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(54) Timing system for internal combustion engines.

(57) In an internal combustion engine, each cylinder is provided with rotating inlet valves (4, 5) which are supported by a floating metal sheet (26) which ensures sealing as a result of the pressure existing in the cylinder.

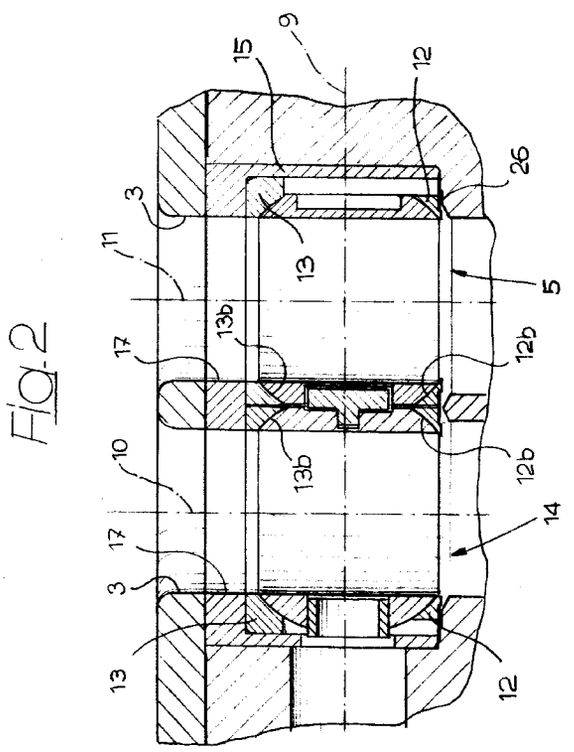


FIG.2

EP 0 668 435 A1

The present invention relates to a timing system for an internal combustion engine including at least one cylinder, having associated therewith at least one inlet duct and at least one outlet duct, provided with respective inlet and outlet valves,

in which at least the, or each, inlet valve is in form of a rotating valve having a body which is rotatably mounted within a respective duct and is adapted to be rotated intermittently so as to reach in sequence an opened position, in which a through hole formed through said valve body is in line with said duct, to allow passage of fluid through said duct, and a closed position, in which said valve body obstructs said duct,

said system further comprising cam-like driving means, having an input shaft which is rotated continuously in one direction by a driving transmission, and an output shaft connected to the body of the rotating valve, which rotates intermittently to bring said valve in sequence into its opened and closed positions, and

wherein said valve body is rotatably supported by a first and a second support rings located on opposite sides of the valve body with their apertures arranged coaxially to said duct, said support rings each having a spherical front surface in contact with a corresponding spherical surface of the valve body,

said system further comprising means for urging said support rings and the valve body in the direction of the axis of said duct to ensure a seal against fluid leakage.

A timing system of the above indicated type is described and illustrated for example in US-A-4 776 306.

One of the main limits to the performance of an internal combustion engine, either for a motor-vehicle, or for a motor-cycle, specially for race vehicles, is constituted by the maximum rotational speed which is practicable. The timing system is that which often first reaches critical conditions. The conventional mushroom-shaped valves which are usually used to open and close the ports for passage of gas are driven by cams to have a reciprocal movement, which gives rise in operation to inertia forces which are such as to jeopardize, beyond given speeds, the proper operation and also the integrity of all the components of the timing system. Another problem is represented by the quantity of air/fuel mixture which can pass through the inlet ducts and can be trapped within the engine. The displacement laws provided with mushroom-shaped valves are relatively unsuitable to fulfil the above mentioned mechanical needs.

On the basis of these considerations, there have been already proposed in the past, in replacement of mushroom-shaped inlet valves, rotating valves which have the following advantages:

ports opening laws which are more favourable for engine filling,

elimination of obstructions to the air flow represented by the valve guide bushes and the valve stems,

elimination of the retaining springs and resonances thereof,

possibility of providing smaller and more regular combustion chambers, since there is no need of cavities within the piston to avoid interference with the valves at the top dead center, so as to obtain higher compression ratios and more efficient combustion.

