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(54) **CYLINDER HEAD**

ZYLINDERKOPF

CULASSE

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US-B1- 6 399 176

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Description

[0001] The invention relates to a cylinder head of a reciprocating engine.

[0002] The trends to reduce fuel consumption and emissions in reciprocating engines have placed increased demands on the performance of many components. One way to reduce fuel consumption and emissions is to increase the engine compression ratio. However, this increase in cylinder pressure typically results in increased bending of the cylinder head and the motion between the mating surfaces of the cylinder head and cylinder block. Consequently, the cylinder pressure may escape from the cylinder combustion space to the engine cooling system where the pressure pulses can cause damage to the coolant pump and other components of the cooling system.

[0003] Document FR 2 826 598 A1 discloses a method for manufacturing a cylinder head of an internal combustion engine. Molten metal is poured into a mould containing porous insert with the mould located in a sealed chamber with a pressure above atmospheric and the insert connected to a low-pressure source. The pressure on the mould and the molten metal can be produced by a gas from a source linked to the chamber.

[0004] DE 101 35 358 A1 discloses production of a component made from a metal-ceramic composite material comprises inserting a ceramic crude material into a mould insert arranged outside of a casting tool, pressing into a pressed mould, inserting into a casting tool, infiltrating the preform with liquid casting material under elevated pressure, and removing the component. The component can be a cylinder head of an internal combustion engine.

[0005] In WO 2008/059329 A1 an open-deck cylinder block which is cast with a cylinder liner incorporated therein, a MMC sleeve that is made from a metal matrix composite is closely fitted on the outer periphery of the cylinder liner and the outer periphery of the MMC sleeve faces a water jacket, at a deck-face portion of the cylinder block. Thus, a layer made only from an aluminum alloy is not present in the deck-face portion, whereby the strength of the deck-face portion is enhanced. Also, the strength of the entire cylinder bore portion is enhanced by fitting the MMC sleeve on the entire outer periphery of the cylinder liner. Thus, it is possible to provide an open-deck cylinder block having an enhanced strength at its upper-end portion of the cylinder block, and a method for producing such cylinder block.

[0006] DE 101 21 928 A1 describes production of locally reinforced light metal parts comprises placing a porous reinforcing element made from a sintered ceramic with a sponge-like structure on the site to be reinforced in a die casting mould; and infiltrating with a melt.

[0007] FR 2 831 086 A1 discloses casting of metal components including a part formed by a core, incorporates a core fabrication stage in which: the core is produced by moulding a mixture of 96 - 98 % of foundry sand and 4 - 2 % of a resin containing at least 50 % of acrylic copolymer and a peroxide hardener; the core is hardened by contact with a gas containing 90 - 95 % of CO2 and 10 - 5 % of SO2; the core is then placed in a casting mould and the liquid metal is cast into the mould at a pressure of at least 35 MPa.

[0008] US 6 399 176 discloses a composite wear component produced by casting and consisting of a metal matrix whose working face or faces include inserts which have a very high wear resistance. The inserts consist of a ceramic pad, this ceramic pad consisting of a homogeneous solid solution of 20 to 80% of Al_2O_3 and 80 to 20% of ZrO_2, the percentages being expressed by weights of the constituents, and the pad then being impregnated with a liquid metal during the casting.

[0009] The object of the present invention is to improve the stiffness of the cylinder head.

[0010] The object is achieved as is disclosed in the independent claim. A member made of ceramic foam is inserted into a cylinder head mould, molten cylinder head base material is poured into the mould, the mould and pores of the member are filled with the molten cylinder head base material, and the molten cylinder head base material is solidified in the mould and in the pores of the member.

[0011] A member made of ceramic foam is arranged in the cylinder head. Pores of the member are filled with cylinder head base material.

[0012] Significant benefits can be achieved. When the cylinder head base material solidifies in the pores of the member, an iron-ceramic composite structure is formed in the member, which increases the stiffness of the cylinder head. This, in turn, reduces the bending of the cylinder head and problems resulting from it. Further, the cylinder head according to the invention can be manufactured easily and cost-effectively.

[0013] In the following the invention is described in more detail, by way of an example, with reference to the accompanying drawings, in which

Fig. 1 shows an embodiment of the cylinder head according to the invention, viewed from the side of a fire plate.

Fig. 2 shows the cylinder head of fig. 1 as a side view.

