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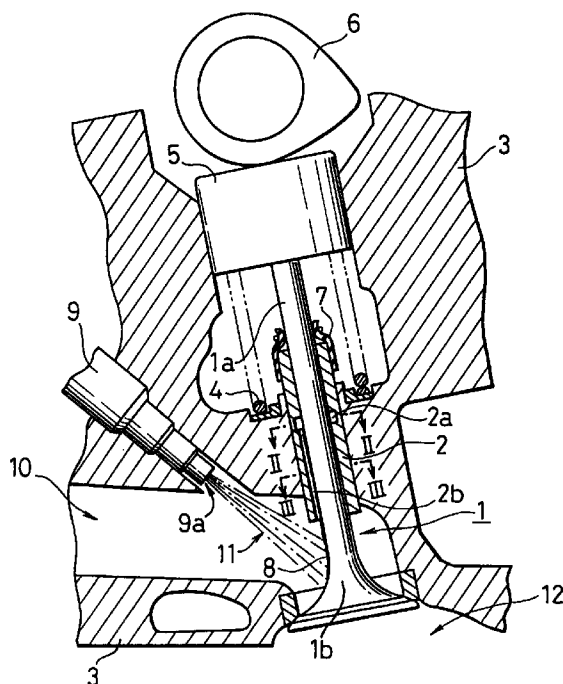
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**(54) Intake valve device for preventing adhesion of deposits**

(57) An intake valve in an internal combustion engine comprises a valve stem and a valve head and moves up and down. On either of contact surfaces between the valve stem and a valve guide, annular and elongate grooves are formed to communicate with an intake port at the lower end. Lubricating oil invaded into a gap between the valve stem and the valve guide goes down through the grooves, gets out of the valve guide and adhere onto the valve head in the intake port. The oil on the valve head is washed down by fuel injected from a fuel injector.

FIG. 1



## Description

The present invention relates to an intake valve device for preventing adhesion of deposits.

In poppet valves in engines of automobiles and ships, especially, in intake valves which has relatively low heat load, if high boiling point organic substances in lubricating oil leaked from a gap between a valve guide and a valve stem adhere to a valve head and adjacent area, they will be carbonised at of 200 to 300°C of the intake valve, gradually aggregated and developed, thereby forming sludges or bulk of deposits. In the deposits, corrosion ingredients may be contained, which causes corrosion in the valve head and adjacent area.

To overcome the disadvantages on the surface of the valve head and adjacent area, an intake valve is suggested as mentioned Japanese Patent Laid-Open Pub. No.6-235308, wherein a coating layer which has oxidation catalytic function is formed on the valve head and adjacent area, thereby preventing high boiling point organic substances from adhering on the valve head and adjacent area owing to oxidation catalytic reaction thereof. However, in the intake valve in this publication, an engine runs for a long time at low load and speed, so that the surface of catalyst is partially covered with high boiling point organic substances in the lubricating oil owing to oil-down until the intake valve becomes reaction temperature of the catalyst, and the catalyst is blocked against air or oxygen. Thus, oxidization catalytic reaction may not be achieved enough.

To overcome the disadvantage, it is an object of the present invention to provide a valve device in which oil-down is directed toward a fuel injection device to prevent deposits from adhering to a valve head and adjacent area and catalyst surface from being covered by lubricating oil.

According to one aspect of the present invention, there is provided an intake valve device for preventing adhesion of deposits in an internal combustion engine, the device comprising an intake poppet valve which comprises a valve head and a valve stem; a valve guide in which the valve is slidably inserted; and fuel injection means which injects fuel toward the valve head, either of contact surfaces between the valve stem and the valve guide having an annular groove and an elongate groove which communicates with the annular groove, a lower end of the elongate groove opening toward an intake port in the vicinity of the fuel injection means.

According to another aspect of the present invention there is provided an intake valve device for preventing adhesion of deposits in an internal combustion engine, the device comprising an intake poppet valve which comprises a valve head and a valve stem; a valve guide in which the valve is slidably inserted; and fuel injection means which injects fuel toward the valve head, either of contact surfaces between the valve stem and the valve guide having a spiral groove, a lower end of the spiral groove opening toward an intake port in the

vicinity of the fuel injection means.

