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(71) Applicant: **KABUSHIKI KAISHA S.S LIMITED**
2-33-19 Minamikugahara Ota-ku
Tokyo(JP)

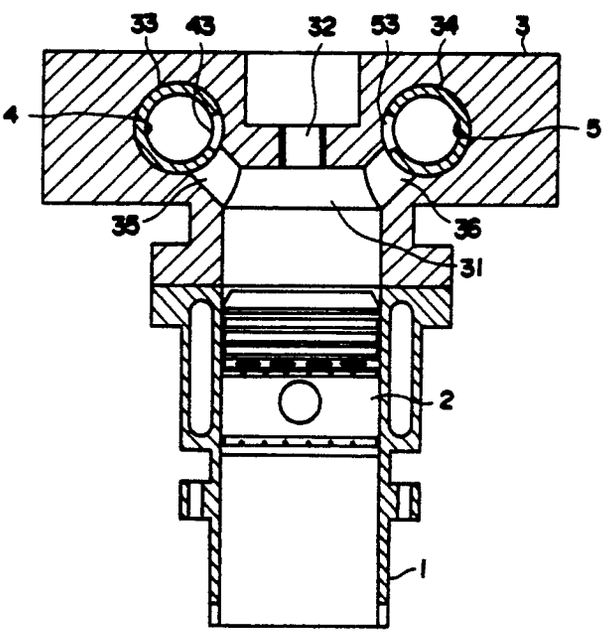
(72) Inventor: **Harada, Nobuo**
2-33-19 Minamikugahara
Ota-ku Tokyo(JP)

(74) Representative: **Rees, David Christopher et al**
Kilburn & Strode 30 John Street
London WC1N 2DD(GB)

(54) Rotary valve internal combustion engine.

(57) A four stroke internal combustion engine including a rotary intake valve (4) and rotary exhaust valve (5) having substantially a cylindrical shaft shape and formed with an intake port (43) and exhaust port (53) at positions corresponding to a combustion chamber (31). The intake valve (4) and the exhaust valve (5) are rotatably arranged in a cylinder head (3) so as to be adjacent the combustion chamber. The intake valve (4) is connected to a carburettor and the exhaust valve (5) is connected to an exhaust pipe. The engine also includes a rotation transmitting device for transmitting the rotation of a crankshaft (9) to the rotary valves.

FIG. 2



EP 0 258 511 A1

INTERNAL COMBUSTION ENGINE

The present invention relates generally to internal combustion engines and more particularly to improvements in and relating to the valve installation of four cycle or four-stroke engine which draws fuel mixture into the combustion chamber of the engine and discharges the combustion exhaust gases from the combustion chamber.

In conventional four-stroke petrol engines, the intake and exhaust valve gear of its combustion chamber is generally constructed to operate mushroom type poppet valves by the rotation of an engine crankshaft through cams, tappets, followers, etc., and the use of a large number of such component parts not only complicates the construction and increases the weight (with resulting increases in cost) but also increases the power loss due to the operation of these parts. Also, since the intake and exhaust mushroom type poppet valves are each opened and closed against a coiled spring, heavy vibrations and noise are caused and therefore there is a limitation to the maximum rotation speed of the engine. Moreover, periodic inspections and adjustments for the valve clearance adjustment, etc., are required and particularly heavy wear is caused in the mushroom type poppet valves and the valve seats thus requiring their grinding after a long period of use and requiring replacement of the push rods, the mushroom type poppet valves, the coiled springs, etc., in some cases.

On the other hand, two cycle engines of the type employing disc-type rotary valve mechanisms are known, however, the valve mechanism is disadvantageous in that the sliding resistance to the rotation of the disc is increased by the negative pressure acting on the disc.

It is an object of the present invention to provide a four-stroke internal combustion engine having an intake and exhaust valve installation in which the number of component parts is reduced and in which the power loss and the noise due to their operation is reduced.

It is another object of the invention to provide such an engine which avoids any increase in the sliding resistance to the operation of its valves and shows excellent sealing properties between the intake and exhaust valves.

In accordance with the invention there is provided a four-cycle internal combustion engine having at least one cylinder in which an intake valve and an exhaust valve are arranged in a cylinder head closing a combustion chamber of the engine, the intake valve and the exhaust valve being driven by the rotation of an output shaft rotated by a piston, characterised in that: the intake valve comprises a first rotary valve member of generally cylindrical shaft shape, the valve member being rotatable about its own axis in the cylinder head so as to open periodically to conduct a fuel mixture into the combustion chamber; the exhaust valve comprises a second rotary valve member of generally cylindrical shaft shape, the valve member being rotatable about its own axis in the cylinder head so as to open periodically to conduct exhaust gases from the combustion chamber; the first and second valve members being rotated by the rotation of the output shaft.

