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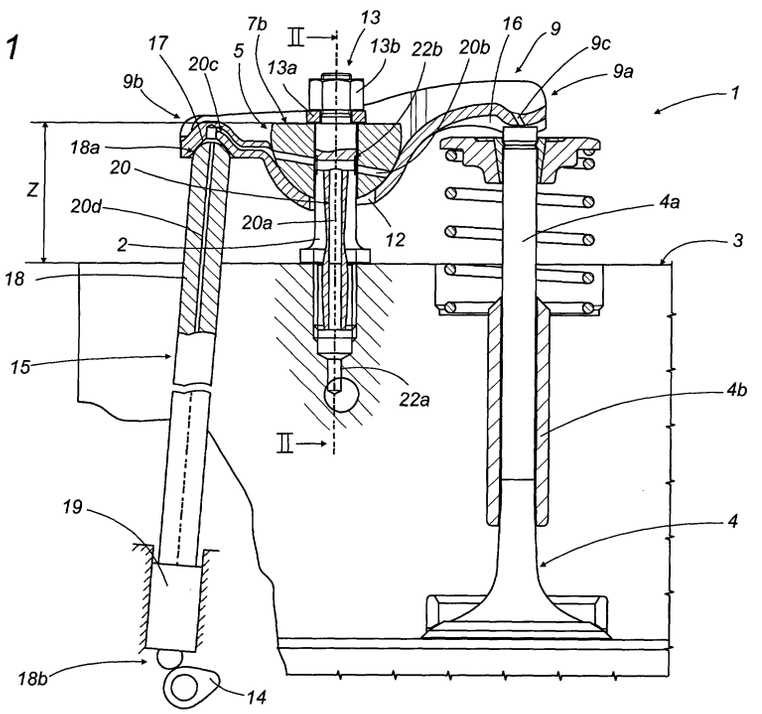
(54) A rocker arm mechanism for actuating valves in internal combustion engines

(57) A rocker arm mechanism for actuating valves in internal combustion engines comprises a support shaft (2) extending from the head (3) of an engine, a pin (5) mounted in such a way that it slides on and turns about the shaft (2) and a rocker arm (9) connected to the pin (5). The rocker arm has a first end (9a) which engages with the stem (4a) of a valve (4) on the engine and has a seat (10) for the pin (5), so that, together with the pin (5), it forms a turning pair; the mechanism also comprising a camshaft (14) which is kinematically connected to the second end (9b) of the rocker arm (9); the cross-section of the rocker arm (9), at the seat (10), being substantially U-shaped, forming a concave surface (11) facing the free end of the support shaft (2) and housing the pin (5).

FIG.1



EP 1 279 797 A1

Description

[0001] The present invention relates to a rocker arm mechanism for actuating valves in internal combustion engines, in particular for diesel engines.

[0002] As is known, reciprocating internal combustion engines have a given number of valves which allow the cylinder to be supplied with fresh air or a fuel and air mixture, and allows the burnt gases to escape. The valves are actuated by suitable mechanisms which are kinematically connected to the drive shaft.

[0003] In particular, there are known valve actuating mechanisms in internal combustion engines, comprising a rocker arm which pivots on a support fixed above the head of the engine. One end of the rocker arm acts upon the engine valve stem, whilst the opposite end is connected to a camshaft by means of a connecting rod.

[0004] This type of rocker arm mechanism is described in document US-3 139 872.

[0005] In said document, the rocker arm is positioned on a support shaft, by means of a pin mounted on the shaft in such a way that it slides on and turns about it.

[0006] The pin is cylindrical in shape and is inserted in two circular openings in the side walls of the rocker arm to form a turning pair. There is a hole in the pin to allow the passage of the support shaft, with an axis at a right angle to the shared axis of the circular openings in the rocker arm, and the pin is held in position relative to the rocker arm by suitable spring means.

[0007] As a result of the connection to the pin alone, the rocker arm can turn, relative to the pin, in a plane containing the axis of the support shaft. Moreover, it can slide vertically on the support and turn in a plane at a right angle to the support together with the pin.

[0008] The valve stem at one end, the connecting rod at the opposite end and a nut fixed on the shaft, against which the pin stops, hold the rocker arm in position.

[0009] The actual motion of the rocker arm, caused by rotation of the camshaft, is an oscillation in the vertical plane about the pin. Therefore, the movement of the rocker arm causes the valve alternating motion.

[0010] The rocker arm mechanism of the type described is complex and bulky.

