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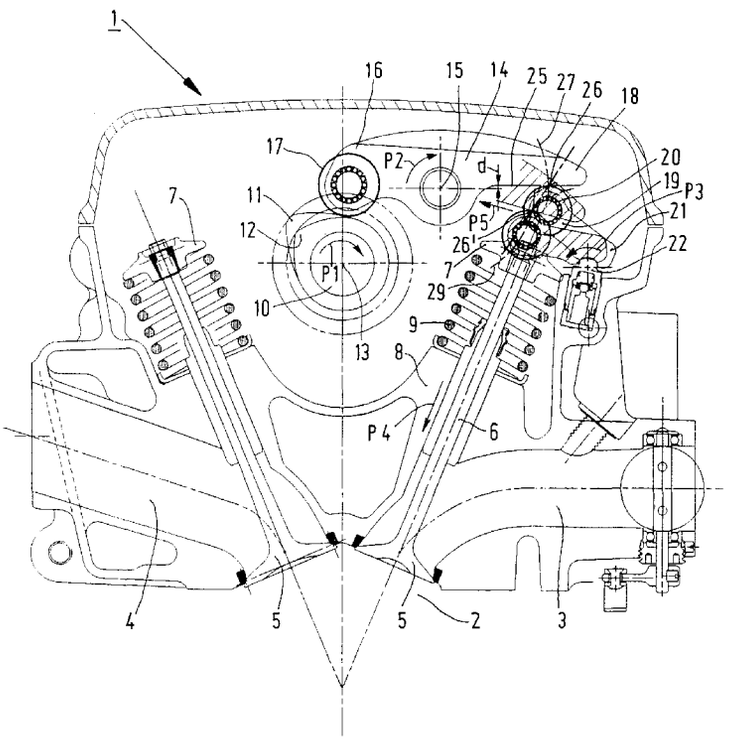
(54) Combustion engine

(57) A combustion engine (1) provided with a camshaft (10), a rocker arm (14) which is tiltable around a tilting axis (13) by means of the camshaft, a lever (21) which is pivotable around a pivot axis (22) by means of the rocker arm and a valve (5) which is movable by means of the lever from a closed position to an open position. The relative position of a point of contact of said rocker arm with said lever is dependent on the amount of tilt of said rocker arm. By the closed position of the valve, the angle between a line from the tilting axis to the point of contact and a line from the point of contact to the pivot axis lies in a range from 80 to 170°.



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Description

The invention relates to a combustion engine provided with a camshaft, a rocker arm which is tiltable around a tilting axis by means of the camshaft, a lever which is pivotable around a pivot axis by means of the rocker arm and a valve which is movable by means of the lever from a closed position to an open position, whereby the relative position of a point of contact of said rocker arm with said lever is dependent on the amount of tilt of said rocker arm.

In a common combustion engine a camshaft provided with cams is rotated, whereby a cam is in engagement with one end of a rocker arm which is capable of tilting movement about a tilting axis. The rocker arm is in engagement, with an end remote from the camshaft, with a valve which is movable against spring force. An entrance to a combustion chamber of the combustion engine is opened and closed by means of the valve.

From JP-A-58-217710 a combustion engine is known as indicated in the preamble of claim 1, whereby a lever is located between the rocker arm and the valve. Said lever is used to limit the height of the engine. When the rocker arm is tilted the position of the point of contact between the rocker arm and the lever varies. Due to the relative sharp angle between a line from the tilting axis of the rocker arm and the point of contact and a line from the point of contact to the pivot axis of the lever, the influence of the changing of the point of contact on the movement of the valve is neglectable.

The motion profile of the valve, that is the movement of the valve during opening and closing, therefore depends mainly on the shape of the cam. The extent of the movement is dependent on the fixed transmission ratio of the rocker arm, which is determined by the ratio between the distance between the point of contact of the cam with the rocker arm and the tilting axis of the rocker arm and the distance between said tilting axis and the point of contact of the rocker arm with the lever.

Because increasingly high demands are being made with regard to the velocity and acceleration with which the valve must be opened and closed, the shape of the cam is becoming more and more complicated. It is relatively costly to produce such complicated cam shapes. In addition to that the movements imposed by the cam can only be followed by means of a relatively small cam follower.

The object of the invention is to provide a combustion engine wherein relatively high velocities and accelerations of the valve are possible, whilst the shape of the cam present on the camshaft can be kept relatively simple.

