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D E C I S I O N
of 12 April 1994

Case Number: T 0275/92 - 3.2.5

Application Number: 85112132.7

Publication Number: 0176942

IPC: B23P 6/00

Language of the proceedings: EN

Title of invention:
Method for repairing metal in an article

Patentee:
General Electric Company

Opponent:
Gebrüder Sulzer Aktiengesellschaft

Headword:
-

Relevant legal norms:
EPC Art. 56

Keyword:
"Inventive step (yes)"

Decisions cited:
-

Headnote/Catchword:

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Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 0275/92 - 3.2.5

D E C I S I O N
of the Technical Board of Appeal 3.2.5
of 12 April 1994

Appellant: (Opponent)
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Representative:
-

Respondent: (Proprietor of the patent)
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Decision under appeal:
Decision of the Opposition Division of the European Patent Office announced at the end of the oral proceedings of 10 January 1992 and dispatched on 28 January 1992, rejecting the opposition filed against European patent No. 0 176 942 pursuant to Article 102(2) EPC.

Composition of the Board:

Chairman: C.V. Payraudeau
Members: H.J. Seidenschwarz
A. Burkhart

Summary of Facts and Submissions

I. The Appellant (Opponent) lodged an appeal against the decision of the Opposition Division by which the opposition against the European patent No. 0 176 942 had been rejected pursuant to Article 102(2) EPC.

The documents GB-A-2 052 566 (E1) and US-A-4 323 756 (E3) referred to in the reasons for the decision of the Opposition Division are also relevant to the present decision.

II. Oral proceedings were held.

(i) The Appellant requested that the decision under appeal be set aside and that the patent be revoked.

(ii) The Respondent (Patentee) requested that the appeal be dismissed, and that the patent be maintained unamended (main request), and as a subsidiary request, that the patent be maintained in amended form on the basis of a new Claim 1 incorporating the features of Claim 5.

(iii) Claim 1 of the patent as granted reads as follows:

"1. A method for repairing an article having an article portion (66) of a metallic material, comprising the steps of: concurrently applying to the article portion (66) a laser beam (60) and a powder (48) comprising metal powder; the metal powder being of a composition substantially the same as the metallic material of the article portion (66); the laser being applied, at a laser beam spot (68), to the

powder (48) and the article portion beneath the powder (48) in a power density range of 10^{3} to 10^{6} watts per square centimeter to melt both the metal powder (48) and material of the article portion (66) to generate a molten interaction zone from the metal powder and the metallic material of the article portion (66), while maintaining an interaction time in the range of 0.005-2 seconds between the laser beam (60) and the powder (48) and article portion (66) beneath the powder (48) thereby reducing the heat affected zone in the article portion (66) and providing a repair layer on the article portion (66) consolidated from the powder (48) and the metallic material of the portion (66)."

(iv) The Appellant essentially argued as follows:

Document E1 discloses a method of applying a metallic coating to a metallic substrate, whereby a laser beam and a metal powder are simultaneously applied to the same spot. The relevant process parameters, i.e. the power density and the interaction time, are such that the metallic coating material is fused to the substrate. Fusion, however, can only take place when both the metallic coating material and the substrate in the area of the impingement of the laser beam are melted, thus forming a strong bond when the molten interaction zone solidifies.

The process parameters as disclosed in document E1 are substantially in the same range as the parameters according to the method of the patent in suit. The only difference between the process according to document E1 and the process

according to the patent in suit is that in document E1 a process for **coating** an article is described, whereas in the patent in suit a process for **repairing** an article is claimed. Since applying a coating to an article sometimes serves to recreate the original geometrical configuration of that article, e.g. when it is worn out, the aforementioned difference is merely a matter of linguistics. It is obvious to the person skilled in the art that in the case of a **repair** coating the coating material and the substrate can have the same composition.

Furthermore, in the method according to the patent in suit the composition of the powder is not necessarily the same as the composition of the article to be repaired, see e.g. the example described in the paragraph bridging pages 3 and 4, where a titanium powder conforming to Aerospace Material Specification AMS 4928H is applied to a Ti-6-4 alloy.