Preferably, each of the valve members includes an axial inner passage opening to one axial end thereof and an opening connecting the outer surface of each valve member with its inner passage. Preferably, the passages each extend to midway along the valve members and the openings are at mid positions along the valve members. Thus, when the valve member is rotated in the cylinder head, the hole is opened to the cylinder head inner passage communicating with the combustion chamber periodically, e.g., at the rate of once for every two revolutions of the crankshaft. The timing at which the hole is opened to the cylinder head inner passage is of course different in time between the intake valve and the exhaust valve and this phase difference conforms with the four cycle strokes of the engine. The communication with the carburettor or the exhaust pipe is made through the respective openings at the axial ends of the valve member.

Preferably, the rotation is transmitted from the output shaft to the valve members by means of gears attached to the closed ends of the valve members. Preferably, the valve members each include a pair of peripheral grooves on the axial sides of the hole opening to the outer surface, and a sealing O-ring fitted into each of the peripheral groves. Each valve member preferably also includes a pair of axial grooves on the circumferential sides of the hole in the outer surface, and a sealing member fitted in each of the axial grooves.

Thus, in the present invention, the camshaft, tappets, push rods, rocker arms, intake and exhaust mushroom type poppet valves and coiled springs required by a conventional intake and exhaust valve system are eliminated and it is only necessary to mount cylindrical shaft-type intake and exhaust valves in the cylinder head. This may not only greatly simplify the construction, reduce the weight and decrease production cost, but may also reduce the power losses inherent in the operation of the conventional parts.

Furthermore, the occurrence of vibrations and noise is practically eliminated making it possible to increase the rotation speed of the engine. Also, there are no parts which require any adjustment and thus no periodic inspection and adjustment are required. Still further, the use of parts prone to wear such as cams, tappets and followers is practically eliminated with the resulting increase in life. Finally, the intake and exhaust ports of the intake and exhaust valves are enclosed by O-rings and the sealing members and are almost completely sealed thus minimising the danger of leakage of the combustion gas and the exhaust gases.

The invention may be carried into practice in various ways and some embodiments will now be described by way of example with reference to the accompanying drawings in which:-

FIGURE 1 is a plan view showing one embodiment of an engine in accordance with the present invention;

FIGURE 2 is a sectional view taken along the line A-A in FIGURE 1;

FIGURE 3a is a front view showing an embodiment of the intake valve forming an essential part of the invention;

FIGURE 3b is a sectional view taken along the line B-B in FIGURE 3a;

FIGURES 4a to 4d are diagrams showing successive stages in the operation of an engine in accordance with the invention;

FIGURE 5 is a schematic diagram showing another embodiment of the invention; and

FIGURE 6 is a partially cutaway perspective view showing a conventional petrol engine.

Prior to a description of preferred embodiments of the invention, a conventional gasoline engine will be described for reference, with reference to FIGURE 6.

A conventional four-stroke petrol engine usually employs an intake and exhaust valve system including a camshaft gear 82 driven by a crankshaft 81, a camshaft 83 connected to the gear 82 and having two cams for each cylinder 90, two push rods 85 and 85a respectively having tappets 84 and 84a and moved vertically by the cams, and rocker arms 86 and 86a located above a cylindrical head 91. The rocker arms 86 and 86a are arranged in such a manner that one of their ends in each case is moved by the push rods 85 and 85a to make rocking motion so that intake and exhaust mushroom type poppet valves 87 and 87a are respectively driven by the other ends of the rocker arms 86 and 86a. Two coiled springs are employed 88 and 88a to urge the poppet valves 87 and 87a against their valve seats whereby, in dependence upon the position of the piston 92, the poppet valves 87 and 87a are opened and closed so that the combustible gas is drawn into the cylinder 90 from the carburettor through the poppet valve 87 and the exhaust gases are discharged from the cylinder 90 through the poppet valve 87a.

The present invention will now be described with reference to FIGURES 1 and 2. The engine comprises a cylinder 1, a piston 2, a cylinder head 3 made for example of an aluminium alloy, a combustion chamber 31, a plug hole 32, and cylindrical openings 33, 34 formed above the combustion chamber 31 on each side whose inner surfaces have a sprayed chromium plating, or a ceramic coating or the like. The openings 33 and 34 communicate with the combustion chamber 31 through an intake passage 35 and an exhaust passage 36, respectively.