This objective is accomplished with the combustion engine according to the invention in that by the closed position of the valve, the angle between a line from the tilting axis to the point of contact and a line from the point of contact to the pivot axis lies in a range from 80 to 170°.

The tilting of the rocker arm causes said lever to pivot, whereby the point of contact between the rocker arm and the lever is changed. As a result of this and due to the angle of 80 till 170° between the rocker arm and the lever, the transmission ratio between the rocker arm and the lever will change substantially during the tilting of the rocker arm and the pivoting of the lever. Due to the changing transmission ratio the motion profile of the valve is determined not only by the shape of the cam but also partially by the changing transmission ratio of the rocker arm. This results in a great freedom of design with regard to the cam shape. A suitable selection of the cam, the rocker and the lever makes it possible to use motion profiles which so far could not be realised by a cam alone. When the angle lies outside the indicated range no or negligible influence will be noticed on the motion profile of the valve.

One embodiment of the combustion engine according to the invention is characterized in that said rocker arm and said lever can roll over one another, whereby at least either said rocker arm or said lever is provided with a rotatable roller.

By having the rocker arm and the lever roll over each other, frictional forces which cause undesirable wear will be avoided.

The invention will be explained in more detail hereafter with reference to the drawing, in which:

Figure 1 is a cross-sectional view of a combustion engine according to the invention;
Figure 2 is a perspective view of a part of the combustion engine shown in Figure 1;
Figure 3 shows a motion trend of the rocker arm and the lever of a combustion engine according to the invention; and
Figures 4A and 4B show a closed and an open position respectively of a valve of the combustion engine shown in Figure 1.

Like parts are numbered alike in the Figures.

Figure 1 shows a combustion engine 1 which is provided with a combustion chamber 2 located within a cylinder. Two inlet channels 3 and one outlet channel 4 are connected to said combustion chamber 2. The passages of inlet channels 3 and outlet channel 4 in combustion chamber 2 can be closed by means of valves 5 (two intake valves and one exhaust valve respectively). Each valve 5 comprises a valve rod 6, which is provided with a disc-shaped plate 7 on one side remote from the valve 5. Valve rod 6 is journalled in a housing 8 of combustion engine 12. A compression spring 9 is disposed between housing 8 and disc-shaped plate 7, which spring urges the valve 5 in the closed position shown in Figure 1. Combustion engine 1 is furthermore provided with a camshaft 10, which is positioned between the valves 5, which are arranged in the shape of a V, of inlet channels 3 and outlet channel 4 respectively. Camshaft 10 extends transversely to the plane of drawing of Figure 1 and is provided with a plurality of cams 11, 12, whereby

each valve 5 has two different cams 11, 12 associated therewith. The camshaft 10 is movable in the direction transversely to the plane of drawing, by means which are known per se (not shown), whereby either cam 11 or cam 12 may be coupled to valve 5, depending on the position of camshaft 10. Camshaft 10 is rotatable about an axis 13 in a direction indicated by arrow P1. Combustion engine 1 is furthermore provided with a rocker arm 14 positioned above camshaft 10, which is capable of tilting movement about a tilting axis 15 in a direction indicated by arrow P2 and in a direction opposite thereto. Rocker arm 14 is at one end 16 provided with a ball bearing 17 constituting a cam follower, which abuts against cam 11 or 12, depending on the position of camshaft 10. One end 18 of rocker arm 14 positioned on another side of tilting axis 15 abuts against one end 20 of a lever 21, which is provided with a ball bearing 19. Figure 1 also shows in hatched lines another position of rocker arm 14 and lever 21. The lever 21 pivots about a pivot pin 22 in a direction indicated by arrow P3 and in a direction opposite thereto. As can be clearly seen in Figure 2, lever 21 is provided with three fingers, whereby the two outer fingers 23 each butt on a disc 7 of a valve 5 closing an inlet channel. The middle finger 24 forms the end 20 of the lever, around which ball bearing 19 is rotatably journalled. Rotation of camshaft 10 in the direction indicated by arrow P1 will cause the rocker arm 14 to tilt, as a result of which the lever 21 is pivoted in a direction indicated by arrow P3. The pivoting movement of the lever 21 will cause the valves 5 to move in the direction indicated by arrow P4, as a result of which the passage of inlet channels 3 to combustion chamber 2 is opened. For easy reference only one valve 5 is shown in Figure 2.

