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Datasheet for the decision of 19 April 2016

Case Number: T 0572/13 - 3.2.03

Application Number: 03768447.9

Publication Number: 1583628

IPC: B22F3/105

Language of the proceedings: EN

Title of invention:
ARRANGEMENT AND METHOD FOR PRODUCTION OF A THREE DIMENSIONAL OBJECT

Patent Proprietor:
ARCAM AB

Headword:

Relevant legal provisions:
EPC Art. 100(a), 54, 56
RPBA Art. 13(1), 13(3)

Keyword:
Late-filed document - admitted (yes)
Late-filed request - admitted (yes)
Novelty - main request (yes)
Inventive step - main request (yes)

This datasheet is not part of the Decision.
It can be changed at any time and without notice.

Decisions cited:

Catchword:

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Case Number: T 0572/13 - 3.2.03

D E C I S I O N
of Technical Board of Appeal 3.2.03
of 19 April 2016

Appellant: (Patent Proprietor)	ARCAM AB Krokslätts Fabriker 30 431 37 Mölndal (SE)
Representative:	Zacco Sweden AB P.O. Box 5581 114 85 Stockholm (SE)
Decision under appeal:	**Decision of the Opposition Division of the European Patent Office posted on 11 February 2013 revoking European patent No. 1583628 pursuant to Article 101(3)(b) EPC.**

Composition of the Board:

Chairman	G. Ashley
Members:	V. Bouyssy
	E. Kossonakou

Summary of Facts and Submissions

I. European patent No 1 583 628 (in the following: "the patent") concerns 3D printing by electron beam melting.

II. The patent as a whole was opposed on the ground of Article 100(b) and on two grounds of Article 100(a) EPC, namely for lack of novelty and inventive step.

III. The opposition division decided that Article 100(a) EPC prejudiced the maintenance of the patent as amended according to the main and auxiliary requests before it, and hence revoked the patent.

IV. This decision was appealed by the patent proprietor (in the following the appellant).

V. By letter dated 12 May 2015, the opponent (here the respondent) withdrew its opposition.

VI. With the summons to oral proceedings, the Board sent a communication pursuant to Article 15(1) of the Rules of Procedure of the Boards of Appeal (RPBA) indicating its preliminary opinion of the case.

VII. Oral proceedings before the Board were held on 19 April 2016.

VIII. Requests

The appellant requested that the decision under appeal be set aside and the patent be maintained as amended on the basis of the main request as filed in the oral proceedings, or alternatively on the basis of one of auxiliary requests 1 to 3 as filed with the letter dated 6 April 2016.

IX. Claims of the appellant's main request

Independent method claim 1 reads as follows (compared with claim 1 as granted, added features are indicated in bold, deleted features in strike-through):

"1. A method for production of three-dimensional bodies by successive fusing together of selected areas of a powder bed, which parts correspond to successive cross sections of the three-dimensional body, which method comprises the following method steps: application of powder layers to a work table, supplying energy from a radiation gun according to an operating scheme determined for the powder layer to said selected area within the powder layer, fusing together that area of the powder layer selected according to said operating scheme for forming a cross section of said three-dimensional body, a three-dimensional body being formed by successive fusing together of successively formed cross sections from successively applied powder layers, ~~characterized in that~~ **wherein** said selected area is divided into one or more inner areas I, each having an edge R, where the inner area I is fused together in the course of a movement pattern for the focal point of the beam of the radiation gun which comprises a main movement direction and an interference term which is added to said main movement direction and has a component in a direction at right angles to the main movement direction, **wherein the interference term is of such a nature that a fusion zone is formed which has a width corresponding to twice the amplitude of the component of the interference term in a direction at right angles to the main movement direction, and wherein at least that edge which forms an inner or outer lateral surface of the finished body is fused**

together in the course of a movement which follow the edge without addition of an interference term, and wherein the radiation gun consists of an electron gun."

Dependent claims 2 to 8 define preferred embodiments of the method of claim 1.