(v) The Respondent disagreed with the Appellant and argued essentially as follows.

The application of a metallic coating and the method for repairing a metallic article are quite different processes which cannot be compared. The purpose of applying a coating is to modify the properties of the surface of an article. To that end, the coating material and the substrate have different compositions, as the example of document E1 demonstrates. The requirement that the metal powder being of a composition substantially the same as the material of the metallic article to be repaired is essential to the present invention. Firstly,

the invention relates to a **repair** process for a damaged portion of a metallic article with the purpose to recreate its original configuration and having its original microstructure. Secondly, in order to effectively create a molten interaction zone of the metal powder and the material of the metallic portion, the melting point of the powder and of the article portion should be preferably identical or at least close, which means in practice that also the composition of the powder and of the metallic portion should be substantially the same.

When applying a coating, it is undesirable to generate a molten interaction zone of the molten coating material and the substrate, because a degree of mixing will take place resulting in a deterioration of the coating. Nothing in document E1 indicates that a molten interaction zone is formed; in fact, the fusion takes place between the heated, not molten, substrate and the molten metallic coating material. In the example disclosed on page 2, lines 43 to 73 of document E1 the melting point of the substrate is considerably higher than the melting point of the coating material, and, moreover, the heat dissipation of the substrate is higher than that of the powder, so that a molten interaction zone will not be created. From this it follows that **fusion** means in this known method that only the metallic coating material is molten.

Document E1 also fails to address the problem of reducing the extent of the heat affected zone. That some of the process parameters according to document E1 and according to the patent in suit

are in a similar range is an accidental coincidence. Since the processes involved are fundamentally different a comparison of these process parameters is meaningless.

Reasons for the Decision

1. *Novelty*

It is not disputed by the parties that neither document E1 nor document E3, which is already referred to in the description (page 2, lines 17 to 19) of the patent in suit, discloses all the features of Claim 1 of the patent in suit. There is no need for further substantiation of this matter.

The subject-matter of Claim 1 of the patent as granted is therefore new within the meaning of Article 54 EPC.

2. *The invention*

The invention relates to the repair of a metallic portion of an article using a metal powder and a laser beam.

The problem this invention seeks to solve is to provide an improved method for repairing a damaged metallic portion of an article to recreate its original configuration and material while reducing adverse effects on the article resulting from the method by limiting the extent of the heat affected zone (cf. page 2, lines 20 to 23, of the description).

This problem is solved by the method with the features as specified in Claim 1.

In particular, by concurrently applying to one spot of the article portion the laser beam and the powder a molten interaction zone from the metal powder and the metallic material of the article portion is generated, whereby the extent of the heat affected zone in the article portion is reduced by controlling the power density and the interaction time.

According to Claim 1, the powder that is applied to the article portion comprises metal powder, which is of substantially the same composition as the metallic material of the article portion. It is this metal powder which permits to recreate the original microstructure of the article to be repaired in the molten interaction zone, which is created from said metal powder and said material.

3. *Inventive Step*

The invention is not suggested by the teachings of documents E1 and E3 for the following reasons:

3.1 Document E1 discloses a method of applying a metallic coating to a metallic substrate, whereby a laser beam and a metal powder are concurrently applied to the spot to be coated.

An essential feature for applying successfully a metallic protective coating to a metallic substrate is the quality of the bonding between coating and substrate. One method for improving this bonding between the metallic coating and the metallic substrate comprises applying the coating material to the substrate in powder form so as to provide a layer of the powder which is subsequently melted using the laser beam. Such a method is disclosed in document E3. Whilst an improved

bonding results from this known method, it is difficult to accurately control the coating area and depth (cf. document E1, lines 4 to 44).

