



Europäisches Patentamt
European Patent Office
Office européen des brevets



(11) Publication number: **0 399 400 B1**

(12)

EUROPEAN PATENT SPECIFICATION

- (49) Date of publication of patent specification: **02.11.95** (51) Int. Cl.⁶: **B22F 3/26**, B22F 7/00,
F01L 1/14
- (21) Application number: **90109458.1**
- (22) Date of filing: **18.05.90**

(54) **Process to manufacture a sintered metallic product and product thus obtained.**

- (30) Priority: **26.05.89 IT 6740189**
- (43) Date of publication of application:
28.11.90 Bulletin 90/48
- (45) Publication of the grant of the patent:
02.11.95 Bulletin 95/44
- (84) Designated Contracting States:
DE ES FR GB SE
- (56) References cited:
WO-A-83/04382
GB-A- 544 903
GB-A- 960 479
GB-A- 1 106 864

- (73) Proprietor: **FIAT AUTO S.p.A.**
Corso Giovanni Agnelli 200
I-10135 Torino (IT)
- (72) Inventor: **Antona, Paolo Luca**
Corso Montecucco, 86
10100 Torino (IT)
Inventor: **Taricco, Stefano**
Via Cellini, 23
10100 Torino (IT)
- (74) Representative: **Jorio, Paolo et al**
STUDIO TORTA Società Semplice
Via Viotti 9
I-10121 Torino (IT)

Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid (Art. 99(1) European patent convention).

EP 0 399 400 B1

Description

The present invention relates to a process to manufacture a sintered metallic product and to the product thus obtained. Particularly, but not exclusively, the aforesaid invention consists of a lifter head for an internal combustion engine.

Preferably, lifter heads consist of a first base material layer which, in use, is joined to a respective shank by means of a conventional operation (welding, brazing, mechanical junction, etc.) and of a second layer, bound up with the first layer, which consists of a material so-called "noble" owing to its particular resistance to the abrasion resulting from the percussion, rolling and slip stresses owing to the cam which, in use, acts upon it.

Processes (plasma spray, transferred arc plasma, laser alligation, etc.) able to lay a base metallic material substratum with a layer of "noble" metallic material are known.

Although widely used, these processes are not without drawbacks. Actually the "noble" material laid onto the metallic substratum is prevented from undergoing the thermal contraction during the temperature decreasing phase. Thereof it is subject to internal tensile stresses and consequently susceptible of cracking.

It is known from the document GB-A-544 903 a process of manufacturing a continuous strip of sintered materials, including the steps of diffusing into a porous matrix a soft metal powder. The strip is firstly rolled by pressure rollers and then heated in a furnace to cause the metal powder to melt and to flow into the pores of the matrix. The molded article is a porous strip of soft metal.

It is also known from the document WO-A-83/04382 a process of making a wear resistant ferrous part, provided with wear surfaces formed of a diluted aqueous slurry of wear resistant particles deposited into the pores of the part, which are finally dried.

The object of the present invention is to conceive a process and to manufacture a product able to obviate the aforesaid drawbacks of the known processes and products.

Said object is attained according to the present invention by a process to manufacture a sintered metallic product having at least a portion subject to abrasion stresses, comprising the following operations:

- providing a porous matrix by compacting premixed iron-based powders as to form a housing corresponding to said portion and laterally delimited by a projecting part;
- filling said housing with a layer of metallic material capable of diffusing into said porous matrix at the sintering temperature of said porous matrix;

- sintering said porous matrix and said layer at said temperature until the material of said layer is completely diffused into the pores of said porous matrix, thus obtaining a substratum substantially deprived of porosity;
- depositing in said housing a predetermined amount of a powder metallic material resistant to abrasion stresses;
- compacting said amount of powder metallic material till obtaining therein a predetermined degree of porosity; and
- sintering said amount of powder metallic material so compacted to form a filling in said housing adhering to said substratum.