X. Prior art

(a) In the statement setting out the grounds of appeal, the appellant referred to the following prior art documents, which were filed in the opposition proceedings and are cited in the decision under appeal:

D1: DE 102 08 150 A1
D7: US 4 863 538 A

(b) In a letter dated 23 February 2015, the respondent relied on the following documents:

D3.2: JP 62101408 A
D3.1: Abstract of D3.2
D3:3: English translation of D3.2

Of these, D3.1 and D3.2 were filed in the opposition proceedings and are cited in the decision under appeal.

In the following, this set of documents is referred to collectively as D3.

(c) In the oral proceedings, the Board relied on the following document:

D8: Swedish patent application SE 0001557-8

XI. The arguments of the appellant, and those of the respondent before the withdrawal of the opposition, insofar as relevant for the present decision, can be summarised as follows:

(a) Article 100(b) EPC

Argument of the respondent:

It follows from paragraph 23 of the patent specification that, in a preferred embodiment of the invention, the average speed of the absolute value of the movement of the focal point in the direction of the interference term exceeds "the speed of the heat propagation in the material". This parameter is not clearly defined and it is insufficiently disclosed in the patent how to calculate or measure it.

(b) Main request - Novelty

Appellant's case:

The opposition division considered that the subject-matter of claim 1 lacked novelty over D1 and D7.

The subject-matter of claim 1 as now amended is novel in light of D1 and D7 because none of these documents discloses the following features of the claim:

- "the radiation gun consists of an electron gun";
- "the interference term is of such a nature that a fusion zone is formed which has a width corresponding to twice the amplitude of the component of the interference term in a direction at right angles to the main movement direction"; and

- "at least that edge which forms an inner or outer lateral surface of the finished body is fused together in the course of a movement which follow the edge without addition of an interference term".

Argument of the respondent:

Contrary to the appellant's view, D7 discloses the third feature in the above list. It follows from column 6, lines 5 to 24 of D7 that the desired boundaries of each cross-sectional section of the 3D part are fused in the so-called vector mode, wherein the laser beam actually traces the desired boundaries, without any "interference term" in a transverse direction. According to column 6, lines 12 to 15, it is preferred that the laser beam is moved according to a movement pattern, i.e. the so-called raster scan mode shown in figure 2, only when irradiating the interior.

(c) Main request – Inventive step

Appellant's case:

The three afore mentioned features that distinguish claim 1 from D7 reduce the risk of overheating the powder and thus of inducing surface irregularities and internal stresses and, at the same time, ensure that the lateral surface of the end product is smooth. In contrast to the laser beam of D7 which sinters the powder, the electron beam can fully melt the powder. In addition, the electron beam can be controlled in a much faster and more precise manner than the laser beam. This allows to improve the material properties of the end product and its dimensional accuracy. When seeking to achieve these technical effects, the skilled person would have no motivation to consider D1, D3 or D8 and,

even if he did, these documents could not lead to the claimed solution. Thus, the claimed invention has an inventive step when starting from D8.

D8 discloses a process for manufacturing 3D parts by electron beam melting a metal powder bed. Claim 1 differs from it by the different movements for the electron beam to fuse the inner area I and the edge R of the desired part within each powder layer. These features allow to reduce the risk of overheating and thus of the appearance of shape deviations and residual stresses in the end product, while ensuring that the surface of the end product is smooth. As explained above, these features are not hinted, let alone taught, in the cited prior art.

Reasons for the Decision

1. Withdrawal of the opposition means that the opponent ceases to be party to the proceedings in respect of the substantive issues. In the context of the patent proprietor's appeal, however, the Board can take into account the facts, arguments and evidence submitted by the opponent prior to the withdrawal of the opposition, when examining the correctness of the decision under appeal (see also Case Law of the Boards of Appeal of the EPO, 2013, IV.C.4.1.2 and IV.E.3.4.1).

2. Consideration of the appellant's main request

2.1 Under Article 13(3) RPBA, amendments made after oral proceedings have been arranged are not admitted if they raise issues which the Board or the other party or parties cannot reasonably be expected to address without an adjournment of the oral proceedings. In addition, it is established case law that amended

claims belatedly filed at such a stage, in particular during oral proceedings, must be clearly allowable in order to be admitted into the proceedings.

