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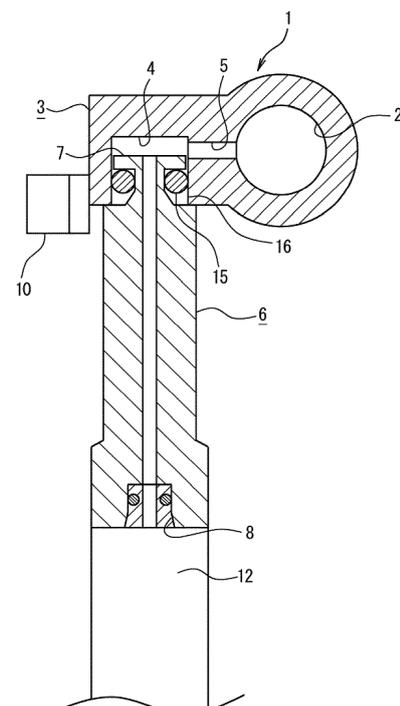
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(54) **GASOLINE DIRECT-INJECTION RAIL**

(57) Obtaining a fuel rail capable of forming a fuel rail body by hot forging and having high flexibility of the layout with a simple structure while reducing the cost even when the distance from the fuel rail body to the combustion chamber is long. A fuel rail body 1 and an injector cup adapter 6 independently formed from the fuel rail body 1 are included, the fuel rail body 1 is formed by hot forging, the injector cup adapter 6 is formed by cutting, and the injector cup adapter 6 and the fuel rail body 1 are connected and fixed to each other in a state that a connection portion 16 is sealed by an O-ring 15.

Fig. 1



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**Description**

## TECHNICAL FIELD

**[0001]** The present invention relates to a gasoline direct-injection rail having a fuel rail body and an injector cup adapter.

## BACKGROUND ART

**[0002]** Conventionally, as shown in Patent Document 1, it has already known that an injector is connected to a fuel rail body for a high pressure internal combustion engine via a connection member such as a cap nut. However, because of the relation with the layout and the like, when the above described fuel rail body is installed on an upper portion of an engine, the distance from the fuel rail body to a combustion chamber is long by the presence of peripheral components such as camshafts and valves. Therefore, the above described conventionally and generally used injector receives restrictions when the distance to the combustion chamber is long. That is a problem.

**[0003]** In order to solve the above described problem, it can be considered that a special injector (33) formed in a long shape corresponding to the distance from a (not illustrated) fuel rail body to a combustion chamber (32) as shown in Fig. 3 is connected with the above described conventional fuel rail body. Alternatively, it can be considered that a long injector cup is integrally formed with the fuel rail body as the method of using the conventional injector cup. Alternatively, it can be considered that a pipe connecting an injector cup and a rail body is integrally formed instead of the long injector cup and a conventionally and generally used injector is connected and fixed to the injector cup. Patent Document 1: Japanese Unexamined Patent Application Publication No. 2010-7651

## DISCLOSURE OF THE INVENTION

[Problems to be Solved by the Invention]

**[0004]** However, as shown in Fig. 3, when the injector (33) formed in a long shape corresponding to the distance from the (not illustrated) fuel rail body provided on an upper portion of an engine (31) to the combustion chamber (32) provided on a lower part of the engine (31) is connected, the injector (33) formed in a long shape should be specially manufactured. Thus, the manufacturing cost increases.

**[0005]** Furthermore, when the long injector cup is integrally formed with the fuel rail body, the size of the entire fuel rail becomes large. Accordingly, the flexibility of the layout is decreased and the size of the entire product becomes large. Thus, handling is complicated.

**[0006]** Furthermore, a fuel pressure of a gasoline direct injection engine is expected to become higher. Thus,

there is a concern that a fuel rail formed by fixing and arranging various members on a raw pipe by in-furnace brazing and the like may cause an insufficient strength. Therefore, it is required that the fuel rail is formed by hot forging. However, it is difficult to form the fuel rail provided with the above described long injector cup by hot forging.

**[0007]** The present invention is made for solving the above described problem and obtaining the fuel rail capable of forming the fuel rail body by hot forging and having high flexibility of the layout with a simple structure while reducing the cost even when the distance from the fuel rail body to the combustion chamber is long.

