



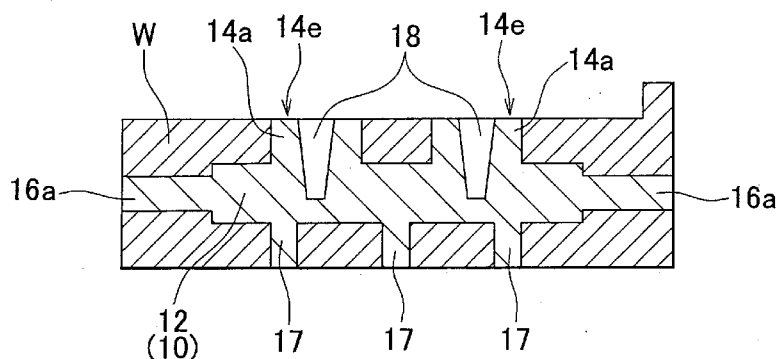
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FIG. 3



(S7) Abstract: A core 10 is used for casting a cylinder head W with a water jacket. The core 30 is provided with a heat transfer hole 18 in an upper surface 14e of an upper cylindrical section as a non-cavity surface. The heat transfer hole 18 extends toward a center of the core 10. The core 10 is produced by packing a material that is a mixture of sand and resin in a mold and baking the material. The mold is provided with a protruding section that forms the heat transfer hole 18.

CASTING CORE AND PRODUCTION METHOD OF THE CASTING CORE

BACKGROUND OF THE INVENTION

5 1. Field of the Invention

[0001] The present invention relates to a core that is used for casting.

2. Description of Related Art

[0002] In the case of producing a casting in a complex shape, particularly a casting that has a space inside, a mold set for defining an outer shape of the casting and also another mold set for defining an interior space of the casting which is separate from the mold set for defining the outer shape of the casting may be used. The mold set for defining the outer shape of the casting typically includes a drag, a cope, and a cheek. Some mold sets can define the shape of a cavity with only the drag and the cope, and some mold sets can define the cavity with the cope, the drag, and plural cheeks. Herein, assembling the mold set to define an enclosed space of the cavity is referred to as “closing a mold.”

[0003] The mold for defining the interior space of the casting is called a core. The mold set referred in this specification include the core. Also, in this specification, a part of the core (end) is referred to as a core print, and a part other than core prints is referred to as a casting shape forming part. The “core print” is a term that is used in casting engineers. The core print is a core end that does not contribute to the shape forming of the castings, and its upper and lower parts are held by the other parts. The core print is most commonly held by the cope and the drag, or the drag and the cheek. The “casting shape forming part” is a part of the core except for the core prints, namely, a part that contributes to the shape forming of the castings. In addition, a surface of the mold that defines the cavity when the mold is closed is referred to as a cavity surface, and a surface other than the cavity surface is referred to as a non-cavity surface. The casting shape forming part of the core corresponds to a part that has the cavity surface. In

addition, the typical “non-cavity surface” is a surface that contacts with a surface of the other mold when the mold set is closed, and a surface of the core print.

[0004] In the casting such as aluminum die casting, the core is produced by baking a mixture of sand and resin. The resin serves as a binder to harden the sand.

5 Such the material is called resin coated sand.

[0005] After casting, the core is removed as follows. First, the casting is removed from the mold, together with the core. Then, an impact is given to the casting, and the core is broken up. Blocks of sand that is broken and grained are discharged from a hole that is provided at the time of casting. A machine that gives the impact to the casting is called a knockout machine. In addition, the hole that is provided in the casting may be a hole that is formed into the shape of the casting in some cases or may be a hole that is provided in order to discharge sand blocks in the other cases. In the latter case, the hole is closed after removal of the sand blocks. A method of breaking a core is disclosed in Japanese Patent Application Publication No. 9-239521, for example. In addition, methods of discharging the sand blocks of the core after breaking are disclosed in Japanese Patent Application Publication No. 61-009961 and No. 3-297552, for example.

[0006] When the breaking of the core is insufficient, large sand blocks remain in the mold, and therefore such the sand blocks may be difficult to be discharged from the casting. However, applying an excessively strong impact to the casting affects precision of the casting, and thus avoided preferably.

