(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 557 520 A1**

(12) **EUROPEAN PATENT APPLICATION published in accordance with Art. 158(3) EPC**

(21) Application number: **90916825.4**

(51) Int. Cl.[5]: **F02B 23/00**

(22) Date of filing: **16.11.90**

(86) International application number:
PCT/JP90/01495

(87) International publication number:
WO 92/08884 (29.05.92 92/12)

(43) Date of publication of application:
01.09.93 Bulletin 93/35

(84) Designated Contracting States:
DE FR GB IT SE

(71) Applicant: **OHKUMA, Takeshi**
29-1, Chuo, Seyaku
Yokohama-shi, Kanagawa-ken 246(JP)

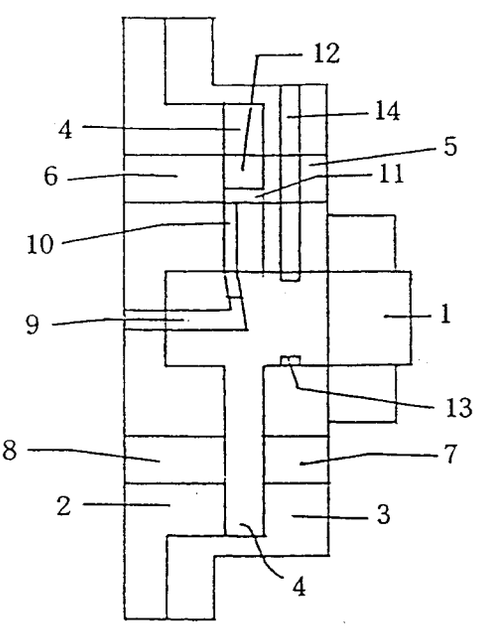
(72) Inventor: **OHKUMA, Takeshi**
29-1, Chuo, Seyaku
Yokohama-shi, Kanagawa-ken 246(JP)

(74) Representative: **Piesold, Alexander James**
Frank B. Dehn & Co. Imperial House 15-19 Kingsway
London WC2B 6UZ (GB)

(54) **PRESSURE CHANGE-OVER VALVE FOR MUTUAL OPERATION BETWEEN PRESSURE RECEIVING PISTONS.**

(57) A pressure change-over valve disposed in a liquid passage for operating pressure-receiving pistons in order to permit mutual operations between the pressure-receiving pistons of a combustion promotion apparatus of an internal combustion engine. A rotary disc (4) or a rotary shaft (1) rotating with the revolution of the engine is provided with pressure change-over portions (12) and (15) (or 9 and 10 in Fig. 9), and pressure change-over holes (5), (6), (7) and (8) communicating with the operation portion of the rpessure-receiving piston (5A) of the combustion promotion apparatus are provided in the outer portion (2) and (3) of the rotary disc (or the rotary shaft). The liquid which is discharged when one of the pressure-receiving pistons (5A) performs a main operation (B) is sent to another pressure-receiving piston through the pressure change-over valve and the pressure-receiving piston is operated reversely (A).

FIG 1



EP 0 557 520 A1

TECHNICAL FIELD

This invention relates to a pressure-change valve for reciprocal motion of a pressure piston for a fire promoting device whereby the pressure piston is reversely driven by exhausted oil or other liquid.

BACKGROUND OF TECHNOLOGY

Conventionally, a cam or hydraulic system has been used to drive a pressure piston of a fire promoting device of an internal combustion engine.

When a pressure piston is controlled by the conventional hydraulic system, its main driving is carried out by a pressure of a main combustion chamber, its reverse driving opposite to the main driving is carried out by a hydraulic pump supplying hydraulic oil into a pressure piston oil chamber.

It is possible to carry out the reverse driving at low rotation, but it becomes impossible to deliver hydraulic oil at high rotation.

Even if reverse driving can be carried out by a repulsion of a spring, it is impossible to deliver hydraulic oil quickly, and when pressure takes place in the combustion chamber of the internal engine, the pressure being higher than a repulsion force of the spring, it is likely that when the pressure piston begins the main driving on account of a shortage of hydraulic oil or other liquid, a sub-piston which is integrally driven with the pressure piston is moved into a reverse direction opposite to the main driving by the repulsion of the spring at low pressure within the combustion chamber, thus causing fire to heat both of the surface and bottom face of the sub-piston and also breaking the same.

Such phenomenon has been confirmed by this invention.