[0014] The drawings show a cylinder head 1 of a large reciprocating engine, which can be used as a main or auxiliary engine of a ship or in power plant for the production of heat and/or electricity. The engine is a medium speed, four-stroke engine. The rotational speed of the engine is 300-1200 rpm. The cylinder bore of the engine is typically 20-80 cm.

[0015] Each cylinder is provided with a separate cylinder head 1. The cylinder head 1 comprises bores 2 for fastening screws, by means of which the cylinder head 1 can be fastened to the cylinder block of the engine. Additionally, the cylinder head 1 comprises at least one

inlet port 3 for combustion air and at least one outlet port 4 for exhaust gas. In the embodiment shown in the drawings the cylinder head 1 is provided with two inlet ports 3 and two outlet ports 4. Each port has a valve seat 5 surrounding the port opening. The cylinder head 1 comprises a fire plate 6. The fire plate 6 is a region on the cylinder head, which delimits the combustion space of the cylinder. Base material of the cylinder head 1 is cast iron, typically ductile cast iron.

[0016] To improve the stiffness, a member 7 made of ceramic foam is arranged in the cylinder head 1. The member 7 is made of open cell ceramic foam. The foam material can be any suitable ceramic carbide or oxide compound such as silicon carbide (SiC), alumina, zirconium oxide (ZrO), zirconium carbide (ZrC) or combinations thereof. The member 7 comprises pores, which are filled with the cylinder head base material.

[0017] The member 7 is arranged at a fire plate 6 region of the cylinder head. A layer 8 of cylinder head base material is provided between the fire plate 6 surface and the member 7. The thickness of the layer 8 depends on the dimensions, especially the thickness, of the cylinder head. Typically the thickness of the layer 8 is at least 1 cm. The member 7 extends over the entire fire plate 6 region or only part of the fire plate 6 region.

[0018] Open porosity of the member 7 is 0.3 - 0.7. Open porosity refers to the ratio of volume in which fluid flow is effectively taking place (this excludes dead-end pores or non-connected cavities) to the total volume of porous material. The size of the open pores is 1 mm to 10 mm.

[0019] The cylinder head 1 can be manufactured as follows. The member 7 made of ceramic foam is inserted into the cylinder head mould at a desired location. The member 7 can be supported to the walls of the mould. Mould cores are also inserted into the mould at desired locations. Prefabricated valve seat rings can be placed in the mould. When necessary, the mould can be preheated before casting. Thereafter, molten cylinder head base material is poured into the cylinder head mould. The mould and open pores of the member 7 are filled with the molten cylinder head material. The cylinder head base material solidifies in the mould and in the pores of the member 7. As a result, an iron-ceramic composite structure is formed in the member 7. The mould is removed from around the solidified cylinder head. Thereafter, mould cores are removed from the cylinder head in a conventional manner. Finally, the cylinder head is finished by machining.

Claims

1. A cylinder head (1) of a reciprocating engine, wherein a member (7) made of ceramic foam is arranged in the cylinder head (1) and pores of the member (7) are filled with cylinder head base material, **characterized in that** the member (7) is arranged at a fire plate (6) region of the cylinder head, and that a layer (8) of cylinder head base material is provided between the fire plate (6) surface and the member (7).

2. The cylinder head according to claim 1, **characterized in that** the member (7) extends over the entire fire plate (6) region.

3. The cylinder head (1) according to any preceding claim, **characterized in that** the member (7) is made of silicon carbide (SiC), alumina, zirconium oxide (ZrO), zirconium carbide (ZrC) or combinations thereof.

4. The cylinder head (1) according to any preceding claim, **characterized in that** the base material of the cylinder head (1) is cast iron.

5. The cylinder head (1) according to claim 1, **characterized in that** the thickness of the layer (8) is at least 1 cm.

Patentansprüche

1. Zylinderkopf (1) eines Kolbenmotors, wobei ein Element (7), das aus Keramikschaum besteht, in dem Zylinderkopf (1) angeordnet ist,
und Poren des Elements (7) mit dem Zylinderkopf-Basismaterial gefüllt sind, **dadurch gekennzeichnet, dass** das Element (7) an einem Abschnitt der Feuerplatte (6) des Zylinderkopfs angeordnet ist, und dass zwischen der Oberfläche der Feuerplatte (6) und dem Element (7) eine Schicht (8) aus dem Zylinderkopf-Basismaterial bereitgestellt ist.