[0011] In particular, the structure of the pin - rocker arm connection makes the assembly very wide, meaning that otto engine spark plugs or diesel engine injectors cannot be mounted on the head of the engine, in advantageous positions.

[0012] The injector of a diesel engine is preferably fitted at the centre of the chamber, between the valves, and projects over the head of the engine in the same area as the rocker arms. The injector is normally inserted between the two mechanisms which move the intake valve and the exhaust valve.

[0013] Moreover, since the turning connection is not directly lubricated, the mechanism is prone to rapid wear and possible seizing.

[0014] Finally, the rocker arm described above is difficult to make, bulky and expensive, since its particular shape requires the use of machining for removing material or the construction of complex moulds.

[0015] The aim of the present invention is, therefore, to overcome the above-mentioned disadvantages.

[0016] In particular, the aim of the present invention is to provide a compact rocker arm mechanism for actuating valves in internal combustion engines.

[0017] The aim of the present invention is also to provide a rocker arm mechanism for actuating valves in internal combustion engines which is reliable and resistant to wear.

[0018] Another aim of the present invention is to provide a rocker arm mechanism for actuating valves in internal combustion engines which is simple and economical.

[0019] The technical task specified and the preset aims are substantially achieved by a rocker arm mechanism for actuating valves in internal combustion engines comprising the characteristics indicated in claim 1 and in the dependent claims.

[0020] The rocker arm mechanism for actuating valves in internal combustion engines according to the present invention is now described with reference to the accompanying drawings, which illustrate a preferred embodiment without limiting the scope of application, and in which:

- Figure 1 is a side view of a rocker mechanism for actuating valves in internal combustion engines, according to the present invention, mounted on the head of an engine;
- Figure 2 is a cross-section along line II - II illustrated in Figure 1;
- Figure 3 is a plan view of a first element of the mechanism illustrated in Figure 1;
- Figure 4 is a cross-section along line IV - IV illustrated in Figure 3;
- Figure 5 is a view from above of a second element of the mechanism illustrated in Figure 1;
- Figure 6 is a cross-section along line VI - VI illustrated in Figure 5;
- Figures 7 and 8 are a cross-section and a view from above of several details of an alternative embodiment of the mechanism illustrated in Figure 1; and
- Figure 9 is a cross-section of another embodiment of the mechanism illustrated in Figure 1.

[0021] With reference to the accompanying drawings, the numeral 1 denotes a rocker arm mechanism for actuating valves in internal combustion engines.

[0022] The rocker arm mechanism 1 comprises a support shaft 2 extending from the head 3 of an internal combustion engine, known and therefore not illustrated, at the position of an intake and/or exhaust valve 4 comprising a stem 4a. The shaft 2 may be made of hardened and tempered steel.

[0023] A support pin 5 is fitted on the shaft 2 in such

a way that it slides and turns. As illustrated in the accompanying drawings, the pin 5 is semi-cylindrical, that is to say, it has the shape of one of the two portions obtained from the cross-section of a cylinder according to a plane parallel with the longitudinal axis of the cylinder and containing the axis, or passing close to the axis. The pin 5 may be made of sintered steel or aluminium.

[0024] The pin 5 has a first, flat base 6a, a second, flat base 6b opposite the first, a first, convex side surface 7a and a second, flat side surface 7b.

[0025] A through-hole 8 with straight axis is made in the semi-cylinder. The support shaft 2 is inserted in this hole. The hole 8 has a first open end 8a on the first, convex side surface 7a of the pin 5 and a second open end 8b on the second, flat side surface 7b of the pin 5.

[0026] The semi-cylinder is then mounted on the shaft 2 with the directrices at right angles to the axis of the shaft 2.

[0027] The mechanism 1 also comprises a rocker arm 9 mounted on the shaft 2 by connection with the pin 5.

[0028] The rocker arm 9 may be made by moulding, striking or smelting.

[0029] The rocker arm 9 has a seat 10 for the pin 5, the seat having a concave surface 11 connecting with the convex surface 7a of the pin 5, so that together with the pin 5 it forms a turning pair and allows relative rotation between the two elements in a vertical plane containing the axis of the support shaft 2.

[0030] In particular, at the seat 10 the cross-section of the rocker arm 9 is substantially U-shaped, open towards the free end of the support shaft 2. The side and bottom of the pin 5 are, therefore, connected to the internal surface of the rocker arm 9 and completely housed in it.

[0031] The shaft 2 passes through the rocker arm 9 at an opening 12 made in the rocker arm 9 and aligned with the hole 8 in the pin 5.