[0007] Here, the principle of how large sand blocks remain in the mold is described. Although the core is made by mixing sand with resin to be baked, materials gradually harden as heat is applied, but conversely soften by further application of heat. FIG. 5 is a chart that schematically shows the change of an amount of heat which is applied per unit mass of the material of the core versus the hardness of the material. The core is produced through a baking process, and the material of the core is baked so as to be in a hardening region at the baking. The core is also heated by molten metal in the casting processes, and the state transition occurs from the hardening region to a

breakdown region in this time. The core in which the state reaches to the breakdown region may easily collapse. However, when the size of the core itself increases, the inside of the core is insufficiently baked in the baking process. That is to say, the state in the vicinity of the surface of the core achieves the hardening region; however, the state of the inside of the core may remain in the non-hardening region. In other words, the inside of the core remains in a so-called unbaked state. If the casting is produced with such the core, the state in the vicinity of the surface of the core is shifted to the breakdown region by the heat of the molten metal, but the state of the inside of the core remains in the hardening region. Accordingly, the inside of the core becomes rigid after the casting processes. Thus, the inside of the core is hardly broken, and therefore large sand blocks remains inside the core when the core is broken with the knockout machine.

SUMMARY OF THE INVENTION

[0008] An object of the present invention is to provide a core in which large sand blocks hardly remain at the time of breaking.

[0009] A first aspect of the present invention relates to a casting core. The casting core is formed by baking sand and includes a hole in a non-cavity surface other than a cavity surface that defines a shape of a casting object. The non-cavity surface does not define the shape of the casting object.

[0010] The hole that is formed in the non-cavity surface is hereinafter referred to as a heat transfer hole. This hole is referred to as the "heat transfer hole" because heat in the baking is transferred to the inside of the core through the hole. Although the core is produced by packing a mixture of resin and sand in a mold and baking the mixture, the core is baked with the mold that is provided with a protruding section which forms the heat transfer hole. In a baking process, the protruding section in the mold is subjected to high temperature, and therefore the inside of the core is well heated through the heat transfer hole. That is to say, an evenly heated core can be formed. In other words, the strength of the core in the cavity surface becomes approximately the same as

the strength of the core in an inner periphery of the hole. Because a state of the inside of such the core evenly reaches to a breakdown region after the casting, large sand blocks hardly remain at the time of breaking. Furthermore, the heat transfer hole secures a space inside the core as a result, and therefore an advantage is obtained such that large sand blocks hardly remain physically.

[0011] The heat transfer hole may extend from the non-cavity surface toward a center of the core.

[0012] The strength of the core in the cavity surface may be the same as the strength of the core in an inner periphery of the hole.

[0013] A second aspect of the present invention relates to a casting. The casting is produced by using the casting core that is described above. The core of such the casting can be easily removed, and therefore the core can be produced at reduced cost.

[0014] A third aspect of the present invention relates to a production method of the casting core. The production method of the casting core is such that the casting core is formed with a mold that is provided with a protruding section which forms the hole in the core according to the first aspect of the present invention.

[0015] A fourth aspect of the present invention relates to a production method of the casting core. The production method includes: using a mold that is provided with a protruding section which forms a hole of a non-cavity surface other than a cavity surface that defines a shape of a casting object; and packing a mixture of sand and resin in the mold.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] Features, advantages, and technical and industrial significance of exemplary embodiments of the invention will be described below with reference to the accompanying drawings, in which like numerals denote like elements, and wherein:

FIG. 1 is a schematic perspective view of a core according to the embodiment of the present invention;

FIG. 2 is a perspective view of a casting that is produced by using the core;

FIG. 3 is a cross-sectional view of the casting (including the core);

FIG. 4 is a cross-sectional view of a mold for baking the core; and

FIG. 5 is a schematic chart that shows a relation between an amount of heat which is
5 applied to a material of the core and hardness of the material.

DETAILED DESCRIPTION OF EMBODIMENTS

[0017] FIG. 1 shows a perspective view of a core 10 according to an
embodiment of the present invention. The core 10 is used in casting of a cylinder head
10 of an engine. FIG. 2 shows a schematic view of a cylinder head W that is casted by
using the core 10. It is noted that FIG. 1 and FIG. 2 schematically show shapes of the
core 10 and the cylinder head W for the purpose of illustration only, and those shapes are
inaccurately illustrated. The cylinder head W has a bore hole 14b and a space 20 for a
water jacket. The core 10 is used to form the bore hole and the space for the water
15 jacket around the bore.

