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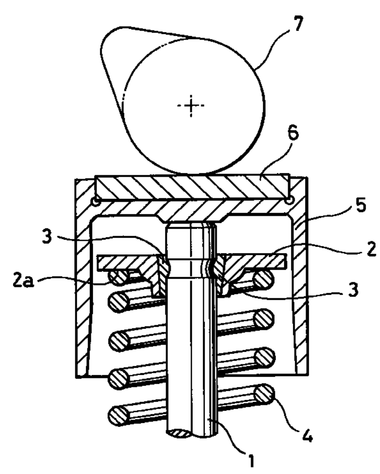
(54) Composite shim for use in internal combustion engine

(57) There is provided a structure of a shim (6) to be inserted in a clearance provided between a cam (7) and a tappet (5) in a moving valve (1) mechanism of an internal combustion engine, which comprises a matrix of aluminium alloy and at least one member selected from particles, whiskers and fibers, and made from SiC, SiN or/and CrC, in an amount ranging from 3 volume percent to 25 volume percent.

FIG. 1



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Description

Field of the Invention

The present invention relates to a new composite for use in a valve clearance adjusting shim to be provided and to be inserted directly between a valve tappet and a cam for an overhead valve engine with a camshaft placed in an internal combustion engine. Particularly, it relates to a composite shim comprising aluminum alloy, and ceramic material.

Description of the Prior Art

FIG. 1 shows schematically a cross section of a cam-valve tappet movement mechanism comprising an engine valve 1, a spring retainer 2, mounted on a shaft end of the engine valve 1 through cotters 3 and 3 and a valve spring 4 provided between a cylinder (not shown) and the spring retainer 2.

The engine valve 1 reciprocates by a rotation of a cam 7 to press on a top surface of a shim 6 mounted in a tappet 5.

In the moving valve mechanism, a cam 7 mounted on a camshaft (not shown) is rotated in a very high rate, and pushes the valve 1 through the shim 6 and a tappet 5, so as to open and close acutely periodically the valve 1 to comply the timing of the valve with the revolution rate of the engine. Therefore, much shock and concentrated force must be loaded periodically and repeatedly on the contact surface of the shim 6 with which the cam 7 is in contact.

In the moving valve mechanism of direct type, reduction of weight of the moving mechanism is highly requested so as to improve an allowance revolution number of the engine. There is an approach to replace steel with aluminum alloy for use in the tappet 5, so as to improve the lightweight of the engine.

Practically, the shim 6 mounted on the upper surface of the tappet 5 is highly loaded by the cam 7, and further exposed to strong abrasion by reciprocating movement, and then, a hard and abrasion-resistance metal material e.g. chromium molybdenum steel may be used for manufacture of the shim.

A reinforced aluminum alloy might be used as a material for a lightweighted tappet shim, but it does not satisfy the requirement on abrasion resistance and toughness of the shim.

Further, there is found a limit for reducing the weight of the moving mechanism, and then, it will be an obstacle for increasing an allowance revolution number of the engine.

Further, when it needs surface treatment process and/or plating process so as to improve the allowance revolution number of the engine using a tappet shim, and then, the cost of manufacturing will be increased.

Japanese Patent Laid-open application No. 60-183207/1985 proposed use of sintered steel for the valve shim to improve strength against the shock from the tappet rod motion.

Japanese Patent Laid-open application No. 3-83307/1991 proposed an internal hollow(s) or concaved hollow provided within the shim to reduce its weight.

Summary of the Invention

It is an object of the present invention to provide a tappet shim having light weight without reduction of both higher mechanical strength and higher abrasion strength of the shim, to improve the allowance revolution number of the engine.

It is the other object of the present invention to provide the tappet shim with lighter weight and lower cost, so as to expand the choice of the clearance adjustment shim.

The further object of the present invention will be understood from the below description.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows schematically a cross section of a cam-valve tappet movement mechanism using the shim of the present invention.

FIG. 2 shows a process of manufacturing the tappet shim in accordance with the present invention.