Accordingly, a principal object of this invention is to provide a pressure-change valve for reciprocal motion of a pressure piston of a fire promoting device whereby a reverse driving can be carried out at any rotation area.

DISCLOSURE OF INVENTION

The essential feature of this invention is a pressure-change valve for reciprocal motion of a pressure piston for a fire promoting device which comprises a pressure piston including an outer disk casing having a central inner protruding ring and a plurality of pressure-change openings corresponding to the number of pistons, an inner disk casing having a corresponding central inner protruding ring and a plurality of pressure-change openings and a driving shaft having a disk rotatably disposed within a disk space defined by the outer and inner disks, the drive shaft having a rotary disk and several pressure-change openings and a pressure-change channel which is characterized in that exhausted hydraulic oil or other liquid is delivered into a pressure switch chamber of a fire promoting device during its main driving, when the pressure-change openings of the rotary disk are coincided with the pressure-change openings of the outer and inner disk casings at a compressed upper dead point or during its firing stroke, the pressure piston is driven into its main direction, the compressed air, fuel and flame within a sub-cylinder are injected through a gap between the sub-cylinder and the sub-piston into the combustion chamber and the flame within the cylinder, and the exhausted hydraulic oil or other liquid is delivered into the pressure switch chamber of the pressure piston to drive the pressure piston reversely, when the piston arrives at a compression stroke, the air or fuel within the combustion chamber or the flame near the upper dead point is delivered into the sub-cylinder of the fire promoting device working integrally with the pressure piston through the gap between the sub-cylinder and the sub-piston whereby the pressure-change valve is locked during when the exhausted hydraulic oil or other liquid is switched while repeating driving of the fire promoting device.

Another essential feature of this invention is a rotary valve for reciprocal motion of a pressure piston for a fire promoting device which comprises a pressure piston including an outer disk casing having a central inner protruding ring and a plurality of pressure-change openings corresponding to the number of pistons, an inner disk casing having a corresponding central inner protruding ring and a plurality of pressure-change openings and a drive shaft having a disk rotatably disposed within a disk space defined by the outer and inner disks, the drive shaft having several pressure-change openings and a pressure-change channel which is characterized in that during the main driving hydraulic oil or other liquid is released, and the exhausted oil or other liquid is delivered into a fire promoting device provided at a combustion chamber whereby reverse driving can be carried out opposite to the main driving.

BRIEF EXPLANATION OF DRAWING

FIG. 1 is a vertical sectional view of the first example of a pressure-change valve for reciprocal motion of a pressure piston for a fire promoting device of this invention, especially showing a plurality of pressure-change openings for hydraulic oil provided through an outer disk casing, an inner disk casing and a drive shaft rotatably disposed in a space defined by these outer and

inner casings;

FIG. 2 is an elevation partly in section of a disk having a pressure-change opening for hydraulic oil;

FIG. 3 is an elevation partly in section of an inner disk casing, a driving shaft having several pressure-change openings and a pressure-change channel;

BEST MODE of EMBODIMENT OF INVENTION

FIG. 1 shows the aforementioned pressure-change valve which comprises an outer disk casing, an inner disk casing, a drive shaft having an integral disk arranged within a cylindrical space defined between the outer and inner disk casings.

More particularly, a reference numeral 1 designates a drive shaft, 2 an outer disk casing, 3 an inner disk casing, 4 a rotary disk which is integral with the drive shaft 1 respectively.

The reference numeral 5, 6, 7, 8 show pressure-change openings provided through the outer and inner disk casings 2 and 3 respectively.

9 designates a central pressure-change opening for supplying hydraulic oil, and other pressure liquid, 10 a radial pressure-change passage, 11 another pressure-change passage provided through the rotary disk 4, 12 a pressure-change opening, 13 a small groove provided around a periphery of the drive shaft 1, and 14 a radial opening provided through the inner disk casing 3 respectively.

Drawing A (added drawing) is a vertical sectional view of this pressure-change valve. 1A shows a combustion chamber, 2A a sub-piston, 3A a sub-cylinder, 4A a gap defined by an outer diameter of the sub-piston and an inner diameter of the sub-piston, 5A a pressure piston, 6A a control cylinder, 7A a control unit, 8A a fire promoting device, 9A a pressure-control chamber, 10A an opening supplying hydraulic oil and other pressure liquid, 11A a lower face of the control unit, 12A a upper face of the control unit, 13A a pressure chamber, 14A a threaded groove for securing the fire promoting device to the engine, and 15A a bolt for securing the fire promoting device to the engine respectively.