[0018] A core body 12 of the core 10 is a casting shape forming part that forms
the space 20 for the water jacket. An upper cylindrical section 14a of the core 10 is a
casting shape forming part that forms the bore hole 14b of the cylinder head W. A
cylindrical section (connecting section 16a) that is denoted as a reference numeral 16a in
20 FIG. 1 is a part that connects the core body 12 to the core print. Here, the core print is
not shown in the drawing. A cylindrical hole 16b in the cylinder head W, which
corresponds to the connecting section 16a, is a part that is not necessary for an objective
shape of the casting but that is necessary for supporting the core 10 on the inside of a
casting mold. The cylindrical hole 16b is closed in a later process. It is apparent in
25 comparison between FIG. 1 and FIG. 2 that the surface of the core body 12 and a
periphery (outer periphery) of the upper cylindrical section 14a define an interior space
of the cylinder head W. That is, the surface of the core body 12 and the periphery of the
upper cylindrical section 14a correspond to a cavity surface, and surfaces other than the
former correspond to non-cavity surfaces. As shown in FIG. 1, an upper surface 14e of

the upper cylindrical section 14a as a non-cavity surface is formed with a heat transfer hole 18. The non-cavity surface does not contribute to define a shape of a casing object. In the other words, when the mold set is closed, the non-cavity surface does not face inner circumference surfaces of the mold set which define the cavity surface. The non-cavity surface faces outside of the mold set through a hole formed in the mold set. In addition, although hidden and not shown in FIG. 1, a protruding section that forms a sand discharging hole is formed in a lower surface of the core 10.

[0019] FIG. 3 shows a cross-sectional view that is taken along a line III-III of FIG. 2. The cross-sectional view of FIG. 3 shows a cross section of the cylinder head W that includes the core 10. As shown in FIG. 3, the core 10 is formed with the heat transfer hole 18 that extends from the upper surface 14e of the upper cylindrical section 14a toward a center of the core 10. A reference numeral 17 denotes a protruding section 17 where a discharging hole for discharging the sand blocks of broken core 10 is provided. The discharging hole is also closed after the casting of the cylinder head.

[0020] FIG. 4 is a cross-sectional view of a mold set 30 for baking the core 10. The mold set 30 includes a cope 32 and a drag 34. When the cope 32 and the drag 34 are closed, a cavity space CV as a closed section that has the same shape as that of the core 10 is formed. The cope 32 has a protruding section 32a that forms the heat transfer hole 18 of the core 10.

[0021] The core 10 is made through packing the mixture of the sand and resin in the mold set 30 and then heating (baking) the mixture. In a baking process, the mold set 30 (cope 32 and drag 34) is heated almost evenly. That is, the temperature of the protruding section 32a becomes approximately the same as that of the other parts in the mold. Therefore, the surface of the core and an inner periphery of the heat transfer hole 18 are subjected to approximately the same temperatures. As a result, the core is heated evenly to the inside, and the surface and the inside of the core achieve approximately the same hardness. When the cylinder head W is casted by using such the core 10, the core 10 is evenly heated again. The surface and the inside of the core 10 are also reheated evenly, and thus the state of the whole core 10 reaches the breakdown region.

[0022] In addition, as apparent from FIG. 3, a space that extends to the center of the core is formed by the heat transfer hole 18, and the space causes the core to break easily. After the cylinder head W is casted by using the core 10, when an impact is applied to the cylinder head with the knockout machine (not shown), the core 10 is
5 evenly broken into fine blocks. Fine sand blocks can be easily removed from a sand discharging hole or the bore hole 14b.

[0023] As described above, according to the technique that is disclosed herein, when the heat transfer hole 18 is provided to the core 10, the core 10 that has a constant hardness even in its inside can be realized. Such the core 10 can be easily removed
10 from the castings because large sand blocks hardly remain at the time of breaking.

[0024] While the present invention has been described in detail with reference to example embodiments thereof, it is to be understood that those examples are merely illustrative and claims of the present invention are not limited to those examples. Techniques that are disclosed in the claims of the present invention are intended to cover
15 various modifications and equivalent arrangements of the example embodiments that are described above. In addition, the technical elements that are disclosed in the specification and the drawings exhibit technical usefulness alone or in various combinations and configurations, and those are not limited to the combinations and configurations that are disclosed in the claims at the time of filing. The techniques that
20 are illustrated in the specification and the drawings can achieve a plurality of objects simultaneously, and the achievement of one object thereof itself has technical usefulness.

CLAIMS:

1. A casting core that is formed by baking sand, comprising a cavity surface which defines a shape of a casting object; and a non-cavity surface which does not define the shape of the casting object, and on which a hole is formed.
2. The casting core according to claim 1, wherein the hole extends from the non-cavity surface toward a center of the core.
3. The casting core according to claim 1 or 2, wherein the strength of the core in the cavity surface is the same as the strength of the core in an inner periphery of the hole.
4. A casting that is produced by using the casting core according to any one of claims 1 through 3.
5. A production method of the casting core according to any one of claims 1 through 3 wherein the casting core is formed with a mold that is provided with a protruding section which forms the hole.
6. A production method of the casting core, comprising:
using a mold that is provided with a protruding section which forms a hole of a non-cavity surface other than a cavity surface that defines a shape of a casting object; and
packing a mixture of sand and resin in the mold.