[0032] The opening 12 extends longitudinally on the rocker arm 9 in such a way that the support shaft 2 does not interfere with the rocker arm 9 and allows the latter to oscillate on the pin 5.

[0033] Therefore, as a result of a connection to the pin 5 only, the rocker arm 9 is free to turn in a vertical plane, moving relative to the pin 5, sliding along the support shaft 2 and turning about the longitudinal axis of the shaft 2, integral with the pin 5.

[0034] Alternatively, in an embodiment which is not illustrated, the pin 5 may be semi-spherical, that is to say, with the shape of one of the two portions obtained from the cross-section of a sphere according to a plane passing through the centre of the sphere or close to its centre.

[0035] In this case, the pin - rocker arm connection allows the rocker arm 9 to turn in any plane passing through the centre of the semi-spherical pin 5.

[0036] To prevent the pin 5 and rocker arm 9 from coming off the support shaft 2, the mechanism 1 comprises retaining means 13 which, in the present embodiment, simply consist of a washer 13a locked with a nut 13b screwed onto the free end of the shaft 2.

[0037] The second, flat side surface 7b of the pin 5 and the upper surface of the support shaft 2 where the washer 13a rests are at a height Z from the head 3 fixing surface. The height Z defines the precise system mounting position without the need for other adjustments.

[0038] The rocker arm 9 also has a first end 9a engaged with the valve 4 stem 4a and a second end 9b, opposite the first 9a, kinematically connected to a camshaft 14 by suitable means 15.

[0039] At the two ends 9a, 9b, the rocker arm rests on the valve 4 stem and the means for connection 15 to the camshaft 14 and, through the pin 5, on the contact washer 13a.

[0040] Moreover, to prevent rotation about the shaft 2, the rocker arm 9 is fitted with a guide 16 on the first end 9a, in which the valve 4 stem 4a engages, and with a seat 17 for the connecting means 15 on the second end 9b.

[0041] It should be noticed that by engaging with the end of the stem 4a, the guide 16 holds the rocker arm 9 in the correct operating position without the need for any other devices to prevent rotation about the shaft 2. Any side thrust on the valve 4 is limited and does not increase wear on the stem 4a and the valve guide 4b.

[0042] In the embodiment illustrated, the connecting means 15 comprise a connecting rod 18 with a first end 18a connected to the seat 17, on the second end 9b of the rocker arm 9, and a second end 18b in contact with the camshaft 14, in accordance with the known rod and rocker arm distribution system.

[0043] Moreover, the second end 18b of the rod 18 is fitted with a hydraulic tappet 19 for automatic compensation of valve clearance.

[0044] In an embodiment which is not illustrated there is no rod, since the camshaft 14 is close to the rocker arm 9, therefore, the hydraulic tappet 19 is mounted directly on the rocker arm 9, normally on the second end 9b.

[0045] Advantageously, the mechanism 1 has a channel 20 with at least one open end 21 at the pin 5 seat 10 in the rocker arm 9. The channel 20 is in communication with the engine lubrication circuit and guarantees continuous lubrication of the turning pair.

[0046] Advantageously, the channel 20 has a first portion 20a made in the support shaft 2 along the longitudinal axis. A first end 22a of the first portion 20a allows fluid communication with the engine lubrication circuit, whilst at least one second end 22b opens at the pin 5.

[0047] The channel 20 preferably has at least a second portion 20b, connecting the first portion 20a to the surface of the turning connection through the pin 5.

[0048] As illustrated in the accompanying drawings, the first portion 20a of the channel 20 branches at the pin 5 to form a ring-shaped passage on the entire edge 22b, from which two branches 20b in the pin 5 start. In this way, the contact zone between the pin 5 and the rocker arm 9 can be lubricated more efficiently.

[0049] Advantageously, the channel 20 also has a third portion 20c, made in the rocker arm 9, between the pin 5 seat 10 and the second end 9b of the rocker arm 9, which carries the oil as far as the hydraulic tappet 19.

[0050] In the embodiment illustrated, which comprises the connecting rod 18, the channel 20 has a fourth portion 20d which passes through the rod 18 as far as the hydraulic tappet 19, located at the second end 18b of the rod 18.

[0051] The latter portion, therefore, allows the use of a single circuit to supply the hydraulic tappet and to lubricate the turning pair.

[0052] Figures 7 and 8 illustrate an alternative embodiment of the rocker arm 9, in which the third portion 20c of the lubrication channel is obtained by folding a portion 9d of the sheet metal which forms the rocker arm, so that a cavity is formed.

[0053] The sheet metal has grooves 20e which were obtained previously during the moulding stage. The grooves 20e, in the sheet metal which is folded over itself, form the third portion 20c of the lubricating channel.