Function of the aforemention example will be explained in the following paragraphs.

As shown in the drawings, the pressure-change opening 12 is provided through the rotary disk 4 which is integral with the drive shaft 1 in accordance with the given stroke of the internal combustion engine In addition, other pressure-change openings are provided through and at the corresponding portions of the inner and outer disk casings 2 and 3.

A pressure-change valve for reciprocal motion of a pressure piston for a fire promoting device is provided at the internal combustion engine to surround the pressure switch chamber 13A with a pipe not shown in the drawings.

This connection is carried out by the pressure switch chamber 13A provided at the combustion chamber 1A during a compression stroke, the pressure-change opening 6 of the outer disk casing 2, the pressure-change opening 5 of the inner disk casing 3, the pressure-change opening 12 of the rotary disk 4, the pressure-change opening 6 of the outer disk casing 2, the pressure switch chamber 13A of the combustion chamber 1A during its exhaust stroke, the pressure-change opening 5 of the inner disk casing 3, the pressure-change opening 12 of the rotary disk 4, the pressure-change opening 8 of the outer disk casing 2 and the pressure switch chamber 13A shown in FIG. 10.

When the main piston arrives at the upper dead point during its compression stroke or its combustion stroke, the pressure-change opening 15 of the rotary disk 4 in synchronous with a rotation of a crankshaft arrives at the pressure-change openings 5 of the inner disk casing 3 and also at the pressure-change openings 6 of the outer disk casing 2.

At the same time, it becomes possible to exhaust oil or other liquid within the pressure switch chamber 13A shown in FIG. 10 through the pressure-change openings 5 of the inner disk casing 3 into the pressure switch chamber 13A during its upper dead point or its intake stroke shown in FIG. 10 so that the pressure piston 5A begins to move into a direction shown by an arrow B by pressure within the combustion chamber 1A.

The exhausted oil or other liquid during moving is delivered into the pressure switch chamber 13A at an upper dead point during its exhaust stroke or during its intake stroke so that the pressure piston 5A is forced to move into a direction shown by an arrow A.

Through its further rotation of the rotary disk 4 and when the pressure-change opening 12 of the rotary disk 4 is brought to coincide with the pressure-change openings 8 of the outer disk casing 2 and also with the pressure-change openings 7 of the inner disk casing 3, the pressure piston 5A is forced to move into the direction shown by the arrow B at the upper dead point of its compression stroke or at a desired starting point during its combustion stroke.

The exhausted oil or other liquid within the pressure switch chamber 13A is delivered through the pressure-change openings 7, the pressure-change opening 12, the pressure-change opening 8 of the outer disk casing 2 and again into the pressure switch chamber 13A.

Through its one rotation of the rotary disk 4 and when the pressure-change opening 12 of the

rotary disk 4 is brought to coincide with the pressure-change openings 6 of the outer disk casing 2 and also with the pressure-change opening 5 of the inner disk casing 3, the oil or other liquid within the pressure switch chamber 13A provided at the wall of the combustion chamber 1A is delivered into the pressure switch chamber 13A through the pressure-change openings 6, the pressure-change opening 12 of the rotary disk 4 and the pressure-change openings 7 at its upper dead point of the exhaust stroke or during its intake stroke, thus enabling a reciprocal motion of the pressure piston 5A.

When the combustion chamber 1A shifted into the A direction comes into the compression stroke, the compressed air or fuel gas within the combustion chamber 1A delivers the flame into the sub-cylinder 3A near the upper dead point during the compression stroke through a gap 4A between the sub-cylinder 3A and the sub-piston 2A.

When the combustion chamber 1A is shifted into the direction at the upper dead point during its compression stroke or during its compression stroke, the compressed air, fuel gas or the flame within the main cylinder is injected into the flame just started burning within the sub-cylinder 3A so that a reciprocal motion of the pressure piston 5A can be obtained so as to bring about high combustion with a possible mix ratio.

The oil or other liquid required for reciprocal motion can be delivered through the pressure-change opening 11, the radial pressure-change passage 10 and the pressure-change opening 11 only when the pressure-change openings 6, 8 are coincided with the pressure-change opening 5, 7 and also with the pressure-change opening 11.

The second example of this invention will be explained with reference to the drawings of FIGS. 4 - 6. It should be noted that the same reference numerals as the first example show the same parts of the second example.

