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**Datasheet for the decision
of 23 February 2010**

Case Number: T 1047/07 - 3.2.05

Application Number: 99113361.2

Publication Number: 0972628

IPC: B29C 67/00

Language of the proceedings: EN

Title of invention:

Lamination molding resin-coated sand and lamination molding method using resin-coated sand

Patentee:

Toyota Jidosha Kabushiki Kaisha

Opponent:

EOS GmbH Electro Optical Systems

Headword:

-

Relevant legal provisions:

EPC Art. 54, 56, 83

Relevant legal provisions (EPC 1973):

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Keyword:

"Sufficiency of disclosure - yes"
"Novelty - yes"
"Inventive step - no (all requests)"

Decisions cited:

-

Catchword:

-



Case Number: T 1047/07 - 3.2.05

DECISION
of the Technical Board of Appeal 3.2.05
of 23 February 2010

Appellant: Toyota Jidosha Kabushiki Kaisha
(Patent Proprietor) 1, Toyota-cho
Toyota-shi, Aichi-ken, 471-8571 (JP)

Representative: Winter, Brandl, Fürniss, Hübner Röss, Kaiser,
Polte Partnerschaft Patent- und
Rechtsanwaltskanzlei
Alois-Steinecker-Strasse 22
D-85354 Freising (DE)

Respondent: EOS GmbH Electro Optical Systems
(Opponent) Robert-Stirling-Ring 1
D-82152 Krailing (DE)

Representative: Hofer, Dorothea
Prüfer & Partner GbR
Patentanwälte
Sohnckestrasse 12
D-81479 München (DE)

Decision under appeal: Decision of the Opposition Division of the
European Patent Office posted 17 April 2007
revoking European patent No. 0972628 pursuant
to Article 102(1) EPC 1973.

Composition of the Board:

Chairman: W. Zellhuber
Members: H. Schram
M. J. Vogel

Summary of Facts and Submissions

- I. The appeal is against the decision of the Opposition Division posted on 17 April 2007 revoking European patent No. 0 972 628.

The Opposition Division held that the requirements of Article 83 EPC (insufficiency of disclosure, cf. ground of opposition under Article 100(b) EPC) were met, but that the subject-matter of claim 1 of the main request (claim 1 as granted) and of auxiliary requests 1 and 2 of the appellant (patent proprietor) were not new, Article 54 EPC, and that the subject-matter of claim 1 of auxiliary request 3 did not involve an inventive step, Article 56 EPC.

- II. Oral proceedings were held before the Board of Appeal on 23 February 2010.

- III. The appellant requested that the decision under appeal be set aside and, as main request, to maintain the patent as granted, or, as an auxiliary measure, that the patent in suit be maintained on the basis of any of the sets of claims filed on 27 August 2007 as first, second and fourth auxiliary requests, respectively, or on the basis of the set of claims filed as third auxiliary request during oral proceedings.

The respondent (opponent) requested that the appeal be dismissed.

- IV. Claims 1 and 3 as granted read as follows:

"1. A resin-coated sand used for a lamination molding method for forming a laminated article by laminating sand layers in thickness direction, said resin-coated sand comprising, sand particles (53) which

- a) are coated with a resin that can be cured by laser radiation,
- b) are generally spherical, and
- c) have a diameter in a range of about 20 to 100 μm , wherein the resin (54) has a fusion temperature of about 100 °C or higher and a mean molecular weight of about 2000 to 10000."

"3. A lamination molding method comprising:

- a step of providing a resin-coated sand according to claim 1 or 2;
- a sand application step of applying said resin-coated sand to form a thin sand layer (50);
- a laser radiation step of radiating a laser beam (M) onto said sand layer (50) to cure said resin (54);
- alternately repeating said sand application step and said laser radiation step until sand layers are laminated in thickness direction and an article is formed."

Claim 1 of the first auxiliary request differs from claim 1 as granted in that the expression "about 100 °C or higher" has been replaced by the expression "100 °C or higher".

Claim 1 of the second auxiliary request differs from claim 1 as granted in that the expression "about 100 °C or higher" has been replaced by the expression "higher than 100 °C".