Said object is also attained according to the present invention by a sintered metallic product having at least a portion subject to abrasion stresses, comprising a substratum having a housing in correspondence with said portion, and a filling located in said housing, characterized in that said substratum is formed of a porous matrix made of compacted premixed iron-based powders sintered together with a second metallic material as to cause the pores of said porous matrix to be filled with said second metallic material, said housing being laterally delimited by a projecting part, said filling being made of a predetermined amount of powder metallic material resistant to abrasion stresses, which is compressed and sintered in said housing.

Further embodiments are disclosed in the dependent claims.

The present invention will be more apparent from the description of a preferred embodiment thereof given hereinafter by way of non-limiting example with reference to the accompanying drawings, in which figures 1 to 8 illustrate the successive phases of the process, and figure 8 particularly illustrates a section of an example of a product manufactured in accordance with the process of the present invention.

In figure 1 the reference numeral 1 indicates a mould provided with a cavity filled with a first metallic material 3, and the reference numeral 5 indicates a countermould presenting an annular recess 6 around it. According to the present invention, the material 3 essentially consists of a mixture of preliminarily premixed iron-based powders.

Figure 2 shows how the countermould 5 cooperates with the mould 1 to compact the metallic material 3 in order to obtain (figure 3) a matrix 7 with a concave housing 8 laterally delimited by an annular projecting part 9.

Figure 4 shows how the housing 8 is filled with a second metallic material 10 which, in accordance with the present invention, consists of compacted copper or of a mixture of copper-based powders.

In figure 5, the matrix 7, which consists of the first material 3 and contains the second material 10 in its own housing 8, is subjected to sintering, preferably at a temperature of about 1120 °C and in the presence of hydrogen, until the second material (copper or copper-base powders) diffuses into the first material (compacted mixture of iron-base powders) and completely impregnates it, that is to say, substantially occupying all the pore that the matrix 7 presented at the end of the compacting illustrated in figure 2 . In this way, we obtain a substratum 12 which essentially consists of an iron matrix (first material), the pores of which are completely saturated with copper (second material) .

Actually, as it is well known in the field of sintered materials, the fusion (or rather the diffusion and then the fusion) of the copper powder into the iron matrix enables to obtain a substratum substantially with no porosity whatsoever ; moreover the copper which is in the pores of the iron matrix favours the adhesion of subsequent fillings, according to the description hereinafter .

In figures 6, the housing 8 of the substratum 12 is filled with a third "noble" metallic material 13, and particularly able to resist abrasion stresses such as percussion, rolling, slip, etc.

Then the material 13 (see figure 7) is tamped and/or compacted by means of the mould 1 and a counter mould 14 and then sintered .

In particular, during this latter sintering phase the mould 1 as well, as the counter mould 14, are kept at a temperature substantially identical to the sintering temperature of the material 13 . In this way, we obtain a product 15 (figure 8) without residual tensile stresses and therefore not susceptible of cracking .

Moreover, thanks to the presence of the copper which was impregnated the pores of the matrix 7, all the metallic material 13 stays within the housing 8 so as to fix a filling 16 which substantially consists of "noble" material only .

Preferably, the sintering of the "noble" material 13 is carried out so as to control the porosity of the filling 16, in order to be able to impregnate it later with lubricating oil (according to a conventional method) and therefore to make it self-lubricating .

The advantages of the process and the product provided in accordance with the present invention are therefore apparent from an examination of their characteristics .

In case the product 15 should be used as a lifter head for an internal combustion engine, it would fit all the best service requirements, such as :

- a good abrasion resistance of the filling 16, which entirely consists of self-lubricating noble material ; actually this noble material

could not migrate into the substratum 12 during the respective sintering , the pores of the matrix 7 being impregnated by the second metallic material .

- a strong substratum 12 which can be conveniently joined to a respective support shank; and
- no predisposition whatsoever to cracking, thanks to the gradual and simultaneous cooling of the substratum 12 and the filling 16.

Therefore it is reasonable to think that the sintered product obtained in accordance with the present invention also permits to make maintenance less frequent.