[Means for Solving the Problem]

**[0008]** The present invention solves the above described problem and comprised of a fuel rail body and an injector cup adapter independently formed from the fuel rail body, wherein the fuel rail body is formed by hot forging, the injector cup adapter is formed by cutting, and the injector cup adapter and the fuel rail body are connected and fixed to each other in a state that a connection portion is sealed by an O-ring.

**[0009]** Note that the injector cup adapter and the fuel rail body can be connected and fixed to a cylinder block of the engine by screwing in a state that the connection portion is sealed by the O-ring.

**[0010]** As described above, since the fuel rail body and the injector cup adapter are independently formed from each other, only the fuel rail body can be manufactured by hot forging. Thus, it is possible to bear a higher fuel pressure of the engine. Even when the distance between the fuel rail body and the combustion chamber is long, the length of the injector cup adapter can be formed in a long shape in accordance with the distance. Thus, it is possible to arrange the injector in accordance with the distance between the fuel rail body and the combustion chamber. Accordingly, the fuel rail can be easily manufactured without requiring high cost.

**[0011]** In addition, the fuel rail body can be arranged on an upper portion of an engine. When the fuel rail body is arranged on the upper portion of the engine as described above, the distance between the fuel rail body and the combustion chamber becomes longer. However, the injector cup adapter having the length corresponding to the distance is connected to the fuel rail body in the present invention. Thus, the injector can be arranged on an appropriate position so that the injector faces the combustion chamber. In addition, it is not necessary to specially manufacture the long injector. Thus, the manufacturing cost of the entire fuel injection system can be suppressed.

**[0012]** In addition, the fuel rail body can be fixed and arranged on an upper portion of a cylinder block of the engine, and the injector cup adapter can be arranged in an insertion clearance formed on the cylinder block.

[Effects of the Invention]

**[0013]** In the present invention, the fuel rail body and the injector cup adapter are independently formed from each other as described above. Thus, only the fuel rail body can be manufactured by hot forging. Accordingly, the fuel rail capable of bearing higher fuel pressure of the engine can be obtained. Even when the distance between the fuel rail body and the combustion chamber is long, the length of the injector cup adapter can be adjusted in accordance with the distance. Thus, even when conventionally and generally used injector is used, the injector can be arranged on an appropriate position. Since the specially prepared long injector is not required, the manufacturing cost of the entire fuel injection system can be suppressed and the fuel rail body can be easily manufactured.

**[0014]** Furthermore, when assembled to the engine, since the rail body and the injector cup adapter are independently formed from each other, the position of the rail body can be finely adjusted in accordance with an assembly error caused by each of the engine. Accordingly, the present invention can contribute to improvement of assembling property and relaxation of dimensional accuracy.

#### BRIEF DESCRIPTION OF THE DRAWINGS

##### [0015]

Fig. 1 is a cross-sectional view showing the first embodiment of the present invention.

Fig. 2 is a conceptual diagram of the first embodiment in a state of being assembled to a cylinder block.

Fig. 3 is a perspective view of the conventional example.

#### MODES FOR CARRYING OUT THE INVENTION

##### First embodiment

**[0016]** The first embodiment of the present invention will be explained in Figs. 1 and 2. First, as shown in Fig. 1, (1) is a fuel rail body formed by hot forging. The fuel rail body (1) is formed in a long pipe shape to have a fuel passage (2) inside. As described above, since the fuel rail body (1) is formed by hot forging, the strength of the fuel rail body (1) can be enhanced. Thus, the product capable of bearing higher pressure of an engine (11) in the future can be obtained.

**[0017]** An adapter insertion portion (3) is integrally formed with the fuel rail body (1) to protrude from the fuel rail body (1) in a direction orthogonal to the fuel passage (2). As shown in Fig. 1, a connection recess (4) is provided on the adapter insertion portion (3) so that an injector cup adapter (6) can be connected to the connection recess (4). In addition, the connection recess (4) and the fuel passage (2) are communicated with each other via

a communication passage (5).

**[0018]** The injector cup adapter (6) formed by cutting is connected to the connection recess (4). Namely, a connection protrusion (7) connected to the fuel rail body (1) is provided on one end of the injector cup adapter (6), and a connection recess (8) for connecting one end of an injector (12) is provided on the other end of the injector cup adapter (6). The connection protrusion (7) of the injector cup adapter (6) is connected to an inside of the connection recess (4) of the adapter insertion portion (3) via an O-ring (15).