Claim 1 of the third auxiliary request reads as follows:

"1. A lamination molding method comprising: a step of providing a resin-coated sand, said resin-coated sand comprising, sand particles (53) which

- a) are coated with a resin that can be cured by laser radiation,
- b) are generally spherical, and
- c) have a diameter in a range of about 20 to 100 μm ,

wherein the resin (54) has a fusion temperature of higher than 100 °C and a mean molecular weight of about 2000 to 10000;

a sand application step of applying said resin-coated sand to form a thin sand layer (50);

a laser radiation step of radiating a laser beam (M) onto said sand layer (50) to cure said resin (54);

alternately repeating said sand application step and said laser radiation step until sand layers are laminated in thickness direction and an article is formed."

Claim 1 of the fourth auxiliary request differs from claim 1 as granted in that the expression "coated with a resin" has been replaced by the expression "coated with a phenolic resin of novolak type", and in that the last feature of the claim now reads "wherein the phenolic resin (54) has a fusion temperature of about 110 °C and a mean molecular weight of about 3000 to 8000".

Claim 3 of the first, second and fourth auxiliary requests are identical to claim 3 as granted.

V. The following documents in particular were referred to in the appeal proceedings:

D1 EP-A 0 776 713

D7 WO 95/32824

D12 *Fertigsand umhüllt mit Corrodur® oder Resital®, Verfahren und Prüfmethode*n, Firmenbroschüre der Firma Huettenes-Albertus, RT 5/1990.

D23 JP 2003-112 231 and English abstract

D26 *Römpf Chemie Lexikon*, 9th Edition, pages 3352 and 3353.

D28 Publication of the Japanese Association of Casting Technology (JACT) dated 7 February 1997, pages 1 to 3, and two graphic charts.

VI. The arguments of the appellant, in writing and during the oral proceedings, can be summarized as follows:

Sufficiency of disclosure, Article 83 EPC

In paragraph [0023] of the patent in suit a phenolic resin of the novolak type was mentioned, having a mean molecular weight in the range from 3000 to 8000. This numerical range typically corresponded to a *weight* rather than to a *number* average molecular weight (see eg documents D23 and D28). In the prior art the fusion temperature was as low as 70 to 80°C, see paragraph [0004] of the patent in suit. The crux of the invention

was, as explained in paragraphs [0031] and [0032] of the patent in suit with reference to Figure 4, that a higher fusion temperature $T\alpha$, ie higher than the conventional fusion temperature $T\beta$, was chosen, so that curing, or partial curing, no longer occurred in the regions $\Delta D1$ and $\Delta D2$ of the heat transmission region 50K outside the irradiated area D, thus enhancing the accuracy and quality of the article formed by the lamination molding method which used the resin-coated sand. Claim 1 as granted defined the fusion temperature as being "about 100 °C or higher", since only the minimum value of the range was relevant. The invention was thus sufficiently disclosed.

Main request - Objection of lack of novelty, Article 54 EPC

Document D7 was silent about the fusion temperature and the mean molecular weight of the novolak resin. The disclosure of document D7 could not be read in conjunction with document D26, which was a lexicon. The range for the melting temperature, namely from 50 to 110°C, and range for the mean molecular weight, namely from 400 to 5000, of a novolak resin mentioned in Figure 1 on page 3352 of document D26 constituted a general disclosure of that resin before adding any additives such as curing agents. Notwithstanding the reference to the use of novolak resins as a binder in molding ("Gießereibindemittel") in Table 3 on page 3353, document D26 did not disclose the fusion temperatures of novolak resin-coated sands. The subject-matter of claims 1 and 3 as granted was therefore new with respect to document D7.

*Main request - Objection of lack of inventive step,
Article 56 EPC*

The invention related to resin-coated sand suitable for use in rapid prototyping, ie a lamination molding method for producing articles (molds). The object of the invention was to provide a resin-coated sand and a lamination molding method for producing a formed article with high accuracy and quality, which method used said resin-coated sand. This problem was solved by the subject-matter of claims 1 and 3, in particular by using small resin-coated sand particles which were generally spherical, which had a fusion temperature of at least 100°C and a mean molecular weight within the range reiterated in claim 1 as granted. Document D7, which represented the closest prior art, was silent about the fusion temperature and the mean molecular weight of the novolak resin (see objection of lack of novelty above). No hint or suggestion to use resin-coated sand particles having fusion temperature of at least 100°C was found in the cited prior art. The resin-coated sand known from document D12 had a large diameter in a range of about 40 and 100 AFS (corresponding to about 130 to 400 µm), see the last paragraph of section 4.9. The recommendation given in Section 4.1 of document D12 to use coated sand with a higher melting point applied to the production of shell molds ("Maskenherstellung"). Coated sand with a higher melting point resulted in a better hardening ("Durchbackverhalten") but in a worse peel-back ("Abrollverhalten"). The person skilled in the art would not apply this teaching to use resin-coated sands with a high melting point in a lamination molding

method, since in a lamination molding method a good hardening was more important than good peel-back.