Claims

1. A process to manufacture a sintered metallic product having at least a portion subject to abrasion stresses, comprising the following operations:
 - providing a porous matrix (7) by compacting premixed iron-based powders (3) as to form a housing (8) corresponding to said portion and laterally delimited by a projecting part (9);
 - filling said housing (8) with a layer of metallic material (10) capable of diffusing into said porous matrix (7) at the sintering temperature of said porous matrix (7);
 - sintering said porous matrix (7) and said layer (10) at said temperature until the material of said layer (10) is completely diffused into the pores of said porous matrix (7), thus obtaining a Substratum (12) substantially deprived of porosity;
 - depositing in said housing (8) a predetermined amount of a powder metallic material (13) resistant to abrasion stresses;
 - compacting said amount of powder metallic material (13) till obtaining therein a predetermined degree of porosity; and
 - sintering said amount of powder metallic material (13) so compacted to form a filling (16) in said housing (8) adhering to said substratum (12).
2. A process as claimed in claim 1, characterized in that said layer of metallic material (13) is in form of compacted copper.
3. A process as claimed in claim 1, characterized in that said layer of metallic material (13) is in form of a mixture of copper-based powders.
4. A process as claimed in claim 2 or 3, characterized in that the sintering of said porous

matrix (7) and said layer of metallic material (10) is effected at a temperature of about 1120 °C and in presence of hydrogen.

5. A process as claimed in any previous claim, characterized in that said powder metallic material (13) is compacted in a support body (1, 14) including a mold (1) and a countermold (14), the sintering of said filling (16) being carried out by substantially keeping said support body (1, 14) at a temperature identical to the temperature of said filling (16) to provide, after the sintering, the same decrease of temperature in said substratum (12) and in said filling (16). 5 10 15
6. A process as claimed in any previous claim, characterized by providing, after the sintering of said filling (16), an impregnating of lubricating oil into the pores of said filling (16). 20
7. A sintered metallic product having at least a portion subject to abrasion stresses, comprising a substratum (12) having a housing (8) in correspondence with said portion, and a filling (16) located in said housing (8), characterized in that said substratum (12) is formed of a porous matrix (7) made of compacted premixed iron-based powders (3) sintered together with a second metallic material (10) as to cause the pores of said porous matrix (7) to be filled with said second metallic material (10), said housing (8) being laterally delimited by a projecting part (9), said filling (16) being made of a predetermined amount of powder metallic material (13) resistant to abrasion stresses, which is compressed and sintered in said housing (8). 25 30 35
8. A product as claimed in claim 7, characterized in that said second metallic material (10) is formed of compacted copper or a mixture of copper-based powders. 40
9. A product as claimed in claim 7 or 8, characterized in that said filling (16) is compacted as to provide a predetermined degree of porosity and after being sintered, is impregnated with lubricating oil. 45 50
10. A product as claimed in any claim from 7 to 9, characterized in that it is designed to form a lifter head of an internal combustion engine.

Patentansprüche

1. Verfahren zum Herstellen eines gesinterten Metallproduktes das mindestens einen Bereich

besitzt, der Abriebsbeanspruchung ausgesetzt ist, aufweisend die folgenden Arbeitsschritte:

- Bereitstellen einer porösen Matrix (7) durch Verfestigen von vorgemischten Pulvern (3) auf Eisenbasis, um eine zu dem genannten Bereich passende Ausnehmung (8) zu bilden, die durch ein überstehendes Teil (9) seitlich begrenzt ist;
- Füllen der genannten Ausnehmung (8) mit einer Lage metallischen Materials (10), das imstande ist, bei der Sintertemperatur der genannten porösen Matrix (7) in die genannte poröse Matrix (7) zu diffundieren;
- Sintern der genannten porösen Matrix (7) und der genannten Lage (10) bei der genannten Temperatur, bis das Material der genannten Lage (10) vollständig in die Poren der genannten Matrix (7) eindiffundiert ist, wobei man ein Substrat (12) erhält, das im wesentlichen seiner Porosität beraubt ist;
- Einbringen einer vorbestimmten Menge eines gegen Abrieb widerstandsfähigen, pulverigen metallischen Materials (13) in die genannte Ausnehmung (8);
- Verfestigen der genannten Menge pulverigen metallischen Materials (13), bis ein vorbestimmter Grad der Porosität erhalten ist; und
- Sintern der so verfestigten genannten Menge pulverigen metallischen Materials (13), um eine Füllung (16) in der genannten Ausnehmung (8) zu erhalten, die am genannten Substrat (12) anhaftet.

2. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß die genannte Lage metallischen Materials (13) in Form von verfestigtem Kupfer vorliegt.

3. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß die genannte Lage metallischen Materials (13) in Form einer Mischung von Pulvern auf Kupferbasis vorliegt.

4. Verfahren nach Anspruch 2 oder 3, dadurch gekennzeichnet, daß das Sintern der genannten porösen Matrix (7) und der genannten Lage metallischen Materials (10) bei einer Temperatur von etwa 1120 °C in Gegenwart von Wasserstoff erfolgt.

5. Verfahren nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß das genannte pulverige metallische Material (13) in einem Stützkörper (1, 14) verfestigt wird, der

eine Form (1) und eine Gegenform (14) einschließt und das Sintern der genannten Füllung (16) im wesentlichen dadurch ausgeführt wird, daß man den Stützkörper (1, 14) bei einer Temperatur hält, die identisch mit der Temperatur der genannten Füllung (16) ist, um nach dem Sintern denselben Temperaturabfall im genannten Substrat (12) und in der genannten Füllung (16) sicherzustellen.

6. Verfahren nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß man nach dem Sintern der genannten Füllung (16), für eine Imprägnierung von Schmieröl in den Poren der genannten Füllung (16) sorgt.

7. Gesintertes Metallprodukt, das mindestens einen Bereich besitzt, der Abriebsbeanspruchungen ausgesetzt ist, aufweisend ein Substrat (12), das eine zu dem genannten Bereich passende Ausnehmung (8) und eine Füllung (16) aufweist, die sich in der genannten Ausnehmung (8) befindet, dadurch gekennzeichnet, daß das genannte Substrat (12) aus einer porösen Matrix (7) gebildet ist, die aus verfestigten vorgemischten Pulvern (3) auf Eisenbasis hergestellt ist, die mit einem zweiten metallischen Material (10) zusammengesintert sind, um die Poren der genannten porösen Matrix (7) mit dem genannten zweiten metallischen Material (10) zu füllen, die genannte Ausnehmung (8) seitlich durch ein überstehendes Teil (9) begrenzt ist, und die genannte Füllung (16) aus einer vorbestimmten Menge von gegen Abriebsbeanspruchungen widerstandsfähigem, pulverigem metallischem Material (13) hergestellt ist, welches in der genannten Ausnehmung (8) verfestigt und gesintert ist.

8. Produkt nach Anspruch 7, dadurch gekennzeichnet, daß das genannte zweite metallische Material (10) in Form von verfestigtem Kupfer oder einer Mischung aus Pulvern auf Kupferbasis vorliegt.

9. Produkt nach Anspruch 7 oder 8, dadurch gekennzeichnet, daß die genannte Füllung (16) verfestigt ist, um einen vorbestimmten Grad an Porosität zu erhalten, und nach dem Sintern mit Schmieröl imprägniert ist.

10. Produkt nach einem der Ansprüche 7 bis 9, gekennzeichnet durch seine Verwendung als Stoßel- oder Nockenkopf eines Verbrennungsmotors.

Revendications

1. Procédé de fabrication d'un produit métallique fritté dont au moins une partie est soumise à des contraintes d'abrasion, qui comprend les opérations suivantes :

préparation d'une matrice poreuse (7) par compactage de poudres à base de fer prémélangées (3) de manière à former un logement (8) correspondant à ladite partie et délimité latéralement par un rebord (9) ;

remplissage dudit logement (8) avec une couche de matière métallique (10) qui peut diffuser dans la dite matrice poreuse (7) à la température de frittage de ladite matrice poreuse (7) ;

frittage de ladite matrice poreuse (7) et de ladite couche (10) à ladite température jusqu'à ce que la matière de ladite couche (10) soit complètement diffusée dans les pores de ladite matrice poreuse (7) afin d'obtenir un substrat (12) sensiblement exempt de porosité ;

dépôt, dans ledit logement (8), d'une quantité prédéterminée d'une matière métallique en poudre (13) résistant aux contraintes d'abrasion ;

compactage de ladite quantité de matière métallique en poudre (13) jusqu'à ce qu'elle atteigne un degré prédéterminé de porosité ; et

frittage de ladite quantité de matière métallique en poudre (13) ainsi compactée, afin de former dans ledit logement (8) un remplissage (16) qui adhère au dit substrat (12).