Detailed Description of Preferred Embodiments

In accordance with the present invention, the shim comprises a matrix of aluminum alloy and at least one member selected from particles, whiskers and fibers, and made from SiC, SiN or CrC, in an amount ranging from 3 volume percent to 25 volume percent. Further, when the particles are used, a size of the particles of SiC, SiN or CrC should be less than 5 micrometer. In addition, when the whiskers or/and fibers are used, a size of the whiskers or/and fibers of SiC, SiN or CrC should range from 10 to 100 micrometer.

Aluminum alloy to be used as a matrix for a tappet shim in accordance with the present invention can be reinforced by dispersing finely divided ceramic particles, whiskers or fibers in the matrix alloy phase, so as to obtain high shock resistance and high abrasion resistance.

As an aluminum alloy to be used as a matrix alloy in accordance with the present invention, aluminum alloy having a 2000 order in JIS standard for aluminum alloy is preferable. Further, especially duralumin series alloy may be preferable. Aluminum alloy containing copper, manganese and/or magnesium may be preferable as a matrix alloy to be used in accordance with the present invention.

Finely divided particles, whiskers and/or fibers of at least one selected from the group consisting of SiC, SiN and CrC are dispersed in the alloy matrix in an amount of preferably 3 volume % to 25 volume % so as to prepare a material for use in the shim of the present invention. If the amount is less than 3 volume %, the abrasion resistance of the shim may be not enough. If the amount is more than 25 volume %, the shim will be brittle or fragile, and further may be difficult to be machined. The more preferable amount is 17 volume % to 25 volume %.

The size of finely divided SiC, SiN or CrC particles is preferably less than 5 micrometer. If the size is beyond 5 micrometer, the machining properties of the shim will be lost.

The length of the whiskers or fibers of SiC, SiN or CrC is preferably 10 micrometer to 100 micrometer. The whiskers having this range length are easily available, and easily used and treated.

The starting aluminum alloy to be used in accordance with the present invention should be selected in view of the characteristics of the sintering matrix containing ceramic particles, whiskers or/and fibers.

The tappet shim of the present invention is manufactured as follows:

After desired starting material of aluminum alloy powder is prepared, both powders; aluminum alloy powder and desired ceramic particles or/and whiskers or/and fibers are mixed with desired ratio. The aluminum alloy powder to used as a matrix is mixed with a ceramic powder (or/and whiskers or/and fibers) of desired ceramic material selected from SiC, SiN and CrC in the ratio ranging less than 25 volume %, and homogeneously agitated and mould into a desired form of moulding. Then, the moulding is fired so as to sinter thereby producing porous material of the present invention.

The resulting porous material is treated to degas and then, extruded as shown in FIG. 2 thereby eliminating pores in the material. The resulting material will have higher density as improved by extrusion The resulting material is machined into a desired bar, which will be cut into the desired plate for use in the shim of the present invention.

Therefore, the tappet shim of the present invention comprises aluminum alloy for a matrix, and ceramic finely divided particles or/and whiskers or/and fibers contained therein, which is for use in a shim for an internal engine.

Alternatively, the resulting mixture of aluminum alloy powder and ceramic particles or whiskers or/and fibers may be pressed to form a desired shape. Further, hot isostatic pressing (HIP), hot isostatic pressure sintering, pseudo HIP, injection moulding can be used in the manufacture of the shim by sintering of the product. Sintering in ambient atmosphere can be carried out in a continuous furnace with feeding a protective gas (inert gas such as nitrogen gas) by preheating to vaporize or to decompose a lublicating agent, and then heating so as to make sintering of the composite.

The ceramic material to be used as a starting material for the product of the present invention may include silicon nitride(SiN), silicon carbide(SiC), and chromium carbide (CrC).

The mixture comprising the desired powder components may be prepared, and then, the portion thereof may be put in a cavity of a mould for compression formation. Then, it may be pressed under the certain pressure for premoulding, and thereafter, the remaining mixture may be put in the remain cavity of the mould, and may be pressed additionally under the pressure.

