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(54) **Shell or tubular object and method to manufacture the same.**

(57) A shell or tubular object, particularly having a complicated configuration, said object having an internal surface layer of a thermally sprayed, high temperature and corrosion resistant metal alloy and being intended to be incorporated in a machine or the like, especially in a combustion engine. When manufacturing the object, a relatively thin and essentially pore-free layer (2) is first sprayed onto a core body (1). Then, the core body (1) consisting of e.g. molding sand, is removed, whereupon a second layer (3) is sprayed onto the external surface of the first layer. The second layer (3) may have a substantially greater thickness without any risk for crack formation. The first, thinner layer (2) forms the internal surface layer of the object.

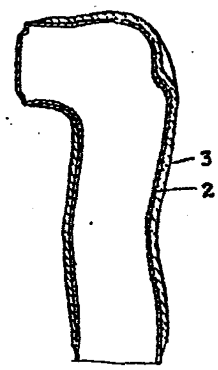

FIG 3

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SHELL OR TUBULAR OBJECT AND METHOD TO MANUFACTURE THE SAME

The invention relates to a shell or tubular object, especially having a complicated configuration, and a method to manufacture the same.

The background of the invention is a desire to make it possible to operate internal combustion engines at a higher working temperature, whereby an increased efficiency and a more complete combustion can be achieved. Thus, it is a well-known problem to accomplish temperature and corrosion resistance of the materials, especially in combustion chambers and exhaust channels, in case the working temperature is to be raised above what is normal in today's engines.

In fact, ceramic materials are high-temperature and corrosion resistant, but it is complicated and expensive to combine ceramics with other, metallic construction materials, such as iron and nickel alloys. Tensions are caused by different temperature coefficients. Certain ceramics will also be subjected to phase transformations in temperature intervals within or very close to the working temperatures in question. Moreover, the subsequent treatment, e.g. the boring of holes, becomes more difficult, if ceramics are used.

Furthermore, experiments have been made to coat especially exposed motor parts with plates or surface layers of some kind of heat and corrosion resistant metal alloy, e.g. of a FeCrAl-type, which however causes problems in case inside cavities, in particular of a complicated geometry, are to be coated.

It has also been suggested to manufacture tubular surface bodies, which have been thermally sprayed in advance, with a remaining mandrel or core. In using this known method, however, only very simple, especially cylindrical or conical tube forms can be used, since it must be possible to take out the mandrel or core after molding.

Furthermore, the published Swedish Patent Application SE-A-8300603-1 discloses a method of manufacturing a machine part, including a heat insulated inlet gas channel, by thermally spraying a very thin first layer, having a thickness of 0.1-0.2 mm, of a soft metal material, such as zinc, tin, lead, copper or aluminium, onto a sand core. A second layer, having a thickness of 0.5-2.5 mm, of a metal material, such as carbon steel, is thermally sprayed onto the first layer, and thereafter a third layer, serving as a heat barrier and consisting of a ceramic material is applied, e.g. by thermal spraying. Then, the sand core with the three layers applied thereon is placed in a mold for molding the machine part in a conventional manner. Upon molding, the sand core is removed, so that the three layers form an internal surface of a channel in the machine part.

However, in this known method, there might be a risk of cracking when thermally spraying the various layers having different expansion characteristics. Furthermore, the innermost layer, forming the internal surface layer of the machine part, is not corrosion resistant and is not suitable e.g. for exhaust channels. Also, the melting point of the soft metal material is far too low to permit the use in an exhaust channel of a combustion engine. Thus, a typical temperature of the exhaust gases is about 850°C, whereas the melting point of Zn is about 420°C.

The object of the invention is to eliminate the disadvantages and restrictions of the known methods and to enable a simple manufacture of shell or tubular objects, even with a complicated geometry, by thermal spraying of a heat and corrosion resistant metal alloy so as to form a relatively thick, first surface layer and a second layer serving as a heat barrier, without any risk of cracking during the spraying process. A further object is to enable the molding of such an object into a molded body having one or several channels or cavities constituted by the molded shell or tubular object according to the invention.

The main object is achieved in that the first layer consists of a high temperature and corrosion resistant alloy with a thickness of 0.5-1.5 mm and in that the second layer likewise consists of a high temperature and corrosion resistant metal alloy, which contains more oxides and/or pores than the first layer and thereby serves as a heat barrier, the second layer being sprayed onto the first layer upon removal of the core body, whereby cracking is avoided.

Other suitable features are stated in the appended claims 2 - 9.

Thus, when manufacturing such an object it is essential that the core body, onto which a first layer is sprayed, will be removed before additional material is applied by spraying. It is particularly suitable to make the core body of molding sand which can loose its form stability and be discharged from the tube or shell, e.g. upon heating. Without risk of cracking due to tensions, which would unavoidably arise if the core body were to remain, continuous spraying may thereafter be effected up to a desired thickness.