An integral rotary disk 4 of a drive shaft 1 is slidably disposed within a rotary space defined by an outer disk casing 2 and an inner disk casing 3, in which the drive shaft 1 is driven to rotate at a speed of 1/2 of a rotation of a crankshaft.

Being different from the first example, a small diameter pressure-change opening 9 for oil or other liquid is provided at a central portion of the outer disk casing 2 to extend into an end portion of the drive shaft 1, four pressure-change opening 5, 6, 7, 8 are provided through the inner casing 3 to be positioned around and apart from the periphery of the drive shaft 1.

In addition, a reciprocal opening 22a is radially provided through the rotary disk 4 to communicate with a pair of the pressure-change openings 6, 7, a plurality of fire promoting devices are provided at a wall according to the number of pistons. Accordingly, when the pressure piston 5A is brought to the upper dead point during its compression stroke or at a given time of its combustion stroke, the pressure-change openings 12, 12 of the rotary disk 4 are brought into contact with the pressure-change openings 6, 7 and also with the radial reciprocal opening 15 so as to bring the pressure piston 5A by the pressure within the combustion chamber 1A into the direction shown by the arrow B.

The oil or other liquid exhausted during moving is delivered from the pressure-change openings 5 through the radial reciprocal opening 15 into the pressure switch chamber 13A so that it begins to move into an upper dead point of its exhaust stroke or into an intake stroke in order to move the pressure piston 5A into the direction shown by the arrow A.

Through the further rotation of the rotary disk 4 and when the pressure-change openings 12, 12 of the rotary disk 4 are brought into contact with the pressure-change openings 5, 7 of the inner casing 3, the pressure piston 5A works at the same time during its same stroke and moves into the direction shown by the arrow A.

When the pressure switch chamber 13A of the pressure piston 5A arrives at the upper dead point of its compression stroke or its combustion stroke, the pressure-change openings 12, 12 are brought into contact with the pressure-change openings 5, 6 through one rotation of the rotary disk 4, the oil or other liquid is exhausted from the pressure-change opening 7 through the radial reciprocal opening 15.

The pressure piston 5A shown in FIG. 10 begins to move into the direction shown by the arrow B, the oil or other liquid exhausted while moving is delivered into the pressure switch chamber 13A from the pressure-change opening 14d at the wall of the combustion chamber 1A so that the pressure piston 5A is moved into the direction shown by the arrow A, thus completing the reciprocal motion thereof.

Through the repetition of the aforementioned strokes, the pressure piston 5A is moved into the direction shown by the arrow A, during its compression stroke of the combustion chamber 1A, gas or fuel gas within the combustion chamber 1A is delivered into the sub-cylinder 3A at the upper dead point during its compression stroke or the flame near the upper dead point through a gap 4A defined by an outer diameter of the sub-piston 2A and an inner diameter of the sub-cylinder 3A, when the main piston arrives at the upper dead point during its compression stroke or during its combustion stroke, the sub-piston 2A is driven by the pressure piston 5A to inject fuel through the gap 4A into the flame of the compressed air or fire just

started burning in a Diesel engine.

The third example will be explained with reference to the drawings of FIGS. 7 - 9. As in the second example, a function of this invention is substantially the same as the second example.

An integral rotary disk of a drive shaft 1 is slidably disposed within a rotary space defined by an outer disk casing 12 and an inner disk casing 2, wherein the drive shaft 1 is driven to rotate at a speed of 1/2 of a rotation of a crankshaft.

A reciprocal opening 10 is radially provided through the rotary disk to communicate with a pair of the pressure-change openings 5, 7, a plurality of fire promoting devices are provided at a wall according to the number of pistons.

When the pressure piston 5A is brought to the upper dead point during its compression stroke or at a given time of its combustion stroke, the pressure-change openings 12, 12 of the rotary disk which is integral with the drive shaft 1 are brought into contact with the pressure-change openings 5, 7 and also with the radial reciprocal opening 10 so as to bring the pressure piston 5A by the pressure within the combustion chamber 1A into the direction shown by the arrow B.

The pressure-change openings 5, 6, 7, 8 of the drive shaft 1 are connected to each pressure switch chamber 13A of a fire promoting device mounted according to the number of the pistons, and when the main piston arrives at its compression stroke or combustion stroke, the reciprocal opening 10 of the drive shaft 1 and pressure-change opening 9, 9 are brought into contact with the pressure-change openings 5, 7, thus beginning to move the pressure piston 5A by pressure within the combustion chamber 1A into the direction shown by the arrow B.