[0054] Figure 9 illustrates an alternative embodiment of the third portion 20c of the lubrication channel. In this case, the folded portion of sheet metal 9d extends downwards in the contact zone between the pin 5 and the rocker arm 9. There is a hole and a recess 20f for the passage of the oil. The recess allows the lubricant to pass from the pin 5 to the rocker arm 9 even during rocker arm 9 oscillations.

[0055] In the zone of the first end 9a engaged with the valve 4 stem 4a, the rocker arm 9 also has a hole 9c which allows improved lubrication in the contact zone between the stem 4a and the rocker arm 9. It should be noticed that the end 9a is spoon-shaped, collecting the lubricant and distributing it, through the hole 9c, to the contact zone between the stem 4a and the rocker arm 9.

[0056] The invention has important advantages. Firstly, the rocker arm mechanism disclosed has a limited width and, therefore, allows easy positioning of the injector on the head of a diesel engine, for example between two adjacent rocker arms which respectively actuate an intake valve and an exhaust valve.

[0057] Moreover, the mechanism disclosed is reliable and relatively silent, since the pin - rocker arm connection is continuously lubricated during operation. In addition, the mechanism disclosed allows automatic compensation of valve clearance by means of hydraulic tappets supplied with the pin - rocker arm connection lubricating oil, without the need for auxiliary systems to supply the oil to the tappet.

[0058] The rocker arm mechanism made in accordance with the present invention is extremely simple to maintain, because all of the components are fully interchangeable. No wear is caused on the head 3, since the connection is limited to contact with the support shaft 2.

[0059] Finally, the rocker arm mechanism disclosed is easy to make and very economical, because the rocker arm body can be made by moulding and/or striking and further machining on machine tools is not required.

Claims

1. A rocker arm mechanism for actuating valves in internal combustion engines, comprising:

   a support shaft (2) extending from the head (3) of an engine;
   a pin (5) mounted in such a way that it slides on and turns about the shaft (2);
   at least one valve (4), located in the head (3) and having a stem (4a) ;
   a rocker arm (9) connected to the pin (5) and having a first end (9a) connected to the stem (4a) and a second end (9b); the rocker arm (9) also having a seat (10) for the pin (5) between the first (9a) and the second (9b) ends so that, together with the pin (5), it forms a turning pair;
   a camshaft (14) for actuating the valve (4);
   means (15) for kinematically connecting the camshaft (14) to the second end (9b) of the rocker arm (9);
   means (13) for connecting the pin (5) to the support shaft (2); the rocker arm mechanism being **characterised in that** at the seat (10) the cross-section of the rocker arm (9) is substantially U-shaped, forming a concave surface (11) facing the free end of the support shaft (2) and containing the pin (5).

2. The rocker arm mechanism according to claim 1, **characterised in that** the first end (9a) comprises a guide (16) which engages with the end of the stem (4a) to hold the rocker arm (9) in the correct position relative to the valve (4).

3. The rocker arm mechanism according to claim 1 or 2, **characterised in that** it comprises at least one channel (20) for the passage of a lubricant, the channel having one open end (21) at the seat (10) for the pin (5).

4. The rocker arm mechanism according to claim 3, **characterised in that** the channel (20) has a first portion (20a) made in the support shaft (2).

5. The rocker arm mechanism according to claim 4, **characterised in that** the channel (20) has at least one second portion (20b) made in the pin (5) and in fluid communication with the first portion (20a).

6. The rocker arm mechanism according to claim 5, **characterised in that** the channel (20) has a third portion (20c) made in the rocker arm (9), between the seat (10) for the pin (5) and the second end (9b) of the rocker arm (9).

7. The rocker arm mechanism according to claim 6, **characterised in that** the means (15) for kinematically connecting the camshaft (14) to the rocker arm (9) comprise a hydraulic tappet (19) mounted on the second end (9b) of the rocker arm (9) and in contact with the camshaft (14); the hydraulic tappet (19) being in fluid communication with the third portion (20c) of the channel (20).

8. The rocker arm mechanism according to claim 6, **characterised in that** the means (15) for kinematically connecting the camshaft (14) to the rocker arm (9) comprise a connecting rod (18) with a first end (18a) attached to the second end (9b) of the rocker arm (9) and a second end (18b) in contact with the camshaft (14); a hydraulic tappet (19) for automatic compensation of valve clearance being mounted on the second end (18b) of the rod (18).