Auxiliary requests - Objection of lack of inventive step, Article 56 EPC

For the same reasons as mentioned for the claims as granted, the subject-matter of the amended claims, which claims were more restricted than the claims as granted, was not obvious.

- VII. The respondent's arguments, in writing and during the oral proceedings, can be summarized as follows:

Sufficiency of disclosure, Article 83 EPC

The feature "*wherein the resin (54) has a fusion temperature of about 100 °C or higher and a mean molecular weight of about 2000 to 10000*" in claim 1 as granted was indeterminate, since there was no indication in the patent in suit whether the "mean molecular weight" was the number or the weight average molecular weight. Moreover, the resin itself was not specified. The invention was therefore not disclosed in a manner sufficiently clear and complete to be carried out by a person skilled in the art, Article 83 EPC. Moreover, the fusion temperature range "*of about 100 °C or higher*" was open ended. The invention could therefore not be carried out over the whole range.

Main request - Objection of lack of novelty, Article 54 EPC

Document D7 disclosed a resin-coated sand used for a lamination molding method, which comprised round sand particles (see page 6, last paragraph) coated with a resin that could be cured by laser radiation and having a diameter in a range of about 50 to 100 μm (see page 19, line 1, to page 20, line 1). The resin could be a novolak resin, see claim 4, and page 10, lines 11 to 30, which described the coating of mold material ("Warmumhüllung"). Since novolak resins had a mean molecular weight of about 400 to 5000 and a melting temperature in the range from 50 to 110°C (see document D26, which disclosed these ranges for the given chemical formula of novolak resins), the subject-matter of claims 1 and 3 as granted lacked novelty.

Main request - Objection of lack of inventive step, Article 56 EPC

Document D7 represented the closest prior art. This document disclosed resin-coated sand suitable for use in a lamination molding method, and a lamination molding method using said resin-coated sand, which included the step of radiating a laser beam onto the sand layer in order to cure the resin. Document D7 taught that with the lamination molding method disclosed in that document molds having small geometrical tolerances (cf. the object of the patent in suit) could be achieved (see page 14, last three lines, and page 18, last six lines). The subject-matter of claims 1 and 3 as granted differed from the resin-coated sand and the lamination molding method known

from document D7 in that ranges for the fusion temperature and the mean molecular weight, namely "100 °C or higher" and "about 2000 to 10000", respectively, were indicated, the fusion temperature and the mean molecular weight (MW) being in fact related parameters, see the graphic charts of document D28 giving the relation between the fusion temperature and MW of the resins given in Tables 1 and 2. Choosing a fusion temperature of 100°C or higher was obvious in view of document D26 (see Figure 1 on page 3352, wherein novolak resins having melting points up to 110°C were disclosed) and document D12 (see page 8, point 4.1).

Document D1 could also be taken as a suitable starting point for assessing inventive step. This document disclosed sand comprising two types of grains: smaller sand grains having a peak diameter of 10 µ and larger sand grains having a peak diameter of 50 µ (see column 19, lines 55 to 59). Document D1 already taught that the boundary between a heat laser exposure area and a non-exposure had to be clearly defined for increasing the dimensional accuracy and that sand having good peel back was preferred (see column 13, lines 31 to 37). A combination of documents D1 and D12 would also lead the person skilled in the art to the claimed invention.

Auxiliary requests - Objection of lack of inventive step, Article 56 EPC

Claim 1 of the fourth auxiliary request mentioned a mean molecular weight of about 3000 to 8000, whereas in column 4, line 2, of the application as filed

(published version) a range for the mean molecular weight of exactly 3000 to 8000 was disclosed. This amendment introduced subject-matter that extended beyond the content of the application as filed. The amendments to claim 1 of the first, second and fourth auxiliary requests, respectively, were already known from document D26 and could not contribute to inventive step. The method claim of the third auxiliary request, which corresponded in substance to claim 3 of the second auxiliary request, comprised the same amendment as claim 1 of the second auxiliary request and was obvious as well.

