PROCESS FOR CASTING-IN OF SINTERED METAL BODIES

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PROCESS FOR CASTING IN OF SINTERED METAL BODIES

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The present invention relates to a process for casting sintered metal bodies into metals, for example, into aluminum or aluminum alloys. When the sintered metal bodies contain constituents which are easily oxidizable, as in the case of aluminum or its alloys, then certain problems arise.

In the manufacture of pistons for internal combustion engines, it is desirable to make the parts of the piston which are subjected to the greatest thermal strains of a material which is particularly heat resistant. For example, mushroom heads of heavy metal or iron plates have been cast into pistons for this purpose and, recently, owing to their low weight and high thermal capacity, sintered bodies of aluminum have been employed. These sintered metal bodies consist of very small particles of aluminum which are pressed together under heat and high pressure and can be re-pressed by extrusion presses. The fine aluminum particles break through the oxide film on the particles at their points of contact and thus produce a body of great strength as well as one having good electrical and thermal conductivities.

However, such sintered metal bodies are always coated with a fine film of oxide on the outer surface of the particles which prevents the sintered bodies, when cast into metals, for example into aluminum or aluminum alloys, from uniting firmly and intimately with the metal of the body. It is therefore necessary to free the sintered body from its surface film of oxide as shortly as possible before the casting is poured, for example, by sand-blasting or any other suitable surface treatment. This entails troublesome and expensive steps in the process. In particular, it has hitherto been impossible, in large scale manufacture, to prepare sintered inserts for stock. Also, it has been impossible to prevent a fresh film of oxide from being formed in the interval between the removal of oxide from the sintered body and the instant of pouring, especially as the cleaned sintered bodies are, as a rule, preheated before the casting operation.

The object of the invention is to obviate these disadvantages. According to the invention, this is achieved by providing the sintered metal bodies, before being poured, with a metallic protecting layer which is applied during or immediately after the detachment of their superficial layer of oxide, the metal of the protecting layer being selected so that on contact with the molten metal, it is removed, either by being dissolved or melted and washed away and also being metal which does not form a substantial oxide film in the air.

In this way, it is possible to produce sintered inserts for stock and to store them for as long as desired. In addition, there is no longer any interval between the removal of oxide and the pouring, when casting in which a fresh film of oxide could be formed, because the application of the protecting layer in an electrolytic bath can be carried out at the same time as the removal of the layer of oxide and the metallic protecting layer is removed wholly or partially only at the instant in which the casting metal itself covers the oxide-free surface of the sintered insert. A further advantage is that the protecting layer, when made of a metal suitably selected for this purpose, unites very intimately with the casting metal in a boundary zone by, for example, solution or diffusion, so that a great strength is between the sintered body and the casting body is ensured. Also, an immediate melting together of the surface layer of the sintered body and the metal of the casting body then occurs.

In a development of the invention a sintered metal insert, before the metallic protecting layer is put thereon, is provided with a casing, which covers the body of sintered metal at least partially and which consists of a metal which is the same as or similar to the metal which is subsequently to be employed as the casting metal. It is advantageous to bring the casing into intimate contact with the body of sintered metal before the application of the protecting layer.

The application of the metallic protecting layer either direct to the sintered metal insert or the metallic casing can, in practice, be carried out in various ways. Preferably, methods are used in which the detachment of the layer of oxide is effected at the same time as the application of the protecting layer of the metal under air-free conditions to prevent re-oxidation. It has been found to be advantageous to produce the metallic protecting layer on the sintered metal inserts by the contact-dipping process, for example, by dipping sintered inserts of aluminum into solutions of basic metal salts, such as zincate solutions. However, the metallic protecting layer may also be produced electrolytically, for example, in a basic bath. Another method consists in melting the metallic protecting layer onto the sintered metal bodies with the employment of supersonic waves. The layer of oxide may be detached from the surface by means of supersonic vibration, to allow the coating metal to unite perfectly with the cleaned surface of the sintered metal body. The metallic protecting layer can be deposited by vaporisation in high vacuum after previously removing oxide from the sintered metal insert.