Generally, the drawbacks encountered with rotating valves are the following:

difficulty in providing efficient valve seals,

risk of wear, due to the presence of surfaces which slide relative to each other and exchange forces with each other,

the valve actuating system is complicated and causes power absorption.

Studies and researches conducted by the Applicant have shown that in order to overcome the above mentioned drawbacks it is necessary firstly that the valves are actuated by cam intermittent devices.

The US patent which has been cited above has already proposed a timing system for rotating valves with cam driving means which cause an intermittent rotation of the valves. In other words, the valves do not rotate continuously, but at intervals, when it is necessary that they move from the opened position to the closed position and vice versa.

In the case of the above mentioned prior reference (figures 10, 11), the cam driving means are constituted by a Geneva mechanism, which however is not fully satisfactory, because of the relatively high bulk thereof, excessive accelerations, and power absorption. Furthermore, in the above mentioned known solution, the means for urging the body of the rotating valve and its two support rings against each other are constituted by a spring which is interposed between the engine structure and one of the support rings; however, this solution is not efficient in operation and is not reliable.

A similar solution is known from EP-A-0 325 655. Devices which instead provide continuously rotating valves are known for example from DE-A-27 13 654, GB-A-536 251, US-A-2 787 988, FR-E-67 213.

The object of the present invention is that of overcoming the drawbacks of the prior art.

In order to achieve this object, the invention provides a timing system for an internal combustion engine including at least one cylinder, having associated therewith at least one inlet duct and at least one outlet duct, provided with respective inlet and outlet valves,

wherein at least the, or each, inlet valve is in form of a rotating valve having a body which is rotatably mounted within the respective duct and is adapted to be rotated intermittently so as to reach in sequence an opened position, in which a through hole formed in the valve body is in line with said duct, to allow passage of fluid through said duct, and a closed

position, in which said valve body obstructs said duct,

said system further comprising cam driving means, having an input shaft which is rotated continuously in one direction by a driving transmission, and an output shaft connected to the body of the rotating valve, which rotates intermittently to bring said valve in sequence to its opened position and its closed position,

wherein said valve body is rotatably supported by a first and second support rings located on opposite sides of the valve body with the apertures thereof arranged coaxially to said duct, said support rings each having a spherical front surface in contact with a cooperating spherical surface of the valve body,

said system further including means for urging said support rings and the valve body against each other in the direction of the axis of said duct to ensure sealing against fluid leakage,

characterized in that said means for urging said support rings and said valve body against each other includes a support floating metal sheet, connected at its periphery to the wall of said duct and having a central floating portion on which said first support ring rests, and having an aperture arranged coaxially with said duct, said second support ring being fixed in a seat formed in the wall of said duct, so that said floating metal sheet is free to deform as a result of a pressure existing within the cylinder to push said first support ring against said valve body and said second support ring, when it is subjected to said pressure in the cylinder.

Due to said feature, the system according to the invention provides a "self-energizing" seal, i.e. a system which keeps the support rings and the valve body pressed against each other with no aid of any outer element, such as a spring, but simply by exploiting the pressure which is present in the cylinder.

In a preferred embodiment, which relates to the case in which for each cylinder there are provided two inlet ducts with two respective inlet valves, according to the invention the bodies of said inlet valves are separate and rotationally connected to each other, and said floating metal sheet has a substantially 8-shaped configuration in order to support both said valve bodies.

Studies and tests conducted by the Applicant have shown that in the system according to the invention it is particularly advantageous to use a cam driving transmission constituted by a device known per se, marketed by the firm Colombo Filippetti S.p.A., of Casirate d'Adda - Bergamo (Italy) and identified with reference CF340P. The overall structure of this device will be briefly disclosed hereinafter.

Further features and advantages of the invention will become apparent from the description which follows with reference to the annexed drawings, given purely by way of non limiting example, wherein:

figure **1** is a diagrammatic cross-sectional view of a detail of an engine provided with the timing system according to the invention,

figure **2** is a cross-section, at an enlarged scale, taken along line II-II of figure 1,

figure **3** is a perspective exploded view, partially in cross section, of the detail of figure 2, and

figures **4A-4G** show the principle of operation of the driving device of the timing system according to the invention.