For opening and closing valve 5 of outlet channel 4, combustion engine 1 is provided with a rocker arm and with a lever, which operate in the same manner as the rocker arm 14 and the lever 21 shown in Figure 1, and which are likewise actuated by camshaft 10. The lever by means of which exhaust valve 5 is opened is provided with a single finger 23, since combustion chamber 2 has only one outlet channel 4. If combustion chamber 2 is provided with two outlet channels, a lever 21 similar to the one used for actuating the intake valves 5 may be used.

The operation of the combustion engine according to the invention will now be explained in more detail. Upon rotation of camshaft 10 in the direction indicated by arrow P1, ball bearing 17 rolls over the outer side of cam 11 and 12 and is moved upwards, seen in Figure 1. Depending on whether the number of revolutions of the combustion engine is relatively high or low, cam 11 or cam 12 is engaged. The movement of the ball bearing 17 will cause the rocker arm 14 to tilt in the direction indicated by arrow P2. The position of rocker arm 14 shown in hatched lines is the uttermost position of rocker arm 14 that is reached when cam 11 is used. In the position of rocker arm 14 shown in Figure 1 the flat underside 25 of rocker arm 14 touches ball bearing 19 of lever 21 in point of contact 26. A line from the tilting axis 15 of the rocker arm 14 to the point of contact 26 and a line from the point of contact 26 and the pivot axis 22 of the lever 21 enclose an angle β which lies between 80 and 170°, and is more specifically 125°. This angle β is, for the sake of clarity, not indicated in figure 1 but in figure 4A. The angle β is measured by a position in which the valve 5 is closed. Said point of contact 26 lies on a circular arc 27, which has tilting axis 15 as its centre. Tilting of rocker arm 14 will cause said rocker arm 14 to move to the position shown in hatched lines in Figure 1 when cam 11 is used. Ball bearing 19 is forced down by the underside 25, seen in Figure 1, causing lever 21 to pivot in the direction indicated by arrow P3. As a result of this valve 5 is moved in a direction indicated by arrow P4. During said tilting and pivoting the point of contact 26 between underside 25 and ball bearing 19 is shifted in a direction indicated by arrow P5. The new point of contact 26' lies on a circular arc 29, which has tilting axis 15 as its centre, whereby the radius of circular arc 29 is smaller than that of circular arc 27. As a result of this the momentary transmission ratio of rocker arm 14 has been changed. As a result of the continuously changing transmission ratio of the rocker arm the movement of valve 5 is dependent not only on the shape of cam 11 or 12 as regards its trend, but also on the continuously changing transmission ratio of rocker arm 14. With the rocker arm 14 shown in Figure 1 the underside 25 extends in a level direction at a distance D above tilting axis 15. Another change in the transmission ratio is obtained by providing the underside 25 of the rocker arm with a curved profile and/or by increasing or decreasing the distance D to the tilting axis 15.

Figure 3 schematically shows the changing of the transmission ratio of the rocker arm. In Figure 3 the underside 25 of rocker arm 14 extends through the tilting axis 15 of rocker arm 14. The diameter of ball bearing 19 of lever 21 is considered to be negligible. For easy reference only the tilting axis 15, the underside 25 of the rocker arm 14 and the pivot pin 22 of rocker arm 14 and lever 21 are illustrated. When lever 21 is pivoted, ball bearing 19 follows circular arc 30. In a first position of the rocker arm and the lever, ball bearing 19 touches the underside 25 in point of contact 31'. When rocker arm 14 is tilted through an angle α in steps, lever 21 is pivoted in the direction indicated by arrow P3 and ball bearing 19 is moved over circular arc 30. The point of contact 31 between ball bearing 19 and underside 25 shifts in the direction indicated by arrow P5, towards tilting axis 15. Point 33 on underside 25 of rocker arm 14, which was located in point of contact 31', is shifted over circular arc 34. The distance between point 33 and point of contact 32 becomes greater as rocker arm 14 is tilted further in the direction indicated by arrow P2. The transmission ratio of rocker arm 14 is determined by the ratio between radius R1 from tilting axis 15 to the point of contact of cam 11, 12 with ball bearing 17 and the dis-