2.2 The appellant filed its main request in the oral proceedings before the Board. The set of amended claims differs from that of the main request filed with letter dated 6 April 2016 only in that device claim 9 has been deleted. Method claim 1 differs from claim 1 of the main request filed with the statement of grounds of appeal in that the following two limiting features have been introduced:

- that "the interference term is of such a nature that a fusion zone is formed which has a width corresponding to twice the amplitude of the component of the interference term in a direction at right angles to the main movement direction" and
- that "the radiation gun consists of an electron gun".

2.3 These amendments have been made with the aim of overcoming all the respondent's objections and of addressing the Board's preliminary opinion. They did not give rise to any new or complex issues that could not be dealt with without adjournment of the oral proceedings. Even though the added feature that "the radiation gun consists of an electron gun" was taken exclusively from paragraph 13 and figure 1 of the patent specification, this amendment could reasonably have been expected by the respondent and it did not take the Board by surprise. Indeed, in the patent, figure 1 is the only illustration of an arrangement used in the method according to the invention and it shows a radiation gun 6 that is an electron gun and means 7 for focusing and deflecting the beam that are electromagnetic coils 7' and 7" (paragraphs 13 to 15 of

the patent). Finally, in the Board's view, the amendments *prima facie* overcome the objections raised by the opposition division and the respondent under Articles 54 and 56 EPC.

2.4 For these reasons, the Board decided to take the appellant's main request into consideration (Article 114(2) EPC and Articles 13(1) and (3) RPBA).

3. Interpretation of claim 1

3.1 Before turning to the questions of added subject-matter, sufficiency of disclosure, novelty and inventive step, it is necessary to construe the feature of the "fusion zone" in claim 1.

3.2 Claim 1 is directed to a reader skilled in the art of 3D printing, also known as additive manufacturing. Thus, the skilled reader is an engineer having experience in the design of 3D printers, including common general knowledge, in particular concerning the melting and sintering of metals.

3.3 Claim 1 defines a process step wherein an inner area of the powder bed "is fused together in the course of a movement pattern for the focal point of the beam of the radiation gun which comprises a main movement direction and an interference term which is added to said main movement direction and has a component in a direction at right angles to the main movement direction, wherein the interference term is of such a nature that a fusion zone is formed which has a width corresponding to twice the amplitude of the component of the interference term in a direction at right angles to the main movement direction".

3.4 In the context of claim 1, the term "fusion zone" is clear and it can only be given its normal meaning, namely that it is the area of the powder bed where there is complete melting and resolidifying of the powder during the process. From the above definition of the width of the "fusion zone" it follows that this area spans the entire area which is scanned by the focal point of the beam in the course of its movement pattern.

3.5 Hence, it follows from the wording of claim 1 alone that, in the movement pattern of the focal point of the electron beam within the inner area(s) I, the interference term is set such that the focal point forms a continuous wide fusion zone which propagates in the main movement direction.

3.6 This understanding is in conformity with the teaching in the description of the patent (paragraph 22 and figure 4; paragraph 39 and figure 8).

4. Articles 123 and 84 EPC

4.1 Claim 1 differs from claim 1 as granted in that it comprises the further limitations that:

(a) "the interference term is of such a nature that a fusion zone is formed which has a width corresponding to twice the amplitude of the component of the interference term in a direction at right angles to the main movement direction";

(b) "at least that edge which forms an inner or outer lateral surface of the finished body is fused together in the course of a movement which follow the edge without addition of an interference term"; and

(c) "the radiation gun consists of an electron gun".

4.2 These amendments are supported by the information in the application documents as originally filed:
- for feature (a) see page 11, lines 16 to 19;
- for feature (b) see edge R in figure 2 and page 12, lines 13 and 14 and lines 23 to 25; figure 9 and page 15, lines 24 to 26; figure 12 and page 27, lines 21 to 23; page 29, lines 8 to 10; figure 18 and page 31, lines 3 and 4; claim 5;
- for feature (c) see figure 1, page 8, line 20 and page 35, line 31.