In figure 1, reference numeral 1 generally designates a detail of an internal combustion engine including for example two cylinders 2, each having associated therewith two inlet ports 3. The passage of fluid through ports 3 is controlled by two rotating valves 4, 5 which will be described in detail hereinafter. Each pair of valves 4, 5 is driven by the output shaft 6 of a cam device 7 with intermittent output of the type marketed by the firm Colombo Filippetti with reference CF340P. The input shaft of the intermitting cam device 7 is constituted by a shaft 8 which is connected to all the intermitting devices 7 associated with the various cylinders of the engine and receives on its turn the rotation by the engine shaft, e.g. through a toothed belt transmission. Each intermitting device 7 is adapted to change the continuous rotation of shaft 8 into an intermittent rotation of shaft 6 so as to bring the associated inlet valves 4, 5 alternatively to the opened and closed position.

With reference to figures 2, 3, the two valves 4, 5 have respective substantially spherical valve bodies 4a, 5a, each rotatably supported around an axis 9 which is orthogonal with respect to axes 10, 11 of the two inlet ducts 3.

Each of the two valve bodies 4a, 5a is constituted of a relatively light material, such as a light alloy or ceramics, and is rotatably supported around axis 9 by two support rings 12, 13, for example made of bronze. The two rings 12, 13 are arranged on opposite sides of each valve body with their apertures 12a, 13a arranged coaxially to axes 10, 11. Rings 12, 13 further have front spherical surfaces 12b, 13b in sliding contact with cooperating spherical surfaces of valve bodies 4a, 5a. These latter each have a through diametrical hole 14, so that each valve allows fluid passage through the inlet duct 3 when it is arranged in a first position, in which the through hole 14 is in line with duct 3, whereas it obstructs the passage in a second position, in which hole 14 is arranged orthogonal with respect to the axis of duct 3.

The support rings 13 are fixedly mounted against the bottom wall of a bush 15, having a bottom wall 16 provided with two apertures 17 arranged coaxially to the inlet ducts 3 and opened on the opposite side. Bush 15 has a skirt 18 which surrounds the two valve bodies 4a, 5a and has a hole 19 for passage of the output shaft of the intermitting device 7 which is to be connected within a seat 20 of the valve body 4a to drive rotation of the latter. Valve body 4a is on its turn

rotationally connected to valve body 5a by a Oldham coupling, constituted by a disk 21 having on its opposite faces two ribs 22, 23 arranged along mutually orthogonal directions, which engage cooperating slots 24 formed in the two valve bodies 4a, 5a.

The two support rings 12 rest- on the edge of two apertures 25 of a floating metal sheet 26 having a substantially 8-shaped configuration. As shown in figure 2, the floating metal sheet 26 is rigidly connected at its periphery to the engine structure, since it is pressed between an inner wall of this structure and the end edge of bush 15. The central portion of metal sheet 26 is free of floating. In particular, this central portion is free to move upwardly (with reference to figure 2) urging rings 12 against valve bodies 4a, 5a and rings 13, under the effect of a pressure existing in the cylinder (which is communicated to the lower part of ducts 3, with reference to figure 2). In this manner, the same pressure existing in the cylinder ensures the seal against fluid leakage through the contact surfaces of the rings and the valve bodies.

With reference to figure 1 and figures 4A-4G, intermitting device 7 used in this embodiment (different devices can also be used) will be described herein only briefly, since it is a device known per se and available on the market. The input shaft 8 of the device drives a continuous rotation of a first body 30 having two cams 31, 32 which are axially spaced apart from each other and cooperate respectively with two shackle-shaped cams 33, 34 mounted on the output shaft 6. Figures 4A-4G show the sequence corresponding to a rotation of 90° of the output shaft 6 as a result of a rotation of 60° of the input shaft 8. As indicated above, the input shaft 8 rotates continuously, whereas the output shaft 6 rotates intermittently through 90°, so as to bring valve bodies 4a, 5a alternatively to their opened and closed position.

