METHOD OF MAKING A HIGH-STRENGTH HEAT-INSULATING CASTING

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ABSTRACT

A method of producing a high-strength heat-insulating casting consisting of a flexible ceramic molded liner product onto which a metallic article has been cast from molten metal, after which said liner has been impregnated with a heat-resistant binder.

5 Claims, 2 Drawing Figures
METHOD OF MAKING A HIGH-STRENGTH HEAT-INSULATING CASTING

BACKGROUND OF THE INVENTION

In the conventional heat-insulating casting which is used as a part of an automotive exhaust system, the ceramic part which is directly exposed to the fast-flowing exhaust gas at an extremely high temperature of 900°C-1000°C is occasionally broken into pieces and flies apart.

A flexible ceramic material whose particles are loosely bonded is especially liable to fly apart and unable to stand long hours of service.

When an exhaust gas recirculator (EGR) is installed to reduce the nitrogen oxides, which constitute one of the harmful auto emissions, the flying ceramic particles are carried with the mixture of gas into the combustion chamber and are likely to cause various problems such as damage to the cylinder bore or injury to the metal parts if the particles become mixed with the lubricating oil.

SUMMARY OF THE INVENTION

The high-strength heat-insulating casting according to the present invention, when used in an automotive exhaust system, serves to keep the exhaust gas hot, thereby reburning it and consequently reducing the harmful auto emissions.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a sectional view taken through a cylinder head made of a high-strength heat-insulating casting as described in Example 1 of the present invention; and FIG. 2 is a sectional view taken through a large-capacity manifold made from a high-strength heat-insulating casting as described in Example 2 of the present invention.

In the drawings, reference numeral 1 indicates the port liner, and reference numerals 2 and 3 indicate ceramic pipes.

DETAILED DESCRIPTION OF THE INVENTION

The present invention relates to a high-strength heat-insulating casting consisting of a flexible ceramic molded liner onto which a metallic article has been cast from molten metal, after which the liner is impregnated with a heat-resistant binder. Heat-resistant binders suitable for this purpose include: sodium silicate, colloidal silica, primary aluminum phosphate, ethyl silicate, etc.

A recommended flexible ceramic suitable for this purpose is a refractory aggregate of alumina, silica, corindierite or magnesia which has been mixed with an adequate amount of alumina cement and then fired to an extent such that the aggregate particles are not perfectly sintered together.

The molten metal may be gray cast iron, spherical graphite cast iron, an aluminum alloy or cast steel, but any casting metal will do.

Examples in which the bending strength is improved through an appropriate selection of the ceramic and the heat-resistant binder with which to impregnate the ceramic are illustrated in Table 1. The bending strength was measured as follows:

Specimens of ceramic materials, 7mm thick × 20mm wide, after having been impregnated with a heat-resistant binder and then heated for two hours at 500°C, 2 were tested for their bending strength 64

<table>
<thead>
<tr>
<th>Ceramic</th>
<th>Bending strength (kg/cm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Molten silica</td>
</tr>
<tr>
<td></td>
<td>(porosity 30%)</td>
</tr>
<tr>
<td>Heat-resistant binder</td>
<td>20</td>
</tr>
<tr>
<td>Sodium silicate</td>
<td>150</td>
</tr>
<tr>
<td>Colloidal silica</td>
<td>70</td>
</tr>
<tr>
<td>Primary aluminum</td>
<td>100</td>
</tr>
<tr>
<td>phosphate</td>
<td></td>
</tr>
<tr>
<td>Ethyl silicate</td>
<td></td>
</tr>
</tbody>
</table>

In manufacturing the heat-resistant casting it is important to avoid using a heat-resistant binder during the molding of the ceramic and to avoid impregnating the ceramic molded product with a heat-resistant binder before casting it in a molten metal. If this precaution is not taken, the ceramic will have such a high modulus of elasticity or bending strength that it may be broken by the compressive force generated when the metal casting is formed against it and consequently the desired heat-insulating casting will not be produced.