4.3 Since these features limit the extent of protection conferred by claim 1, the requirement of Article 123(3) EPC is met.

4.4 Finally, the Board is satisfied that the amendments neither introduce nor give rise to a lack of clarity in amended claim 1.

4.5 In conclusion, the amendments to claim 1 of the main request meet the requirements of Articles 123(2) and (3) and 84 EPC.

5. Article 100(b) EPC

5.1 The patent comprises a detailed description of a number of ways to carry out the claimed invention; a skilled reader of the patent, using common general knowledge, would have no difficulty in putting the invention into practice. Thus, the disclosure of the invention in the patent is sufficiently clear and complete within the meaning of Article 83 EPC.

5.2 Contrary to the respondent's view, it is clear in the context of the patent that, in paragraph 23 of the

description, the expression "the speed of the heat propagation in the material" refers to the propagation speed of the fusion zone (see paragraph 5, line 41). In practice, it is possible to measure the propagation of the heat, or of the fusion zone, by means of a high speed camera (see e.g. video camera 14 in paragraph 70 and figure 13 of the patent specification).

6. Consideration of D3 and D8

6.1 The respondent filed document D3.3 and relied on documents D3.1 and D3.2 for the first time with its submission dated 23 February 2015.

6.2 The filing of these documents constitutes an amendment to the respondent's case after it has filed its reply to the statement of the grounds of appeal, and so one within the meaning of Article 13(1) RPBA.

6.3 The filing of these documents was an appropriate reaction to the filing of appellant's auxiliary requests 1 and 2 with the letter dated 14 March 2014. These documents did not introduce a fresh case: D3.1 and D3.2 were already cited in the opposition proceedings; English translation D3.3 was used only to confirm the teaching in D3.1.

6.4 For these reasons, the Board decided to take these prior art documents into consideration (Article 114(2) EPC and Article 13(1) RPBA).

6.5 D8 is cited as closest prior art in paragraph 3 of the patent specification and thus is part of the proceedings (see e.g. Case Law of the Boards of Appeal of the EPO, 2013, IV.C.1.5). It was available to the

public from 28 October 2001 and hence is prior art in accordance with Article 54(2) EPC.

7. Novelty

7.1 The subject-matter of claim 1 is novel over D1, D7 and D8 for the following reasons.

7.2 Novelty against D1

7.2.1 D1 discloses a method for producing a 3D part by selective laser sintering a powder bed.

7.2.2 D1 does not mention the use of an electron gun.

7.2.3 It is disclosed in D1 that, in each powder layer, the edge which forms a lateral surface of the end product is fused together by moving the focal point of the laser beam forward and backward while tracing the edge, without addition of a transverse movement (paragraphs 15 and 44 and figures 3 and 4, edges K, K_1, K_i, K_n). D1 teaches that the laser beam can be controlled to trace a fused edge which is at least 50% wider than the focal point (paragraphs 46 to 48).

7.2.4 Within the inner areas of the product, the focal point of the laser beam is additionally moved forward and backward in a direction at right angles to the main movement direction X (paragraphs 50 and 51 and figure 6; forward movement V, backward movement R, transverse movement T). The beam thus forms a fusion curve which has the same amplitude as the transverse movement. This fusion curve is not a continuous wide fusion zone as defined in claim 1 (see point 3 above). Even though D1 teaches that the beam can be controlled to trace a fusion curve that is wider or thicker than the focal

point, there is no disclosure in D1 that the fusion curve would overlap itself to form a continuous wide fusion zone as required by claim 1. In fact, D1 mentions the use of lasers having a power of 40 or 60 Watts (paragraphs 47 and 48) and such low-power lasers are unlikely to provide such a fusion zone.

7.2.5 Hence, the subject-matter of claim 1 differs from the selective laser sintering method of D1 in that:

- "the interference term is of such a nature that a fusion zone is formed which has a width corresponding to twice the amplitude of the component of the interference term in a direction at right angles to the main movement direction" and
- "the radiation gun consists of an electron gun".