**[0019]** Consequently, the injector cup adapter (6) and a connection portion (16) of the fuel rail body (1) are connected and fixed to each other in a state of being sealed by the O-ring (15). Accordingly, leakage of the liquid and the like can be prevented at the connection portion (16) between the injector cup adapter (6) and the fuel rail body (1). Note that a flow space is formed between the connection protrusion (7) and the connection recess (4) so that the fuel from the fuel passage (2) of the fuel rail body (1) flows through the flow space.

**[0020]** In addition, a screw fixing portion (10) having a (not illustrated) screw hole is connected and arranged on the adapter insertion portion (3) at an opposite side of the fuel rail body (1). The case where the fuel rail body (1) and the injector cup adapter (6) formed as described above are assembled to an upper portion (17) of the engine (11) will be explained. In the present embodiment, as shown in Fig. 2, an insertion clearance (14) is formed between a pair of cylinder blocks (13) forming the engine (11) so that the injector cup adapter (6) and the injector (12) can be inserted and arranged in the insertion clearance (14).

**[0021]** As shown in Fig. 2, the fuel rail body (1) is arranged on an upper part of the cylinder blocks (13), the injector cup adapter (6) assembled to the fuel rail body (1) is inserted into the insertion clearance (14) and a base end of the injector (12) is inserted and arranged in the connection recess (8). A (not illustrated) screw is inserted into the screw fixing portion (10) formed integrally with the fuel rail body (1) to fix the fuel rail body (1) to the cylinder blocks (13) by the screw.

**[0022]** Here, as described above, since the fuel rail body (1) is provided on the upper portion (17) of the engine (11) in the present embodiment, the distance between the fuel rail body (1) and the combustion chamber is long. Therefore, the injector cup adapter (6) is formed in a long shape corresponding to the long distance between the fuel rail body (1) and the combustion chamber.

**[0023]** Consequently, instead of the injector (33) shown in Fig. 3, the conventionally and widely used injector (12) having a general length is connected to the injector cup adapter (6) having a long shape. Thus, the injector (12) can be arranged on an appropriate position facing the combustion chamber. Therefore, it is not necessary to use a specially prepared long injector (12). Thus, the manufacturing cost of the entire fuel injection system can be suppressed. In addition, the injector cup

adapter (6) is formed in a long shape as described above. Therefore, the injector (12) can be arranged on an appropriate position corresponding to the long distance between the fuel rail body (1) and the combustion chamber. Thus, manufacturing can be facilitated.

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**[0024]** In addition, the injector cup adapter (6) is formed independently from the fuel rail body (1) and the injector cup adapter (6) is formed by cutting. Thus, the dimension can be easily adjusted in accordance with the distance from the fuel rail body (1) to the injector (12). Furthermore, the length of the injector cup adapter (6) can be arbitrarily adjusted in accordance with the position of the other components assembled to the engine (11). Thus, flexibility of the layout can be increased.

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[Description of the Reference Numerals]

**[0025]**

1: fuel rail body

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6: injector cup adapter

11: engine

13: cylinder block

14: insertion clearance

15: O-ring

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16: connection portion

17: upper portion

**Claims**

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**1.** A gasoline direct-injection rail, comprising:

a fuel rail body; and

an injector cup adapter independently formed from the fuel rail body, wherein

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the fuel rail body is formed by hot forging,

the injector cup adapter is formed by cutting, and

the injector cup adapter and the fuel rail body

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are connected and fixed to each other in a state that a connection portion is sealed by an O-ring.

**2.** The gasoline direct-injection rail according to claim 1, wherein

the fuel rail body is arranged on an upper portion of an engine.

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**3.** The gasoline direct-injection rail according to claim 2, wherein

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the fuel rail body is fixed and arranged on an upper portion of a cylinder block of the engine, and

the injector cup adapter is arranged in an insertion clearance formed on the cylinder block.

