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

(11) Publication number: **0 305 746**
A1

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **88112432.5**

(51) Int. Cl.4: **B22F 3/12 , C23C 4/18**

(22) Date of filing: **01.08.88**

(30) Priority: **03.09.87 IT 6775487**

(43) Date of publication of application:
08.03.89 Bulletin 89/10

(84) Designated Contracting States:
DE ES FR GB SE

(71) Applicant: **IVECO FIAT S.p.A.**
Via Puglia 35
I-10156 Torino(IT)

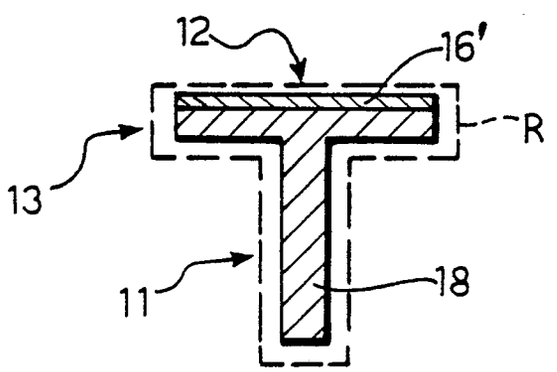
(72) Inventor: **Quaranta, Sante**
Via Umberto I, 11
I-10040 Rivalta (Torino)(IT)

(74) Representative: **Buzzi, Franco et al**
c/o Jacobacci-Casetta & Perani S.p.A. Via Alfieri, 17
I-10121 Torino(IT)

(54) Method for the production of mechanical parts provided with a wear- and/or corrosion-resistant coating.

(57) A method for the production of mechanical parts (18) provided with a wear-resistant coating (16') involves the formation, by the cold compression of powders, of a green which, after a possible pre-sintering stage, is provided with a coating applied hot, and is subsequently subjected to sintering in order to obtain a mechanical part (18) having a wear- and/or corrosion-resistant coating (16') which is not subject to internal stresses.

FIG. 4



EP 0 305 746 A1

Method for the production of mechanical parts provided with a wear- and/or corrosion-resistant coating

The present invention relates to a method for the production of components having a wear-and/or corrosion-resistant coating.

In particular, the present invention relates to a method for the coating of products required to withstand high hammering, rolling and frictional stresses with or without corrosion due to external agents, both cold and hot, with materials which have high wear resistance. According to known technology, such products (for example, tappets, cams, eccentrics, dies, etc.) are normally consituted by a metal body which is not particularly resistant to wear and/or corrosion, in which the most stressed portion is covered with a coating of more expensive material selected in dependence on the type of stress and/or corrosive environment to which the product in question will be subject.

The coating of the metal substrates with friction- and/or corrosion-resistant materials is carried out hot, for example, by the techniques of deferred-arc plasma, laser-beam melting bond, spray coating by means of plasma, etc.

After this hot coating, the material of the coating is stressed by considerable residual internal tensile forces as it cools and these persist in the finished product. These forces arise since the substrate, through the forces due to the adhesion between the substrate and the coating material, prevents the latter from shrinking freely from the temperature used for the coating to the ambient temperature.

These residual stresses, added to the effects of the stresses suffered in use of the product and/or added to the corrosive action of external agents (stress corrosion), greatly limit the useful "life" of the product. In fact, cracks may be generated in the coating which, by losing its continuity, also loses its ability to resist wear and/or corrosion. Moreover, the cracks generated in the coating may be propagated in the base material of the product and may cause fractures which compromise the required functionality or may be highly dangerous.

The object of the present invention is to provide a method of the type specified at the beginning of the description, which does not have the above disadvantages and which enables full use to be made of the advantages of the hot application of a wear- and/or corrosion-resistant coating to products of low-cost base materials.

According to the invention, this object is achieved by virtue of the fact that the method includes the steps of forming a component by the compression of powders, applying the coating to the component, said coating having a melting point higher than the sintering temperature of the component, and subjecting the coated component to sintering.

In this way, by making use of the known phenomenon of contraction of parts during sintering, it is possible to eliminate completely or to bring to a predetermined value the residual internal stresses of the coating layer.