Therefore, according to the method as disclosed by document E1 (cf. Claim 1), the laser beam melts the **particles of the metallic coating material to form a molten pool of said metallic coating material** in the area of impingement of the laser beam upon the substrate and **this pool** traverses said substrate at such a rate that fusion takes place between the substrate and the molten coating material. The fusion can take place since the **substrate** is **heated** by the laser beam (cf. page 2, lines 17 to 20) which means that the **substrate** is not fully molten. This follows also from the fact that the metallic material of the substrate and the particles of the metallic coating material are of different composition: in the given example, the substrate is of a nickel based alloy which has a higher liquidus temperature than the cobalt based alloy used for said particles (cf. page 2, lines 43 to 71). It is therefore the heat transfer to the substrate via the particles which provides the necessary substrate surface conditioning for improving the bond between the substrate and the final solidified coating.

Having regard to the power density and the interaction time which can be calculated on the basis of the figures given in the example of document E1, viz. about 60 kW/cm^2 and 0.17 to 0.2 s, respectively, it is to be noted that these parameters lie in the same range as the parameters defined in Claim 1 of the patent in suit. However, the person skilled in the art would not consider using the parameters defined in a method for applying a metallic coating to a metallic substrate in a method for repairing metal in an article because of the existing differences referred to above.

Consequently, the teaching of document E1 does not suggest the invention such as defined in Claim 1 of the patent in suit, according to which the metal powder has a composition substantially the same as the metallic material of the substrate and, resulting from this feature, a molten interaction zone is produced by melting both the metal powder and the metallic material of the substrate to obtain a repair portion having the same characteristics as the substrate with a reduced heat affected zone.

3.2 Document E3 describes a method for the production of bulk rapidly solidified metallic articles of near-net shape, by depositing multiple thin layers of feedstock using an energy beam to fuse each layer onto a substrate. The method is said to be ideally suited to the field of gas turbine knife edge seal fabrication and repair (cf. column 5, lines 50 to 52). The feedstock may be in the form of metal powder or wire. The method according to document E3 causes significant melting of the substrate surface (cf. the paragraph bridging columns 4 and 5). By applying a plurality of layers of feedstock, each layer is melted more than once, since the thickness of each layer is smaller than the depth to which the substrate is melted. This multiple melting is seen as an advantage of this method (cf. document E3, column 5, lines 6 to 12).

However, the creation of a large heat affected zone is precisely what the present invention tries to avoid (cf. above point 2).

A second major difference between the method of the patent in suit and the known method of document E3 is that according to the invention the feedstock and the laser beam are concurrently applied (for generating concurrently a molten interaction zone from the metal

power and the metallic material of the article portion), whereas document E3 teaches clearly that it is desirable that the feedstock contact the workpiece outside of the energy beam (thus the laser beam melts the substrate and the feedstock material is carried into the laser beam where it also melts and gets mixed with the melted substrate material) (cf. column 3, lines 5 to 8, coulumn 7, lines 44 to 51, and Figure 2).

Consequently, document E3 leads away from the subject-matter of the patent as claimed in at least two points: a large affected heat zone is preferred and the feedstock is fed to the substrate outside of the laser beam. Therefore, the teaching according to document E3 cannot suggest the person skilled in the art the essential features of the patent in suit.

3.3 Summarizing, document E1 relates to a process of applying a coating to a substrate, where a coating material different from the material of the substrate is applied at the laser beam spot and whereby the substrate is not melted, whereas document E3 concerns a repair method, whereby the feedstock is applied outside the laser beam spot and the substrate is melted to a considerable depth. From this follows that there is no reasonable way to reconcile, let alone to combine the teachings of the cited prior art.

This view is supported by the description of the prior art in document E1 referred to in above point 3.1, where the alternative method of applying a layer of coating material in powder form to the substrate is criticized.

The person skilled in the art will therefore - starting from the method of applying a coating to a substrate according to document E1 or the method to repair a metallic article according to document E3 - neither by

his expert knowledge alone, nor in combination with any other teaching of the cited prior art, not arrive at the subject-matter according to Claim 1.

Hence, the subject-matter of Claim 1 involves an inventive step within the meaning of Article 56 EPC.

4. In view of the above, the patent as granted can be maintained with Claim 1 together with the dependent Claims 2 to 8 concerning particular embodiments of the subject-matter of Claim 1.

Order

For these reasons, it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

A. Townend C. Payraudeau