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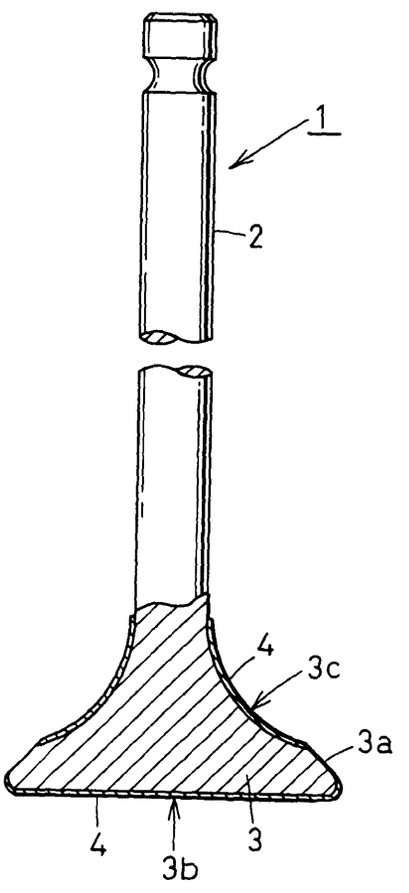
(54) Poppet valve

(57) A poppet valve that comprises a valve head and a valve stem is used in an internal combustion engine. The valve head is covered with a heat-insulating film except a valve face. The film is made of ceramics. Furthermore, a heat-shielding plate is fixed over a front face of the valve head to form a heat-insulating space between the plate and the front face thereby decreasing operational temperature of the valve.

FIG.1



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Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a poppet valve which is capable of reducing thermal load in a valve head.

[0002] An intake valve is heated on a front face of a valve head which faces a cylinder at approximately 100 % and cooled at a rear portion of the valve head so that heat may be left into intake air and at the same time left from a valve stem and a valve face into a cylinder head through a valve guide and a valve seat.

[0003] An exhaust valve is heated at a front face and a rear portion at approximately 7:3. Heat is thereby transferred from a valve stem and a valve face into the cylinder head through the valve guide and the valve seat.

[0004] Temperature of the intake and exhaust valves during operation is determined by the balance between heating and cooling. The valve head increases in temperature, depending on operating conditions, causing an increase in thermal load since cooling is generally less than heating.

[0005] Poppet valves are generally made of martensite heat-resistant steel, mainly for intake valves, and austenite heat-resistant steel for exhaust valves.

[0006] Heat-resistant steels are relatively expensive thereby limiting potential decreases in the manufacturing cost of poppet valves.

[0007] Intake valves having relatively low thermal load are made of Al alloy thereby lightening a valve-operating mechanism to improve engine performance. However, there are disadvantages in high-temperature strength thereby making practical use impossible.

SUMMARY OF THE INVENTION

[0008] In view of the disadvantages, it is an object of the invention to provide a poppet valve in which a valve head is less heated by heat insulation to decrease thermal load and to lower operation temperature of the valve thereby allowing for an expanded selection range of material and decreased costs ultimately leading to increased engine performance.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] 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 partially vertical sectional front view of the first embodiment of a poppet valve according to the present invention;
Fig. 2 is an enlarged vertical sectional view in which a film-forming portion is rough;
Fig. 3 is an enlarged vertical sectional view of a valve head in which multiple layers are contained in a film;
Fig. 4 is a vertical sectional front view of the second embodiment of the present invention;
Fig. 5 is a vertical sectional front view of the third embodiment of the present invention; and
Fig. 6 is a vertical sectional front view of the fourth embodiment of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0010] Fig. 1 illustrates the first embodiment of a poppet valve used as an exhaust valve according to the present invention. The poppet valve 1 consists of a valve stem 2 and a valve head 3 made of austenite heat-resistant steel. The valve head 3 consists of a front face 3b opposite a cylinder (not shown) and a rear portion 3c in an exhaust port. The whole surface of the valve head 3 except a valve face 3a is covered with a film 4 made of heat-resistant heat-insulating material.

[0011] The heat-insulating material includes ceramic oxides such as alumina, cordierite, zirconia, zircon and titanium oxide; ceramic carbides such as silicon carbide; ceramic nitrides such as silicon niride; aluminum silicate; chromium oxide; WC-Co alloy; WC-Ni-W-Cr_3C_2 alloy and Cr_3C_2-Ni-Cr alloy.