The thermal spraying of the second layer should be controlled in such a way that the second layer contains more oxides and/or pores than the first layer, whereby the desired qualities, especially a lower thermal conductivity, are obtained in the second layer. Naturally, it is also possible to apply a third layer, either between the two other layers or as a separate layer sprayed onto the second layer. Preferably, such a relatively thin third layer may e.g. be used as a diffusion barrier for carbon or nickel. Also, it can be used to increase the mechanical qualities at higher temperatures.

The invention will be explained further below with reference to the appended drawings illustrating an embodiment.

Fig. 1 shows schematically a sand core;

Fig. 2 shows said sand core with a first layer sprayed thereupon;

Fig. 3 shows the dessired tubular object after removing the sand core and spraying a relatively thick second layer onto the first layer.

Thus, in a way known per se, a core body 1 is made of molding sand and a phenol resin as a binding agent. As shown in Fig. 1, the core body 1 has an external configuration corresponding to the desired internal configuration of the tubular object and, in addition thereto, holding portions 1a, 1b at each end for holding the core body. In the embodiment, the desired object comprises an exhaust channel in a cylinder head of a combustion engine.

In accordance with Fig. 2, a relatively thin and essentially pore-free layer 2 of a metal alloy containing about 5% Al, 22% Cr and the rest mainly Fe (the contents are by weight) is sprayed onto the core body 1. Porosity, if any, must consist of closed pores. When the layer thickness is at least 0,5 mm, preferably about 1 mm, the spraying operation is interrupted, whereupon the sand core 1 is removed in that the sand core and the layer sprayed thereon is heated in a furnace at about 600°C for 2-3 hours, and thereafter the sand is discharged from the tubular metal alloy layer 2.

Thereafter, a second layer 3 is sprayed onto the first, self-supporting layer 2. In absence of a core body, the first layer is permitted to expand and shrink freely due to variations of temperature, without any risk of tensions and accompanying cracking. The thickness of the second layer may be at least 1 mm. The spraying process can be performed without interruption for cooling.

Different methods of spraying are possible. Preferably, the first, relatively thin layer 2 is sprayed by means of a wire-fed flame sprayer so as to form a dense layer. In case a surface layer of great purity is desired (small quantities of oxides and pores), the layer may be applied by plasma spraying. The second layer 3 may preferably be applied by means of a powder-fed flame sprayer in order to obtain a suitable quantity of pores and oxides. In this case, a quantity of 5-25%, preferably about 15%, pores and oxides is desired.

However, the second layer 3 does not have to be of the same material composition as the first layer 2, but may e.g. consist of another metal alloy of high heat resistance.

With regard to the heat tensions which may appear in the material, it is certainly an advantage if the layer consists of the same material and differs only in porosity and oxide contents. Moreover, a thin third layer may be applied either between or on top of the two above-mentioned layers. The third layer may i.a. function as an adhesive layer or diffusion barrier.

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The object and the manufacturing method according to the invention have several advantages. The geometric shape as well as the materials and the thickness thereof can be chosen at will. Thus, very thick layers (the second layer 3) may be applied after the removal of the core body. Moreover, the manufacturing method is relatively quick (metal can be sprayed onto a red hot substrate) and the handling rather simple. The cassation is very low because of the eliminated risk of cracking. Even the subsequent operations, e.g. molding, are facilitated and can therefore be performed with great accuracy. Moreover, by avoiding ceramic materials, the recircling of scrap is made easier.

C L A I M S

1. A shell or tubular object, especially having a complicated configuration, said object being intended to be incorporated in a machine or the like, particularly in a combustion engine, and comprising a first, internal, layer (2) of a metal alloy thermally sprayed onto a core body (1) and a second, thicker layer consisting of a metal alloy thermally sprayed onto the external surface of said first layer, c h a r a c t e r i z e d in that said first layer (2) consists of a high temperature and corrosion resistant alloy with a thickness of 0.5 - 1.5 mm and in that said second layer (3) likewise consists of a high temperature and corrosion resistant metal alloy, which contains more oxides and/or pores than the first layer (2) and thereby serves as a heat barrier, said second layer (3) being sprayed onto the first layer (2) upon removal of said core body (1), whereby cracking is avoided.

2. An object according to claim 1, c h a r a c t e r i z e d in that the second layer (3) has essentially the same material composition as the first layer (2).

3. An object according to claim 1 or 2, c h a r a c - - t e r i z e d in that the porosity of the first layer (2) consists of closed pores, whereas the porosity and oxide contents of the second layer (3) exceeds 10%.

4. An object according to anyone of claims 1-3, c h a r a c- t e r i z e d in that at least the first layer (2) consists of 1-12% Al, 10-30% Cr, possibly small quantities of one or several elements in the group Si, Mn, Co, Y, Hf, possibly small quantities of oxides and nitrides and the rest Fe.