As shown in FIGURES 1 to 3, there is located within the cylindrical opening 33 a rotary intake valve comprising a valve body 41 composed of a bottomed cylindrical shaft made for example of phosphor bronze. The valve body 41 has an axial intake passage 42 extending from one end up to about the mid portion and an intake port 43 is formed at the inner forward end of the passage 42 to open to the outer surface of the body 41.

A pair of peripheral grooves 44 and 44a are formed in the shaft outer surface on each side axially of the intake port 43 and O-rings 45 and 45a are respectively fitted in the grooves 44 and 44a. Also, straight grooves 46 and 46a are formed in the shaft outer surface on each side circumferentially of the intake port 43 to extend axially between the peripheral grooves 44 and 44a and key-shaped sealing members 47 and 47a for hermetic sealing purposes are respectively fitted in the straight grooves 46 and 46a. A flange 48 is formed at one end of the body 1.

The intake valve 4 is rotatably located in the opening 33 in the cylinder head 3 and oil sealing is provided for the ends on the outside of the peripheral grooves 44 and 44a. In an exemplary case, the tolerances of the opening 33 and the valve 4 are in the range of 0.02 to 0.05mm. The intake port 43 is hermetically sealed by the O-rings 45 and 45b and the sealing members 47 and 47b.

A gear 6 is fixedly mounted on the flange 48. At the other end, the intake valve 4 is open and is slidably pressed against the end face of a bracket 7 which has an opening 71 aligned with the intake passage 42 and a carburettor mounting flange and which is fixedly mounted on the cylinder head 3.

A rotary exhaust valve 5 is identical in construction with the intake valve 4 is rotatably fitted in the opening 34. Also, a gear 6a is fixedly mounted on a flange 58 of the exhaust valve 5 whose other end is slidably pressed against the end face of a mounting portion 81 of an exhaust pipe or manifold 8 which is attached to the cylinder head 3.

In the engine constructed as described above, the gear 6 of the intake valve 4 and the gear 6a of the exhaust valve 5 are connected to a gear 10 driven by a crankshaft 9 through transmitting means (not shown) such as gears, chains or sprocket belts so that they are rotated at one-half the speed of the crankshaft 9.

The operation of the engine will now be described with reference to FIGURES 4 to 4d. It is assumed that the intake valve 4 and the exhaust valve 5 are rotated in the direction of the arrows.

FIGURE 4a shows a condition in which the piston 2 is about to start moving downwards from top dead centre on the exhaust stroke and the intake port 43 of the intake valve 4 and the exhaust port 53 of the exhaust port 5 are opened slightly to the combustion chamber 31. When the piston 2 moves downwards, the intake and exhaust valves 4 and 5 are rotated in the direction of the arrows.

The intake port 43 is open to the cylinder 1 allowing fuel mixture to be drawn in and the exhaust port 53 is closed to the cylinder 1.

Then, as the piston 2 reaches bottom dead centre on the intake stroke, (FIGURE 4b), a part of the intake port 43 of the intake valve 4 is still open to the combustion chamber 31 while the exhaust port 53 of the exhaust valve 5 is away from the cylinder 1 and is thus blocked from the combustion chamber 31.

When the piston 2 moves upwards on its compression stroke, the intake valve 4 is also closed so that when the piston 2 reaches top dead centre again, the intake port 43 of the intake valve 4 is positioned away from the combustion chamber and the exhaust port 53 of the exhaust valve 5 has moved closer to the combustion chamber 31 thus blocking the combustion chamber 31 as shown in FIGURE 4c. When the combustible gas is ignited to explode and the energy causes the piston 2 to move downwards to reach bottom dead centre as shown in FIGURE 4d, the intake valve 4 remains closed, while the exhaust port 53 of the exhaust valve 5 begins to open to the combustion chamber 31. The opening area is increased as the piston 2 moves upwards thereby discharging the exhaust gases in the cylinder 1 into the exhaust pipe 8 through the exhaust passage 52.

In this case, since the intake port 43 and the exhaust port 53 are almost completely sealed hermetically by the O-rings 45 and 45a and the sealing member 47 and 47a as mentioned previously, the combustible gas is conducted into the combustion chamber 31 without any leakage to the outside and the exhaust gases are discharged through the exhaust pipe 8 without any leakage to the outside.

It is to be noted that although not shown, lubricating oil is supplied between the openings 33 and 34 of the cylinder head 3,and the intake and exhaust valves 4 and 5, by a hydraulic pump.

While, in the above-described engine, the timing of the opening and closing of the intake valve 4 and the exhaust valve 5 is the same as the timing of opening and closing of intake and exhaust mushroom type poppet valves in the conventional gasoline engine shown in FIGURE 6, the timing may be adjusted to some extent by changing the shape of the intake port 43 and the exhaust port 53.