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Fig. 1

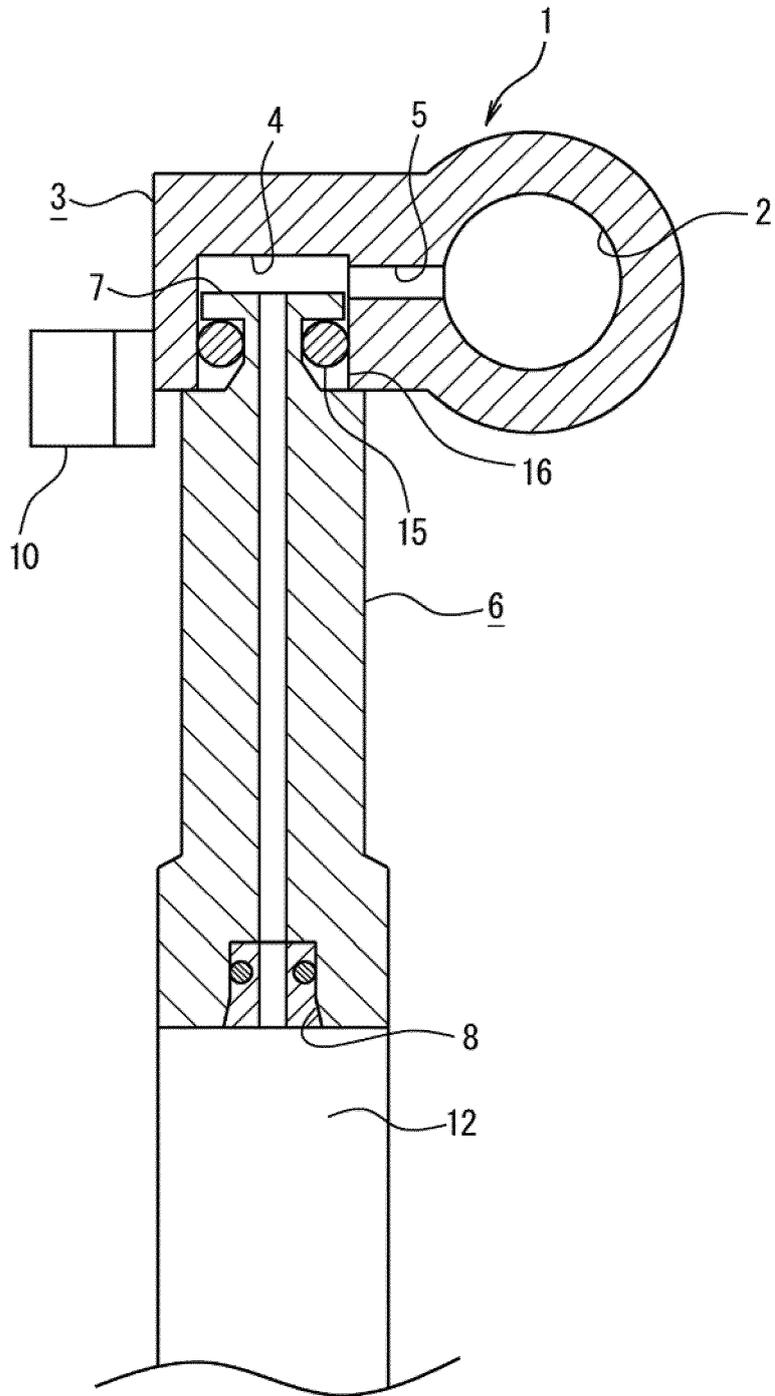