Experiments have shown that numerous metals are suitable for the production of the metallic protecting layer on the sintered inserts. Generally, the coating metal can be selected from two points of view. Firstly, metals or metal alloys may be selected which dissolve in the casting metal. In this case it is immaterial whether or not the casting metal, for example, nickel or chromium, has a considerably higher melting point than that which corresponds to the casting temperature, if there is a sufficient solubility in the casting metal. When employing aluminum or aluminum alloys as the casting metal, zinc, cadmium, silver, copper, nickel and chromium, for example, may be employed as coating metals. Alternatively metals or alloys which are insoluble or only slightly soluble in the casting metal may be employed as the coating metal if their melting points are below the casting temperature, so that these coating metals are melted and washed away from the surface of the sintered body by the casting metal in order to obtain an immediate bonding together with the surface of the sintered body. In this sense, lead, tin, bismuth and antimony, for example, are suitable as protecting metals for sintered bodies of aluminum, if aluminum or an aluminum alloy is employed as casting metal.

The process may, of course, be employed with casting metals other than aluminum. For example, it renders possible the casting of sintered inserts of aluminum into copper. In that case, as also in most other cases, zinc has proved to be a suitable coating metal for the sintered inserts.
In the drawing there is represented a photomicrograph which has been magnified linearly about 100 times and which represents the boundary zone between eutectic aluminium-silicon alloy, which is suitable for pistons, and a sintered insert of aluminium which has been cast into the piston. The typical structure of the sintered body of aluminium can be seen at a, whilst the structure of the eutectic aluminium-silicon alloy can be seen at c. Between them, there is a transition zone b in which the sintered insert has partially melted and bonded with the cast piston metal. The zinc from the transition layer has alloyed itself mainly with the piston metal c.

The thickness of the metallic protecting layer varies in accordance with the metal employed and the time taken by the treatment. In the case of zinc, layers having a thickness of from about 20 to 50 μ are employed. In the case of other metals, for example, chromium, layers having a maximum thickness of 10μ are sufficient.

It has been found in practice that, in some cases, especially when using high casting temperatures, not only the protecting layer which consists of zinc, for example, goes into solution and is washed away by the casting metal, but also particles of the sintered metal inserts are washed away and become embedded in the cast metal and impair the mechanical properties, especially the hardness, of the castings.

This difficulty may be overcome by providing the sintered metal insert with a metal casing made preferably of the casting metal. The metal casing covers at least a large part of the sintered metal, but need not cover the whole of it. The metal casing preferably is made of the same metal as the eventual casting. The whole of the exterior surface of the insert is then covered with a protective metal coating, although this is not essential for the casing if the casing is made from a metal or alloy which is not readily oxidizable.

The sintered metal inserts may be produced by pressing, drawing or sintering the sintered body together with the metallic casing.

The effect of the casing of the sintered metal insert is that, on pouring the casting metal onto or around the insert, attack by the casting metal can extend only to the protecting layer and to the outer zones of the casing of the sintered metal insert, which casing consists of the same material as or of a metal of a similar kind to that of the casting metal, but not to the sintered metal itself. A partial removal of the casing by the casting metal cannot lead to any damaging of the casing. On the contrary, the homogeneous union with the sintered metal is favoured in this way by ensuring a firm embedding of the sintered insert by reason of its intimate mechanical union with the casing which is put on before the casting operation, because, for this purpose, any desired appropriate pretreatment by pressing, sintering, etc., can be carried out.

Two examples of the carrying out of the method will now be given.

**Example 1**

A circular rod of aluminium-sintered material, having a diameter of 50 mms. is inserted in a tube which is made of an alloy suitable for aluminium pistons and is the same or is like the alloy to be used for the castings. The tube has an internal diameter of 50 mms. and an external diameter of 70 mms. The sintered-metal and the casing tube are then treated, while heated, by the extrusion-press method, the reduction of the total diameter being so produced as to form an intimate union between the sintered metal and the metal of the casing is obtained.

From the extruded mass so obtained, discs of a thickness of about 10 mms. are cut and are freed from surface oxide. The discs are then provided with a metallic protective layer of zinc. These disc-shaped plates are, in the case of production of pistons for internal combustion engines, placed in the chill mould in such a manner that they form a part of the piston head.
casting of the piston of said predetermined metal about the body and into contact with both cased and uncased surfaces thereof carrying the aforesaid coating and with the body disposed in the head portion of the piston, said metallic coating being removed from all said last-mentioned surfaces by said molten casting metal during the pouring of the cast and said casting metal thereby bonding with the aforesaid oxide-free uncased surface portions of sintered metal, and said molten casting metal also fusing and combining with outer portions of said casing.