[0012] The film 4 may be made using gas flame or arc spraying, plasma spraying, explosion spraying, sputtering or ion plating. The film 4 may have thickness of 0.1 to 2.0 mm to insulate heat and decrease weight.

[0013] To increase adhesion of the film 4 and to prevent peeling thereof, as shown in Fig. 2, the heat-insulating material as above may be sprayed after the surface on which the film is formed is made rough by using shot blasting or mechanical working.

[0014] To prevent the film 4 from peeling off due to difference in the coefficient of thermal expansion from the valve itself, as shown in Fig. 3, a film 4 that consists of multiple layers having different contents of heat-insulating material may be formed. Specifically, the first layer 4a is a highly adhesive binding layer made from the same material as the valve. Heat-insulating materials are increased in conjunction with the increase in layers. An outermost layer 4b is made only of heat-insulating material. The surface of the film may be sprayed without making a rough surface. In the case of intake valves, the film 4 on the rear portion 3c may be omitted.

[0015] Fig. 4 illustrates the second embodiment of the present invention, in which a thin convex heat-shielding plate 7 made of heat-insulating material, as described above, or heat-resistant material such as heat-resistant steel is mounted to a front face 6a of a valve head 6 of a martensite heat-resistant steel poppet valve 5 to form a heat-insulating space 8 between the plate 7 and the front face 6.

[0016] To mount the heat-shielding plate 7, an L-sec-

tioned mounting portion 7a is formed on the circumferential end, and is engaged in an annular groove 9 on the circumferential end of the front face 6a. Then, the circumferential end of the front face 6a is plastically reconfigured inwards.

[0017] When the heat shielding plate 7 is made of material which can be brazed or welded, the circumferential end of the heat-shielding plate 7 may be welded to the front face 6a. The convex heat-shielding plate 7 provides sufficient bending strength against pressure and decreases concave deformation.

[0018] Fig. 5 illustrates the third embodiment of a poppet valve according to the present invention in which a heat-shielding plate 10, made of the same material as the above, has multiple reinforcement ribs 11 on the upper surface. A mounting portion 10a formed in the upper circumferential end is fixed to the circumferential end of a front face by the above caulking method to form a heat-insulating space 8 against the front face 6a.

[0019] Fig. 6 illustrates the fourth embodiment of a poppet valve according to the present invention in which a front face 6a of a poppet valve 5 is convex. On the lower surface of a poppet valve 5, a concave heat-shielding plate 12 having multiple reinforcement ribs 11 on the upper surface is fixed to the circumferential end of the front face 6a using an L-shaped mounting portion 12a on the circumferential end of the plate 12 by the above caulking method.

[0020] The heat-insulating space 8 is formed between the front face 6a and the heat-shielding plate 12 while the upper ends of the reinforcement ribs 11 are engaged on the front face 6a.

[0021] In the third and fourth embodiments, the reinforcement rib may be formed as grid, concentric circle, vortex, parallel plate, corrugated plate, incomplete circle, arc and protrusion. The reinforcement rib may be provided on the front face 6a.

[0022] The reinforcement rib, as described above, may be provided in the embodiment in Fig. 4.

[0023] In the second through fourth embodiments, the film may be formed on the rear portion 6b similar to the first embodiment in case of exhaust valves.

[0024] In the heat-insulating space 8, a light heat-insulating filler such as glass wool and rock wool or a heat-insulating gas such as Ar may be enclosed under ordinary or high pressure. Space 8 may be vacuous.

[0025] As described above, in the above embodiments of the poppet valve, the front face 3b and the rear portion 3c subjected to a high-temperature combustion or exhaust gas are covered with the film 4 made of heat-insulating material. The heat-shielding plates 7,10,12 are mounted to the front face 6a to form a heat-insulating space 8. Heat into the valve head 3,6 decreases, and generally dissipates through a valve seat or a valve guide thereby decreasing valve temperature during operation and improving durability. Heat into the valve head 3,6 decreases the heat loss rate and increases thermal efficiency thereby improving engine performance such as output and fuel efficiency.

[0026] Furthermore, a decrease in thermal load enables the valve to be made of low-cost material such as carbon steel or mechanical structural steel.

[0027] Most importantly, the present invention allows for poppet valves to be made of lightweight metals such as Al, Mg and Ti alloys which were heretofore difficult in use thereby reducing the inertia mass of a valve-operating mechanism to decrease mechanical loss such as friction so as to achieve double improvement in engine performance with decreased heat loss.