The oil or other liquid exhausted during moving is delivered from the pressure-change openings 5, 7 through the radial reciprocal opening 10 into the pressure switch chamber 13A so that it begins to move into an upper dead point of its exhaust stroke or into an intake stroke in order to move the pressure piston 5A into the direction shown by the arrow A and through the further rotation of the drive shaft 1 and when the pressure-change opening 9 of the drive shaft 1 comes into contact with the pressure-change openings 5, 7, it works as the same stroke and timing as the main piston.

As shown in FIG. 10, the pressure-change passages 9, 9 of the drive shaft 1 is brought into contact with the pressure-change openings 6, 8 during its compression or combustion stroke to exhaust oil or other liquid within the pressure switch chamber 13A and as shown in FIG. 10, the pressure piston 5A begins to move into the direction shown by the arrow B.

In other words, the oil or other liquid exhausted during moving is delivered forcedly into the pressure switch chamber 13A of the pressure piston 5A through the passages 9, 9 and the pressure-change openings 5, 6, 7, 8 during its exhaust stroke or intake stroke as shown in FIG. 10, thus enabling to move the driven pressure piston 5A into the direction shown by the arrow A and also to make the reciprocal movement of the pressure piston 5A at any rotation area.

Function and effect of the sub-piston 2A working integrally with the pressure piston 5A are substantially the same as the aforementioned examples.

As explained in the first example, oil or other liquid required for reciprocal movement of the pressure piston 5A is supplied by a pump (not shown) through the pressure-change openings 11 of the inner disk casing 2 and the pressure-change opening 9, 9 rotated to come into contact with the the pressure-change openings 5, 6, 7, 8.

Timing for starting the pressure piston 30 is selected by a govenor provided at the outer disk casing 12 to have the optimum injection timing.

The fourth example shows that a fire promoting device is disposed at the main piston itself, but not shown here.

The pump supplied oil or other liquid is delivered into the pressure switch chamber 13A of the pressure piston 5A through a small opening of the outer disk casing 12, the pressure-change openings 12, 12 of the rotary disk 1, the pressure-change openings 6, 7 and the radial reciprocal opening 10.

In another example, a reciprocal passage or opening for oil or other liquid is provided at a slidable portion of a connecting rod of a crankshaft, and when the reciprocal passage or opening is brought into contact with the pressure-change openings, the oil or other liquid is released and exhausted.

Claims

1. A pressure change-over valve disposed in a liquid passage for operating pressure-receiving pistons in order to permit mutual operations between the pressure-receiving pistons of a combustion promoting device of an internal combustion engine which comprises an outer disk casing, an inner disk casing and a rotary disk which is integral with a drive shaft, said rotary disk being rotatably disposed in a rotary space defined by the outer and inner disk casings, said outer and inner disk casings having a plurality of pressure change-over passages and said rotary disk having a plurality of pressure change-over openings and a pressure

change-over passage according to the number of the pistons; whereby the liquid discharged when one of the pressure-receiving pistons performs a main operation is sent to another pressure-receiving piston through the pressure change-over valve and the pressure-receiving piston is is operated reversely.

2. A pressure change-over valve disposed in a liquid passage for operating pressure-receiving pistons in order to permit mutual operations between the pressure-receiving pistons of a combustion promoting device of an internal combustion engine as claimed in claim (2) which is characterized in that oil or other liquid is supplied from a pump through a plurality of pressure change-over openings and a passage provided through the outer and inner disk casings and the rotary disk in accordance with the number of pistons when one of the one of the pressure-receiving pistons receives pressure during its combustion or exhaust stroke.