2. Procédé suivant la revendication 1, caractérisé en ce que ladite couche de matière métallique (13) est sous forme de cuivre compacté.

3. Procédé suivant la revendication 1, caractérisé en ce que ladite couche de matière métallique (13) est sous forme d'un mélange de poudres à base de cuivre.

4. Procédé suivant la revendication 2 ou 3, caractérisé en ce que le frittage de ladite matrice poreuse (7) et de ladite couche de matière métallique (10) est effectué à une température de 1120 °C environ et en présence d'hydrogène.

5. Procédé suivant une quelconque des revendications précédentes, caractérisé en ce que ladite matière métallique en poudre (13) est compactée dans un corps de réception (1,14) comprenant un moule (1) et un contre-moule (14), le frittage dudit remplissage (16) étant effectué tout en maintenant ledit corps de ré-

ception (1, 14) sensiblement à une température identique à la température dudit remplissage (16) afin d'obtenir, après le frittage, la même décroissance de température dans ledit substrat (12) et dans ledit remplissage (16).

5

6. Procédé suivant une quelconque des revendications précédentes, caractérisé en ce qu'il comprend, après le frittage dudit remplissage (16), une imprégnation d'huile lubrifiante dans les pores dudit remplissage (16). 10

7. Produit métallique fritté dont au moins une partie est soumise à des contraintes d'abrasion, qui comprend un substrat (12) comportant un logement (8) en correspondance avec ladite partie, et un remplissage ou garnissage (16) situé dans ledit logement (8), caractérisé en ce que ledit substrat (12) est formé d'une matrice poreuse (7) constituée de poudres à base de fer prémélangées et compactées (3) qui sont frittées en même temps qu'une deuxième matière métallique (10) de façon à ce que les pores de ladite matrice poreuse (7) soient remplis avec ladite deuxième matière métallique (10), ledit logement (8) étant délimité latéralement par un rebord (9), ledit remplissage (16) étant constitué d'une quantité prédéterminée de matière métallique en poudre (13) résistant aux contraintes d'abrasion, qui est comprimée et frittée dans ledit logement (8). 15
20
25
30

8. Produit suivant la revendication 7, caractérisé en ce que ladite deuxième matière métallique (10) est formée de cuivre compacté ou d'un mélange de poudres à base de cuivre compactées. 35

9. Produit suivant la revendication 7 ou 8, caractérisé en ce que ledit remplissage (16) est compacté de façon à atteindre un degré prédéterminé de porosité et, après frittage, il est imprégné avec une huile lubrifiante. 40

10. Produit suivant une quelconque des revendications 7 à 9, caractérisé en ce qu'il est destiné à former une tête de soulèvement pour moteur à combustion interne. 45