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FIG. 1

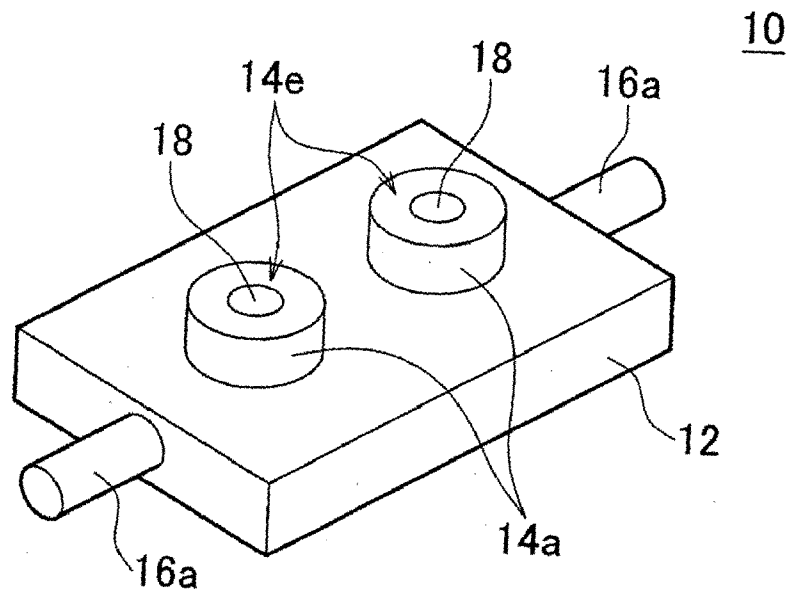


FIG. 2

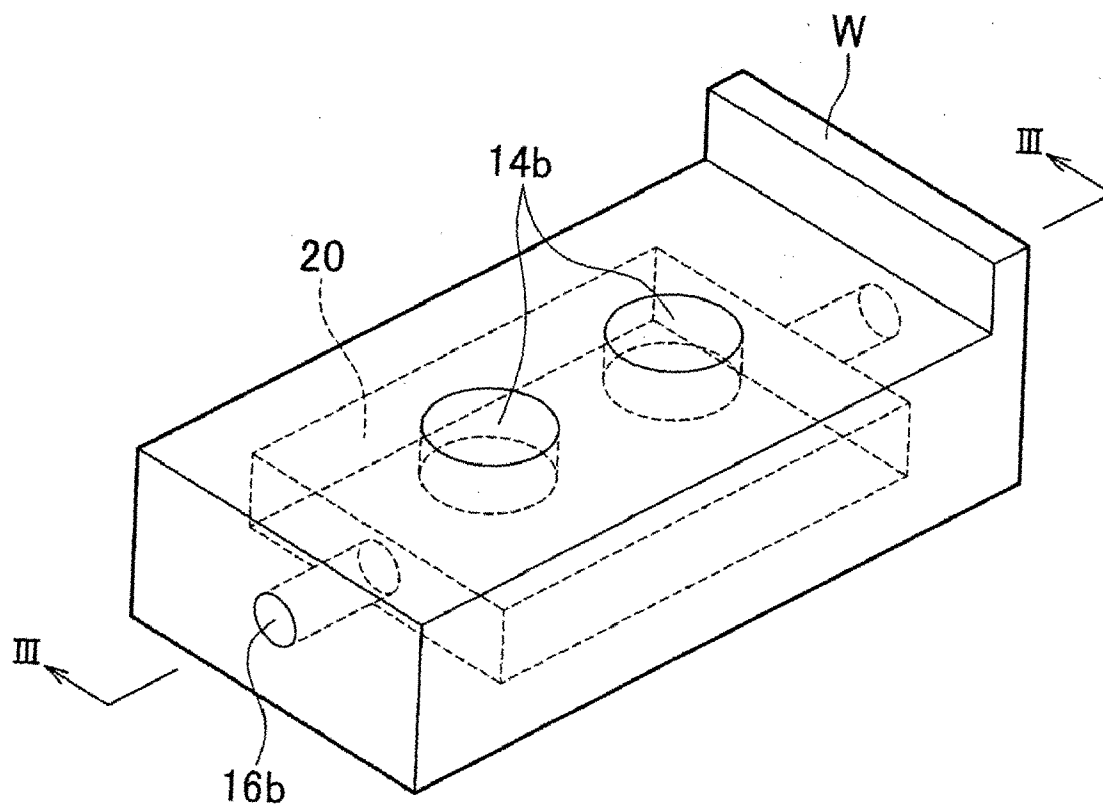
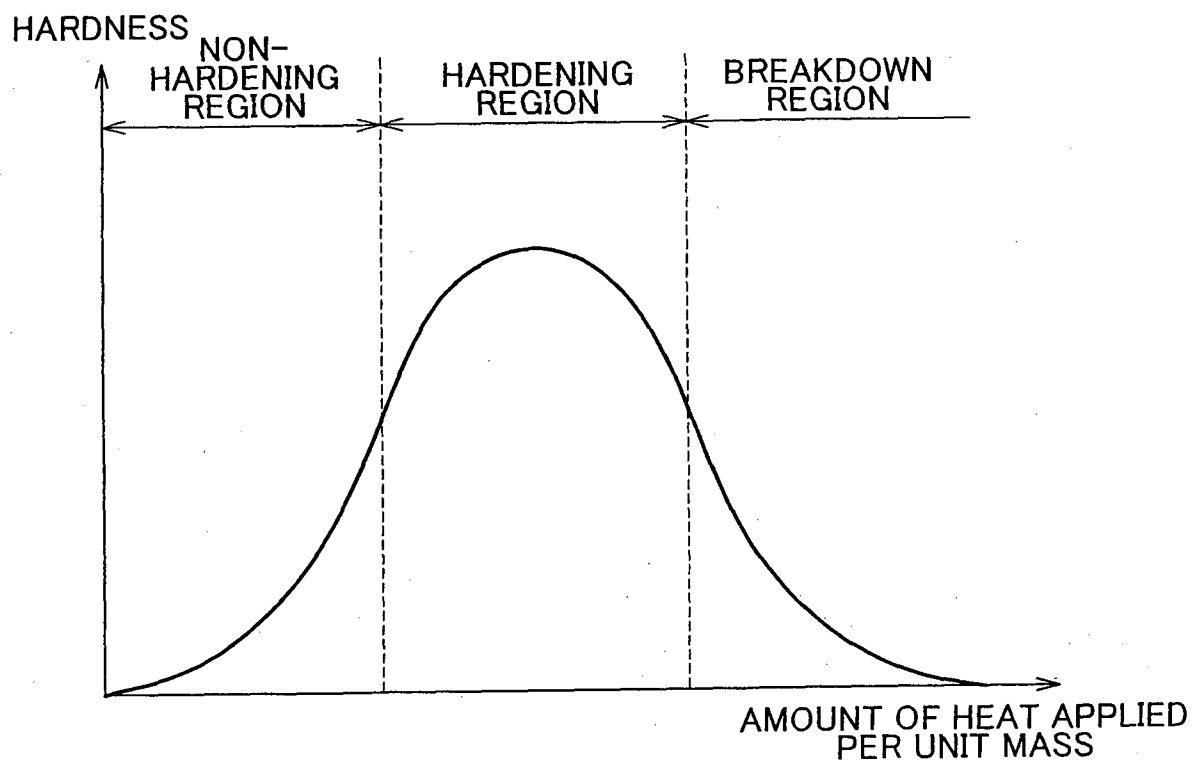


FIG. 5



INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2012/000840

A. CLASSIFICATION OF SUBJECT MATTER

INV. B22C7/06 B22C9/10 B22C9/12
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B22C B22D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EP0-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2002/185242 A1 (NEWCOMB THOMAS P [US] ET AL) 12 December 2002 (2002-12-12) paragraph [0031]; figures 1-5 -----	1-6
X	US 3 264 693 A (FLITZ JOHN L) 9 August 1966 (1966-08-09) the whole document -----	1-6
X	JP 59 107748 A (SINTOKOGIO LTD) 22 June 1984 (1984-06-22) abstract; figures 1-3 -----	1-6

☐

Further documents are listed in the continuation of Box C.

☒

See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2002185242 A1	12-12-2002	CA 2381104 A1 DE 10225654 A1 JP 3676759 B2 JP 2003053482 A MX PA02004624 A US 2002185242 A1	11-12-2002 19-12-2002 27-07-2005 26-02-2003 17-12-2002 12-12-2002
US 3264693 A	09-08-1966	GB 1019730 A US 3264693 A	09-02-1966 09-08-1966
JP 59107748 A	22-06-1984	NONE	