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GB 2458745 A US 7073561 B1
US 6682688 B1

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(54) Title of the Invention: **A method of forming an article using a powder layer manufacturing process**
Abstract Title: **Powder layer manufacturing of an article using a preform to support the article**

(57) A first method of forming a metal article involves inserting a removable preform 5 into a powder bed 3 and building part of the article on the preform 5 using an additive layer process. A second method of forming an article involves providing a first support 2, forming part of the article A using a powder layer manufacturing process up to a level 3a at or beneath the lowest point of a part of the article yet to be formed part which has a base spaced from the first support 2, locating a second support 5 beneath the location on which the part yet to be formed will lie, forming the remainder of the article including the part supported by the second support and then removing the supports 2 and 5.

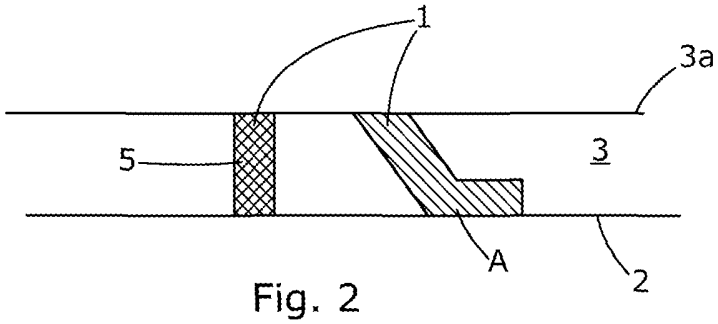

Fig. 2

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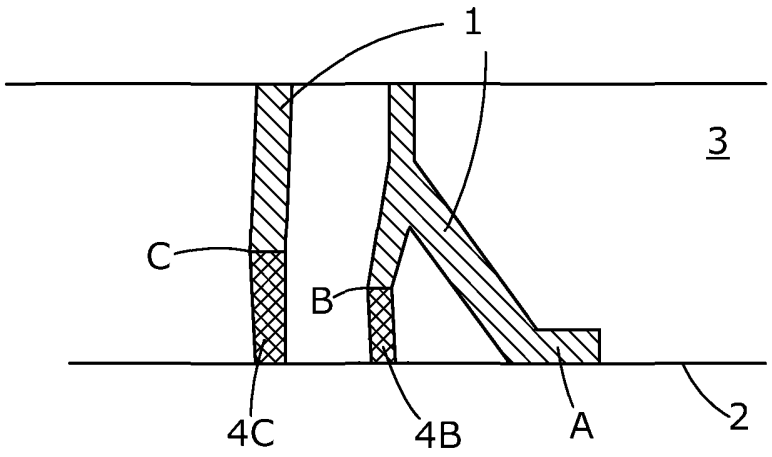