50

55

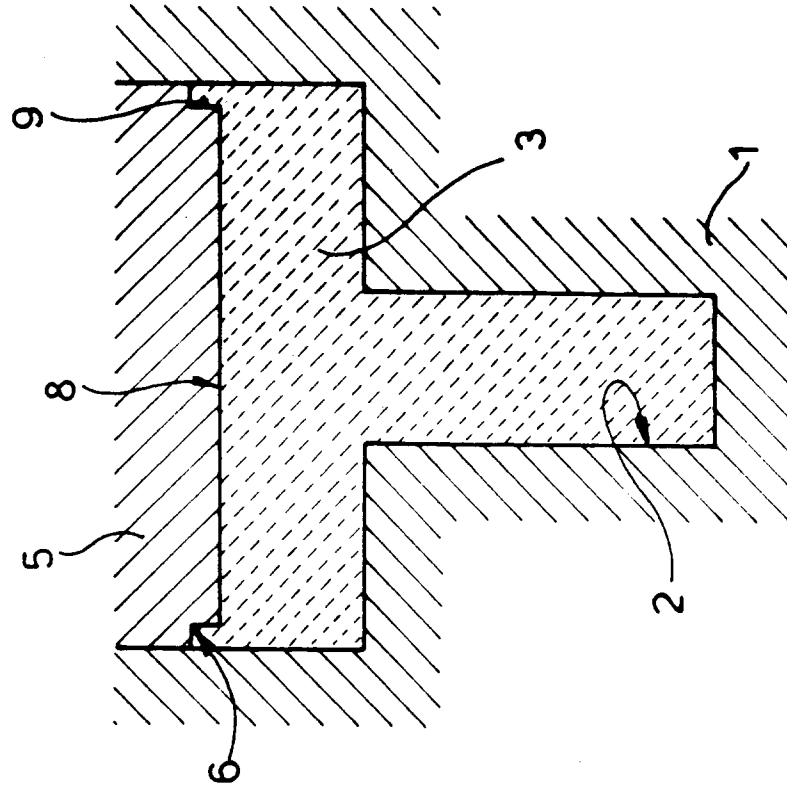


Fig.1

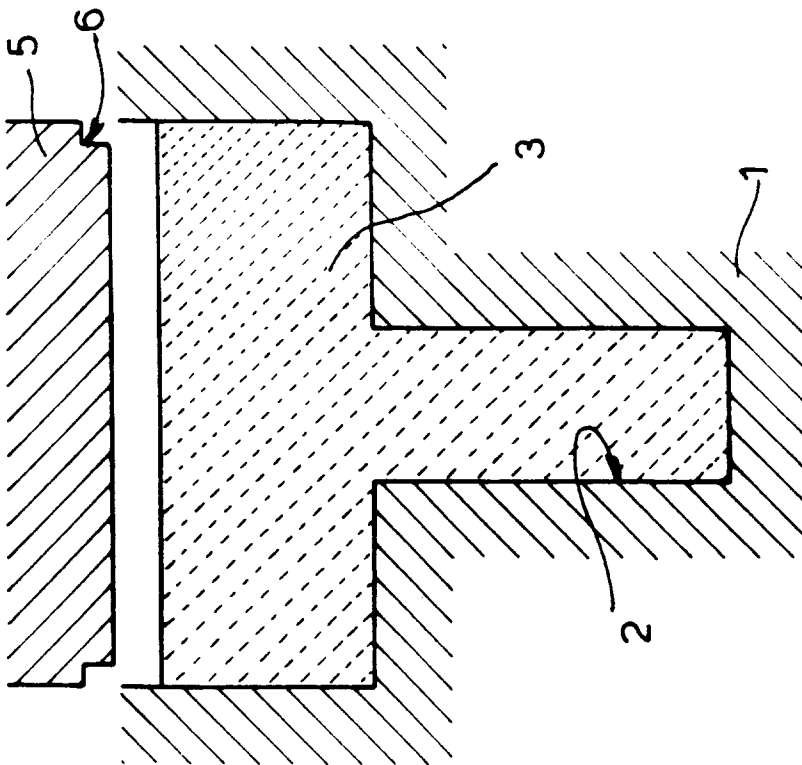


Fig.2

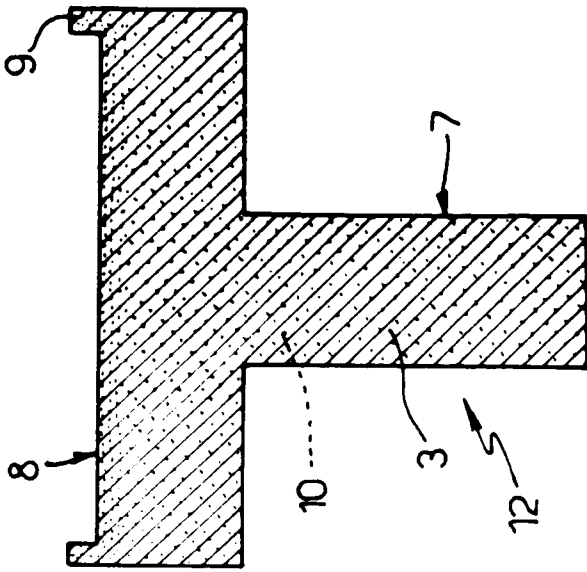


