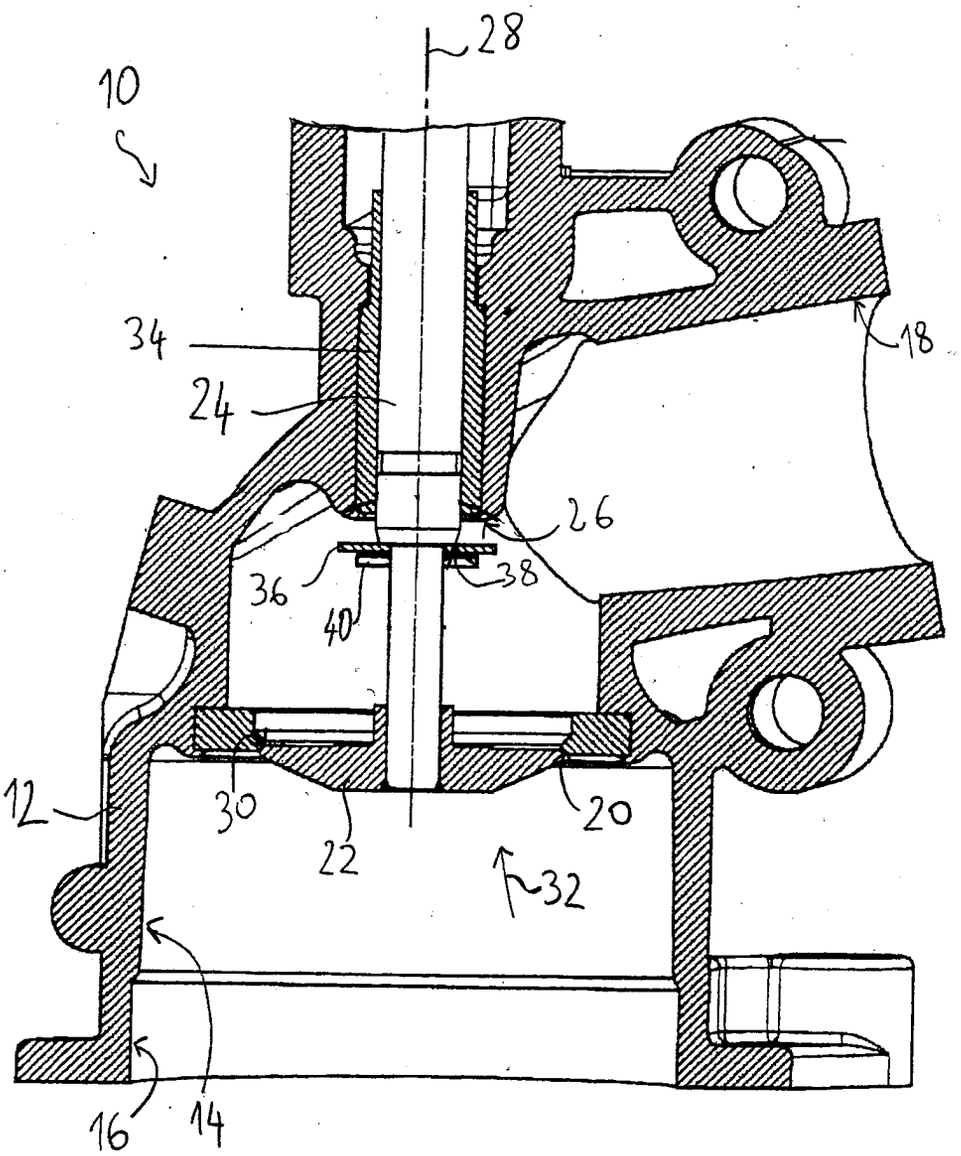

Fig. 1

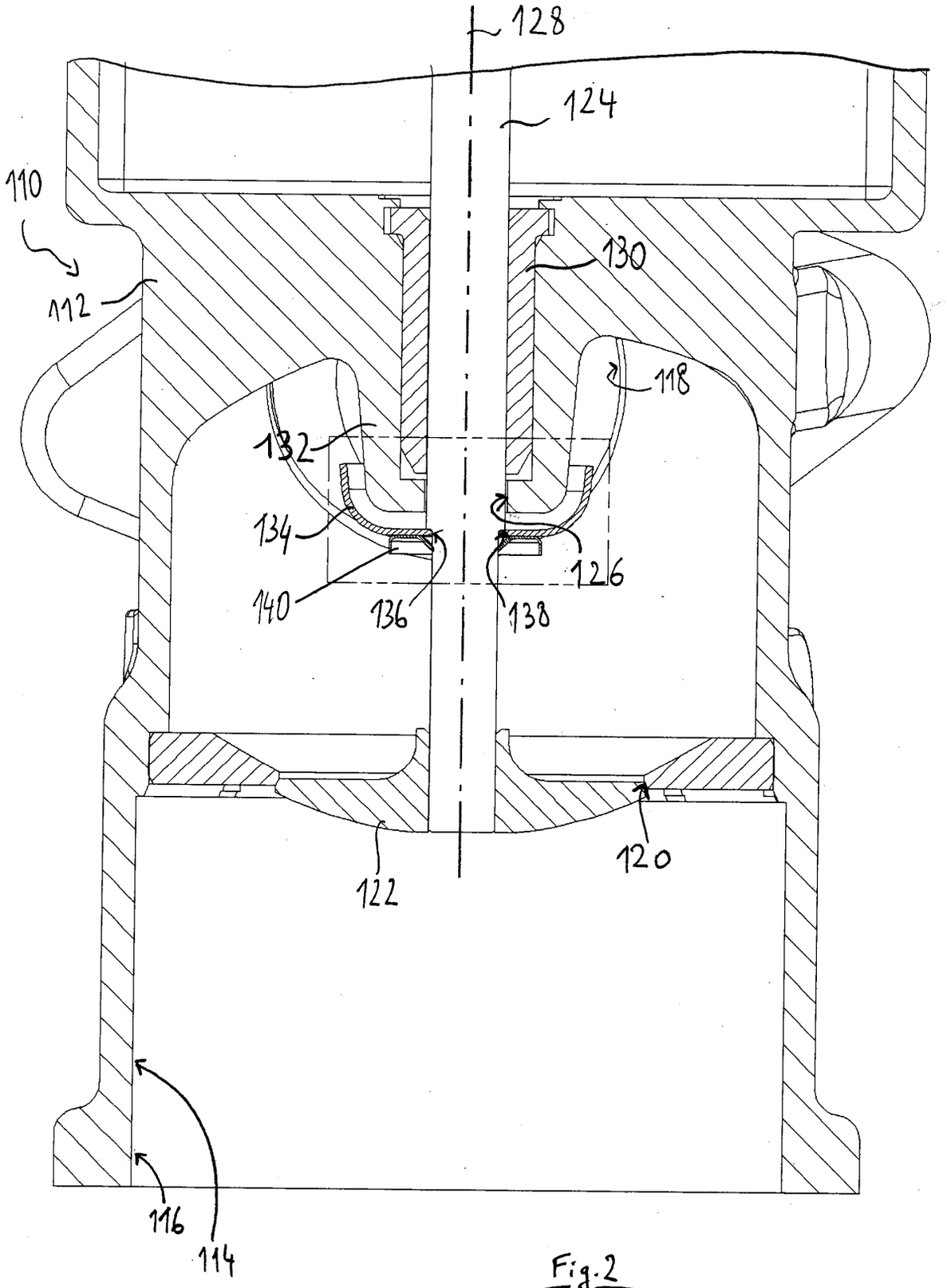

Fig.2

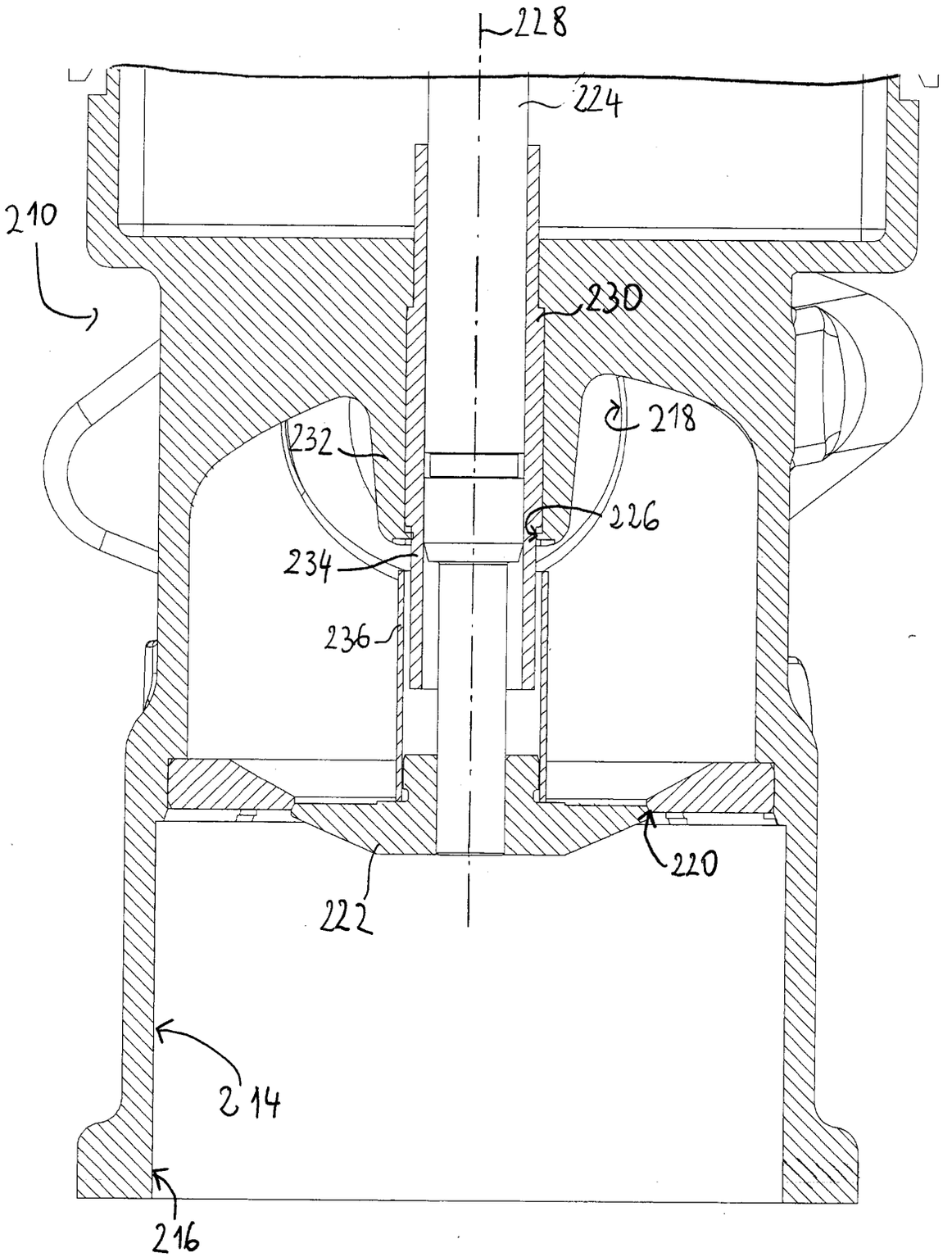