In the illustrated embodiment, a chromium-type sprayed plating, ceramic coating or the like is applied to the inner surface of the openings 33 and 34 formed in the cylinder head 3, however, separate sleeves made of a bearing material may be force fitted or alternatively sliding bearings may be provided.

Also, while, in the above description, the invention is applied to a single cylinder engine, it is of course possible to apply the invention to any petrol engine having a plurality of cylinders. In this case, as shown in FIGURE 5, it is only necessary to arrange, at the sides of cylinders 1a to 1n, intake and exhaust valves 4a and 5a respectively comprising long cylindrical shaft bodies 41a and 51a respectively formed with intake ports 43a to 43n and exhaust ports 53a to 53n which are shifted in phase relative to each other in accordance with the firing order of the cylinders 1a to 1n. The bodies 41a and 51a would then be supported by bearings and would have one of their ends connected to a carburettor in each case and the other to an exhaust manifold.

In the illustrated embodiment, the intake valve and the exhaust valve are rotated in the same direction, however, they may be rotated in the opposite directions. In this case, the carburettor and the exhaust pipe may be connected between the intake valve 4 and the exhaust valve 5. Further, while, in the above described embodiment, the invention is applied to a petrol or gasoline engine, the invention can be equally applied to the exhaust valves of a Diesel engine.

Claims

1. A four cycle internal combustion engine having at least one cylinder (1) in which an intake valve (4) and an exhaust valve (5) are arranged in a cylinder head (3) closing a combustion chamber of the engine, the intake valve (4) and the exhaust valve (5) being driven by the rotation of an output shaft (9) rotated by a piston (2), characterised in that: the intake valve comprises a first rotary valve

member (4) of generally cylindrical shaft shape, the valve member (4) being rotatable about its own axis in the cylinder head (3) so as to open periodically to conduct a fuel mixture into the combustion chamber; the exhaust valve comprises a second rotary valve member (5) of generally cylindrical shaft shape, the valve member (5) being rotatable about its own axis in the cylinder head so as to open periodically to conduct exhaust gases from the combustion chamber; the first and second valve members being rotated by the rotation of the output shaft (9).

2. An internal combustion engine as claimed in Claim 1, characterised in that each of the valve members (4,5) includes an axial inner passage (42,52) opening to one axial end thereof and an opening (43,53) connecting the outer surface of each valve member with its inner passage (42,52).

3. An internal combustion engine as claimed in Claim 2 characterised in that the passages (42,52) each extend to midway along the valve members (4,5) and the openings (43,53) each extend to midway along the valve members (4,5) and the openings (43,53) are at mid positions along the valve member (4,5).

4. An internal combustion engine as claimed in any preceding claim characterised in that the rotation is transmitted from the output shaft (9) to the valve members (4,5) by means of gears (6,6a) attached to the closed ends of the valves members (4,5).

5. An internal combustion engine as claimed in any preceding claims charactersied in that the valve members (4,5) are caused to rotate at half the speed of the output shaft (9).

6. An internal combustion engine as claimed in any preceding claim characterised in that each of the valve members (4,5) includes in its outer surface a pair of ring-shaped sealing members (45,45a) arranged on axial sides of its opening (43,53).

7. An internal combustion engine as claimed in Claim 6 characterised in that each of the valve members (4,5) includes in its outer surface a pair of straight sealing members (47,47a) arranged on circumferential sides of its opening (43,53) to extend between the pair of ring-shaped sealing members (45,45a).

8. An internal combustion engine as claimed in any preceding claim characterised in that the fuel mixture is conducted to the intake valve (4) by a carburettor and the exhaust gases are expelled into an exhaust pipe (8).

9. An internal combustion engine as claimed in any preceding claims characterised in that the engine comprises a plurality of cylinders and the intake and exhaust valves (4a,5a) each comprise an elongate generally cylindrical shaft body (41a,51a) formed respectively with intake ports (43a to 43n) and exhaust ports (53a to 53n) which are shifted in phase relative to each other in accordance with the firing sequence of the cylinders (1a to 1n).