Fig.5

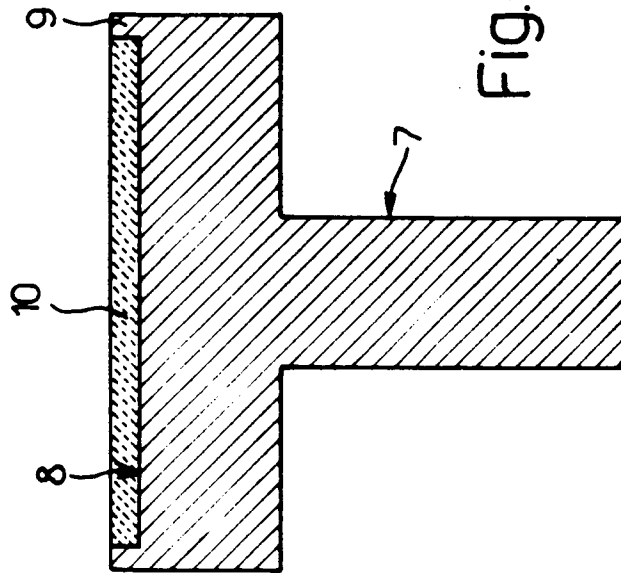


Fig.4

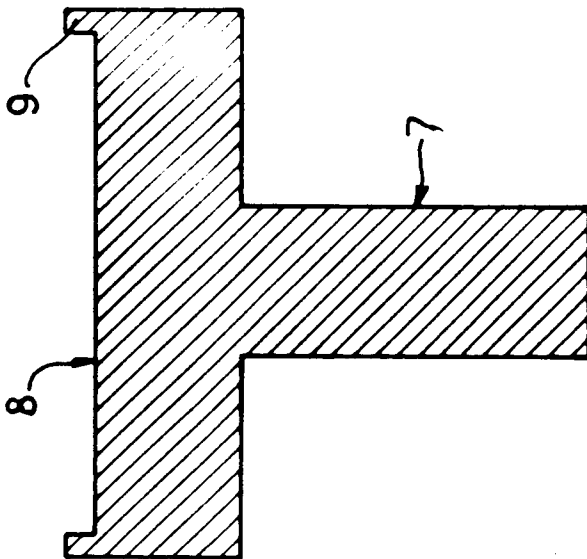


Fig.3