5. An object according to anyone of claims 1-4, c h a - r a c t e r i z e d in that the thickness of said second layer (3) is greater than 1 mm, preferably about 2,5 mm.

6. An object according to anyone of the preceding claims, c h a r a c t e r i z e d by a third layer between or on top of the two other layers and substantially thinner than said other layers.

7. A method to manufacture a shell or tubular object according to anyone of the preceding claims, said object being manufactured by thermal spraying of a high temperature and corrosioin resistant metal alloy, c h a r a c t e - r i z e d in that a first, relatively thin and essentially porefree layer (2) is formed by thermal spraying onto a core body (11), the external dimensions of which correspond to the internal dimensions of the finished object, whereupon the core body (1) is removed and a second, relatively thick layer (3) is applied by thermal spraying onto the external surface of the first layer (2), so that the internal surface of said finished object is constituted by the first layer (2).

8. A method according to claim 7, c h a r a c t e r i z e d in that the core body (1) is made of molding sand.

9. A method according to claim 7 or 8 c h a r a c t e- r i z e d in that the thermal spraying is controlled in such a way that said second layer (3) contains more oxides and/or pores than the first layer (2).

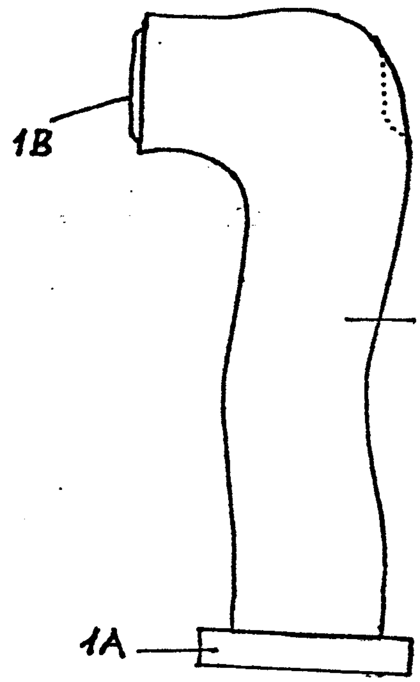

FIG 1

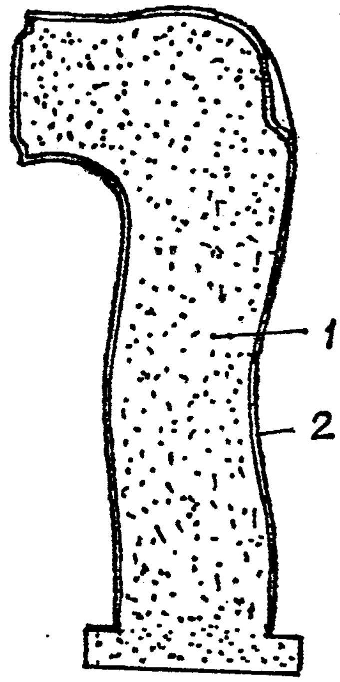

FIG 2

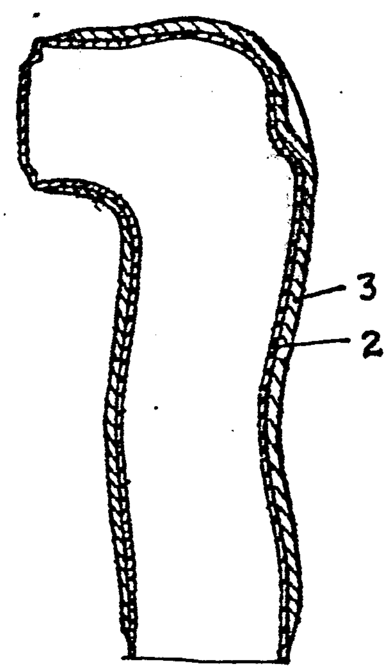

FIG 3

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EUROPEAN SEARCH REPORT

0191008 Application number

EP 86 85 0030

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.4)
X	FR-A-2 431 335 (AUTOMOBILES PEUGEOT ET S.A. AUTOMOBILE CITROEN) * Page 2, line 23 - page 3, line 25; figures 1,2 *	1-3,5, 7	B 22 D 23/00
A	PATENTS ABSTRACTS OF JAPAN, vol. 8, no. 67 (C-216) [1504], 29th March 1984; & JP - A - 58 217 671 (MITSUBISHI JUKOGYO K.K.) 17-12-1983		
A	PATENTS ABSTRACTS OF JAPAN, vol. 7, no. 46 (C-153) [1191], 23rd February 1983; & JP - A - 57 198 256 (ISUZU JIDOSHA K.K.) 04-12-1982		
			TECHNICAL FIELDS SEARCHED (Int. Cl.4)
			B 22 D C 23 C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	24-04-1986	STEIN K.K.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
O : non-written disclosure
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