FIG 1

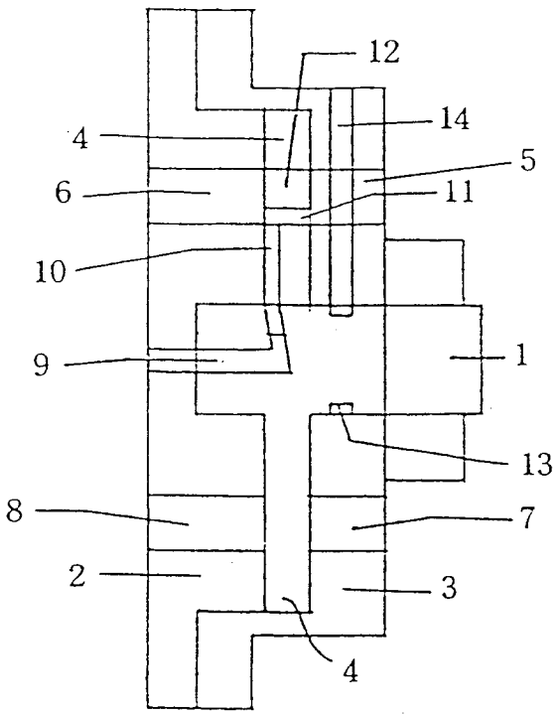


FIG 2

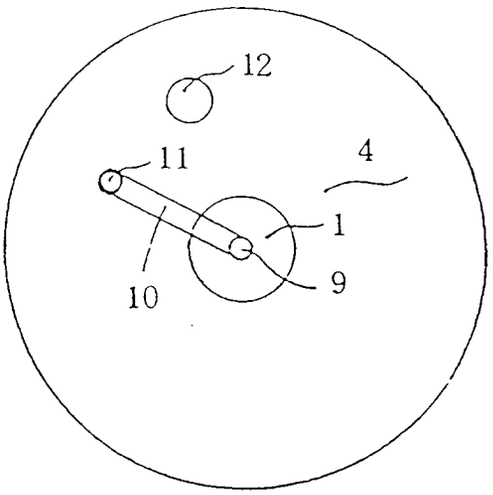


FIG 3

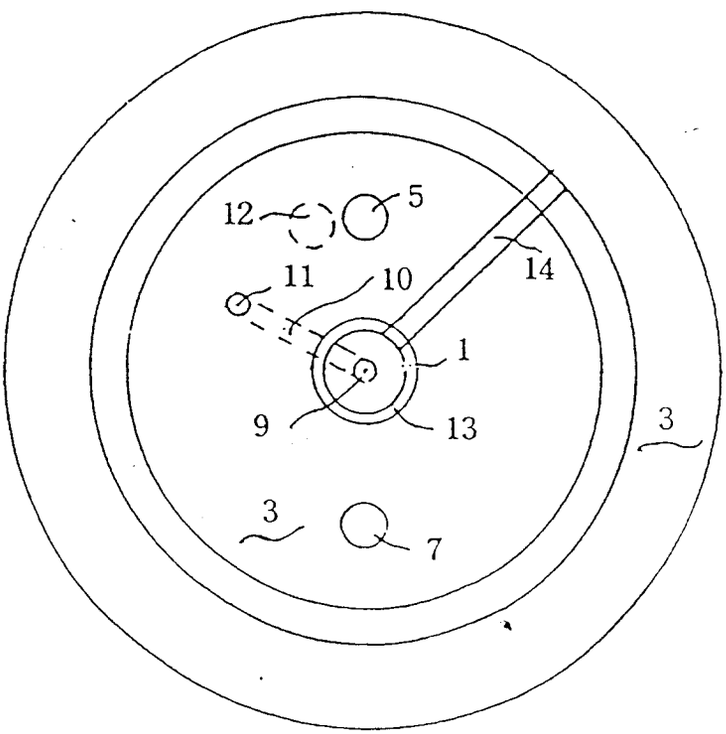


FIG 4

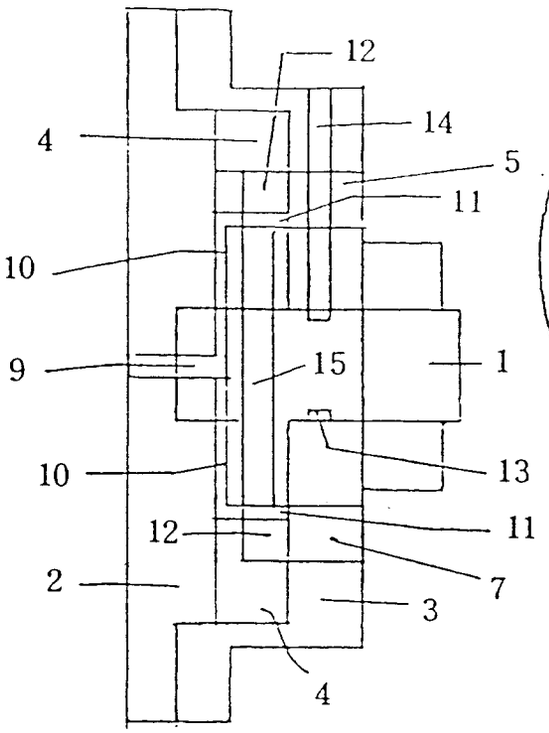


FIG 5

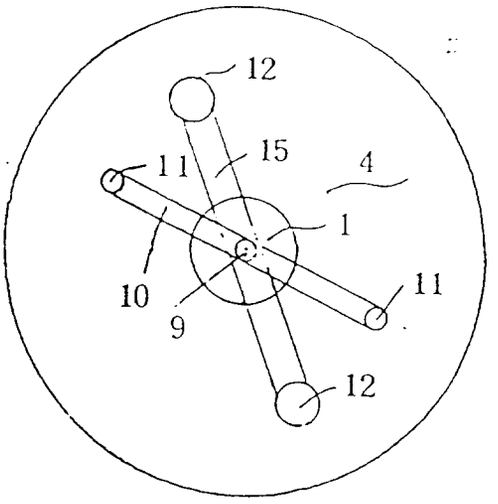


FIG 6

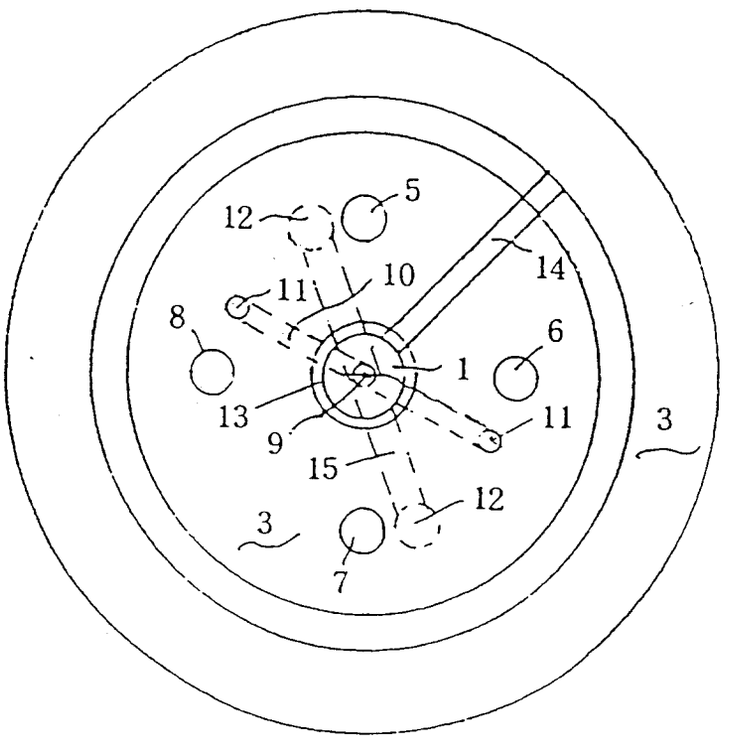


FIG 7

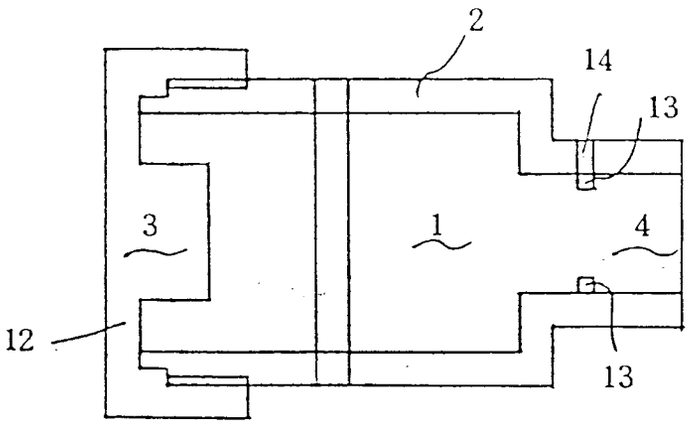


FIG 8

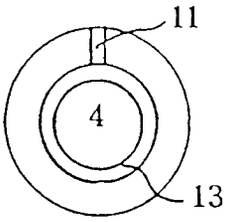


FIG 9