2. Zylinderkopf nach Anspruch 1, **dadurch gekennzeichnet, dass** sich das Element (7) über den gesamten Bereich der Feuerplatte (6) erstreckt.

3. Zylinderkopf (1) nach einem vorhergehenden Anspruch, **dadurch gekennzeichnet, dass** das Element (7) aus Siliziumkarbid (SiC), Alumina, Zirconiumoxid (ZrO), Zirconiumkarbid (ZrC) oder Kombinationen davon besteht.

4. Zylinderkopf (1) nach einem vorhergehenden Anspruch, **dadurch gekennzeichnet, dass** das Basismaterial des Zylinderkopfs (1) Gusseisen ist.

5. Zylinderkopf (1) nach Anspruch 1, **dadurch gekennzeichnet, dass** die Dicke der Schicht (8) wenigstens 1 cm beträgt.

Revendications

1. Culasse (1) d'un moteur alternatif, dans lequel un élément (7) fait en mousse céramique est agencé

dans la culasse (1) et des pores de l'élément (7) sont remplis d'un matériau de base de la culasse, **caractérisée en ce que** l'élément (7) est agencé sur une zone de plaque pare-feu (6) de la culasse, et qu'une couche (8) du matériau de base de la culasse est prévue entre la surface de la plaque pare-feu (6) et l'élément (7).

2. Culasse selon la revendication 1, **caractérisée en ce que** l'élément (7) s'étend au-dessus de la totalité de la zone de plaque pare-feu (6).

3. Culasse (1) selon l'une quelconque des revendications précédentes, **caractérisée en ce que** l'élément (7) est en carbure de silicone (SiC), alumine, oxyde de zirconium (ZrO), carbure de zirconium (ZrC) ou des combinaisons de ceux-ci.

4. Culasse (1) selon l'une quelconque des revendications précédentes, **caractérisée en ce que** le matériau de base de la culasse (1) est en fonte.

5. Culasse (1) selon la revendication 1, **caractérisée en ce que** l'épaisseur de la couche (8) est d'au moins 1 cm.

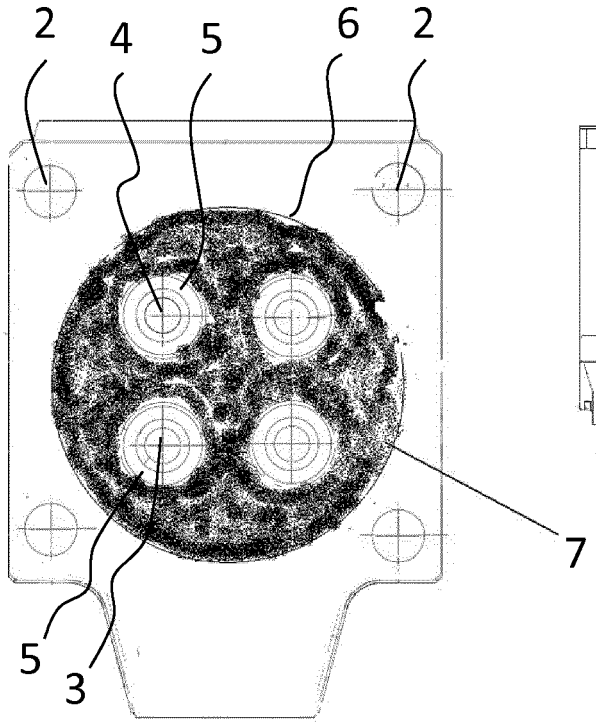

Fig. 1

1

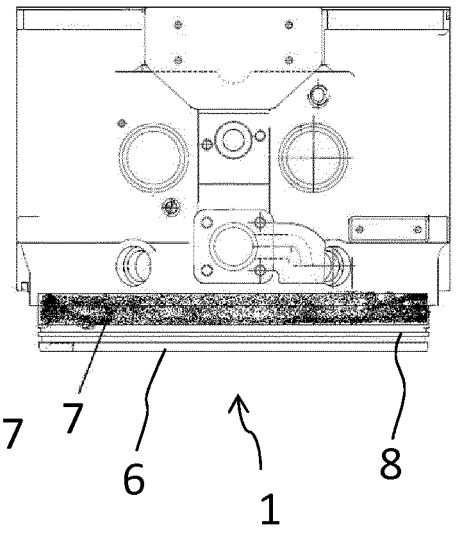

Fig. 2

REFERENCES CITED IN THE DESCRIPTION

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