7.3 Novelty against D7

7.3.1 D7 discloses a method to produce a 3D part by selective laser sintering a powder bed.

7.3.2 As ruled by the opposition division, D7 discloses the different beam movements required in claim 1 for fusing the edge of the 3D part and its inner area in each powder layer (column 6, lines 12 to 15), namely:

- a "vector mode" wherein the laser beam (64) is directed in a vector fashion to trace the outline and interior of each cross-sectional region of the desired part and thus to actually trace the desired boundaries of the part;

in combination with

- a "raster scan mode" wherein the laser beam (64) is moved along a low scan axis (70) (the "main movement direction" of claim 1) and a fast scan axis (68) (the "interference term" of claim 1) to

irradiate the interior within the boundaries defined in the vector mode (figure 2).

7.3.3 The appellant contests that, in the vector mode of D7, the edge is fused together "in the course of a movement which follows the edge without addition of an interference term", as required in claim 1. However, D7 teaches that the focal point of the beam traces the desired shape of the edge in the vector mode (column 6, lines 5 to 8 and 14) and this clearly is a movement which follows the edge "without addition of an interference term" in the sense of claim 1 (see also the two last sentences in paragraph 79 of the patent specification).

7.3.4 There is no mention in D7 of an electron gun being used to fuse together the powder.

7.3.5 D7 also fails to disclose a continuous wide fusion zone as defined in claim 1 (see point 3 above). In the raster scan pattern 66 shown in figure 2, the laser beam 64 sweeps over a target area of the powder bed in a zig-zag manner. As the beam is moved along the axis 68, it is turned on to sinter the powder and trace a fusion line. When the beam is moved forward along the axis 70, it is turned off and the powder is not sintered. Thus, in this raster scan mode, the beam traces a series of fusion lines that extend across the target area and are parallel to the axis 68. There is no disclosure in D7 that the beam be focused and moved in such a manner that the fusion lines would overlap each other to form a continuous wide fusion zone in the target area. In fact, D7 mentions that the laser preferably has a power of up to 100 Watts (column 4, lines 51 to 54) and it is unlikely that this low-power

laser could form a continuous wide fusion zone in the course of the movement pattern shown in figure 2.

7.3.6 Hence, the subject-matter of claim 1 differs from the selective laser sintering method of D7 in that:

- "the interference term is of such a nature that a fusion zone is formed which has a width corresponding to twice the amplitude of the component of the interference term in a direction at right angles to the main movement direction" and
- "the radiation gun consists of an electron gun".

7.4 Novelty against D8

7.4.1 D8 discloses a method for manufacturing 3D products by electron beam melting a metal powder bed (see figure 1 which shows an electron gun 6 and electromagnetic means 7 for focusing and deflecting the electron beam).

7.4.2 It is apparent that the subject-matter of claim 1 differs from this 3D printing method in that:

- within each powder layer, the selected area "is divided into one or more inner areas I, each having an edge R";
- "the inner area I is fused together in the course of a movement pattern for the focal point of the beam of the radiation gun which comprises a main movement direction and an interference term which is added to said main movement direction and has a component in a direction at right angles to the main movement direction, wherein the interference term is of such a nature that a fusion zone is formed which has a width corresponding to twice the amplitude of the component of the interference term in a direction at right angles to the main movement direction";

- "said interference term has a component which is parallel to the main movement direction, wherein the movement pattern corresponds to a partly overlapping helical movement of the beam of the radiation gun";
- "the main movement direction has a propagation speed which corresponds to the propagation speed of the fusion zone of the treated material"; and
- "at least that edge which forms an inner or outer lateral surface of the finished body is fused together in the course of a movement which follows the edge without addition of an interference term";

8. Main request - Inventive step

8.1 Inventive step with respect to D8

8.1.1 The 3D printing method disclosed in D8 is a more promising starting point for the assessment of inventive step than that disclosed in either D1 or D7, because it is presented in the patent specification as the starting point for the invention (paragraph 3) and it uses an arrangement for electron beam melting which is identical to that used in the claimed invention (see figure 1 of D8 and figure 1 of the patent specification).

