(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 005 285**
B1

(12) # EUROPEAN PATENT SPECIFICATION

(45) Date of publication of patent specification: 17.03.82

(51) Int. Cl.³: C 23 C 7/00

(21) Application number: 79200170.3

(22) Date of filing: 09.04.79

(54) **Process for applying a dense layer of cermets or cemented carbides to a metal object.**

(30) Priority: 26.04.78 NL 7804454

(43) Date of publication of application:
14.11.79 Bulletin 79/23

(45) Publication of the grant of the patent:
17.03.82 Bulletin 82/11

(84) Designated Contracting States:
CH DE FR GB IT NL SE

(56) References cited:
FR - A - 1 434 158
GB - A - 1 367 762
NL - A - 6 709 916

(73) Proprietor: SKF Industrial Trading & Development Company B.V.
Kelvinbaan 16 P.O. Box 50
NL-3430 AB Nieuwegein (NL)

(72) Inventor: van Nederveen, Hans Bertil
Reelaan 23
Bosch en Duin (NL)
Inventor: Verburgh, Martin Bastiaan
Bisschopsweg 212
Amersfoort (NL)

(74) Representative: Merkelbach, B.
SKF Engineering & Research Centre B.V. P.O. Box 50 Plettenburgerweg 6A
NL-3430 AB Nieuwegein (NL)

EP 0 005 285 B1

Courier Press, Leamington Spa, England.

Process for applying a dense layer of cermets or cemented carbides to a metal object

The invention relates to a process for applying a dense, hard and wear-resistant layer of cermets or cemented carbides to a metal object by spraying a powder material consisting of hard particles of cermets or cemented carbides, followed by consolidation of the sprayed-on layer at high temperature and pressure.

British patent specification 1.451.113 discloses a process for spraying a layer on a metal object, such layer consisting of a metal or an alloy, which may contain ceramic materials (so-called cermets). In spraying by known methods, for example flame spraying or plasma spraying of powdered materials, a porous layer is obtained. In many cases, the adhesion of this layer to the base material is found unsatisfactory, and therefore the said patent specification recommends consolidating the porous layer by fusing the binder metal present therein under vacuum, thus reducing the porosity. To combat oxidation, this fusion is carried out under vacuum. According to the said patent specification, good results are obtained by this method if the layer consists of 50 percent by weight of tungsten carbide in a matrix of a nickel-chromium alloy serving as binder metal.

As the content of binder metal in the layer decreases, and the content of hard particles accordingly increases, it seems to become more and more difficult to consolidate the layer by fusing the binder metal, and at a binder metal content of 30 percent or less, it becomes practically impossible.

DE - A - 1.783.061 proposes application of a comparable dense layer by built-up welding, using a tubular or rod welding electrode containing a binder metal and tungsten carbides. Such an electrode, according to the specification, preferably contains 30—40 percent by weight of binder metal and 70—60 percent by weight of carbide particles. During welding, this material is further mingled with some quantity of molten base material. According to DE - A - 1 783 061, the binder metal must contain at least one of the metals Co, Ni, Fe or Cr as chief constituent.

By this method also, it is not possible to apply a dense layer to a metal object in such a way that the layer consists of more than 70 percent by weight of ceramic particles, such as hard metal carbides, for example tungsten or titanium carbide, or other hard materials. In a layer with so high a content of hard particles, a cohesive and/or adhesive bond cannot be improved by internal fusion.

According to the invention, in a process of the type initially referred to, the consolidation of the sprayed-on porous layer is accomplished by isostatic compaction at a temperature of at least 1000°C and a pressure of at least 1000 bars, for at least one half hour, whereby said binder metal is not melted.

In this way, i.e. at a specific isostatic pressure process, it is possible to obtain an applied layer of high density and markedly improved bonding to the base material, which can have a complicated shape. British Patent specification 1.367.762 discloses a method to form a sprayed-on cermet coating on a surface of a thin metal sheet whereby both coating and substrate are subjected to hot pressing or sintering. According to this method pressing is executed from one side or opposite sides of the metal sheet; therefore this method is not suitable when more, e.g. rounded sides of a body have to be processed with improved layers in one step.

The process according the invention is especially suitable for applying a layer of tungsten carbide/cobalt to a forged, cast or sintered core or similar base material Cermets or other metals or ceramic materials may alternatively be used, for example TiC or Si_2N_4. As binder metal, a metal or an alloy consisting predominantly of Ni, Co, Fe or Cr may be used. Preferably cobalt or an alloy of cobalt and nickel (Co/Ni) is used. The proper choice of course depends partly on the base material used, to which the applied layer must bond well.

The layer is applied by spraying on of a powder mixture containing the binder metal and the particles in the desired proportion for the layer. This spraying may be carried out in conventional manner, for example by flame spraying or plasma spraying, a porous layer being formed in either case. The objects may be completely or only partly coated with the sprayed layer. Depending on the desired thickness of layer, the coating material may be applied in one or several steps. If desired, the successive layers may differ from each other in composition.