[0028] The foregoing merely relates to embodiments of the invention. Various changes and modifications may be made by persons skilled in the art without departing from the scope of claims wherein:

Claims

1. A poppet valve comprising:

   a valve stem; and
   a valve head at an end of the valve stem, a surface of the valve head being covered with a film made of heat-resistant heat-insulating material.

2. A poppet valve as claimed in claim 1 wherein the surface of the valve head except a valve face is covered with the film.

3. A poppet valve as claimed in claim 1 wherein the valve head comprises a front face opposite a cylinder and a rear portion, only the front face being covered with the film when the poppet valve is used as intake valve.

4. A poppet valve as claimed in claim 1 wherein the heat insulating material is comprised of one of oxide, carbide and nitride ceramics.

5. A poppet valve as claimed in claim 1 wherein the surface of the valve head to be covered with the film is rough.

6. A poppet valve as claimed in claim 1 wherein the film comprises multiple layers with a first layer of the film being made from the same material as the valve itself and additional layers containing increased amounts of heat-insulating material with each successive layers; an outermost layer being only the heat-insulating material.

7. A poppet valve comprising:

   a valve stem;
   a valve head at an end of the valve stem, and
   a heat-shielding plate fixed over a front face of

the valve head opposite a cylinder to form heat-insulating space between the front face and the heat-shielding plate with said plate being made of heat-resistant heat-insulating material.

8. A poppet valve as claimed in claim 7 wherein a circumferential end of the heat-shielding plate is fixed to a circumferential end of the front face of the valve head by caulking.

9. A poppet valve as claimed in claim 7 wherein the heat-shielding plate is concave.

10. A poppet valve as claimed in claim 7 wherein a rib is provided on the heat-shielding plate or the front face of the valve head to contact the other in the heat insulating space.

11. A poppet valve as claimed in claim 10 wherein multiple ribs are provided in the heat-insulating space.

12. A poppet valve as claimed in claim 7 wherein a heat-resistant heat-insulating filler is enclosed in the heat-insulating space.