Reasons for the Decision

MAIN REQUEST

1. *Sufficiency of disclosure, Article 83 EPC*

The molecular weight distribution in a polymer describes the relationship between the number of moles of each polymer species and the molar mass of that species. The two most common definitions of the average ("mean") value are the weight and the number average molecular weight. The patent in suit does not specify which definition has been used.

This ambiguity or unclarity does not automatically imply that the invention cannot be carried out. The Board takes the stance that each definition of "mean molecular weight" may be the correct one until proven wrong. The ambiguity is to the detriment of the patent proprietor, in the sense that prior art wherein the

weight or the number average molecular weight is in the range claimed in claim 1 as granted can be considered.

On the basis of the range of 3000 to 8000 given in paragraph [0023] of the patent in suit for the mean molecular weight of a phenolic resin of the novolak type, the person skilled in the art could for example assume that the weight average molecular weight is probably the correct definition.

The respondent has not argued, or filed any evidence, that the invention cannot be carried out on the basis of the above assumption, ie for eg a phenolic resin of the novolak type having a weight average molecular weight in the claimed range.

In the judgment of the Board, the presence of an open-ended fusion temperature range "*of about 100 °C or higher*" in claim 1 as granted does not imply that a person skilled in the art cannot carry out the invention "over the claimed range", since in the present case it is the minimum value of the fusion temperature (here: about 100°C) that defines the invention. The upper value of the fusion temperature is not interesting, see paragraph [0017] of the patent in suit. The fusion temperature must be sufficiently lower than the actual temperature T of the irradiated area for curing to take place.

The invention claimed in claim 1 as granted is therefore disclosed in a manner sufficiently clear and complete to be carried out by a person skilled in the art, Article 83 EPC.

2. *Objection of lack of novelty, Article 54 EPC*

The established case law of the Boards of Appeal holds that for an invention to lack novelty its subject-matter must be clearly and directly derivable from a single piece of prior art, including features which for the skilled person are implicit in what is explicitly disclosed.

Claim 1 requires that "the resin (54) has a fusion temperature of about 100 °C". The fusion temperature is a property of the (thermally curable) resin-coated sand (see paragraph [0017] of the patent in suit), ie of the resin present as a coating, which may include a curing agent.

Document D7 discloses a resin-coated sand suitable for use in a process for making casting molds comprising sand particles which can be generally spherical (see paragraph bridging pages 6 and 7), and which are coated with a resin such as a phenolic resin of the novolak type (see claim 4, page 7, lines 5 to 11, and page 10, lines 11 to 20) that can be cured by laser radiation (see paragraph bridging pages 16 and 17, and paragraph bridging pages 19 and 20).

Since the thickness of a layer of coated sand particles in document D7, which is in the range of 0,1 to 0,2 mm, may be twice the average diameter of the coated sand particles (see page 19, lines 1 to 5, and page 20, line 1), it follows that the average diameter of the coated sand particles is in the range of 0,05 to 0,1 mm.

Document D7 is silent about the fusion temperature of the novolak resin-coated sand and is silent about the mean molecular weight of that resin.

Document D26 discloses how novolak resins can be obtained by reacting phenol and formaldehyde, see page 3352, lines 11 to 20. In Figure 1 it is stated that novolak resins have a mean molecular weight in the range of ca. 400 - 5000 ("mittlere Molmasse") and a melting temperature of 50 - 110°C. The respondent has argued that these properties were intrinsic properties of novolak resins, which were for the skilled person implicitly disclosed in document D7. However, this is disproved by document D28, which discloses novolak resins having mean molecular weights larger than 5000, see Table 1, resins D and E. Moreover, document D26 is silent about the properties of novolak resin if used as a coating of sand particles.

The subject-matter of claim 1 as granted is therefore new vis-à-vis document D7.

3. *Objection of lack of inventive step, Article 56 EPC*

Document D7 represents the closest prior art. This document discloses a lamination molding method for forming a laminated article by laminating sand layers of resin-coated sand particles, and resin-coated sand. The advantages of the method are summarized on the last paragraph of page 14 of document D7 and include the high accuracy of the formed article.

The subject-matter of claim 1 as granted differs from the resin-coated sand known from document D7 in that

"the resin (54) has a fusion temperature of about 100 °C or higher and a mean molecular weight of about 2000 to 10000".

The distinguishing feature solves the problem of providing a resin-coated sand suitable for use in a lamination molding method for producing a formed article with high accuracy and quality, see paragraph [0007] of the patent in suit.