Various methods for casting a half-finished flexible ceramic in a molten metal and then impregnating it with a heat-resistant binder are available such as a brush; a sprayer; immersion in a solution of the binder; impregnation in a vacuum; or pressurized impregnation. Selection should be made on the basis of the porosity of the ceramic and the viscosity of the heat-resistant binder. Depending on the type of heat-resistant binder, the impregnation may be followed by heating at an adequate temperature; the optimum temperature should be selected after considering the type of molten metal as well.

For the purpose of specific illustration, two examples of methods of manufacturing the improved casting are given below.

EXAMPLE 1

This example relates to the use of the high-strength heat-insulating casting according to the present invention as the material for the port liner of an aluminum alloy cylinder head in a 1600 cc four-cylinder gasoline engine. A sectional view of the cylinder head is shown in FIG. 1. A ceramic port liner 1 (wall thickness 4mm), as shown in the figure, was impregnated with sodium silicate as the heat-resistant binder. This port liner 1 had been manufactured by adding 22 parts of water to 100 parts of a mixture of 25 parts of alumina aggregate (maximum grain size 2.5mm) and 25 parts of alumina cement (parts are invariably parts by weight) and casting a slurry obtained by stirring these constituents.

This ceramic port liner was set in a casting mold to produce a cylinder head by low pressure casting. After casting, the core sands in the exhaust port were removed and then 100 parts by volume of sodium silicate JIS No. 3 added with 30 parts of water was applied to the port liner with a brush. This silicate JIS No. 3 consists of 28-30% of SiO₂, 9-10% of Na₂O and the balance of water, its viscosity being over 40 at 15°C by means of a Baume hydrometer. After perfect penetration of the sodium silicate, the liner was heated for three hours at 200°C.
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The cylinder head thus produced was assembled into an automobile, which was subjected to an endurance test for 400 hours at 600 rpm under full load without developing any defects.

After casting the cylinder head, heavy vibrations were produced by an air hammer to remove the core sand from the water jacket, but no defects developed. In the case of a conventional cylinder head such heavy vibrations occasionally break the ceramic.

EXAMPLE 2

In this example the high-strength heat-insulating casting according to the present invention is used in a large-capacity manifold in a 2000 cc six-cylinder gasoline engine.

A sectional view of said manifold is shown in FIG. 2, the ceramic pipes 2 and 3 of which (having a wall thickness of 5 mm) were impregnated with colloidal silica as the heat-insulating binder. These pipes 2 and 3 were produced by adding 18 parts of water to 100 parts of a mixture containing 80 parts of molten silica aggregate (maximum grain size 1.5 mm) and 20 parts of alumina cement and casting the slurry obtained by stirring them together.

These pipes were set in a casting mold, into which a molten gray cast iron (equivalent to ASTM A 48-64 No. 30A) was poured to cast a manifold. After casting, the casting sands were completely removed and then the product was immersed for 30 minutes in a solution of colloidal silica (silica concentration: 20%).

Following the immersion, the product was dried and heated for 12 hours at 500°C. The large-capacity manifold thus produced was installed in an engine, which was subjected to 100 hours of cold-hot cycle testing (one cycle being 10 minutes of running at an exhaust gas temperature of 950°C, immediately followed by 5 minutes of running at an exhaust gas temperature of 150°C), but no undesirable effects resulted.

What is claimed is:

1. Method of manufacturing a high-strength, heat-insulating casting which comprises the steps of:
   molding a flexible porous ceramic liner from a mixture of a refractory material and alumina cement, which mixture is substantially free from any heat-resistant binder,
   casting an article which is to carry said liner by forming molten metal against said liner, and
   impregnating said liner with a heat resistant binder after completion of said casting step.

2. Method as claimed in claim 1 in which said refractory material is selected from the group consisting of alumina, silica, cordierite and magnesia.

3. Method as claimed in claim 1 in which said heat resistant binder is selected from the group consisting of sodium silicate, colloidal silica, primary aluminum phosphate and ethyl silicate.

4. Method as claimed in claim 1 in which said metal is selected from the group consisting of gray cast iron, spherical graphite cast iron, aluminum alloys, and cast steel.

5. Method as claimed in claim 1 in which said flexible ceramic molding is fired before said article is cast thereon to an extent insufficient to completely sinter said refractory material and cement together, and leaving said molding in a flexible, somewhat porous form.