According to the present invention, lubricating oil owing to oil-down is guided to the valve head through the annular and elongate grooves or the spiral groove and washed down by fuel injected by the fuel injection means, thereby avoiding the lubricating oil from adhering to the intake valve.

The features and advantages of the invention will become more apparent from the following description with respect to embodiments as shown in appended drawings wherein:

Fig. 1 is a sectional view of the first invention;  
Fig. 2 is an enlarged horizontal sectional view taken along the line II-II in Fig. 1;  
Fig. 3 is an enlarged horizontal sectioned view taken along the line III-III in Fig. 1;  
Fig. 4 is an enlarged horizontal sectioned view of a valve guide of the second invention;  
Fig. 5 is an enlarged vertical sectioned view of an embodiment of the present invention; and  
Fig. 6 is an enlarged view of a coating layer.

The first invention is illustrated in Fig. 1, in which the numeral 1 denotes an intake valve which is molded from martensitic heat resisting steels and which comprises a valve stem 1a and a valve head 1b at the lower end thereof. The valve stem 1a of the intake valve 1 is slidably inserted in a cylindrical valve guide 2 which is pressed in a cylinder head 3, and the intake valve 1 is moved up and down by pushing the upper surface of a cylindrical tappet 5 at the upper end of the valve stem 1a by a cam 6. 4 denotes a valve spring.

At the upper end of the valve guide 2, a lip seal 7 is engaged over the outer circumferential surface of the valve stem 1a, thereby preventing excessive lubricating oil 8 from running into a gap between the valve stem 1a of the intake valve 1 and the valve guide 2.

In the vicinity of the intake valve 1, an injector 9 for injecting gasoline in vapour is provided in the cylinder head 3, and an injection port 9a is directed to the surface of the valve head 1b in the intake port 10. On the surface of the valve guide 2 which contacts the intake valve 1, there is formed an annular groove 2a and an elongate groove 2b which communicates with the annular groove 2a at the upper end and which extends to the lower end of the valve guide 2. The lower end of the elongate groove 2b opens toward the intake port 10, which is also shown in Figs. 3 and 4.

The function of the embodiment as above will be described. The lubricating oil 8 which runs in the gap between the valve stem 1a of the intake valve 1 and the valve guide 2 is temporarily held in the annular groove 2a. The lubricating oil 8 in the annular groove 2a runs into the lower end of the valve stem 1a of the intake valve 1 in the intake port 10 and reaches the valve head 1b in the vicinity of the injector 9 via the elongate groove 2a. The gasoline 11 is blown to the lower end of the valve stem 1a of the intake valve 1 and the head 1b by

the injector 9, so that the lubricating oil 8 which adheres thereon is washed down by the gasoline 11 and sucked into the cylinder 12. Therefore, the lubricating oil 8 hardly adheres on the surface of the intake valve 1 in the intake port 10.

In the above embodiment, the annular groove 2a and the elongate groove 2b are both formed on the valve guide 2, but may be formed on the intake valve 1.

Preferably, the annular groove 2a may be formed as low as possible. So far as the lubricating oil 8 invaded in the gap between the valve guide and the intake valve 1 is held in the annular groove 2a, the lubricating oil does not reach the contact surface lower than the annular groove 2a. It is for preventing lubrication decrease.

An embodiment of the second invention will be illustrated in Fig. 4. Difference between the above and present embodiments is only a groove in the inner circumferential surface of the valve guide 13, and the other illustration will be omitted. A spiral groove 14 is formed on the whole inner circumferential surface of the valve guide 13, and an opening 14a at the lower end of the spiral groove 14 communicates with the intake port 10 in the vicinity of the injector 9 similar to the elongate groove 2b in the foregoing embodiment.

The lubricating oil 8 invaded into a gap between the intake valve 1 and the valve guide 13 runs into the spiral groove 14 and reaches the valve head 1b of the intake valve 1 in the vicinity of the injector 9 similar to the foregoing embodiment. The oil 8 which adheres on the valve head 1b is washed down by the gasoline 11 from the injector 9. This embodiment achieves similar advantage to the foregoing embodiment, and the spiral groove 14 provides excellent oil-maintenance capability compared with the elongate groove 2b, and increases lubricating properties of contact surfaces of the intake valve 1 and the valve guide 13.