It may be noticed that the lower value of about 100°C for the fusion temperature is a quantitative, not a qualitative value, since in order to inhibit the resin in the heat transition region from being thermally set with a view to enhancing the accuracy of the formed article, the fusion temperature should merely be higher than the temperature of the interface between the laser radiation area and the area not irradiated by the laser. The temperature of the interface T1 is 100°C in Figure 4, but this empirical value is arbitrary in the sense that it can be varied by varying the power of the laser beam.

It may be noticed that the problem of the accuracy of a lamination molding method has already been addressed in column 13, lines 31 to 37, of document D1, which is cited in paragraph [0006] of the patent in suit. In said passage of document D1 it is stated that "it is particularly important to clearly define the boundary between a heat laser exposure area and a non-exposure area and increase dimensional stability".

According to document D12 (see page 8, left column, section 4.1), melting points of resin-coated sands

(measured in a way similar to the determination of the fusion temperature, cf. paragraph [0017] of the patent in suit) lie in general in the range of 80 to 100°C, depending on the resin. Sands with a low melting point show good curing ("Durchbackverhalten"), but a poor peel-back. In the last sentence of said section it is stated that in a process for making casting molds preferably a resin-coated sand with a *higher* melting point should be used. The person skilled in the art derives from document D12 the teaching that using resin-coated sand with a *higher* melting point leads to an improved peel-back.

There is no indication that the person skilled in the art starting from document D7 should ignore the teaching of document D12 mentioned above, only because the resin-coated sand known from document D12 is not as fine as the resin-coated sand used in document D7. Document D7 mentions that it is a particular advantage of the invention that all components of the molding material system used have been known and proven in the foundries for a long time, see page 28, lines 15 to 20.

In the judgment of the Board, the person skilled in the art would derive the incentive from document D12 to use resin-coated sands with a *higher* melting point of about 100°C or more, and a correspondingly higher fusion temperature, also in a lamination molding method.

Furthermore, novolak resins, having fusion temperatures in the range of 108°C to 115°C (when used for coating sand), are known from document D28 (see Table 1, items B, C, D, F and G). These resins have a weight average molecular weight in the range of about 2000 to 10000.

In the judgment of the Board, it was thus obvious to a person skilled in the art starting from the resin-coated sand particles suitable for use in a process for making casting molds disclosed in document D7 to use novolak resins known from document D28 for coating the sand particles with a fusion temperature and a mean molar mass in the ranges claimed in claim 1 as granted.

The subject-matter of claim 1 as granted therefore does not involve an inventive step.

FIRST AND SECOND AUXILIARY REQUESTS

4. *Objection of lack of inventive step, Article 56 EPC*

Claim 1 of the first auxiliary request requires that the resin-coated sand has "a fusion temperature of 100 °C or higher" (the term "about" present in claim 1 as granted has been deleted).

Claim 1 of the second auxiliary request requires that the resin-coated sand has "a fusion temperature of higher than 100 °C".

Since each of the amended features is already known from document D28, the conclusion arrived at in point 3 above holds *mutatis mutandis* for the subject-matter of claim 1 of the first and second auxiliary requests.

THIRD AUXILIARY REQUEST

5. Claim 1 of the third auxiliary request is directed to "A lamination molding method comprising: a step of providing a resin-coated sand ...", whereby said resin-

coated sand is the resin-coated sand according to claim 1 of the second auxiliary request.

The Board has already decided (see point 4 above) that the resin-coated sand suitable for use in a lamination molding method according to claim 1 of the second auxiliary request does not involve an inventive step.

If a "resin-coated sand suitable for use in a lamination molding method" is obvious, then a lamination molding method, which steps are known per se and which only differs from a known lamination molding method in that it uses said sand, is itself obvious.

FOURTH AUXILIARY REQUEST

6. *Objection of lack of inventive step, Article 56 EPC*

Claim 1 of the fourth auxiliary request is restricted to a phenolic resin of novolak type having a fusion temperature of about 110°C and a mean molecular weight of about 3000 to 8000.

Such resins are known from document D28 (see Table 1, items C and D). It follows that the subject-matter of claim 1 of the fourth auxiliary request does not involve an inventive step for the same reasons as given in point 3 above.

With this state of affairs there was no need to examine whether the word "about" in the expression "about 3000 to 8000" in claim 1 of the fourth auxiliary request introduces subject-matter extending beyond the content of the application as filed, Article 123(2) EPC.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:

The Chairman:

D. Meyfarth

W. Zellhuber