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(71) Applicant: **FUJI OOZX INC.**  
**Fujisawa-shi, Kanagawa-ken (JP)**

(72) Inventors:  
• **Mori, Akiyoshi**  
**Fujisawa-shi, Kanagawa-ken (JP)**

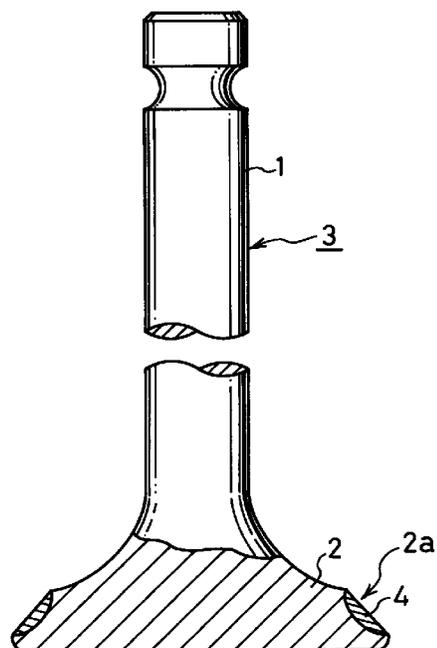
• **Umino, Shinichi**  
**Fujisawa-shi, Kanagawa-ken (JP)**

(74) Representative:  
**Bubb, Antony John Allen et al**  
**GEE & CO.**  
**Chancery House**  
**Chancery Lane**  
**London WC2A 1QU (GB)**

(54) **Poppet valve and method of making it**

(57) A poppet valve (3) comprises a valve stem (1) and a valve head (2) which is made of light metal such as A1 alloy. On a valve face (2a) of the valve head, a hard alloy layer (4) which comprises wear resistance increasing material and the light metal of the valve head is formed to increase wear resistance.

**FIG. 1**



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## Description

### BACKGROUND OF THE INVENTION

The present invention relates to a poppet valve and a method of making it, and particularly, to a poppet valve in which a valve face is hardened to increase wear resistance.

The obstacle to increase in allowable rotation speed of an engine is increase in inertia mass owing to weight of a valve operating system. Especially, if the poppet valve is heavy, movement of the valve element which follows a cam is failed, as rotation speed becomes higher, so that output decrease occurs. Therefore, to lighten the valve element, the whole valve element or valve head is made of light metal such as Al and Ti instead of ordinary heat resistant steel.

However, the above light metal has lower hardness than that of heat resistant steel and is poor in high temperature features. Therefore, in a valve face which is engaged on a valve seat and repeatedly subjected to large impact load, there is a problem in wear resistance, thereby decreasing durability and reliability. To overcome the problem, it is suggested that the valve face is regulated and hardened with heat treatment, or that a hard coated layer is formed on the valve face by surface treatment such as spray coating and plating so as to increase wear resistance.

However, the valve element made of light metal such as Al does not attain hardening by the regulation, and wear resistance required for the valve face is not obtained. In the above heat treatment, hard coated layer is relatively thin, and expected to disappear within a short time. Therefore, it is not practical.

### SUMMARY OF THE INVENTION

In view of the disadvantages, it is an object of the invention to provide a poppet valve and a method of making it, in which a relatively thick surface layer of a valve face is hardened, thereby improving wear resistance in the portion greatly.

According to one aspect of the present invention, there is provided a poppet valve which comprises a valve stem and a valve head, at least the valve head being made of light metal, a hard alloy layer which contains wear resistance increasing material and the light alloy of the valve head being formed on a valve face of the valve head.

The hard alloy layer is formed on the valve face, thereby increasing wear resistance and reliability. The alloy layer is formed only on the valve face, which does not affect lightening of the poppet valve.

According to another aspect of the present invention, there is provided a method of making a poppet valve which comprises a valve stem and a valve head, the method comprising the steps of:

joining wear resistance increasing material onto a valve face of the valve head made of light metal; and

heating the valve face to weld part of the valve face and the wear resistance increasing material to form an alloy layer which contains the light alloy of the valve head and the wear resistance increasing material.

It facilitates hardening to the light metal such as Al, and makes it possible easily to manufacture the poppet valve in which only the valve face is hardened.