According to another characteristic, the component is subjected to a pre-sintering treatment before the application of the coating.

In this way, it is possible to coat components which already have a certain mechanical strength. Furthermore, with the pre-sintering, it is possible to define, and hence more precisely to control, the dimensional variations of the sintered and coated parts and therefore the residual stress in the coating layer.

Further advantages and characteristics of the method according to the invention will become clear from the detailed description which follows, provided purely by way of non-limiting example, with reference to the appended drawings, in which:

Figure 1 is a cross-section of a so-called green formed from powders,

Figure 2 is a section of the pre-sintered part obtained from the green of Figure 1,

Figure 3 is a view similar to Figure 2 and shows the pre-sintered part of Figure 2 provided with a wear-resistant coating, and

Figure 4 is a section which shows the sintered part obtained from the pre-sintered part of Figure 3.

With reference to the drawings, a green is indicated 10 and, after the sintering process, is intended to constitute a tappet element of an internal combustion engine, comprising a shaft 11 and a flat 13 provided with a working surface 12. The green 10 may, for example, be made of sintered low-alloy steel corresponding, for example, to a conventional C10. After formation of the green 10, achieved by cold compression in a die, it may be introduced into a pre-sintering furnace (not illustrated), both in order to obtain a more easily handled product and in order to be able to control the dimensional shrinkage, shown in the drawings by broken lines R. A pre-sintered part 14 is thus obtained which has characteristics of strength such as to enable it to proceed without problems to the subsequent stage of coating of the working surface 12 with a layer 16 of coating material having a melting point higher than the sintering temperature of the green and having high wear- and/or corrosion-resistance. The layer 16 is constituted by

powders deposited at high temperature by various techniques (deferred-arc plasma, laser melting bond, plasma spray etc.). The hot application of the coating 16 means that, as it bonds to the pre-sintered part 14 which is at a lower temperature, the coating is subjected during cooling to internal tensile stresses which persist after cooling.

The next stage involves the passage of the pre-sintered part 14, with the layer of coating 16, into a sintering furnace in which the presintered part 14 is transformed, at a high tempera ture, and for a time from 1 to 3 hours into a sintered part 18 with a further change in dimensions. This change means that the layer of coating 16 of the pre-sintered part 14 is transformed into a layer 16′ in which the tensile stress condition is cancelled out or transformed into a compressive stress condition which, in the specific case of a tappet with a flat, is particularly suitable for the type of stress to which the product will be subjected in use (impact, rolling and sliding stress from the cam acting on the tappet). In other cases, it may be convenient to eliminate any stress condition between the coating 16′ and the sintered part 18, or it may be opportune to maintain a condition of slight tensile stress so that any problems of thermal stress can be resolved without disadvantages to the part. This "piloting" of the stress condition of the coating layer 16′ may be obtained by a suitable selection of the particle size and elements of the powders used to produce the green 10, defined in dependence on the reduction in volume which is to be obtained as a result of the self-densification undergone by the product in the sintering process. Another variable on which it is possible to act to produce the desired stress condition in the coating 16′ is the duration of the initial pre-sintering stage.

According to another embodiment of the invention, the method may be carried out by coating the green 10 directly, without its passing through the pre-sintering stage.

According to a further embodiment, the adhesion between substrate and coating layer is achieved by the cold compression in a die of a green formed by a main body of low cost metallic powders and by a coating portion of powder material having high wear- and/or corrosion resistance. Also in this embodiment, the material of the coating portion must have a melting point higher than the sintering temperature of the main body. The main body and the coating portion are then sintered with the same thermal cycle, or by means of liquid phase sintering.

During the sintering process according to the last mentioned embodiment, the main body is subjected to a reduction in volume which is higher than that of the coating portion, allowing to stop the process when a desired stress condition is obtained between the sintered body and the sintered coating portion.

The method according to the invention has advantages for the sintering of ceramic powders or metal-ceramic powder mixtures too.

Claims

1. A method for the production of elements, particularly mechanical elements, having a wear- and/or corrosion-resistant coating, characterised in that it comprises the steps of:
- forming the element (10) by the compression of powders,
- applying the coating (16) to the element (10, 14), said coating having a melting point higher than the sintering temperature of the element, and
- subjecting the element (10, 14) with the coating (16) to sintering.