The present invention is further illustrated by the following examples to show the structure of the shim in accordance with the present invention, but should not be interpreted for the limitation of the invention.

<u>EXAMPLE</u>

Aluminium alloy corresponding to JIS 2024 is used as a matrix aluminum alloy. The JIS 2024 aluminum alloy power and SiC powder were mixed and agitated uniformly. Then, the two species of bars comprising the aluminum alloy matrix and SiC particles respectively in the amounts of 17 volume percent and 25 volume percent dispersed therein were prepared and machined. Further, two species of samples were tested for engine application.

After the engine incorporating the tappet shim of the present invention was operated for 100 hours, the amounts of abraded in the upper and bottom surface of the shim were measured. Further, the conventional shim was exposed to the same engine test, as a reference.

The result of the tests is that the abrasion amounts of the ceramic incorporated aluminum alloy shim of the present invention was 4 to 9 micrometer per 100 hours, while the abrasion amounts of the conventional steel shim was 5 to 8 micrometer. It is evident that the shim of the present invention is competitive.

FIG. 2 illustrates a process of manufacturing a tappet shim comprising aluminum alloy and finely divided ceramics incorporated therein. The ceramics incorporated aluminum alloy as sintered 11 was exerted on an extruding machine 12 to extrude into a bar 13. The resulting bar 13 was cut as shown in FIG. 2 (B) into each blank 14. The blank 14 is machined into a finished shim. Pores or porosity 15 in the sintered material 11 were pressed and then, mostly eliminated so that the relative density is improved from relative density of about 80 % to relative density of about 90 %.

The shim of the present invention may be relatively uncostly and easy to be manufactured.

It is apparent that the shim structure of the present invention can be manufactured without reduction of high strength and high abrasion durability even with lighter weight.

The shim of the present invention can be manufactured relatively uncostly. Then, the allowance revolution number of the engine using this shim can be improved.

Claims

1. A tappet shim to be inserted in a clearance provided between a cam and a tappet in a moving

valve mechanism of an internal combustion engine, which comprises a matrix of aluminum alloy and at least one member selected from particles, whiskers and fibers, and made from SiC, SiN or/and CrC, in an amount ranging from 3 volume percent to 25 volume percent.

2. The shim in accordance with claim 1, wherein when the particles are used, a size of the particles is less than 5 micrometer.

3. The shim in accordance with claim 1, wherein when the whiskers or/and fibers are used, a size of the whiskers or/and fibers ranges from 10 to 100 micrometer.