tance between tilting axis 15 and point of contact 31. As a result of the fact that point of contact 31 shifts from 31' to 31" etc. to 31'"", the transmission ratio will become smaller with every change of angle. This can be seen in Figure 3, because the angle through which lever 21 pivots, with the tilting of rocker arm 14 through an angle α remaining unchanged, will become smaller as point of contact 31 is shifted further in the direction of tilting axis 15. When rocker arm 14 is tilted with a constant velocity, point 33 is shifted over circular arc 34 with a constant velocity. Ball bearing 19, however, will be moved in the direction indicated by arrow P3 with a decreasing velocity. In this manner it is possible to cause the valve 5 to open with a decreasing velocity by means of a cam which has a shape which makes the rocker arm tilt with a constant velocity. The shape of cams 11, 12 is relatively simple thereby. With the combustion engine shown in Figure 1 also the distance between point of contact 31 and pivot axis 22 will change, because ball bearing 19 has a particular dimension, as a result of which a different point of contact 25 will cause in a different part of ball bearing 19 to butt against underside 25.

Figures 4A and 4B show valve 5 in a closed and in an open position respectively, whereby arrows P10, P10' indicate the velocity with which the valve 5 will be moved when rocker arm 14 is tilted at an angular velocity W. In the position of the valve shown in Figure 4A the point of contact 26 between rocker arm 14 and ball bearing 19 lies at a distance R1 from tilting axis 15. Ball bearing 19 experiences a velocity WR1 in the direction indicated by arrow P7. Arrow P7 indicates both the direction and the magnitude of the velocity which ball bearing 19 experiences. This momentary velocity P7 can be converted into a velocity P8 with which ball bearing 19 is pivoted about pivot axis 22 by projection of arrow P7 on a line which extends transversely to the connecting line 39 between pivot axis 22 and the axis of rotation 40 of ball bearing 19. The point of contact 41 between lever 21 and disc 7 is shifted with a momentary velocity P9, whose magnitude depends on the momentary velocity P8 and whose direction is perpendicular to the connecting line between pivot axis 22 and point of contact 41. Valve 5 is moved in the direction indicated by arrow P4 with a momentary velocity P10, which is a projection of the velocity P9 in the direction indicated by arrow P4.

In the open position shown in Figure 4B, point of contact 26 lies at a distance R1' from tilting axis 15 which is smaller than the distance R1. The velocity P7' with which point of contact 26 is shifted is also smaller, therefore, and is equal to WR1'. In the same manner as shown in Figure 4A velocity P7' can be converted, via velocity P8' of ball bearing 19 with respect to pivot axis 22, into a velocity P9' of point of contact 41 with respect to pivot axis 22 and a velocity P10' of valve 5 in the direction indicated by arrow P4. It will be apparent that the magnitude of the velocity of valve 5 indicated by the length of arrow P10' is considerably smaller than the magnitude of the velocity indicated by arrow P10. This is the consequence of a decreased length R1 and an increased angle α between connecting line 39 and arrow P7.

Depending on the selection of, among other things, the shape of the underside 25 of rocker arm 14 and the position with respect to tilting axis 15, the size of ball bearing 19 and the positions of tilting axis 15, pivot axis 22 and axis of rotation 40 relative to each other, it is possible to determine the cam shape for a desired motion profile of the valve. Thus a relatively great freedom of design has been created, which makes it possible to obtain a desired deceleration, acceleration or velocity while using relatively simple cam shapes.

Instead of moving the camshaft axially it is also possible to change cams in other manners which are known per se.

Claims

1. A combustion engine provided with a camshaft, a rocker arm which is tiltable around a tilting axis by means of the camshaft, a lever which is pivotable around a pivot axis by means of the rocker arm and a valve which is movable by means of the lever from a closed position to an open position, whereby the relative position of a point of contact of said rocker arm with said lever is dependent on the amount of tilt of said rocker arm, characterized in that by the closed position of the valve, the angle between a line from the tilting axis to the point of contact and a line from the point of contact to the pivot axis lies in a range from 80 to 170°.

2. A combustion engine according to claim 1, characterized in that said rocker arm and said lever can roll over one another, whereby at least either said rocker arm or said lever is provided with a rotatable roller.