2. A method according to Claim 1, characterised in that the element (10) is subjected to a pre-sintering treatment before the application of the coating (16).

3. A method according to Claim 1, characterised in that the application of the coating (16) is carried out by the compression of powders simultaneously with the compression-forming of the element (10).

4. A method according to Claim 1 or Claim 2, characterised in that the coating (16) is applied by means of deferred-arc plasma.

5. A method according to Claim 1 or Claim 2, characterised in that the coating (16) is applied by means of laser melting bond.

6. A method according to Claim 1 or Claim 2, characterised in that the coating (16) is applied by means of plasma spray coating.

7 . A method according to any one of the preceding claims, characterised in that the element (18) is obtained from metal powders.

8. A method according to Claim 7, characterised in that the element (18) is made of sintered metal.

FIG. 1

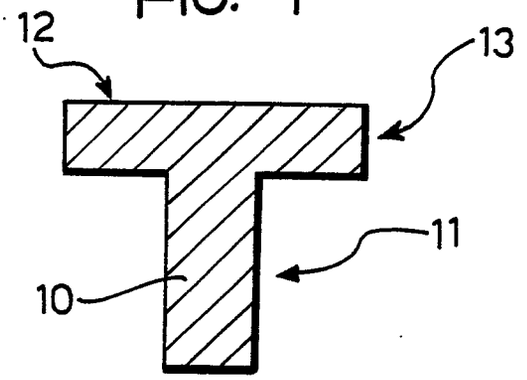


FIG. 2

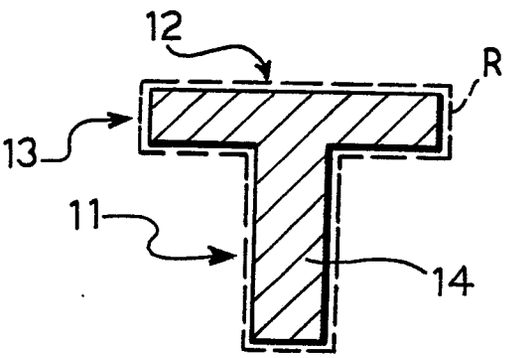


FIG. 3

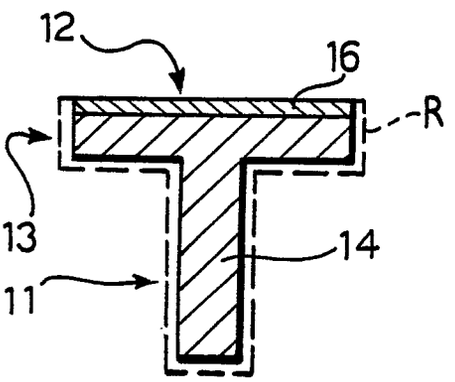
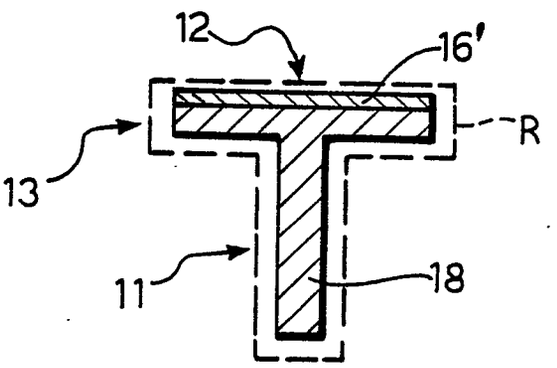


FIG. 4



European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 88 11 2432

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-2 350 404 (MASCHINENFABRIK AUGSBURG-NURNBERG) * Whole document * ---	1-8	B 22 F 3/12 C 23 C 4/18
X	US-A-4 339 271 (ASEA) * Column 4, example 5 * ---	1-8	
X	PATENT ABSTRACTS OF JAPAN, vol. 10, no. 362 (C-389)[2419], 4th December 1986; & JP-A-61 159 566 (DAIDO STEEL CO., LTD) 19-07-1986 * Abstract * -----	1-8	

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

B 22 F
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	02-12-1988	SCHRUERS H.J.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P0401)