FIG. 1

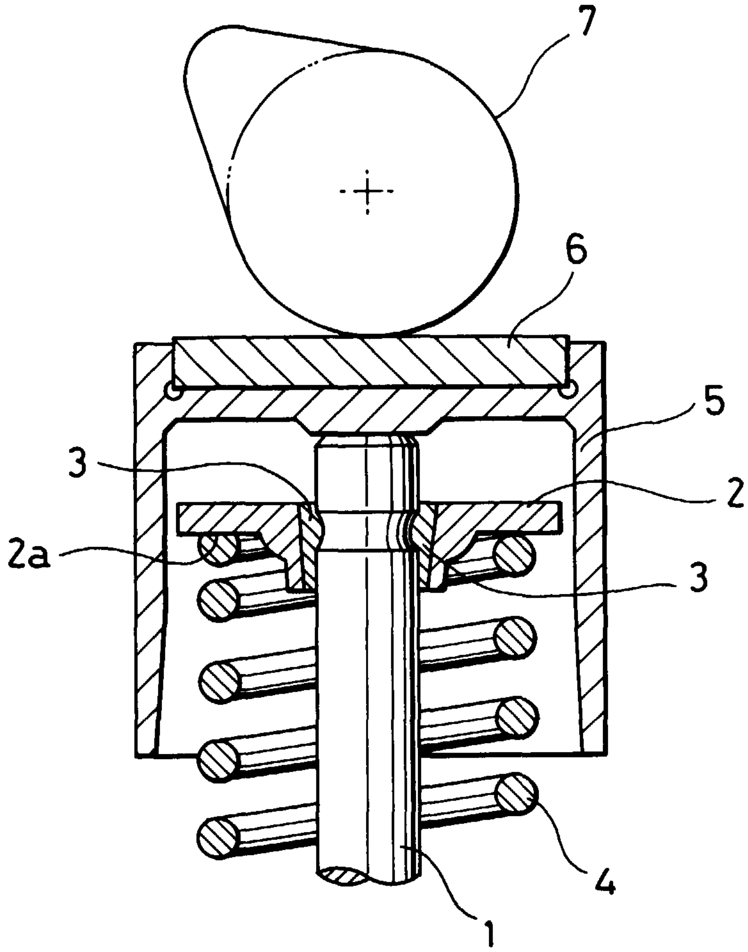


FIG. 2A

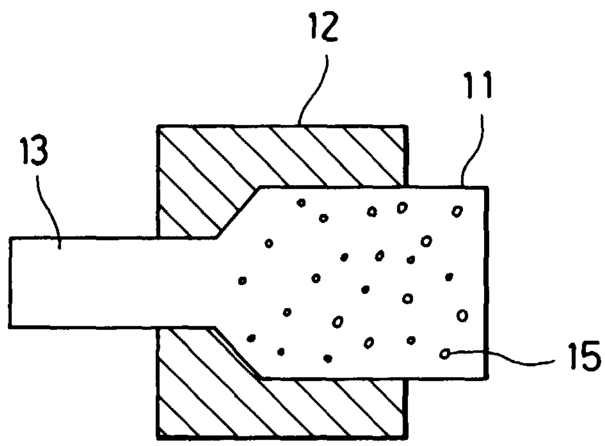
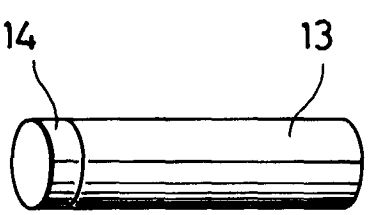


FIG. 2B



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EUROPEAN SEARCH REPORT

Application Number
EP 95 30 9155

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)
Y	PATENT ABSTRACTS OF JAPAN vol. 006, no. 260 (M-180), 18 December 1982 & JP-A-57 153912 (TOYO KOGYO KK), 22 September 1982, * abstract *	1	F01L1/20 F01L1/16
Y	METALLURGICAL TRANSACTIONS A. PHYSICAL METALLURGY AND MATERIALS SCIENCE, vol. 23A, no. 10, 1 October 1992, pages 2833-2847, XP000356340 MANISH ROY ET AL: "THE EFFECT OF PARTICULATE REINFORCEMENT ON THE SLIDING WEAR BEHAVIOR OF ALUMINUM MATRIX COMPOSITES" * page 2833, paragraph 1 * * page 2835; table 1 *	1	
A		2	
Y	JOURNAL OF THE CERAMIC SOCIETY OF JAPAN, INTERNATIONAL EDITION, vol. 100, no. 4, 1 April 1992, pages 498-501, XP000294748 MAMORU MABUCHI ET AL: "SUPERPLASTIC BEHAVIOR IN A HIGH STRAIN RATE RANGE OF 6061 ALUMINIUM COMPOSITES REINFORCED WITH SI3N4 WHISKERS OR PARTICULATES" * page 498, paragraph 1 - paragraph 2 *	1	TECHNICAL FIELDS SEARCHED (Int.Cl.6)
A		3	F01L F02F C22C
A	PATENT ABSTRACTS OF JAPAN vol. 013, no. 376 (M-862), 21 August 1989 & JP-A-01 130008 (OTAI IRON WORKS CO LTD;OTHERS: 01), 23 May 1989, * abstract *	1	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	20 May 1996	Lefebvre, L

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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