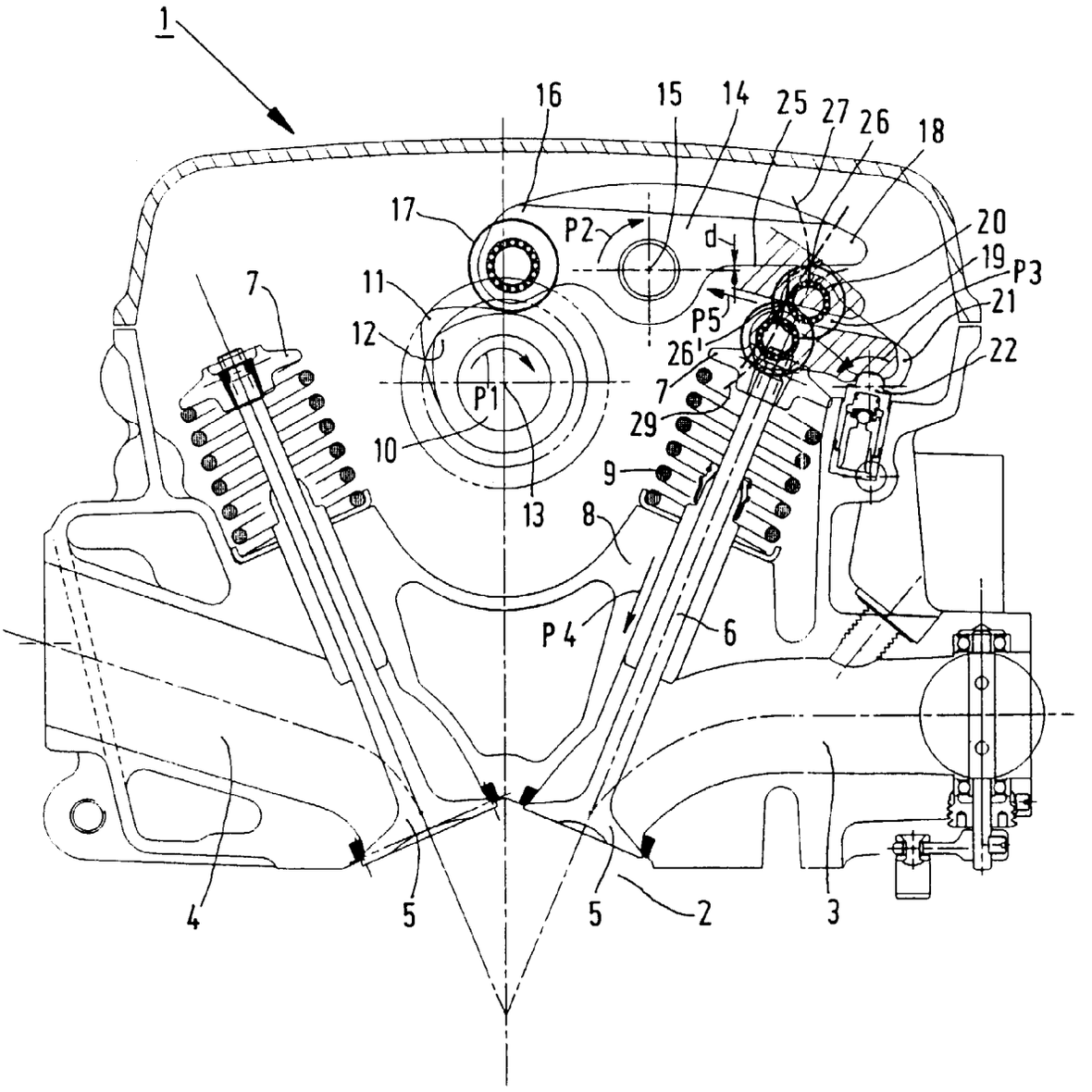
3. A combustion engine according to claim 2, characterized in that said roller is a rolling bearing positioned on said lever.

4. A combustion engine according to claim 1 or 2, characterized in that said lever comprises three fingers, whereby a middle finger butts against said rocker arm and the outer two fingers butts against two valves which are movable against spring force.

5. A combustion engine according to any one of the preceding claims, characterized in that said camshaft comprises at least two cams positioned side by side, which can be alternately coupled with said rocker arm.