FIG. 1

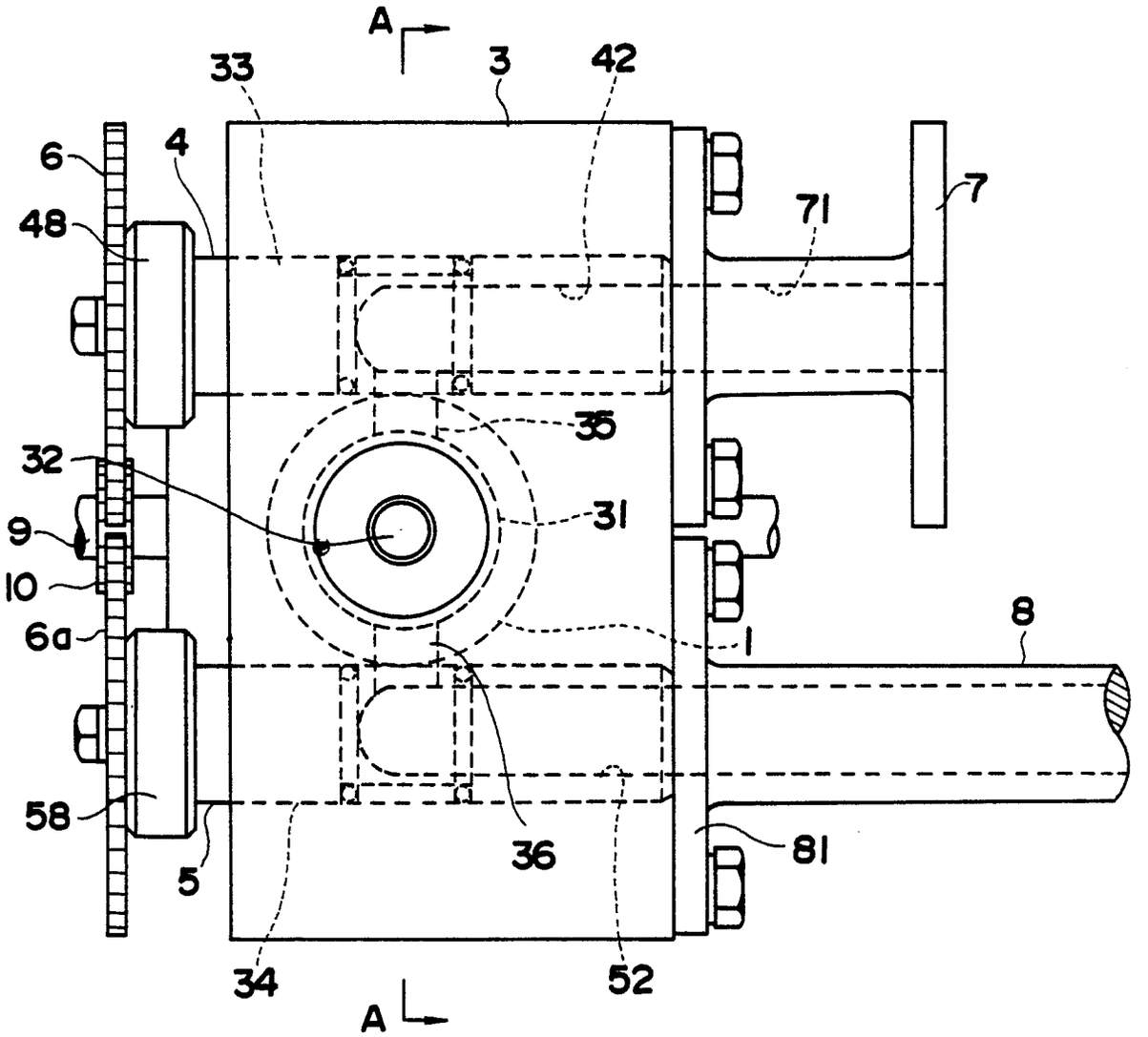


FIG. 2

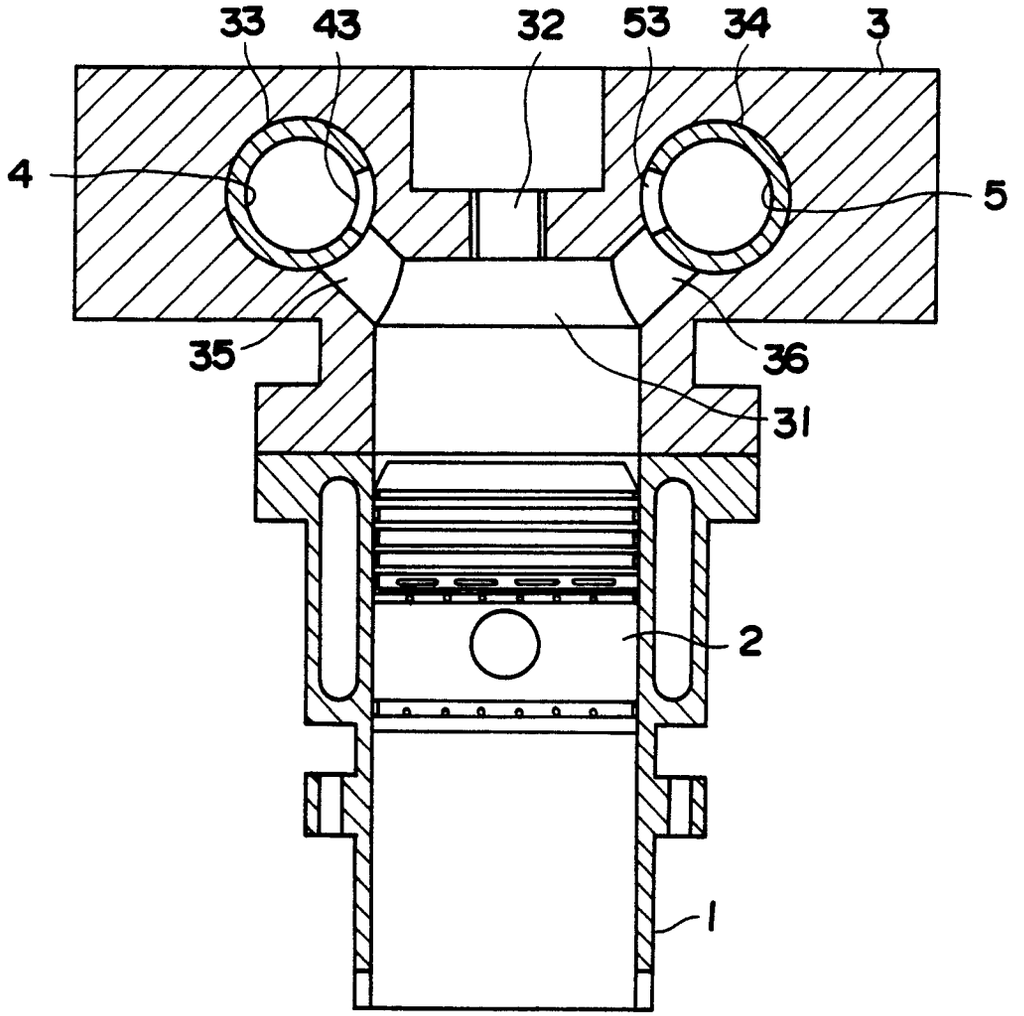


FIG. 3a

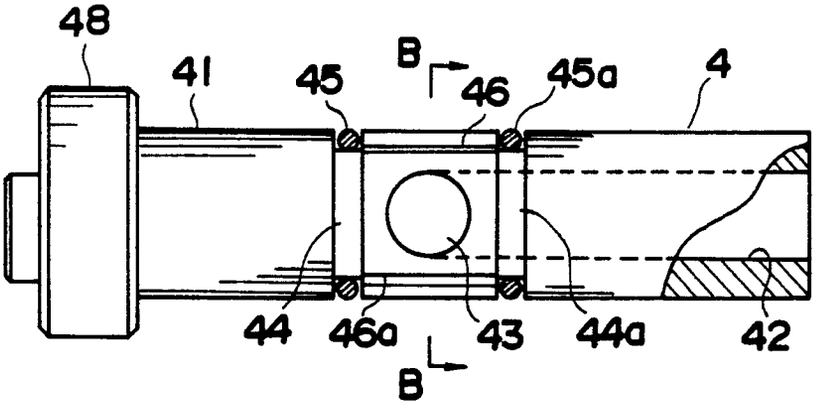


FIG. 3b

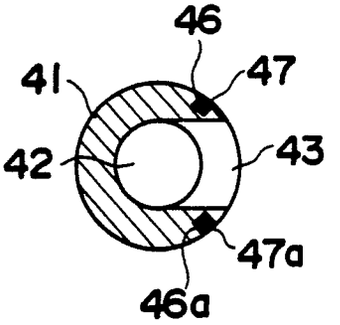


FIG. 4a

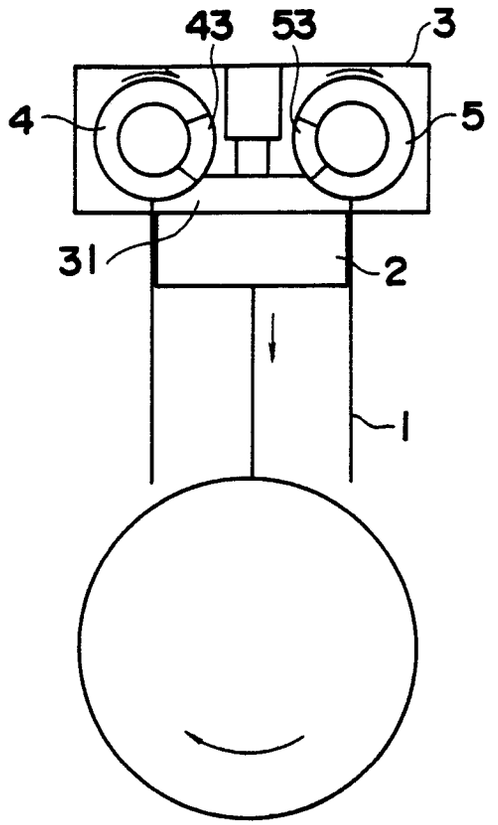


FIG. 4b

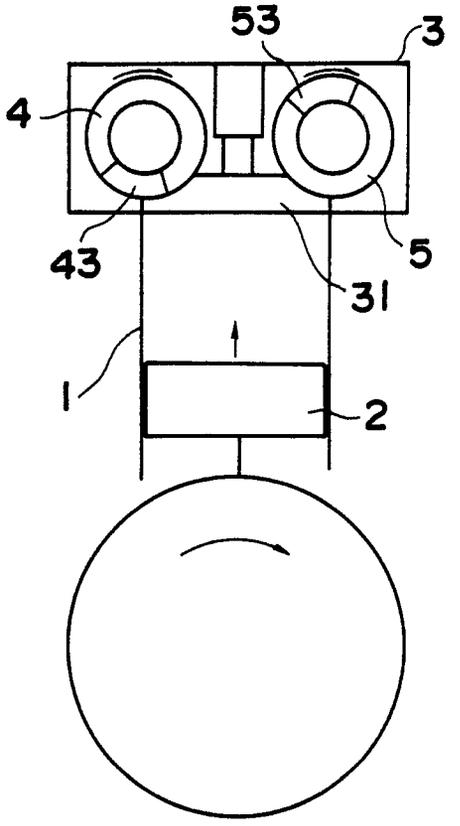


FIG. 4c

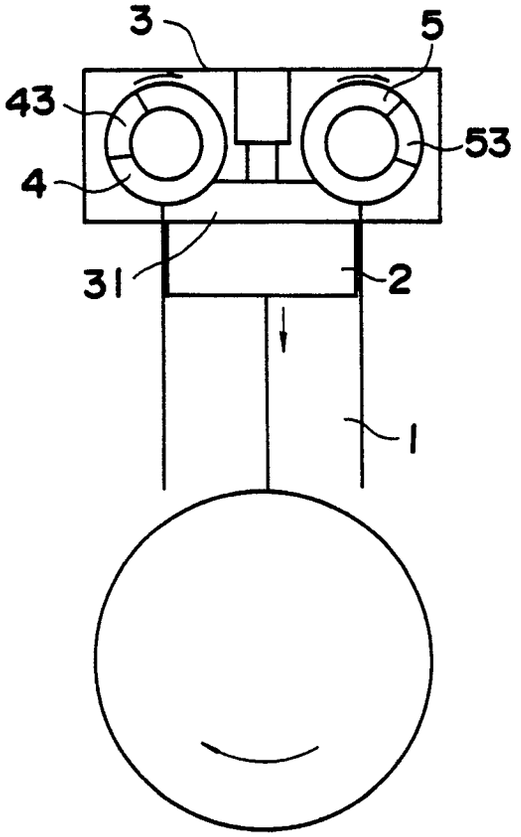