13. A poppet valve as claimed in claim 12 wherein the filler is glass or rock wool.

14. A poppet valve as claimed in claim 7 wherein a heat insulating gas is enclosed in the heat-insulating space.

15. A poppet valve as claimed in claim 14 wherein the heat-insulating gas is Ar.

16. A poppet valve as claimed in claim 7 wherein the heat-insulating space is vacuous.

FIG.1

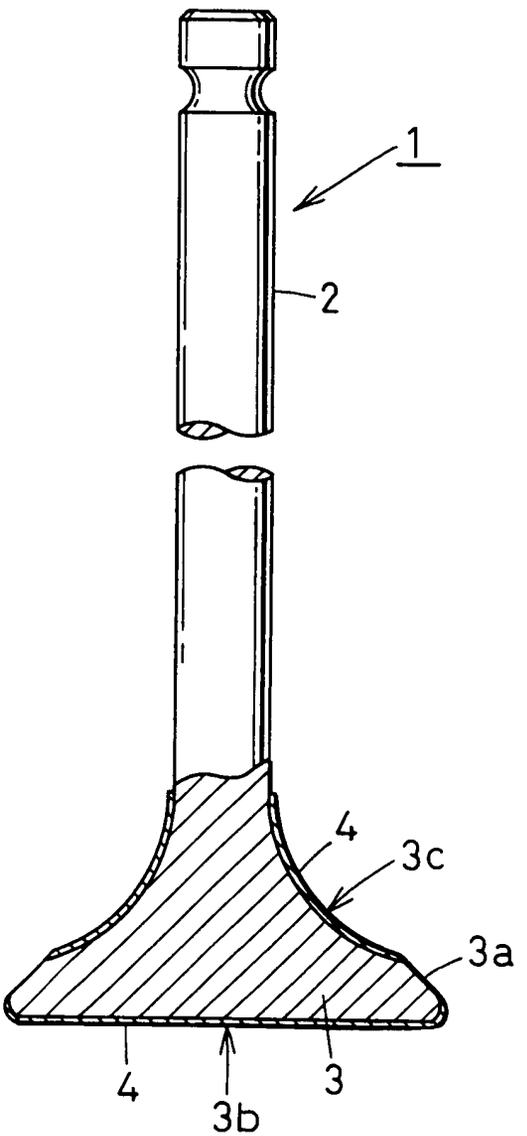

FIG.2

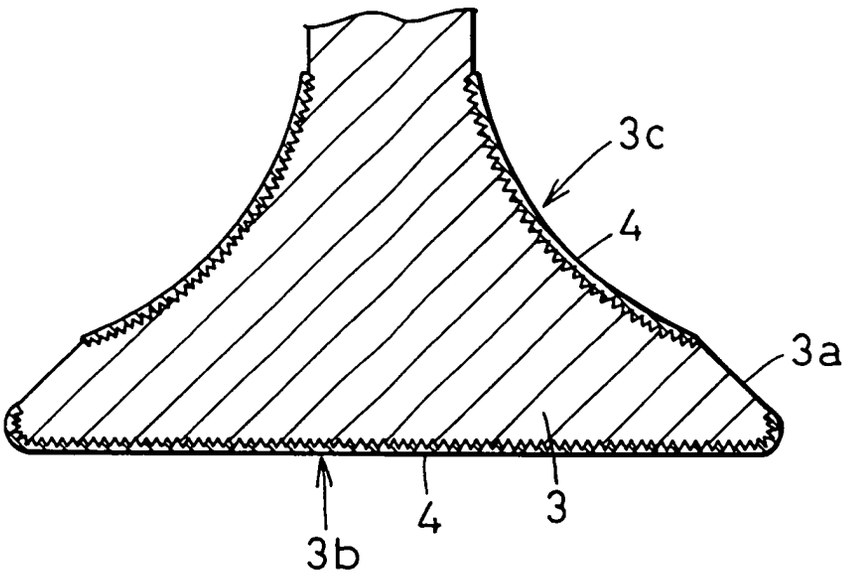

FIG.3

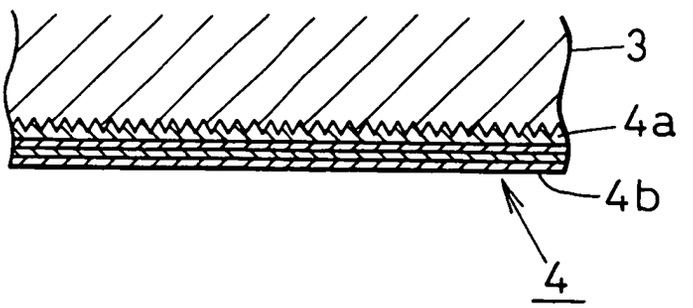

FIG.4

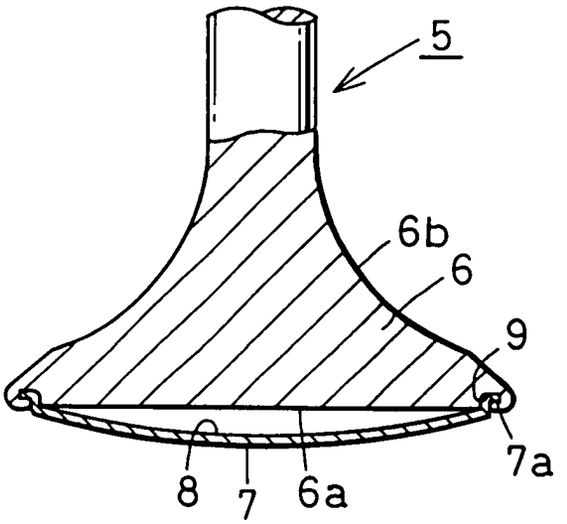

FIG.5

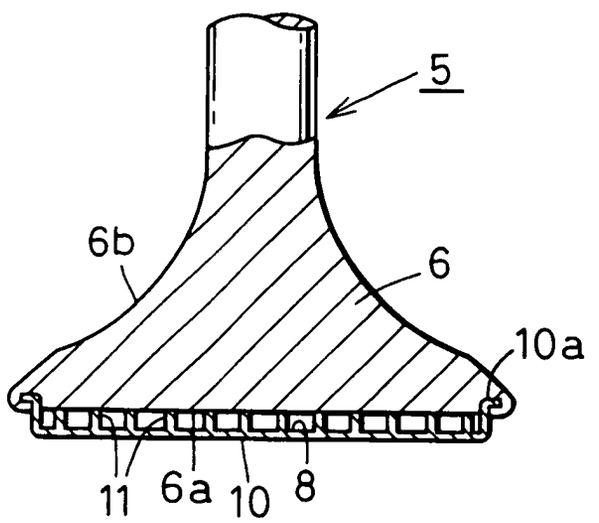

FIG.6