6. A combustion engine according to any one of the

preceding claims, characterized in that said rocker arm and said lever include an obtuse angle with each other.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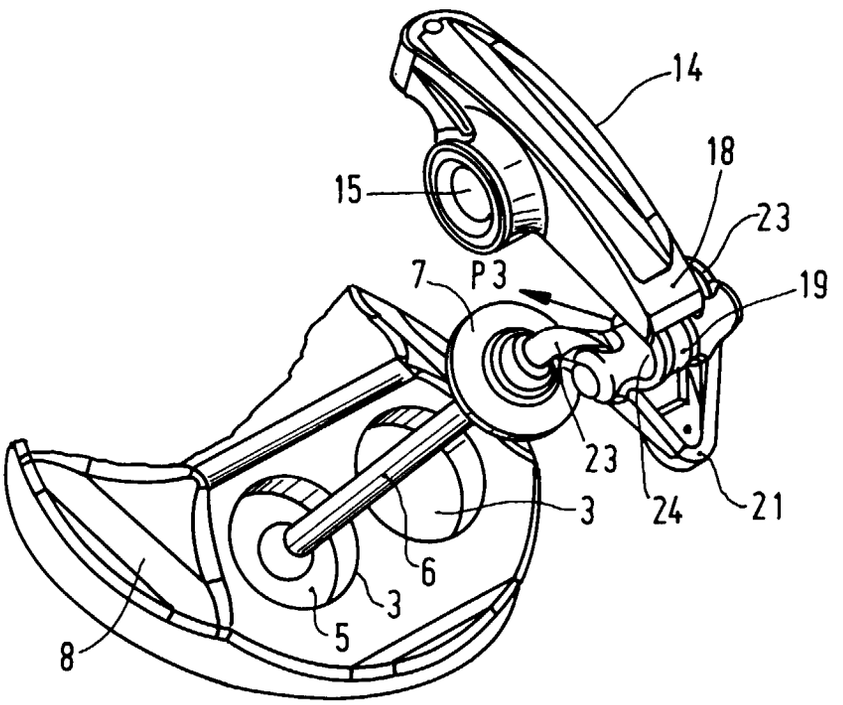
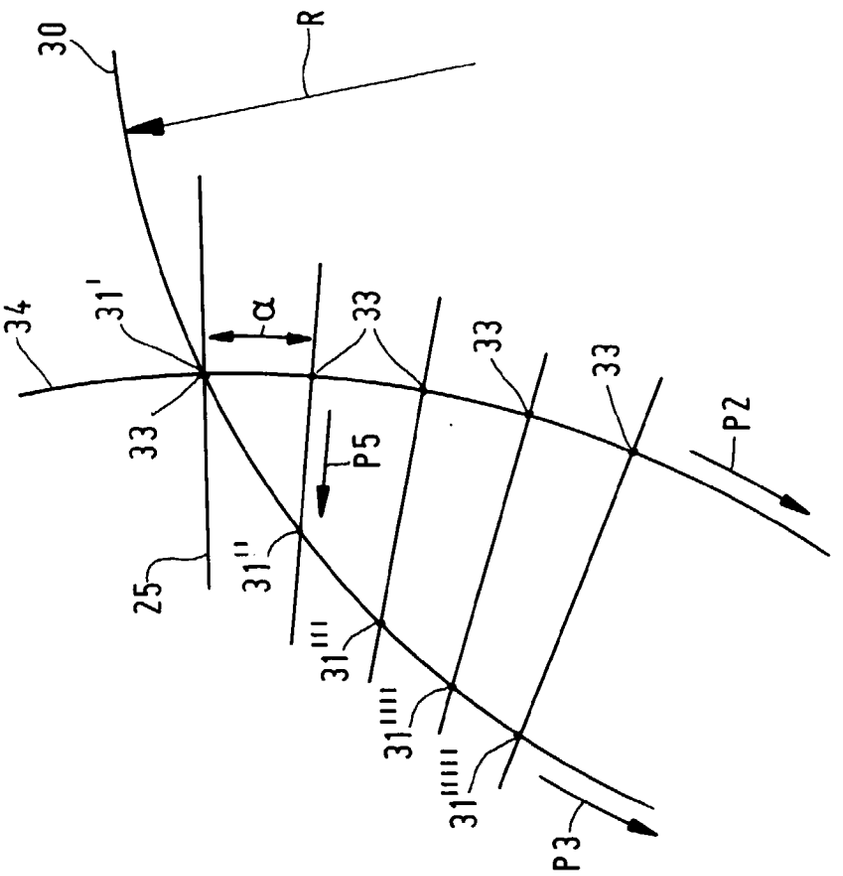


FIG. 2



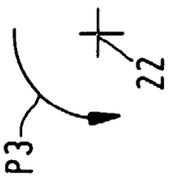
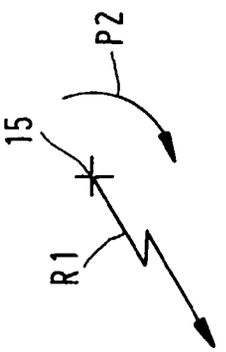