Fig. 1

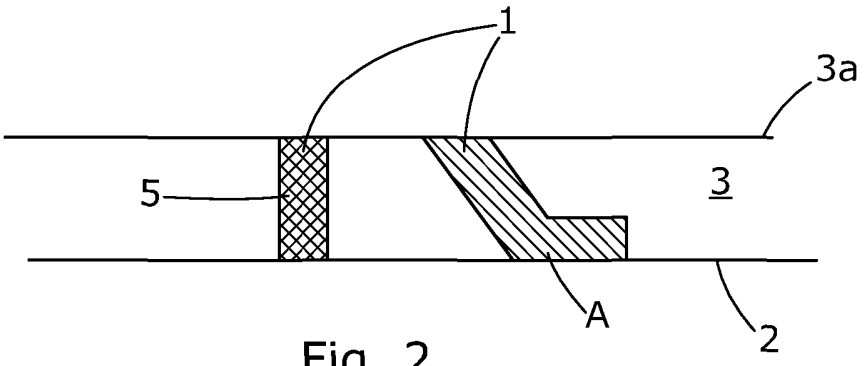

Fig. 2

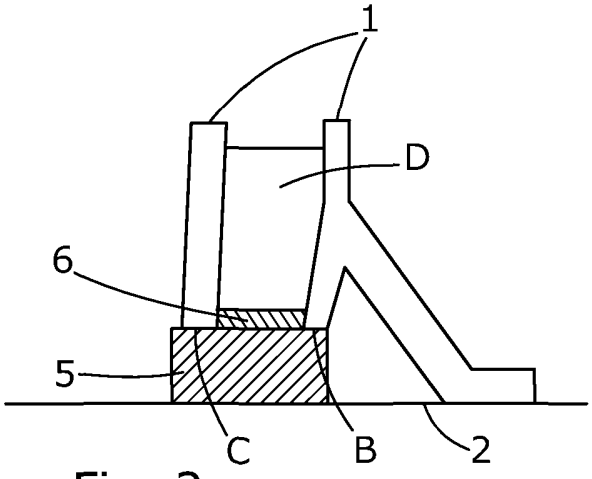

Fig. 3

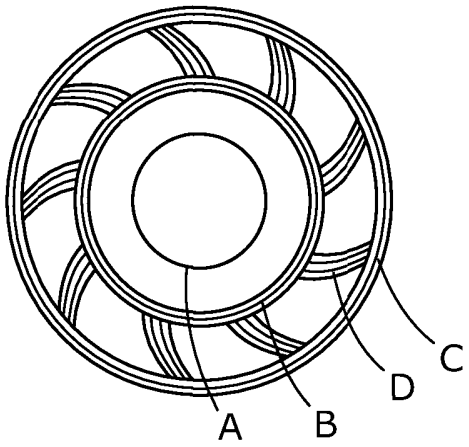

Fig. 4

A METHOD OF FORMING AN ARTICLE USING A POWDER LAYER MANUFACTURING PROCESS

This invention relates to a method of forming an article using a powder layer manufacturing process.

Power layer manufacturing processes operate by forming successive build layers of powder on a support and selectively locally sintering, melting or otherwise binding the powder so as to form an article. Examples of such processes are described in US-A-4863538 and US-A-4247508.

Typically these processes are carried out using metal powders. Unlike plastics, metals have a rapid transition from solid to low viscosity liquid and back to solid when heated and cooled. All metals, and most alloys, also have relatively large co-efficiency of thermal expansion. As a result, and particularly when there is no significant heating of the powder bed, the conversion of metal powder into an element of the solid part by melt and re-solidification creates compressive stresses in the part. This in turn can cause mechanical deformation, if the part is not rigidly restrained. Also, without a solid surface to wet upon, the molten metal will tend to bend up under tensile stress and will not commence the building of a solid part from a layer of unrestrained powder.

A consequence of this is that in building parts in metal, each element of the desired metal structure must be supported by an element of a previous layer and the entire part must be restrained during building. It is therefore typical to build the first layer on a base plate, which must subsequently be removed. This base plate must also be sufficiently stiff so as to restrain the tendency to relieve

mechanically the inherent stress caused by cooling and by re-solidification of the metal from the powder bed into a solid part. It is also known that powder layer manufacture may be used to repair an existing article or build up from a preform. In either case the existing article or preform (which subsequently forms the lower part of the completed article) must fulfil the functions of a baseplate as described here.

Because of these issues, the ideal is to modify the design of a part so that as little support structure is required to build the part as possible. However, not all designs enable this approach to be used.

A typical prior art approach is illustrated in Figure 1. An article to be formed is generally indicated at 1 and is shown in cross section. It will be seen that a base plate 2 is provided on which an element A is directly built. Elements B and C, which begin above the base plate, however, need separate support and these are shown at 4B and 4C. These elements B and C are typically built up using the same process as is used to form element A and then have to be removed. This can cause issues with delicate edges such as veins and further the need to form 4B and 4C from the powder 3 means that the process is slower due to more activity from the laser.

From one aspect the invention consists in the method of forming an article using a powder layer manufacturing process including:

(a) providing a first support;

(b) forming a part of an article up to a level at or beneath the lowest point of a to-be formed part, which has a base from the first support;

(c) locating a pre-formed support beneath the location in which the to-be formed part will lie such that that part can be formed on the preformed support and wherein the preformed support does not project beyond the level; and

removing the preformed support when the to-be formed part and/or article is completed.