Fig. 3

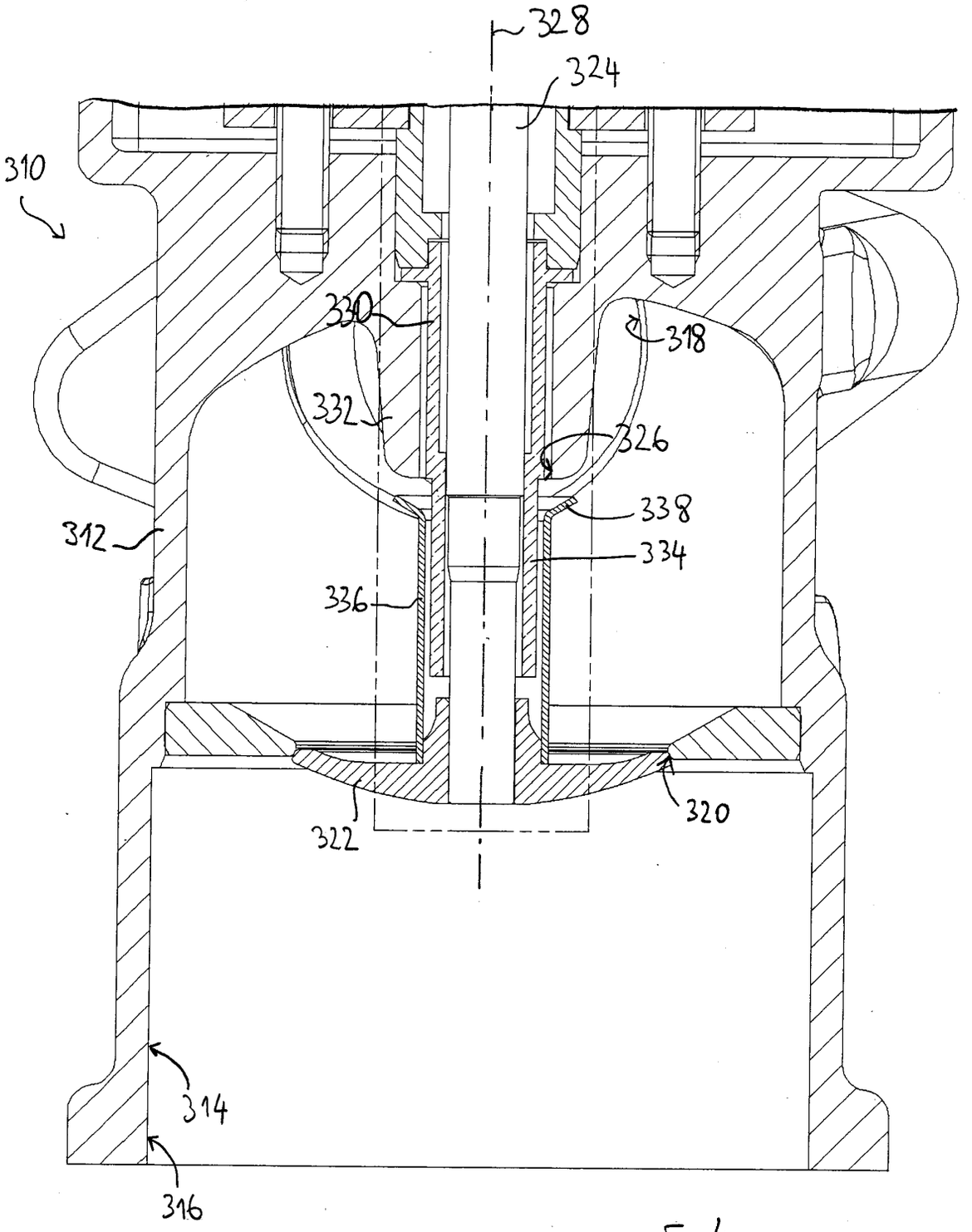

Fig. 4

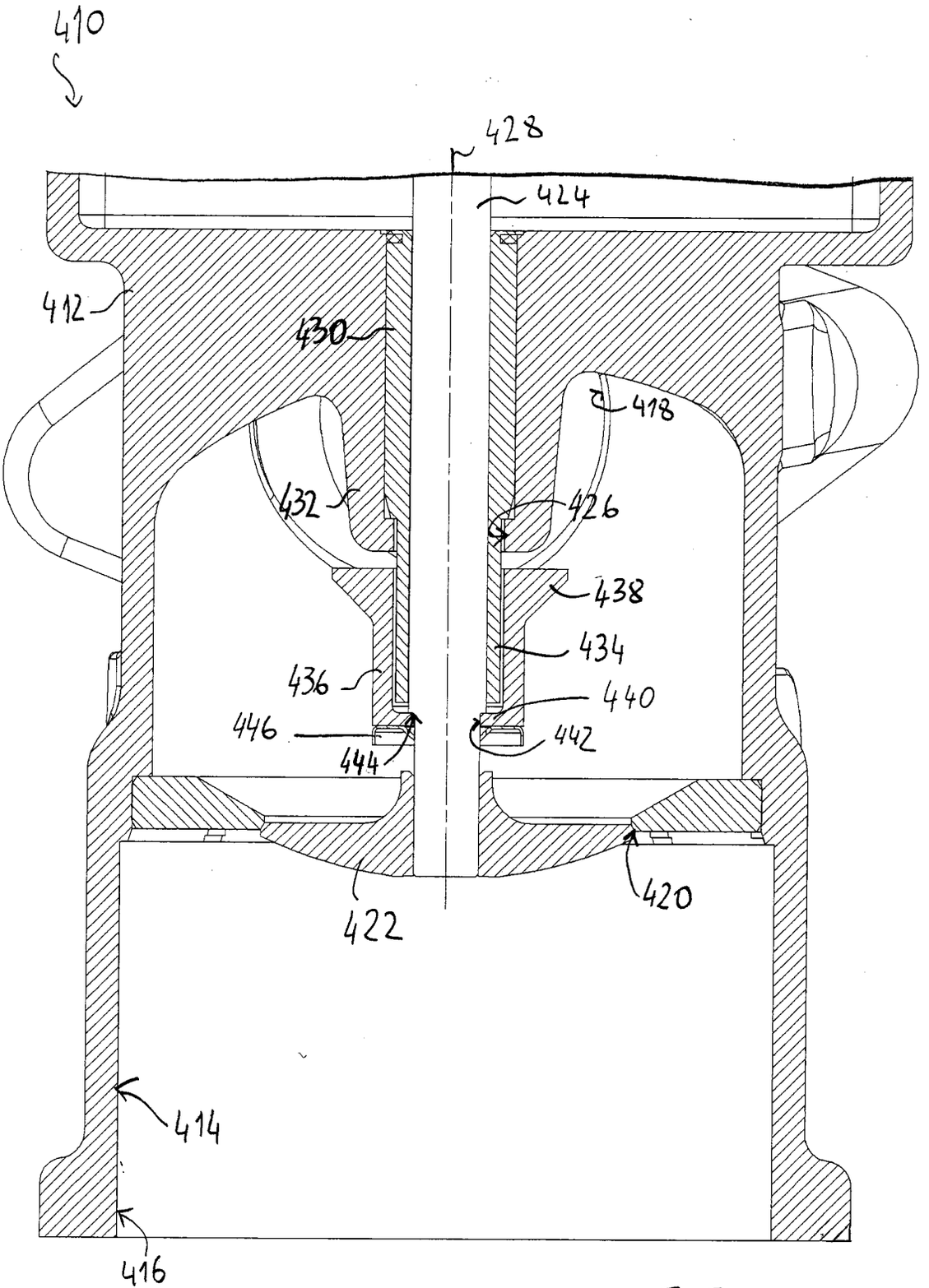
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Fig. 5

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 03 10 0369

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	11 July 2003	Döring, M

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EUROPEAN SEARCH REPORT

Application Number
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 03 10 0369

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