9. The rocker arm mechanism according to claim 8, **characterised in that** the channel (20) has a fourth portion (20d) made in the connecting rod (18) and extending between the third portion (20c) and the hydraulic tappet (19), carrying the lubricant to the hydraulic tappet (19).

10. The rocker arm mechanism according to any of the foregoing claims, **characterised in that** the shape of the pin (5) is substantially semi-spherical.

11. The rocker arm mechanism according to any of the foregoing claims, **characterised in that** the pin (5) is substantially semi-cylindrical and has directrices at right angles to the longitudinal axis of the support shaft (2).

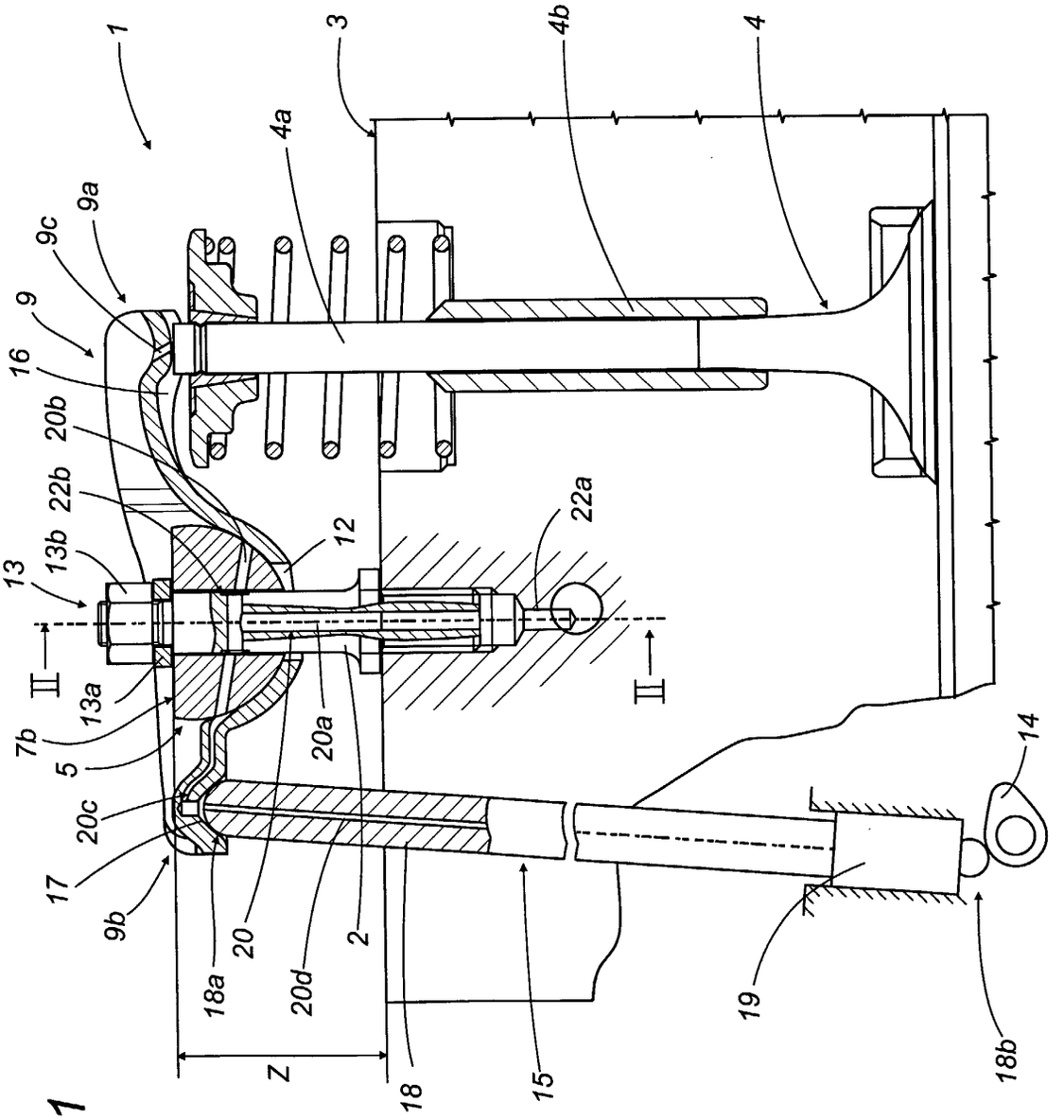

1
3
4b
4
4a
9a
9c
9
16
20b
22b
13b
13
12
22a
II
II
13a
7b
5
20c
17
9b
20
18a
20d
2
20a
Z
18
15
19
14
18b