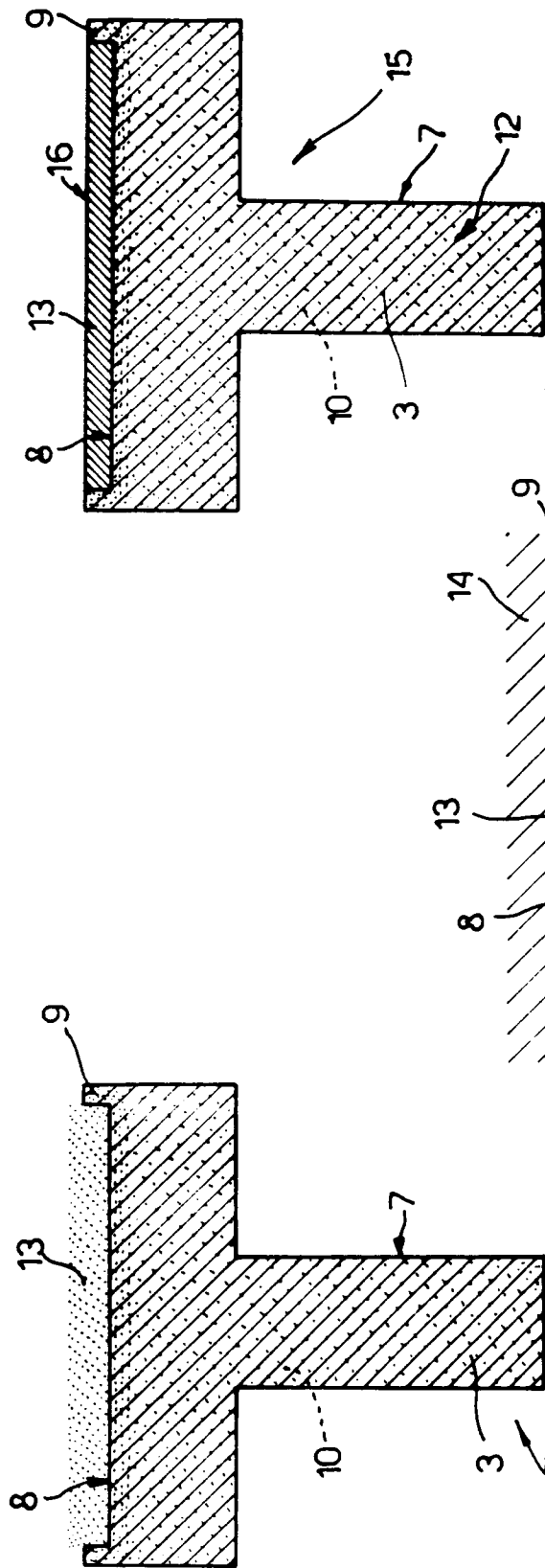


Fig. 6

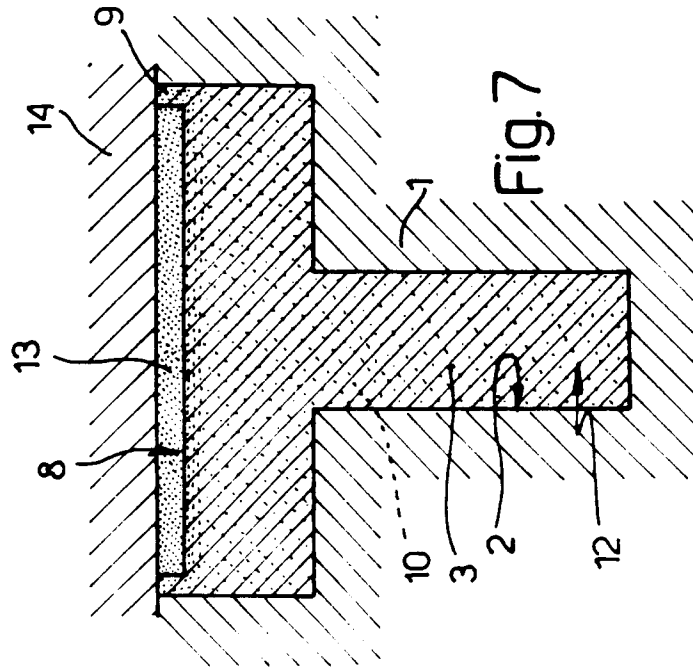


Fig. 7

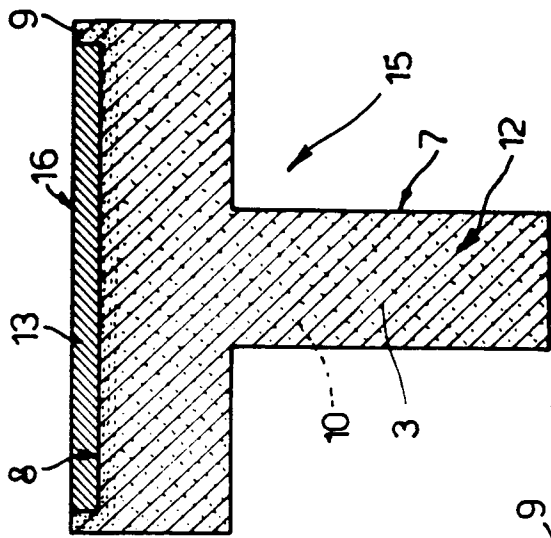


Fig. 8