If necessary, the surface may then be finished smooth. In most cases, however, this can be omitted because the roughness of the surface after consolidation is chiefly determined by the grain size of the pressure transmitting medium. If the proper grain size is used, the smoothness of the surface will be sufficient in most cases even without finishing. A grain size of 0.10—0.25 mm is very satisfactory for many purposes.

According to a preferred form of the invention, a mixture containing at least 7 percent by weight of cermet particles is used for the sprayed-on layer, and preferably a mixture consisting of 83—94 percent by weight of tungsten carbide, remainder cobalt.

The thermal expension coefficients of cermets or cemented carbides differ appreciably from those of metals. To prevent the applied layers from cracking loose as a result of thermal

stresses during cooling at the end of the consolidating operation, it is preferable to vary the content of cermets or ceramic materials in the direction of depth by applying the coating layer in two or more steps, the content of binder metal being varied from one sprayed-on layer to another.

The invention will now be further illustrated with reference to figures.

Fig. 1 schematically representing an object produced according to the invention, and Fig. 2 and 3 showing photographs of a compacted layer before and after the hot isostatic compaction.

After spraying on of the layer 4, the coated object 3 is placed in a comparatively thin-walled holder 2, for example of low-alloy steel. Then the holder is completely filled with a pressure transmitting medium 5 and closed gastight with a cover 1. Then the holder 2 is placed in a hot isostatic press (not shown) in which the holder is heated to the consolidating temperature, which is at least 1000°C, preferably 1000—1400°C. The temperature during this operation is always such that the consolidation takes place in the solid phase. At this temperature the binder metal does not melt, but some sintering does occur. Simultaneously with the raising of the temperature, or after the desired temperature has been reached, the gas pressure in the press is raised to at least 1000 bars, preferably up to 1800 bars. This diminishes the volume of the holder 2, and the gas pressure is transmitted by way of the pressure transmitting medium 5 to the object 3 with sprayed-on layer 4. Under the influence of this temperature and pressure, the layer 4 is consolidated, while at the same time a diffusion is formed with the base material 3. This process takes at least one half-hour, counting from attainment of the consolidation temperature to the commencement of the cooling. Preferably the operation is continued for 1/2 to 2 hours. Then the temperature and pressure are allowed to return to normal, after which the object is removed from the holder 2.

Fig. 2 shows a photograph of a plasma-sprayed layer 4A on a base material 3A before hot isostatic compaction.

Fig. 3 is a photograph taken after hot isostatic compaction and shows that 1) layer 4 has attained maximum density, 2) an optimum diffusion bond 6 has been formed between 3 and 4.

Claims

1. Process for applying a dense, hard and wear-resistant layer of cermets or cemented carbides to a metal object by spraying a powder material consisting of hard particles of cermets or cemented carbides followed by consolidation of the sprayed-on layer at high temperature and pressure, characterized in that the sprayed-on layer is consolidated by isostatic compacting at a temperature of at least 1000°C and a pressure of at least 1000 bars for at least 1/2 hour, whereby the binder metal is not melted.

2. Process according to claim 1, characterized in that a mixture containing at least 70 percent by weight of ceramic particles, is used for the sprayed-on layer.

3. Process according to claim 1 or 2, characterized in that the sprayed-on layer contains 83—94 percent by weight of tungsten carbide, remainder cobalt.

4. Process according to claim 3, characterized in that the consolidation is carried out during a period of 1/2 to 2 hours at a temperature of 1000—1400°C and a pressure of 1000—1800 bars.

5. Process according to claims 1 to 4, characterized in that the coating layer is applied in two or more steps, the content of binder metal in the sprayed-on layers being so varied as to prevent the layers from cracking loose because of differences in coefficient of expansion.

6. Metal objects completely or partially coated with a dense layer obtained according to one of the preceding claims.

Revendications

1. Procédé pour appliquer une couche dense, dure et résistante à l'usure, de cermets ou de carbures cémentés à un objet métallique par pulvérisation d'une matière pulvérulente consistant en des particules dures de cermets ou de carbures cémentés suivie par une consolidation, à une température et une pression élevées, de la couche formée par pulvérisation, caractérisé par le fait que l'on consolide la couche formée par pulvérisation à l'aide d'un compactage isostatique à une température d'au moins 1000°C et une pression d'au moins 1000 bars pendant au moins 1/2 heure, grâce à quoi le métal formant le liant ne fond pas.

2. Procédé suivant la revendication 1, caractérisé par le fait que l'on utilise pour la couche formée par pulvérisation un mélange contenant au moins 70% en poids de particules de céramique.

3. Procédé suivant les revendications 1 ou 2, caractérisé par le fait que la couche formée par pulvérisation contient 83—94% en poids de carbure de tungstène, le reste étant du cobalt.

4. Procédé suivant la revendication 3, caractérisé par le fait que l'on effectue la consolidation pendant une péroide de 1/2 à 2 heures à une température de 1000—1400°C et à une pression de 1000—1800 bars.