FIG. 4d

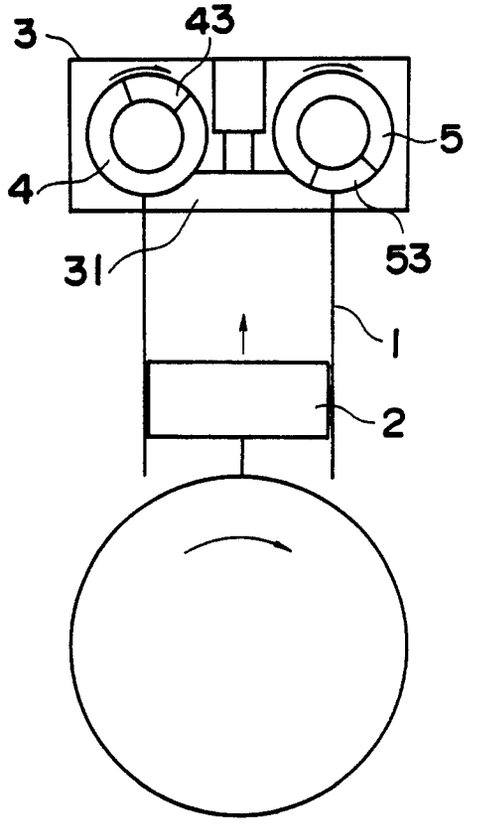


FIG. 5

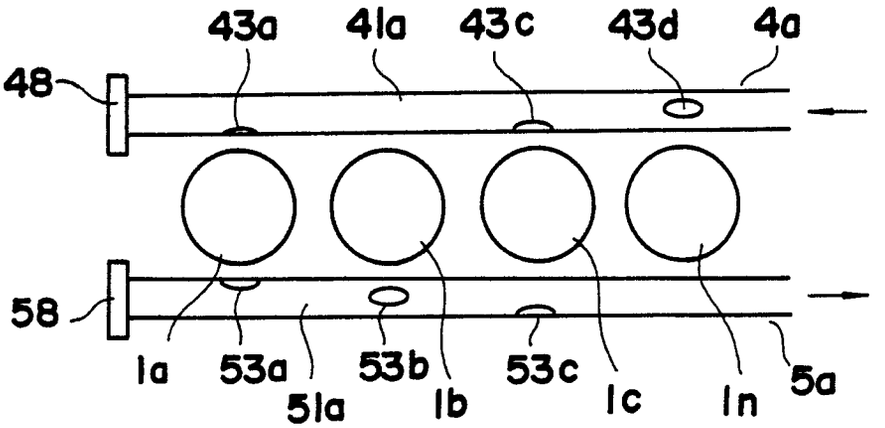
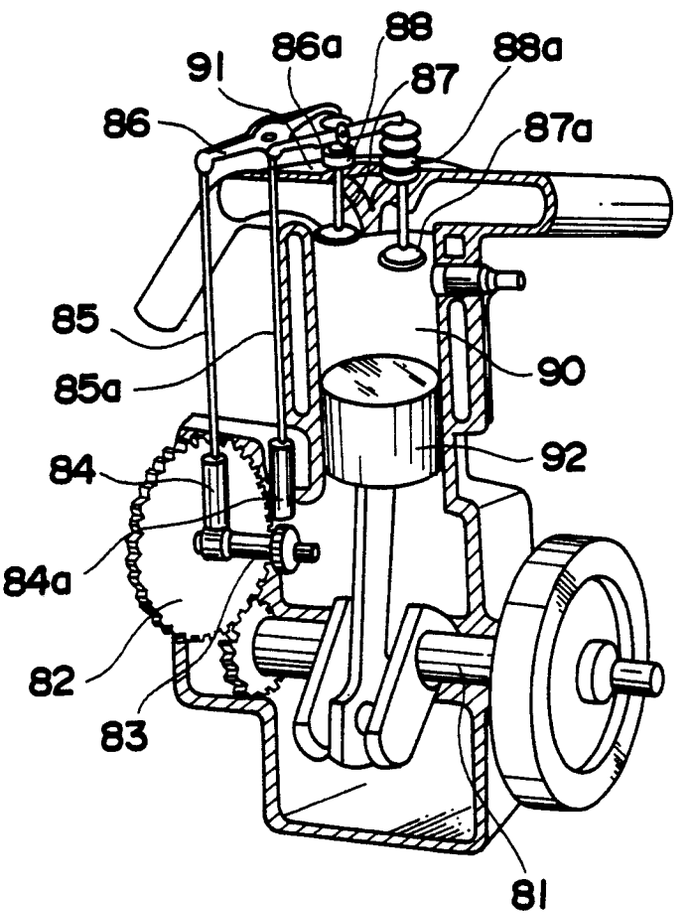


FIG. 6 PRIOR ART



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EUROPEAN SEARCH REPORT

Application number

EP 86 30 7613

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.4)
X	FR-A- 611 576 (AULAGNON) * Page 1, line 29 - page 2, line 14; figures 1,2 *	1,2,4-9	F 01 L 7/02
X	FR-A-1 461 493 (REMY) * Page 1, lines 1-72; figures 1-4 *	1,2,4,5,8,9	
X	FR-A- 402 246 (SEGOND) * Page 1, lines 1-30; figures 1,2 *	1,2,4,5,8,9	
X	DE-A-3 422 826 (WARZECHA) * Page 3, lines 6-39; figures 5-8 *	1-5	TECHNICAL FIELDS SEARCHED (Int. Cl.4)
X	CH-A- 471 317 (MONATH) * Column 3, line 65 - column 4, line 65; figures 2,3 *	1-5,8	F 01 L
X	US-A-1 398 354 (WRIGHT) * Page 1, lines 13-22; figures 1-3 *	1,2,4,5,9	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	29-07-1987	LEFEBVRE L.J.F.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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