8.1.2 The above mentioned features distinguishing claim 1 from D8 guarantee that the lateral surface of the end product is smooth and reduce the risk of overheating and thus the appearance of shape deviations and residual stresses in the end product (paragraphs 5 and 22 of the patent specification).

8.1.3 Starting from D8, the objective technical problem solved by these features can thus be formulated as how to improve the properties of the end product.

8.1.4 The claimed solution to this objective problem is not part of common general knowledge and is neither disclosed nor suggested in any of the prior art documents D1, D3 and D7.

8.1.5 In particular, D1 and D7 fail to disclose that, in the course of its movement pattern to irradiate an inner area, the beam forms a propagating continuous wide fusion zone as defined in claim 1 (see points 7.2 and 7.3 above). Moreover, D7 does not even address the problem to be solved. It teaches that the movement pattern shown in figure 2 is less precise but simpler to implement than the vector mode (column 6, lines 3 to 24), but there is no indication that this movement pattern improves the properties of the end product, let alone that it reduces overheating, surface irregularities or internal stresses.

8.1.6 When seeking to solve the above defined problem, the skilled person would disregard the teaching of D3. Firstly, this document is not at all concerned with the fabrication of 3D parts by selectively melting or sintering a metal powder bed layer-by-layer. Instead it is concerned with stereolithography, that is the photo-fabrication of 3D parts by selectively irradiating a photo-curable liquid resin with a laser beam. Secondly, the gist of D3 is that, to reduce deviations between the intended shape of a 3D part and its actual shape, the laser beam is moved along a main path while effecting repeated micro-motions covering the main path to cure the periphery of the part (see figure 2 and, in D3.3, page 7, paragraph 2, page 9, paragraph 2 and the

paragraph bridging pages 13 and 14). This problem is remote from the above defined problem of improving the properties of a 3D part obtained by fusing together metal powder.

8.1.7 Thus, starting from D8, the subject-matter of method claim 1 involves an inventive step in the sense of Article 56 EPC.

8.2 Inventive step with respect to D7

8.2.1 The respondent relied on D7 in its objection of lack of inventive step.

8.2.2 As set out in point 7.3 above, the subject-matter of claim 1 differs from D7 in that an electron gun is used and in that the beam forms a continuous wide fusion zone in the course of the movement pattern.

8.2.3 As explained by the appellant, the electron gun allows an improvement in the metallurgic properties of the end product as well as the accuracy of the printing process. Firstly, as an electron gun is generally much more powerful than the low-power laser used in D7, the powder can be fully melted rather than sintered. Secondly, the focal point can be controlled in a faster and more precise manner than in D7 because the electron beam is focused and deflected by electromagnetic means instead of mechanical means (see lenses 36 and 38 and mirrors 46 and 47 in figure 1 of D7).

8.2.4 The feature of the continuous wide fusion zone allows the heat distribution to be as uniform as possible in the area scanned by the electron beam and thus reduces the risk of overheating and shape deviations and

residual stresses in the end product (paragraphs 5 and 70 of the patent).

8.2.5 The objective technical problem solved by these distinguishing features is the same as when starting from D8, i.e. how to improve the properties of the end product.

8.2.6 The claimed solution to this problem is not obvious for the reasons given in points 8.1.5 and 8.1.6 above.

8.2.7 Thus, the subject-matter of claim 1 involves an inventive step when starting from D7.

8.3 In conclusion, none of cited grounds for opposition according to Articles 100(b) and (a) EPC prejudices the maintenance of patent on the basis the new main request.

9. The description has been brought into conformity with the amended claims.

10. Under these circumstances, there is no need for the Board to consider auxiliary requests 1 to 3 of the appellant.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the opposition division with the order to maintain the patent as amended in the following version:

- claims 1 to 8 of the main request filed in the oral proceedings before the Board;
- description: pages 2 to 5, 16 and 17 filed in the oral proceedings before the Board; pages 6 to 15 of the patent specification;
- drawings: figures 1 to 22 of the patent specification.

The Registrar: The Chairman:

C. Spira G. Ashley

Decision electronically authenticated