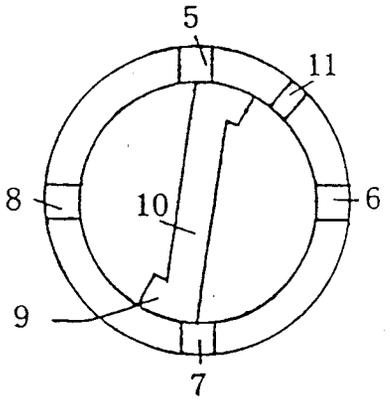
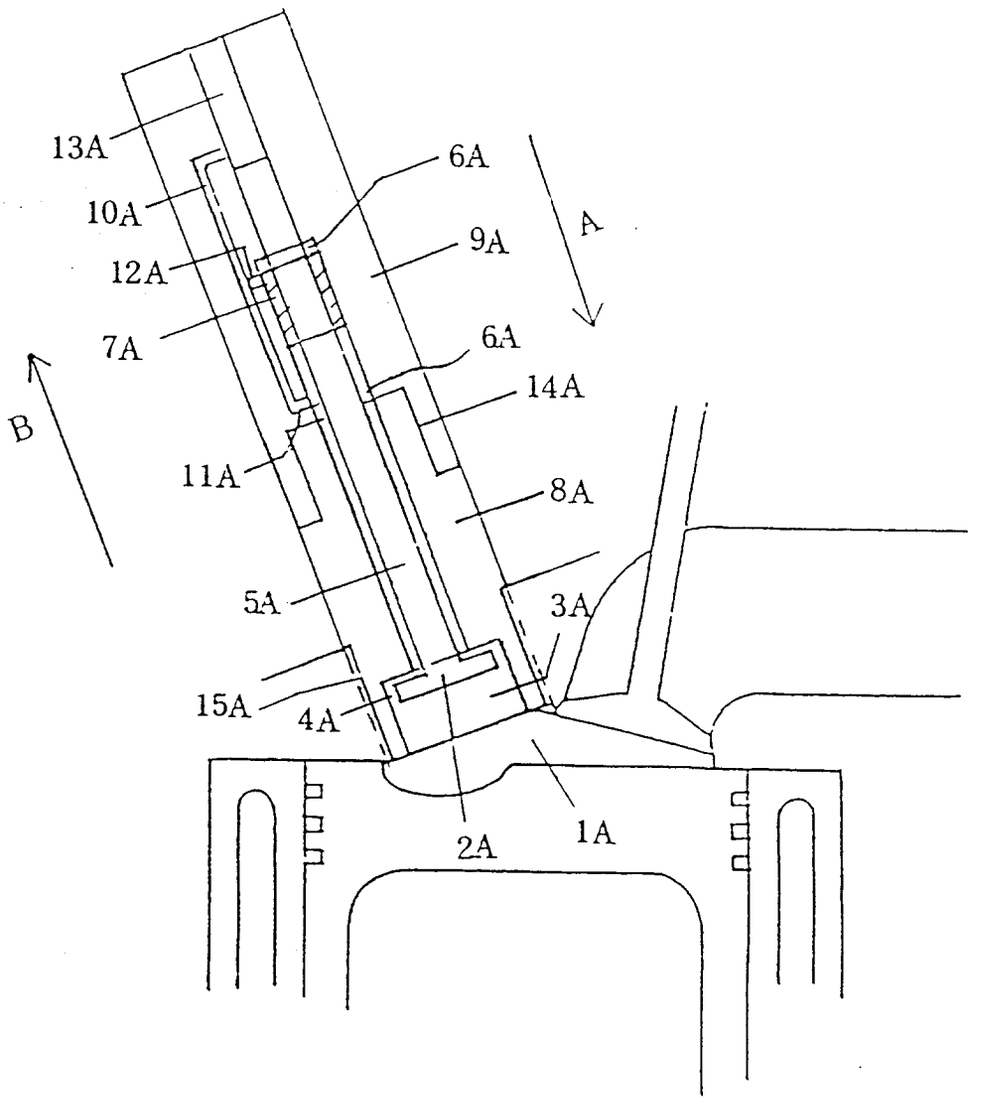


FIG 10



INTERNATIONAL SEARCH REPORT

International Application No PCT/JP90/01495

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl[5] F02B23/00

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System [8]	Classification Symbols
IPC	F02B23/00-23/10, F20D15/00-15/04, F01L13/00-13/08, F15B7/00

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
A	JP, U, 56-15422 (Nissan Motor Co., Ltd.), February 10, 1981 (10. 02. 81), Figs. 1 to 3	1
A	US, A, 3,152,448 (J. Mercier), October 13, 1964 (13. 10. 64), Fig. 1 to 2	1

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
February 12, 1991 (12. 02. 91)	March 4, 1991 (04. 03. 91)
International Searching Authority	**Signature of Authorized Officer**
Japanese Patent Office	