The spiral groove 14 may be formed from a suitable position on the inner circumferential surface of the valve guide 13 to the lower end of the valve guide 13. The spiral groove 14 may be formed on the intake valve 1.

Another embodiment of the present invention will be illustrated in Fig. 5, in which a coating layer having oxidation catalytic function is formed on a portion of the intake valve 1 in the intake port 10, i.e. on the lower end of the valve stem 1a and the head 1b on which high boiling point organic substance is likely to adhere. As enlarged in Fig. 6, the surface of the intake valve 1 is coated with ceramic porous carrier 17 having a limitless number of micropores 16, into which active substances such as Pt, Pd and Rh are dissolved and carried, thereby forming the coating layer 15. The porous carrier 17 may be preferably made of oxide ceramics such as  $Al_2O_3$ ,  $ZrO_2$  and cordierite, and may be coated by surface treatment means such as thermal spray and coating. If the surface of the intake valve 1 is made rough, peeling resistance of the porous carrier 17 will be increased. If the porous carrier 17 comprises two layer structure which comprises treating layer of  $Al_2O_3$  and wash-coat layer of  $\gamma-Al_2O_3$  applied thereon, the surface

area of the micropores 16 will become larger, thereby increasing carrying capability of the active substance.

The high boiling point organic substance included in the lubricating oil 8 which is not washed down by the gasoline 11 and in the lubricating oil 8 which is scattered by up-and-down movement of the intake valve 1 onto the opposite surface of the valve head 1b in the vicinity of the injector 9 is absorbed on the active substance 18 in the coating layer 15. When the intake valve 1 becomes a predetermined temperature of 200 to 350°C, oxidation catalytic reaction occurs from heated portion, thereby leaving the high boiling point organic substance from the active substance 18 and dispersing it, so that high boiling point organic substance is neither carbonized nor deposited on the surface of the valve head 1b.

The present invention may be applied to internal combustion engines other than gasoline engine.

The foregoing merely relate to preferred embodiments of the invention. Various changes and modifications may be made by person skilled in the art without departing from the scope of claims wherein:

#### Claims

1. An intake valve device for preventing adhesion of deposits in an internal combustion engine, the device comprising:
  - an intake poppet valve which comprises a valve head and a valve stem;
  - a valve guide in which the valve stem is slidably inserted; and
  - fuel injection means which injects fuel toward the valve head, either of contact surfaces between the valve stem and the valve guide having an annular groove and an elongate groove which communicates with the annular groove, a lower end of the elongate groove opening toward an intake port in the vicinity of the fuel injection means.
2. An intake valve device as defined in claim 1 wherein the annular and elongate grooves are formed on the contact surface of the valve guide to the valve stem.
3. An intake valve device as defined in claim 1 wherein the annular groove is formed at lower portion at the contact surface of the valve guide.
4. An intake valve device as defined in claim 1 wherein the deposits comprise lubricating oil invaded into a gap between the valve stem and the valve guide.
5. An intake valve device as defined in claim 1 wherein a coating layer having oxidation catalytic function is formed on at least portion of the intake

valve in the intake port.

6. An intake valve device for preventing adhesion of deposits in an internal combustion engine, the device comprising:

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an intake poppet valve which comprises a valve head and a valve stem;

a valve guide in which the valve is slidably inserted; and

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fuel injection means which injects fuel toward the valve head, either of contact surfaces between the valve stem and the valve guide having a spiral groove, a lower end of the spiral groove opening toward an intake port in the vicinity of the fuel injection means.

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7. An intake valve device as defined in claim 6 wherein the spiral groove is formed on the contact surface of the valve guide to the valve stem.

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8. An intake valve device as defined in claim 6 wherein the deposits comprise lubricating oil invaded into a gap between the valve stem and the valve guide.

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9. An intake valve device as defined in claim 6 wherein a coating layer having oxidation catalytic function is formed on at least portion of the intake valve in the intake port.