FIG.1

FIG.2

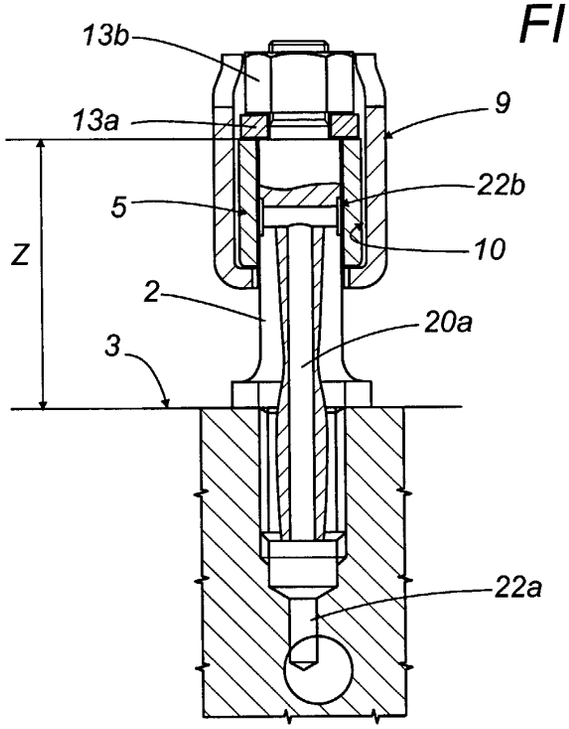


FIG.4

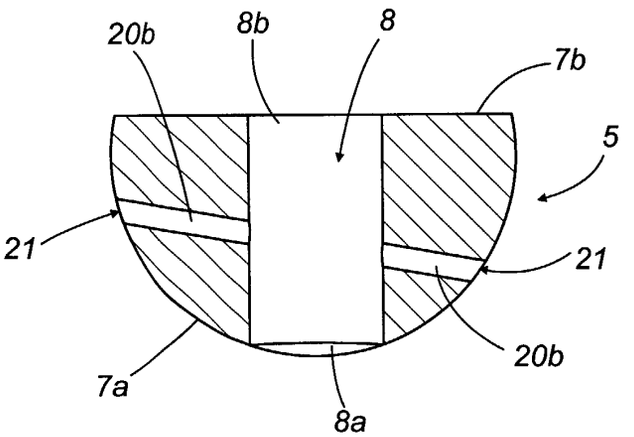


FIG.3

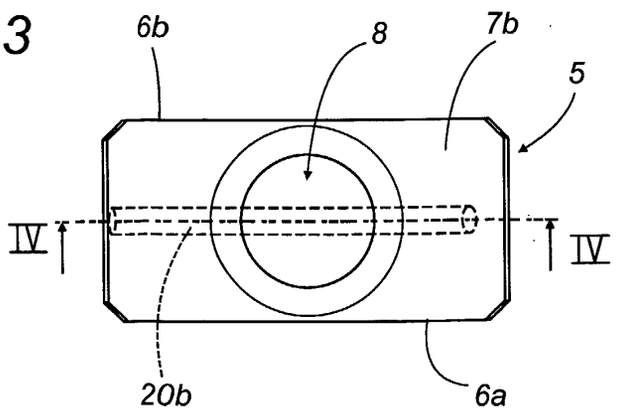


FIG.6

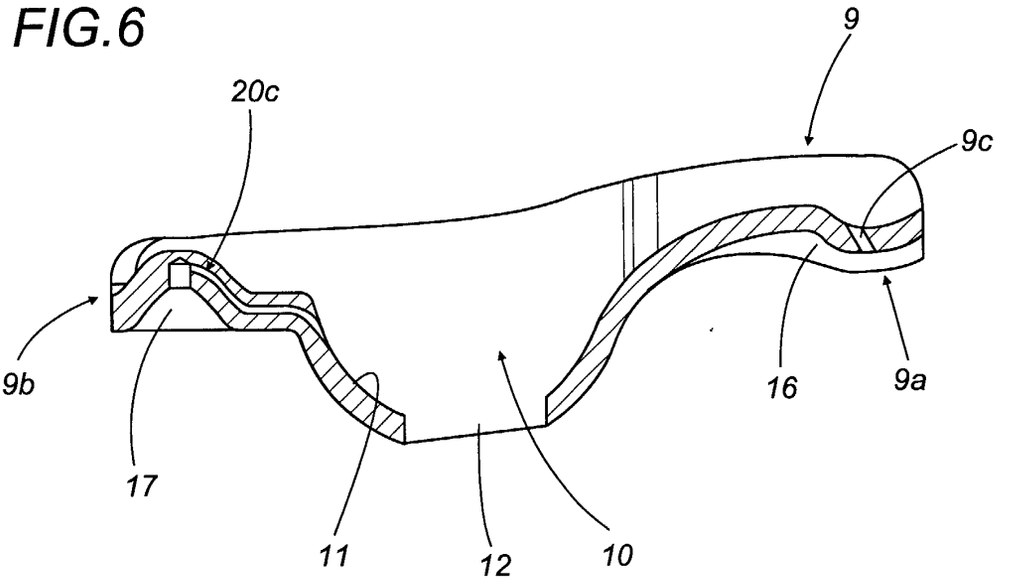


FIG.5

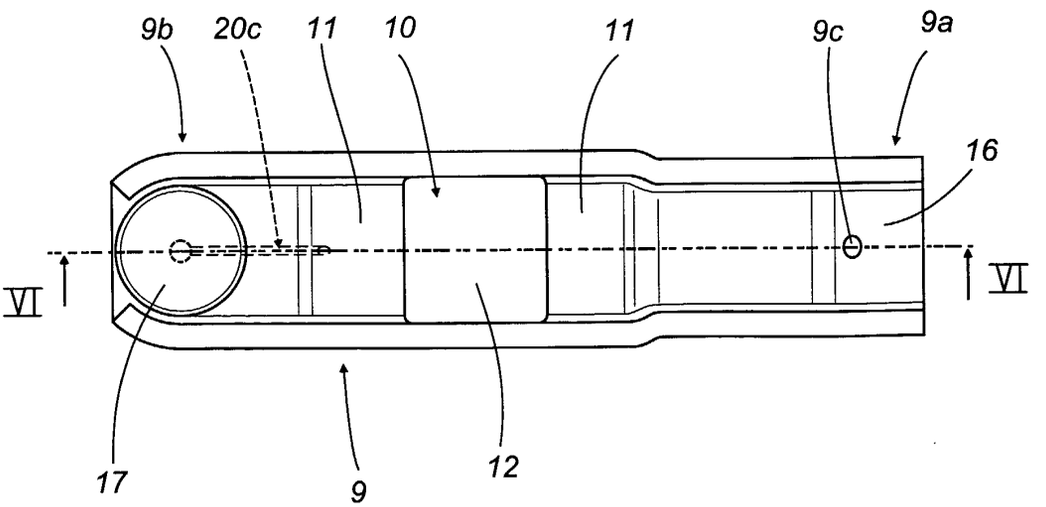


FIG.7

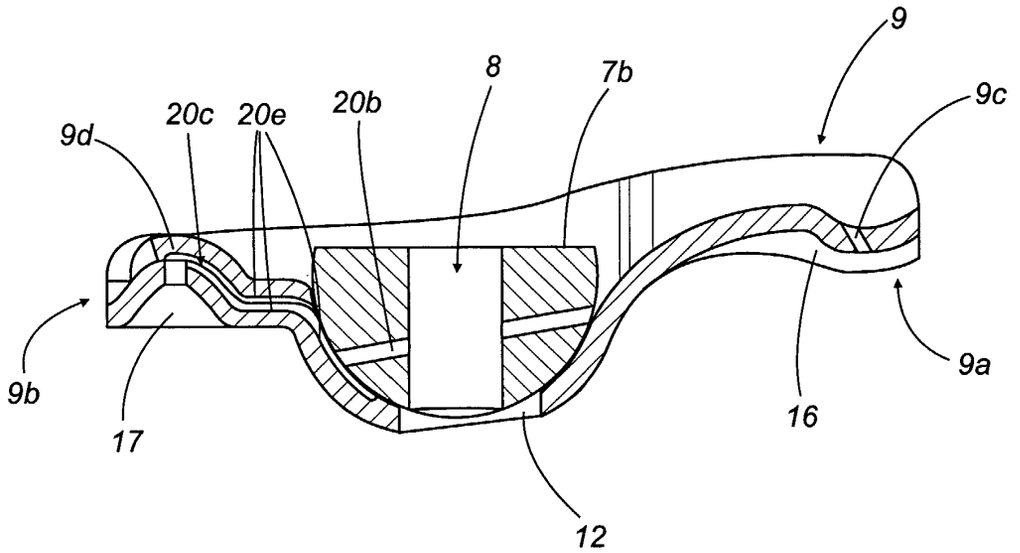


FIG.8

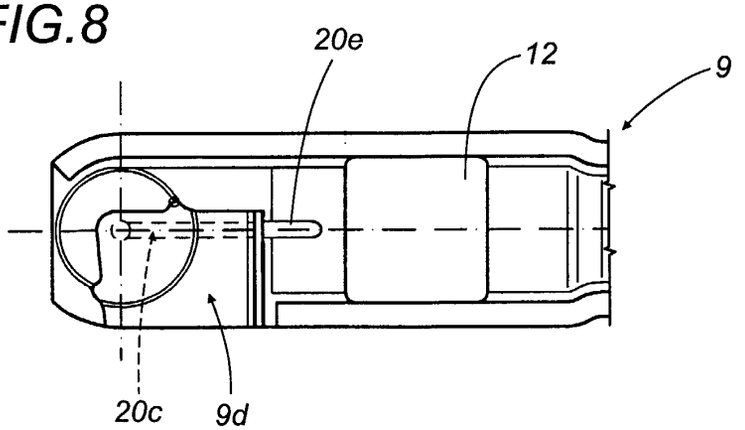
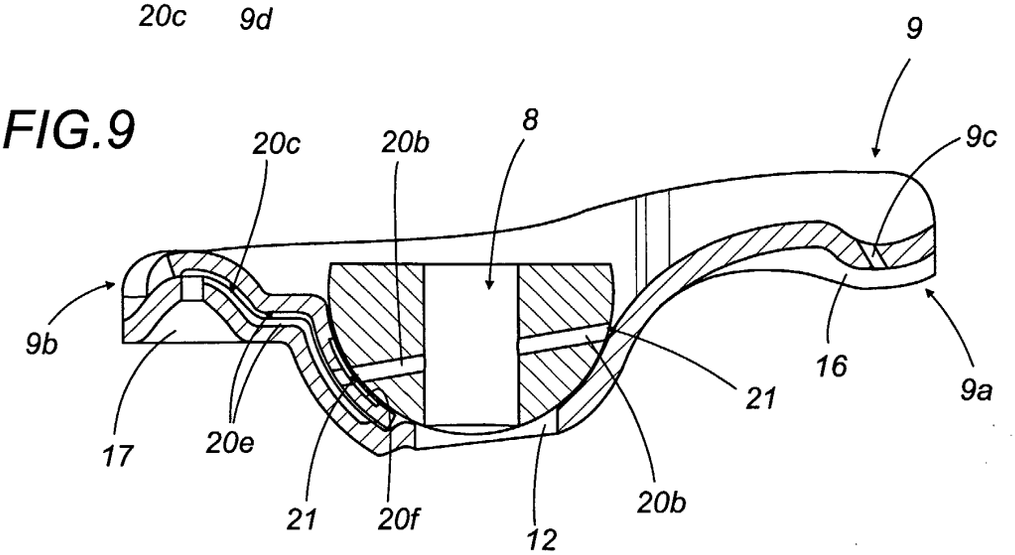


FIG.9



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EUROPEAN SEARCH REPORT

Application Number
EP 01 83 0508