Fig. 2

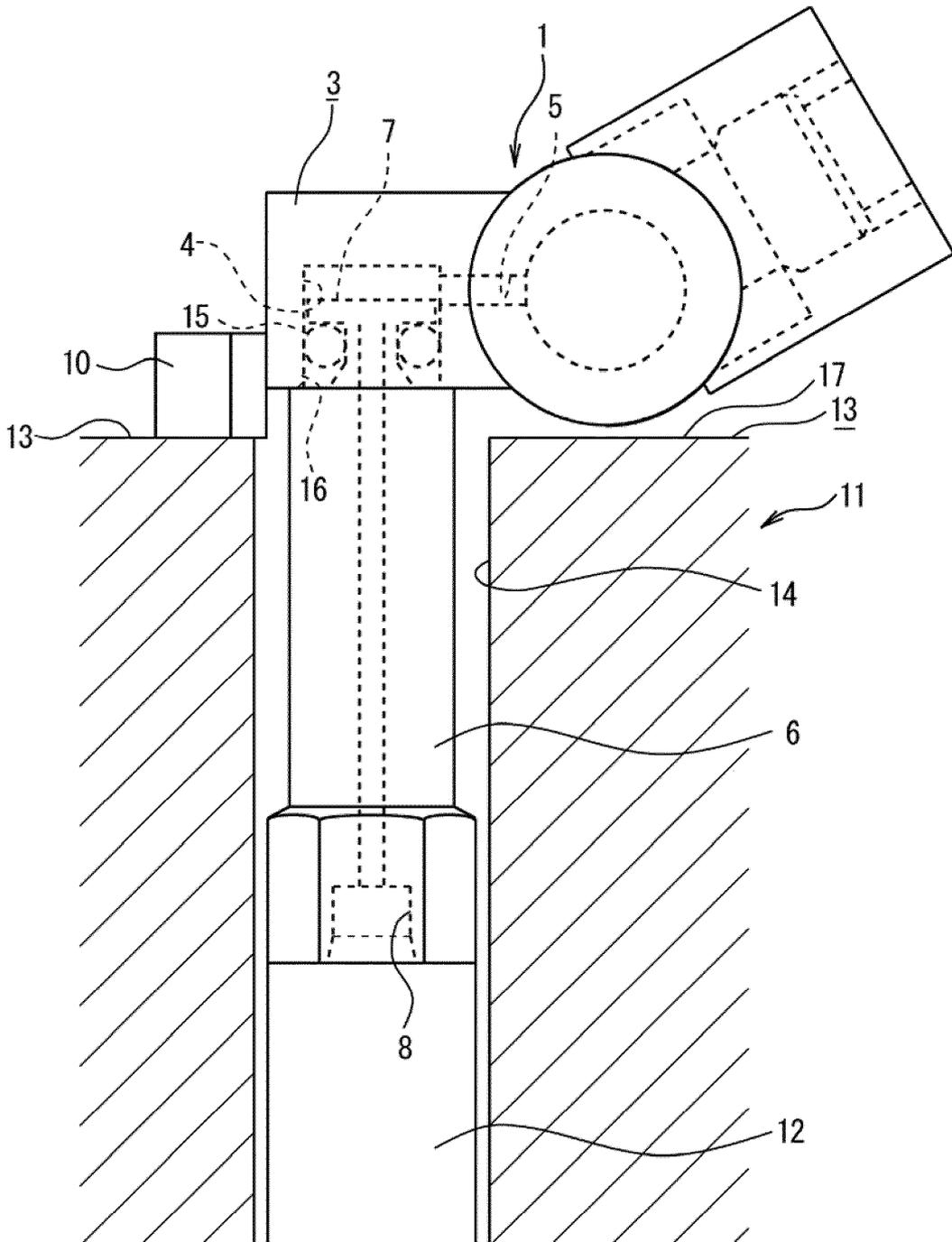
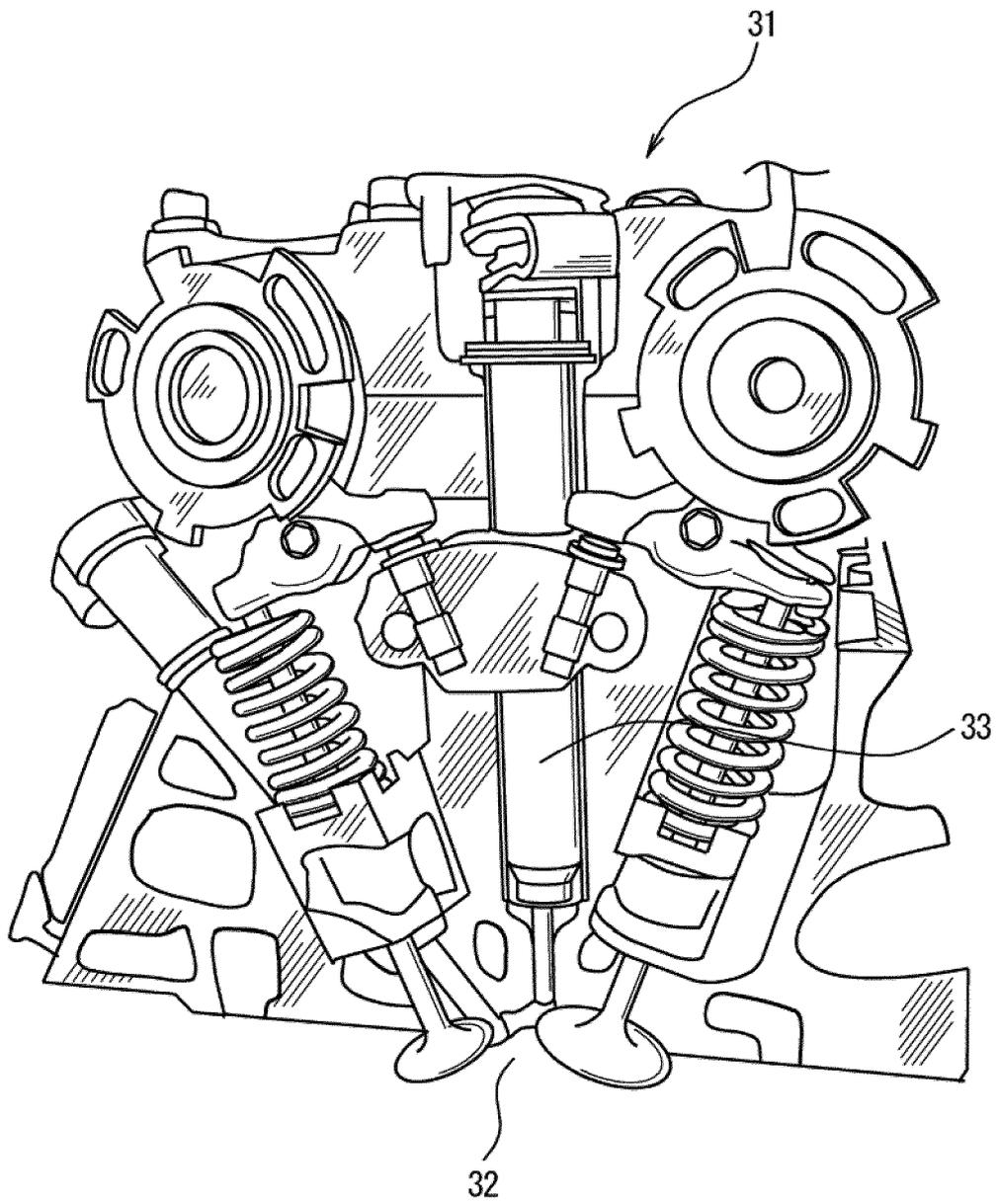