Naturally, while the principle of the invention remains the same, the details of construction and the embodiments may widely vary with respect to what has been described and illustrated purely by way of example, without departing from the scope of the present invention.

Claims

1. Timing system for an internal combustion engine including at least one cylinder, having associated therewith at least one inlet duct (3) and at least one outlet duct provided with respective inlet and outlet valves (4, 5),

   wherein at least the, or each, inlet valve (4, 5) is in form of a rotating valve having a body (4a, 5a) which is rotatably mounted within the respective duct (3) and is adapted to be rotated intermittently so as to reach in sequence an opened position, in which a through hole (14) formed through said valve body (4a, 5a) is in line with said duct (3) to allow passage of fluid through said duct (3) and a closed position, in which said valve body (4a, 5a) obstructs said duct (3),

   said system further comprising cam driving means (7), having an input shaft (8) which is rotated continuously in one direction by a driving transmission, and an output shaft (6) connected to the body (4a, 5a) of the rotating valve, which rotates intermittently to bring said valve (4, 5) in sequence to its opened and closed position,

   wherein said valve body (4a, 5a) is rotatably supported by a first and a second support rings (12, 13) located on opposite sides of the valve body (4a, 5a) with their apertures (12a, 13a) arranged coaxially to said duct (3), said support rings (12, 13) each having a front spherical surface (12b, 13b) in contact with a cooperating spherical surface of the body (4a, 5a),

   said system further including means for urging said support rings (12, 13) and the valve body (4a, 5a) against each other in the direction of the axis of said duct (3) to ensure sealing against fluid leakage,

   characterized in that said means for urging said support rings (12, 13) and said valve body (4a, 5a) against each other includes a support floating metal sheet (26), connected at its periphery to the wall of said duct (3) and having a floating central portion on which said first support ring (12) rests, and having an aperture (25) arranged coaxially to said duct (3), said second support ring (13) being fixed in a seat formed in the wall of said duct (3), so that said floating metal sheet (26) is free to deform as a result of a pressure present in the cylinder, so as to push the first support ring (12) against the valve body (4a, 5a) and the second support ring (13), when it is subjected to said pressure present in the cylinder.

2. System according to claim 1, in which for each cylinder there are provided two inlet ducts (3) with two respective inlet valves (4, 5), characterized in that the bodies of said inlet valves (4, 5) are separate from each other and rotationally connected to each other by an Oldham coupling and said floating metal sheet (26) has a 8-shaped configuration to support both the valve bodies (4a, 5a).

3. System according to claim 2, characterized in that said second support ring (13) is fixed in a seat formed in a bush (15) mounted in the engine structure, said bush (15) having a bottom wall (16) with apertures (17) arranged coaxially to the inlet ducts (3) and a skirt (18) whose end surface is pressed against the peripheral edge of said floating metal sheet (26), said peripheral edge being interposed between said end surface and

a wall of the inlet duct (3).