The preformed support may be mechanically, thermally, chemically or electrochemically removed. Preferably the preformed support is made of a different material from the article, for example to enhance that removal. Thus for example the material of the preformed support may be softer and/or have a different thermal coefficient of expansion than the material of the article.

Although the invention has been defined above it is to be understood that it includes any inventive combination of the features set out above when the following description. It further includes any article made by the base plate.

Turning to Figure 2. An article A is constructed using the powder 3 in the manner known, on a base plate 2. The process continues until the level 3A is reached at which point a preformed support 5 is inserted into the powder 3 and the process continues. In the case shown in Figure 2 the element B could then be built up. Multiple preforms can be inserted to allow the construction of elements C and D. So for example in Figure 3 a larger preformed 5 subsequently supports a preformed 6 in order to form the vein D. The preforms may themselves be of different materials.

The use of these preforms can have several advantages. For example if the article is being made from a very hard material, e.g. cobalt chrome, it can be

extremely difficult to machine that material. If the preforms are made of mild steel, then they can much more readily be machined away. Alternatively, the preform may be removed by thermal, chemical or electrochemical methods by selecting appropriate materials. If a line of weakness can be created between the preform and the built part, then removal may be assisted.

CLAIMS

1. A method of forming an article using a powder layer manufacturing process including:

(a) providing a first support;

(b) forming a part of an article up to a level at or beneath the lowest point of a to-be-formed part which has a base spaced from the first support;

(c) locating a preformed support beneath the location in which the to-be-formed part will lie so that part can be formed on the preformed support and wherein the preformed support does not project beyond the level; and

(d) removing the preformed support when the to-be-formed part and/or the article is completed.

2. A method as claimed in claim 1 wherein preformed support is mechanically thermally chemically or electro-chemically removed.

3. A method as claimed in any of the preceding claims wherein the preformed support is made of a different material from the article.

4. A method as claimed in claim 3 wherein the material or preformed support is softer and/or has a different thermal coefficient of expansion than the material of the article.

5. A method of forming a part by metal (alloy) additive layer process whereby a removable preform is inserted into the powder bed and an element of the part is built upon it.

6. A method according to Claim 5 wherein the additive layer process has a powder bed.

7. A method according to Claim 5 wherein the preform removal method is by mechanical, thermal, chemical or electrochemical methods.

8. A method according to Claim 5 wherein the preform is reusable.

9. A method according to Claim 5 wherein the preform is selectively removed.

10. A method according to Claim 5 wherein a preform is mounted on a preform.

11. A preform used in a metal (alloy) additive layer process to provide support for an element of a part that commences above the level of the baseplate.

12. A preform according to Claim 11 wherein the additive layer process has a powder bed.

13. A preform according to Claim 11 wherein the preform is a metal or metal alloy.

14. A preform according to Claim 11 wherein the material of the preform can be selectively removed from the part.

15. A preform according to Claim 11 wherein the material of the preform is easier to mechanically remove that the material of the part built by the additive layer process.

Application No:	GB1104149.8	**Examiner:**	Matthew Lawson
Claims searched:	1-4	**Date of search:**	24 June 2011

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X,A	X:1-4 A:11-15	US 6682688 B1 (HIGASHI) - column 1 lines 61-67, column 3 lines 34-44, column 6 lines 28-43, column 15 lines 48-59, column 16 lines 20-36 and figures 1A-1E.
X,A	X:1-4 A:11-15	GB 2458745 A (MATERIALS) - figure 2.
A	11,13-15	US 7073561 B1 (HENN) - figures 4-8.

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

Worldwide search of patent documents classified in the following areas of the IPC

B22F; B23K; B29C

The following online and other databases have been used in the preparation of this search report

Online: EPODOC, WPI

International Classification:

Subclass	Subgroup	Valid From
B22F	0003/00	01/01/2006