### BRIEF DESCRIPTION OF THE DRAWINGS

The features and advantages of the present invention will become more apparent from the detailed description of embodiments with respect to the accompanying drawings wherein:

Fig. 1 is a partially broken away front elevational view of a poppet valve according to the present invention;

Fig. 2 shows the steps for making the poppet valve; Fig. 3 is a vertical sectioned front view of main part to show how to mold a valve element by forging while a ring is embedded in a valve face;

Fig. 4 is a partially broken away front view which powder is held in an annular groove of a valve face; and

Fig. 5 is a partially broken away front view in which powder is held in a plurality of grooves of the valve face.

### DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Fig. 1 illustrates one embodiment of a poppet valve according to the present invention, in which a valve element 3 which comprises a valve stem 1 and a valve head 2 provided at the lower end of the valve stem 1 is made of an alloy of light metal Al or Ti, such as Al-Si or Ti-Al-V.

A tapered valve face 2a in the valve head 2 comprises relatively thick hard alloy layer 4 which is different from the valve element 3 in material, the alloy layer 4 being formed by combining Al or Ti alloy of which the valve element 3 is made, with wear resistance increasing material which comprises any of Ni, Cu, Ti, Ta and Mo (Ti is excluded if the valve element is made of Ti alloy), or an alloy which contains two or more elements thereof. The hard alloy layer 4 is formed on the valve face 2a which is repeatedly subjected to a large load by engagement on a valve seat (not shown), so that wear resistance on the portion is greatly increased, thereby increasing durability and reliability. In addition, the alloy layer 4 is formed only on the valve face 2a, so that increase in weight of the valve element 3 is little. It does

not affect lightening of the valve in weight.

A method of making the poppet valve will be described. Fig. 2 (A) to (D) illustrate how to make the valve.

As shown in Fig. 2(A), on the valve face 2a of the valve head 2 of the valve element 3 made of a light metal, an annular groove 5 is formed. The annular groove 5 is formed by forging or mechanical working after forging. Then, as shown in Fig. 2(B), a ring 6 made of the above wear resistance increasing material is put or attached on the annular groove 5. Then, it transfers to a heating step as shown in Fig. 2(C). Heating means in the step may be preferably a known plasma-arc type powder overlaying device "P", which comprises a rotary drive support 7 which is inclined at 35 degrees and rotated slowly in one direction, and a torch 8 which has a vertical axis above the support 7. The torch 8 has in the middle of the lower end a nozzle for generating plasma arc 9 and a plurality of bores 10 (not shown) for generating an inert shielding gas, such as Ar, around the nozzle.

The valve head 2 of the valve element 3 which held the ring 6 in the previous step is put into a holding ring 7a on the rotation drive support 7 of the device "P". Then, the upper end of the valve stem 1 is pressed by a rotatable workpiece holder (not shown), so that the valve element 3 is rotated in a certain direction by moving the rotation drive support 7. At the same time, the plasma arc 9 is generated by the torch 8 above the ring 6, and the inert shielding gas 10 is injected to heat and weld the ring 6 and the annular groove 5 which locally supports the ring 6. At the same time, the torch 8 may be preferably reciprocated horizontally within a predetermined range. The valve element 3 is rotated once, so that, as shown in Fig. 2 (D), a relatively thick hard alloy layer 4' which differs from the valve element 3 in material is formed on the valve face 2a by combining the valve element 3 with the ring 6. The alloy layer 4' contains intermetallic compound such as Al-Ni, Al-Cu, Al-Ti, Al-Ta and Al-Mo when the material is Al alloy, or such as Ti-Ni, Ti-Cu, Ti-Ta and Ti-Mo when it is Ti alloy. The valve element 3 in Fig. 2(D) is finished to a predetermined form by mechanical processing to the valve face 2a after the step (C).

Fig. 3 illustrates another embodiment in which the ring 6 is held. In the embodiment, after the ring 6 is inserted and put into a die 11 for molding the valve element with forging, material (not shown) is strongly pressed by a punch 12, and the ring 6 is embedded in the valve face 2a by making plastic deformation of the material for molding the valve head 2. Accordingly, the steps for forming the annular groove 5 as shown in Fig. 2 (A) and (B) and the step for holding the ring 6 can be omitted, thereby decreasing the number of steps.

In Fig. 4, the annular groove 5 of the valve element 3 is filled with powder 13 which comprises the foregoing wear resistance increasing material instead of the ring 6 as above. The powder 13 may be ordinary, but may be

preferably compressed powder, taking account of dropping during transportation of the workpieces. When it is made of compressed powder, welding of the powder 13 becomes faster, and heating time becomes shorter.