4. System according to claim 1, characterized in that it is applied to outlet valves.

Fig. 1

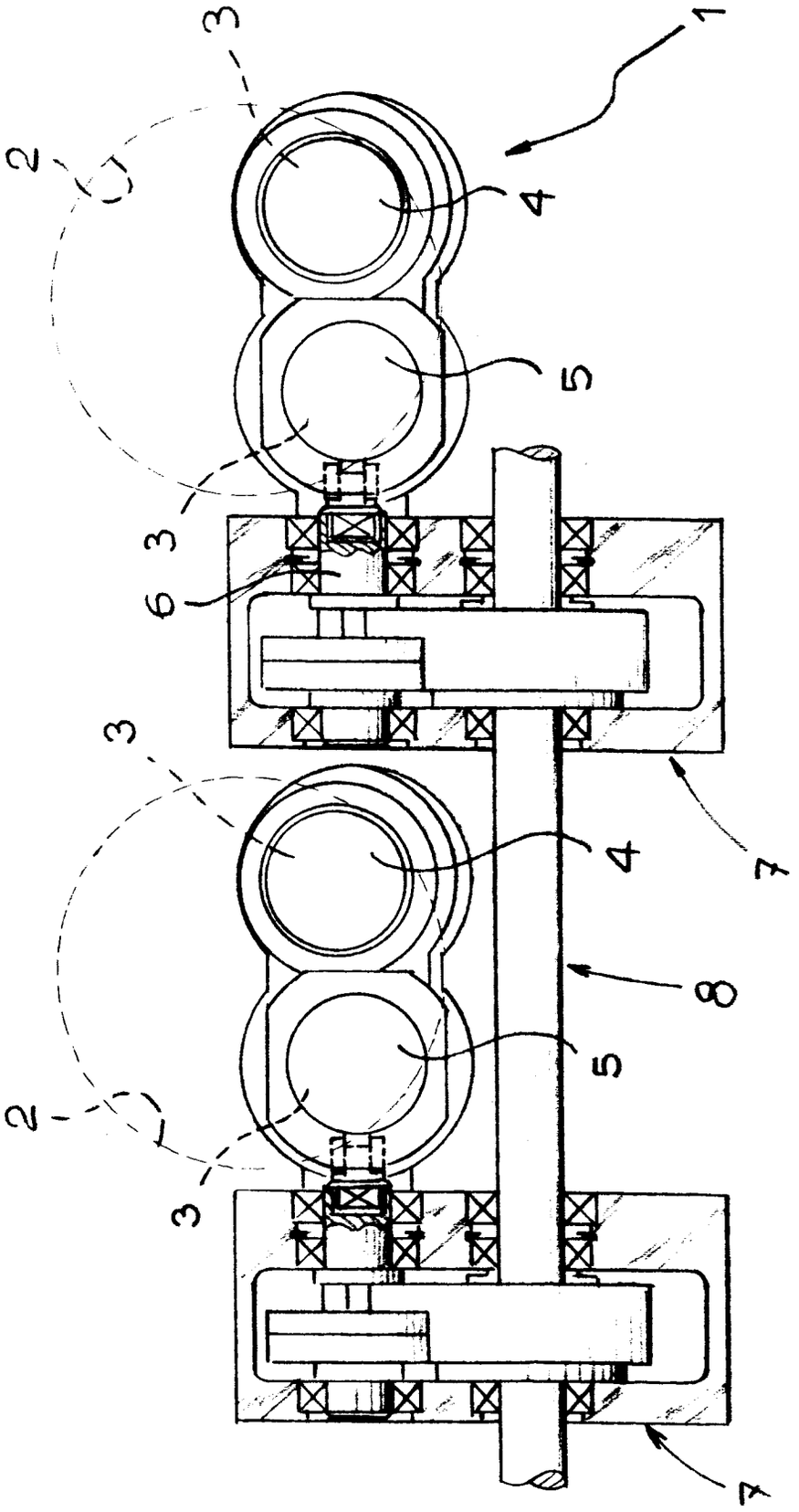


FIG-2

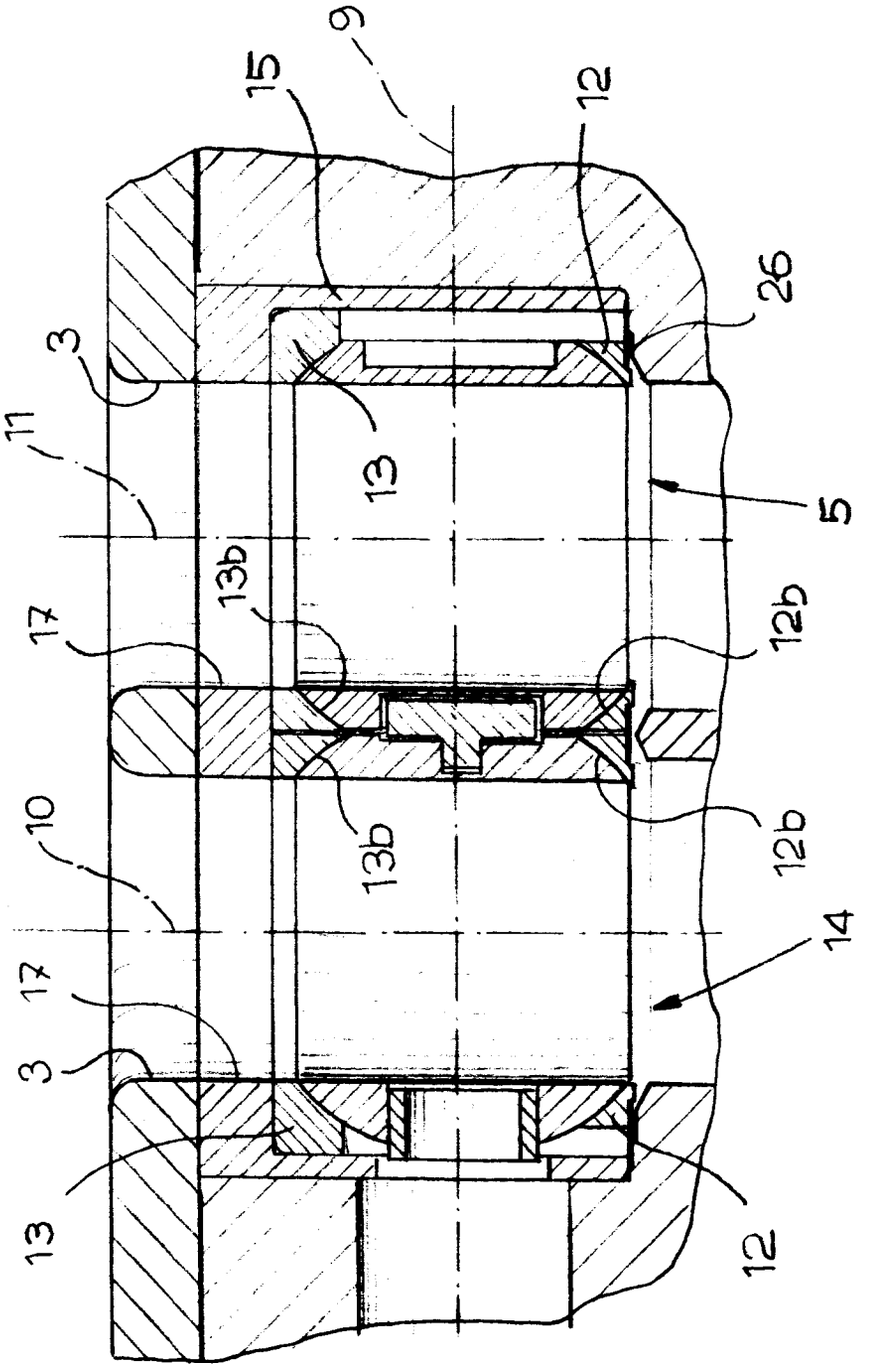


Fig. 3

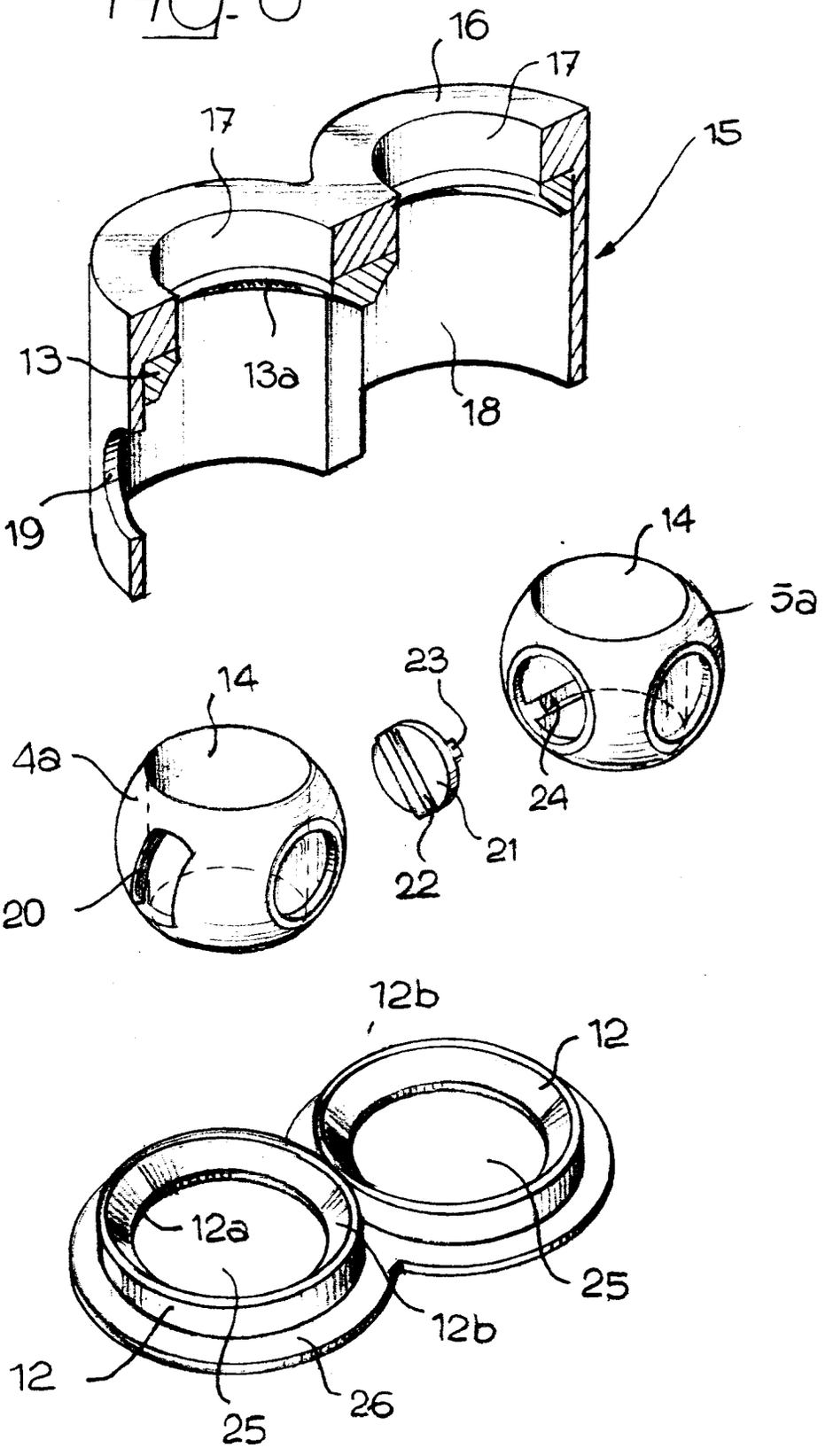

16
17
17
15
13
13a
18
19
14
5a
23
14
4a
24
21
22
20
12b
12
12a
25
12b
12
25
26

FIG. 4A

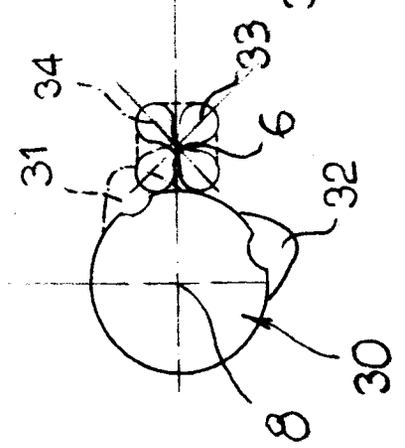