Fig. 3



## INTERNATIONAL SEARCH REPORT

International application No.

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A. CLASSIFICATION OF SUBJECT MATTER									
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FI: F02M55/02 330B, F02M55/02 330D, F02M55/02 340B, F02M55/02 360C									
According to International Patent Classification (IPC) or to both national classification and IPC									
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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched									
<table border="0"> <tr> <td>Published examined utility model applications of Japan</td> <td>1922-1996</td> </tr> <tr> <td>Published unexamined utility model applications of Japan</td> <td>1971-2021</td> </tr> <tr> <td>Registered utility model specifications of Japan</td> <td>1996-2021</td> </tr> <tr> <td>Published registered utility model applications of Japan</td> <td>1994-2021</td> </tr> </table>		Published examined utility model applications of Japan	1922-1996	Published unexamined utility model applications of Japan	1971-2021	Registered utility model specifications of Japan	1996-2021	Published registered utility model applications of Japan	1994-2021
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Published unexamined utility model applications of Japan	1971-2021								
Registered utility model specifications of Japan	1996-2021								
Published registered utility model applications of Japan	1994-2021								
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)									
C. DOCUMENTS CONSIDERED TO BE RELEVANT									
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.							
Y	JP 2001-355540 A (FORD GLOBAL TECHNOLOGIES INC.) 26 December 2001, paragraphs [0004], [0010], [0011], fig. 1, 2	1-3							
Y	JP 2002-070691 A (OTICS CORP.) 08 March 2002, paragraph [0012], fig. 3	1-3							
Y	JP 2000-249024 A (KEIHIN CORP.) 12 September 2000, paragraphs [0004], [0014], [0015], [0019], fig. 1	1-3							
Y	JP 09-317606 A (NISSAN MOTOR CO., LTD.) 09 December 1997, paragraphs [0008]-[0010], [0022], fig. 1, 3	3							
<input type="checkbox"/> Further documents are listed in the continuation of Box C.		<input checked="" type="checkbox"/> See patent family annex.							
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**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

International application No.  
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Patent Documents referred to in the Report	Publication Date	Patent Family	Publication Date
JP 2001-355540 A	26.12.2001	DE 60003784 T2 EP 1150002 A1 paragraphs [0004], [0010], [0011], fig. 1, 2	
JP 2002-070691 A	08.03.2002	(Family: none)	
JP 2000-249024 A	12.09.2000	(Family: none)	
JP 09-317606 A	09.12.1997	(Family: none)	

**REFERENCES CITED IN THE DESCRIPTION**

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**Patent documents cited in the description**

- JP 2010007651 A [0003]