Thus, especially, it is convenient for the valve element 3 made of Al alloy which has a low melting point.

Fig. 5 illustrates that a plurality of grooves 14 are formed on the valve face 2a, powder 13 being embedded in the grooves 14. In this example, the material is partially exposed. Therefore, it is effectively heated and welded to make an alloy readily.

The present invention is not limited to the foregoing embodiments, but may apply to a stem-welding-type poppet valve in which the upper part from a suitable portion such as a middle portion of the valve stem 1 is made of an ordinary heat resistant steel and the lower part of the valve stem 1 which contains the valve head 2 is made of Al alloy or Ti alloy as above, instead of the valve element 3 totally made of Al alloy or Ti alloy as above.

The valve face 2a has a tapered surface, and therefore, may be heated and welded with the ring 6 which is merely put on the face without forming the annular groove 5. The lower surface of the ring 6 may be flat to join the valve face 2a.

The powder 13 may be held on the valve face 2a with adhesion by a suitable binder without the annular groove 5 or groove 14.

To heat the valve face 2a, high density energy such as laser and electronic beam may be employed instead of plasma arc as above.

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

### Claims

1. A poppet valve which comprises a valve stem and a valve head, at least the valve head being made of light metal, a hard alloy layer which contains wear resistance increasing material and the light alloy of the valve head being formed on a valve face of the valve head.
2. The poppet valve as defined in claim 1 wherein the light metal is Al alloy or Ti alloy.
3. The poppet valve as defined in claim 1 wherein the wear resistance increasing material is Ni, Cu, Ti, Ta, Mo or an alloy made of two or more elements thereof.
4. A method of making a poppet valve which comprises a valve stem and a valve head, the method comprising the steps of:

joining wear resistance increasing material

onto a valve face of the valve head made of light metal; and

heating the valve face to weld part of the valve face and the wear resistance increasing material to form an alloy layer which contains the light alloy of the valve head and the wear resistance increasing material.

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5. The method as defined in claim 4 wherein the light metal is Al alloy or Ti alloy. 10
6. The method as defined in claim 4 wherein the wear resistance increasing material is Ni, Cu, Ti, Ta, Mo or an alloy made of two or more elements thereof. 15
7. The method as defined in claim 4 wherein the wear resistance increasing material is formed like a ring which is joined onto the valve face.
8. The method as defined in claim 4 wherein the wear resistance increasing material is formed as powder or compressed powder which joins the valve face. 20
9. The method as defined in claim 4 wherein the wear resistance increasing material is embedded and held on the valve face. 25
10. The method as defined in claim 4 wherein a groove is formed on the valve face, the wear resistance increasing material being held in the groove. 30
11. The method as defined in claim 4 wherein there are a plurality of grooves in which the wear resistance increasing material is embedded. 35
12. The method as defined in claim 4 wherein high density energy such as laser, plasma arc or electron beam is used to heat the valve face.
13. The method as defined in claim 4 wherein the valve face is heated and welded in an atmosphere of an inert shielding gas. 40