5. Procédé suivant les revendications 1 à 4, caractérisé par le fait que l'on applique la couche de revêtement en deux ou plusieurs phases, la teneur du métal formant le liant dans les couches formées par pulvérisation étant modifiée de manière à empêcher les couches de se détacher par fissuration par suite des différences de coefficient de dilatation.

6. Objets métalliques revêtus complètement ou partiellement avec une couche dense obtenue suivant l'une des revendications précédentes.

Patentansprüche

1. Verfahren zum Anbringen einer dichten, harten und abriebfesten Schicht von Cermets oder Hartlegierungen auf einem Metallgegenstand durch Aufsprühen eines pulverigen Materials, bestehend aus harten Teilchen aus Cermets oder Hartlegierungen, und anschließende Verfestigung der aufgesprühten Schicht bei hoher Temperatur und hohem Druck, dadurch gekennzeichnet, daß die aufgesprühte Schicht durch isostatische Verdichtung verfestigt wird bei einer Temperatur von wenigstens 1000°C und einen Druck von wenigstens 1000 Bar während wenigstens einer halben Stunde, wobei das Bindemetall nicht geschmolzen wird.

2. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß für die aufgesprühte Schicht eine Mischung benutzt wird, die zu wenigstens 70 Gew.% keramische Teilchen enthält.

3. Verfahren nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß die aufgesprühte Schicht 83—94 Gew.% Wolframkarbid und im übrigen Kobalt enthält.

4. Verfahren nach Anspruch 3, dadurch gekennzeichnet, daß die Verfestigung während einer Zeitdauer von einer halben bis zwei Stunden bei einer Temperatur von 1000—1400°C und einem Druck von 1000—1800 Bar durchgeführt wird.

5. Verfahren nach den Ansprüchen 1 bis 4, dadurch gekennzeichnet, daß die Überzugsschicht in zwei oder mehr Schritten aufgebracht wird, wobei der Gehalt an Bindemetall in den aufgesprühten Schichten so variiert wird, daß das Abplatzen der Schichten wegen unterschiedlicher Ausdehnungskoeffizienten verhindert wird.

6. Metallgegenstände welche vollständig oder teilweise überzogen sind mit einer gemäß einem der vorhergehenden Ansprüche erhaltenen dichten Schicht.

FIG.1

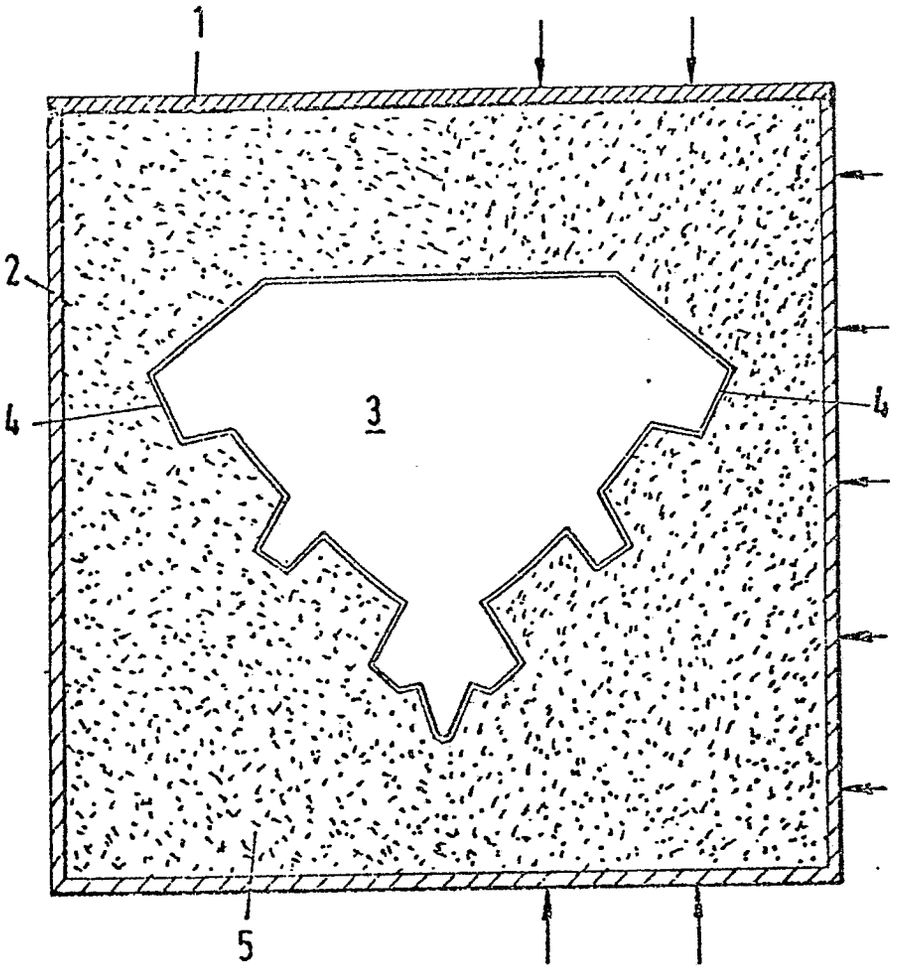

FIG.2

FIG.3