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	US 2 926 645 A (JOSEPH GUARRAIA) 1 March 1960 (1960-03-01) * figures 1-9 * * column 2, line 47 *	1,2,10	F01L1/18
X	DE 24 38 227 A (TATRA NP) 26 February 1976 (1976-02-26) * figures 1-4 * * page 4, line 22 *	1,2,10	
X	US 5 190 000 A (VAN SCHAIK PETER J ET AL) 2 March 1993 (1993-03-02) * figures 1-3 *	1,2,10	
X	US 3 082 755 A (GROPP KARL H) 26 March 1963 (1963-03-26) * figures 1,3-5 *	1,2,11	
X	GB 1 051 107 A (FORD MOTOR) * figures 1-3 *	1,2,11	
A	DE 197 41 078 A (SCHAEFFLER WAELZLAGER OHG) 25 March 1999 (1999-03-25)		TECHNICAL FIELDS SEARCHED (Int.Cl.7) F01L

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	14 January 2002	Paulson, B

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14-01-2002

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2926645 A	01-03-1960	NONE	
DE 2438227 A	26-02-1976	DE 2438227 A1	26-02-1976
US 5190000 A	02-03-1993	CA 2062321 A1	06-09-1993
		AU 3743093 A	05-10-1993
		WO 9318281 A1	16-09-1993
US 3082755 A	26-03-1963	GB 937475 A	18-09-1963
GB 1051107 A		NONE	
DE 19741078 A	25-03-1999	DE 19741078 A1	25-03-1999
		WO 9914466 A1	25-03-1999

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