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FIG.1

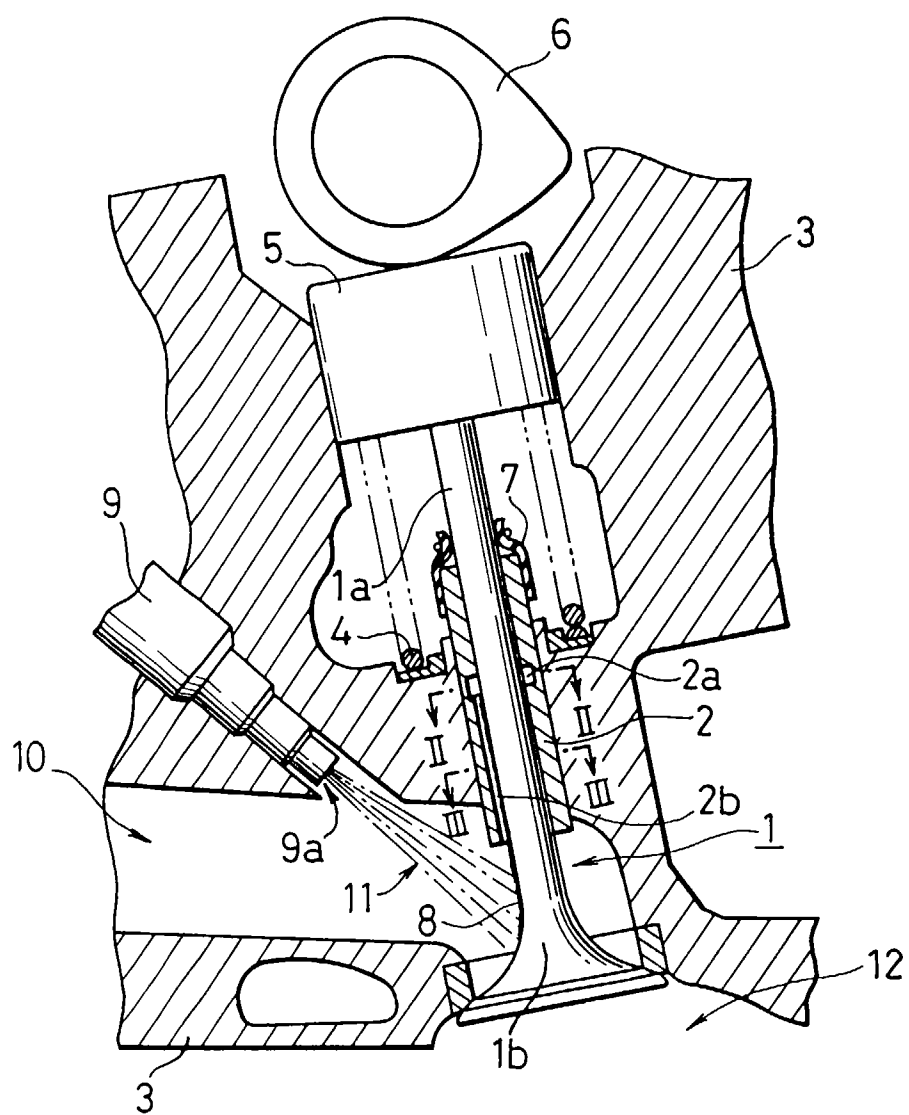


FIG.2

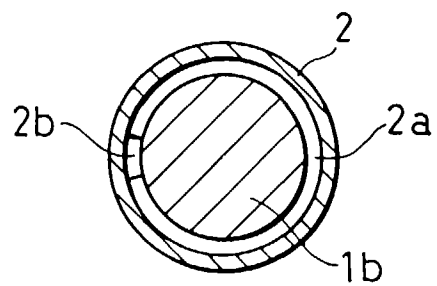


FIG.3

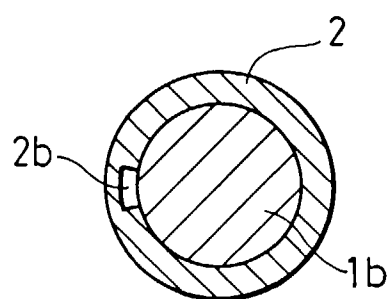


FIG.4

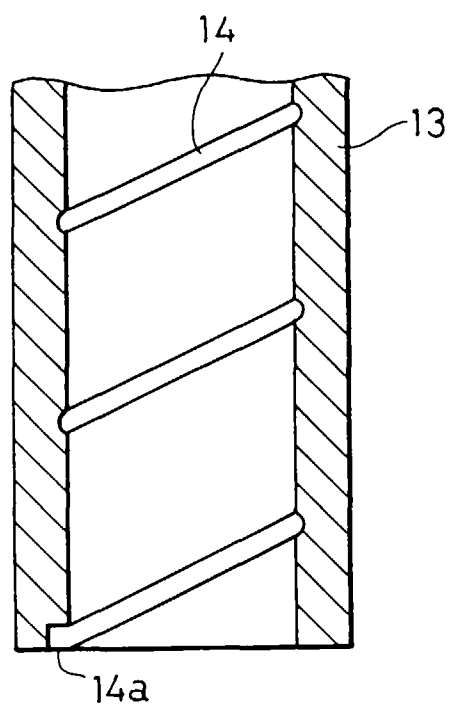


FIG.5

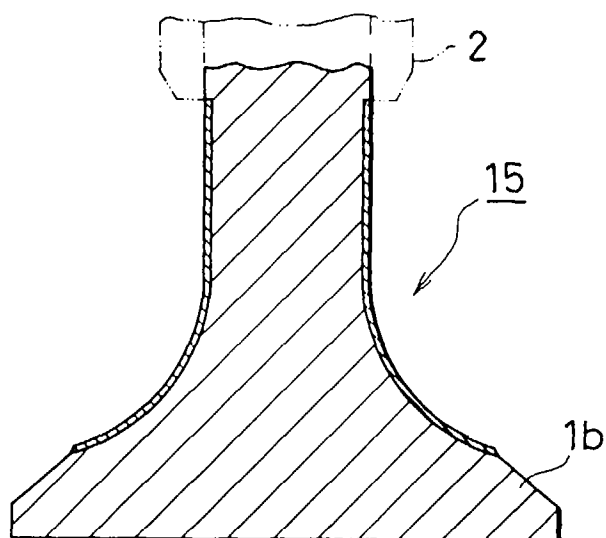
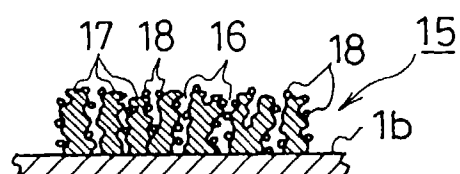


FIG.6





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# EUROPEAN SEARCH REPORT

Application Number  
EP 96 10 5692

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	US-A-5 465 691 (CAPALDO) * the whole document *	1,6,7	F01L3/04 F01L3/08
A	JP-A-07 332 038 (ARAI PUMP MFG CO LTD) * abstract *	1,6,7	
A	PATENT ABSTRACTS OF JAPAN vol. 9, no. 7 (M-350), 12 January 1985 & JP-A-59 158363 (HINO JIDOSHA KOGYO KK), 7 September 1984, * abstract *	1,3,6	
A,D	PATENT ABSTRACTS OF JAPAN vol. 18, no. 613 (M-1709), 22 November 1994 & JP-A-06 235308 (FUJI 00ZX INC), 23 August 1994, * abstract *	4,9	
A	DE-A-37 19 077 (DAIMLER BENZ AG) * column 1, line 61 - page 2, line 31; figure 1 *	4,9	TECHNICAL FIELDS SEARCHED (Int.Cl.6)
A	PATENT ABSTRACTS OF JAPAN vol. 17, no. 671 (M-1525), 10 December 1993 & JP-A-05 223041 (NISSAN MOTOR CO LTD), 31 August 1993, * abstract *	1	F01L
A	FR-A-2 078 676 (CATERPILLAR TRACTOR CO ) -----		
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 23 August 1996	Examiner Klinger, T
<p><b>CATEGORY OF CITED DOCUMENTS</b></p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ----- &amp; : member of the same patent family, corresponding document</p>			

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