FIG. 4B

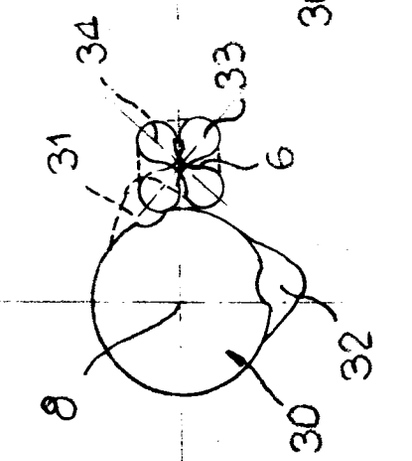


FIG. 4C

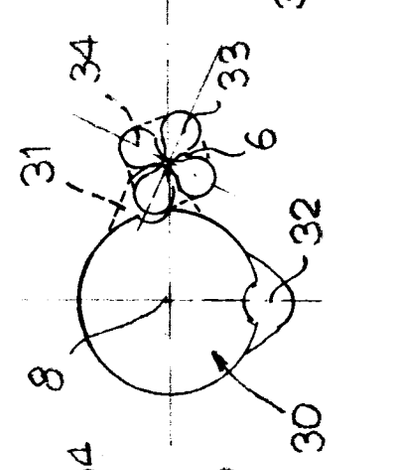


FIG. 4D

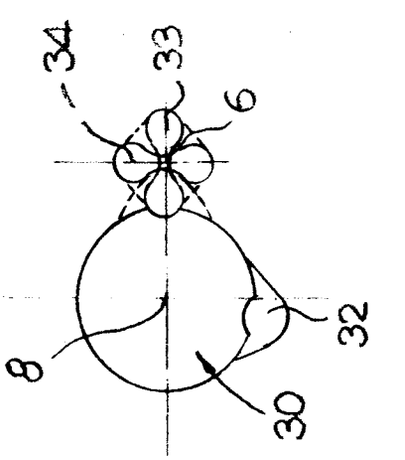


FIG. 4E

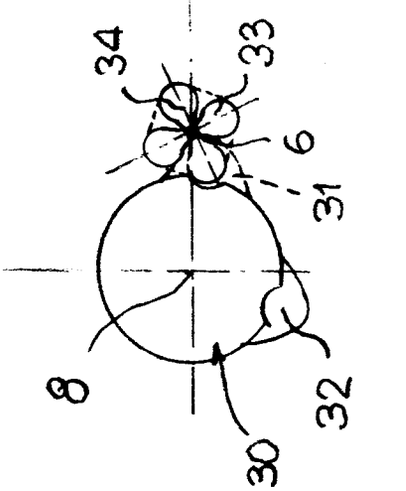


FIG. 4F

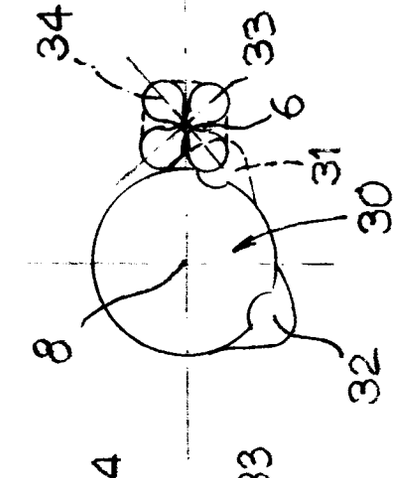
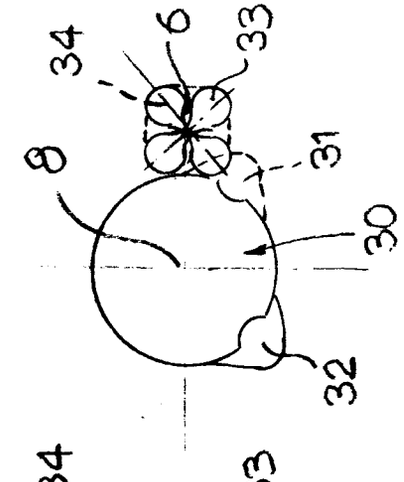


FIG. 4G



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EUROPEAN SEARCH REPORT

Application Number
EP 95 83 0037

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.6)
A	EP-A-0 325 655 (HONDA) * the whole document *	1-4	F01L7/10 F01L7/16
A,D	US-A-4 776 306 (HONDA) * the whole document *	1-4	
A	DE-A-27 13 654 (RAU) * figures *	1	
A	GB-A-536 251 (BAER) * page 1, line 8 - line 79 * * figures *	1	
A	US-A-2 787 988 (GENET) * claims; figures *	1	
A	FR-E-67 213 (GENET) * the whole document *	1	
A	US-A-4 821 692 (BROWNE)		
A	EP-A-0 071 478 (COATES)		

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

F01L

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	17 May 1995	Klinger, T

CATEGORY OF CITED DOCUMENTS

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