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FIG. 1

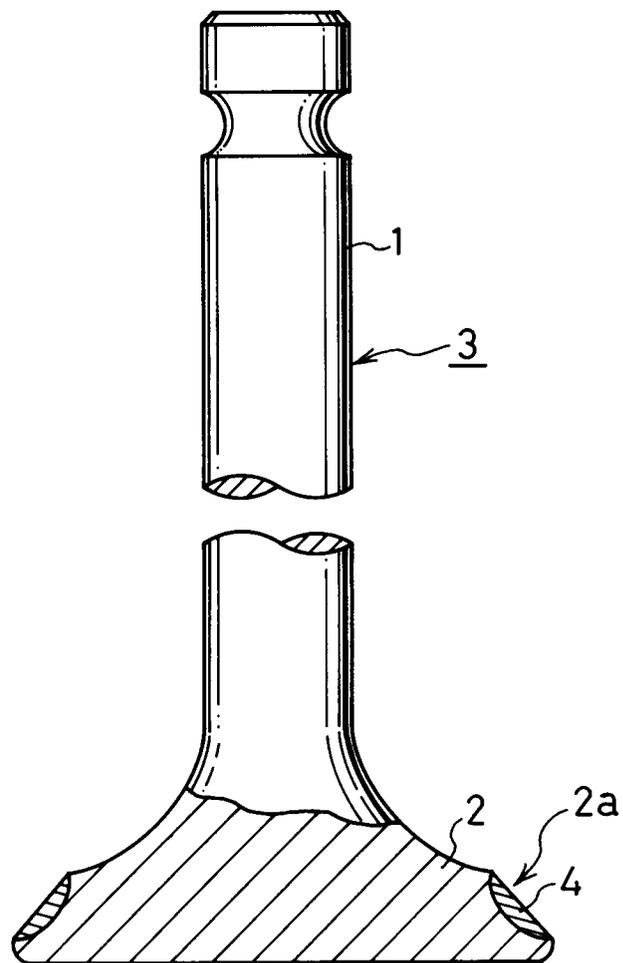


FIG. 2

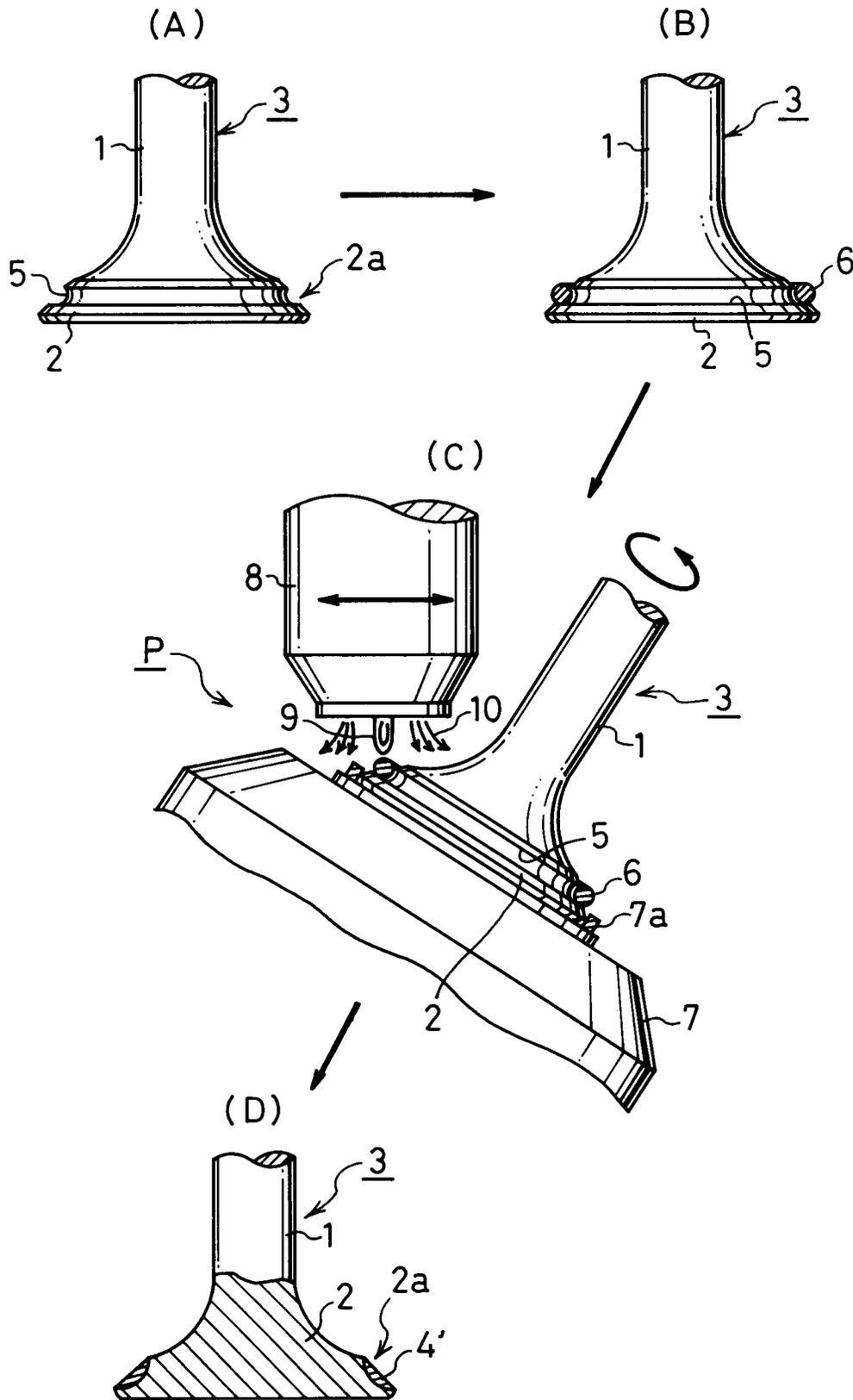


FIG. 3

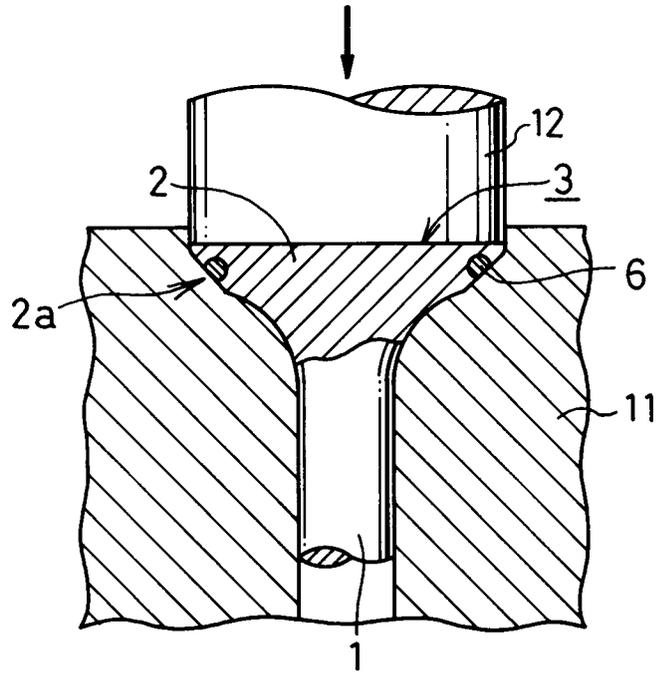


FIG. 4

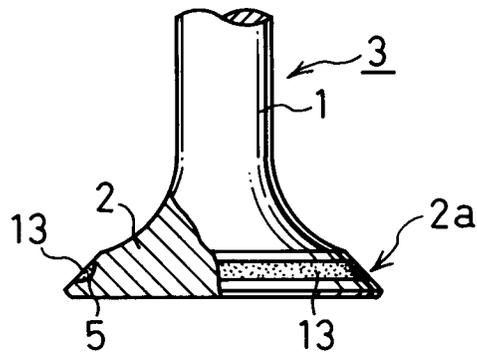
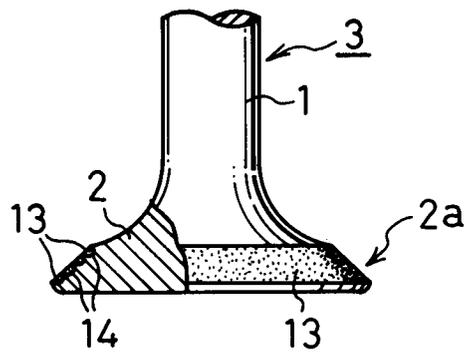


FIG. 5





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EUROPEAN SEARCH REPORT

Application Number  
EP 97 30 0976

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
Y	PATENT ABSTRACTS OF JAPAN vol. 018, no. 563 (M-1693), 27 October 1994 & JP 06 200719 A (HONDA MOTOR CO LTD), 19 July 1994, * abstract *	1-6	F01L3/02 F01L3/04
Y	--- EP 0 543 353 A (SUMITOMO LIGHT METAL IND) 26 May 1993 * column 4, line 20 - line 29 * * column 5, line 5 - line 13 * * figures 1-4 *	1-6	
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The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 13 June 1997	Examiner Lefebvre, L
CATEGORY OF CITED DOCUMENTS 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		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 ..... & : member of the same patent family, corresponding document	

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EUROPEAN SEARCH REPORT

Application Number  
EP 97 30 0976

DOCUMENTS CONSIDERED TO BE RELEVANT		
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
A	CH 465 323 C (BAYERISCHES LEICHTMETALLWERK GRAF BLÜCHER) * figure 2 *  -----	7
		CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
		TECHNICAL FIELDS SEARCHED (Int.Cl.6)
The present search report has been drawn up for all claims		
Place of search	Date of completion of the search	Examiner
THE HAGUE	13 June 1997	Lefebvre, L
<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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