FIG. 3



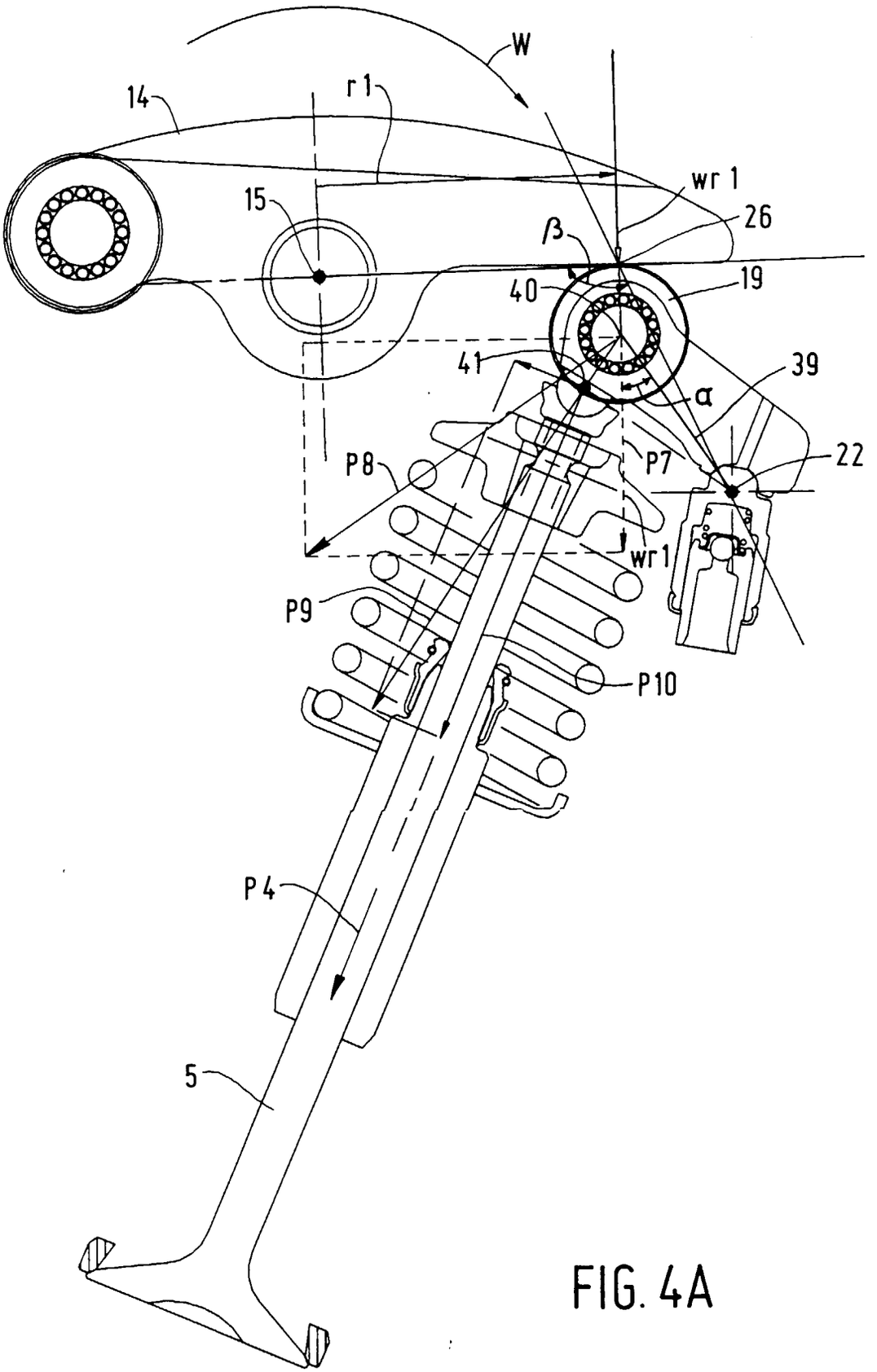


FIG. 4A

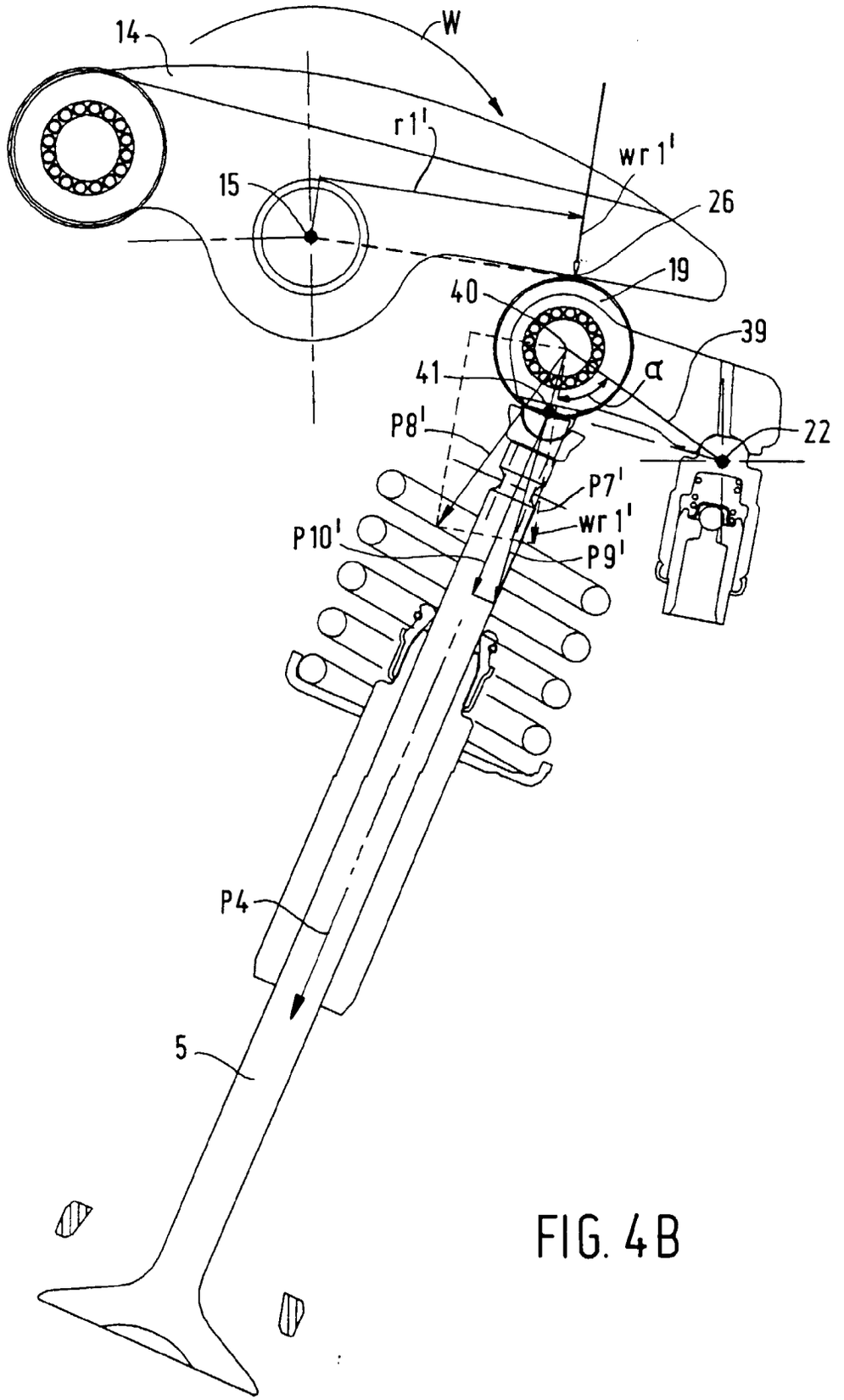


FIG. 4B

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 96 20 2380

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	PATENT ABSTRACTS OF JAPAN vol. 8, no. 69 (M-0286), 31 March 1984 & JP-A-58 217710 (FUJI JUKOGYO KK), 17 December 1983, * abstract * ---	1	F01L1/26 F01L1/18 F01L1/24
A	US-A-5 189 998 (ATSUGI UNISIA CORPORATION) 2 March 1993 * the whole document * ---	1	
A	WO-A-91 12415 (GROUP LOTUS PLC) 22 August 1991 * claims; figures * ---	1	
A	GB-A-132 070 (ANZANI) 11 September 1919 * figure 1 * ---	2	
A	FR-A-2 695 959 (REGIE NATIONALE DES USINES RENAULT) 25 March 1994 * abstract; figures * ---	4	
A	EP-A-0 462 853 (PEUGEOT & CITROEN) 27 December 1991 * the whole document * -----	1,5	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	19 November 1996	Klinger, T

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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