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D E C I S I O N
of 17 December 1996

Case Number: T 0518/94 - 3.2.5

Application Number: 85309311.0

Publication Number: 0188120

IPC: B29C 45/00

Language of the proceedings: EN

Title of invention:
Moulding process

Patentee:
NATIONAL RESEARCH DEVELOPMENT CORPORATION

Opponent:
Klöckner-Werke AG
Solomat Partners

Headword:
-

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step (yes - after amendment)"

Decisions cited:
-

Catchword:
-



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Boards of Appeal

Chambres de recours

Case Number: T 0518/94 - 3.2.5

D E C I S I O N
of the Technical Board of Appeal 3.2.5
of 17 December 1996

Other party:
(Opponent 1)

Klöckner-Werke AG
Klöcknerstr. 29, Postfach 100853
D - 47057 Duisburg (DE)

Representative:

Röther, Peter Dipl. -Phys.
Patentanwalt
Vor dem Tore 16a
D - 47279 Duisburg (DE)

Appellant:
(Opponent 2)

Solomat Partners
Glenbrook Industrial Park 652
Glenbrook Road
US - Stamford, Connecticut 06906 (US)

Representative:

Lyons, Andrew John
Roystons
Tower Building
Water Street
GB - Liverpool L3 1BA (GB)

Respondent:
(Proprietor of the patent)

NATIONAL RESEARCH DEVELOPMENT CORPORATION
101 Newington Causeway
GB - London SE1 6BU (GB)

Representative:

Neville, Peter Warwick
Patents Department
British Technology Group Ltd.
101 Newington Causeway
GB - London SE1 6BU (GB)

Decision under appeal:

Interlocutory decision of the Opposition Division
of the European Patent Office posted 22 April
1994 concerning maintenance of European patent
No. 0 188 120 in amended form.

Composition of the Board:

Chairman: G. O. J. Gall
Members: A. Burkhart
C. G. F. Biggio

Summary of Facts and Submissions

- I. The appellant (opponent 2) lodged an appeal against the interlocutory decision of the Opposition Division on the amended form in which the patent No. 0 188 120 can be maintained.

Two oppositions were filed against the patent as a whole and based on Article 100(a) and (b) EPC (lack of inventive step and enabling disclosure).

The Opposition Division held that the grounds for opposition mentioned in Article 100(a) and (b) EPC did not prejudice the maintenance of the patent as amended, having regard to the prior art cited by the opponents.

- II. The following documents referred to during the opposition proceedings are also relevant for the present decision:

D4: *Plastics and Rubber International*, volume 9, No. 2, April 1984, pages 32 to 36, "Producing void-free thick-section thermoplastic and fibre reinforced thermoplastic mouldings", P. Allan and M. Bevis,

D8: DE-A-2 614 213,

D12: US-A-4 469 649,

D13: *Plastics Mould Engineering*, 1965, pages 438 to 451, and

D18: Drawing sheets A to F, presented by the respondent, dated 31 December 1993, showing frequency and phase variations.

III. Oral proceedings were held on 17 December 1996.

(i) The Board did not admit late filed documents filed by the respondent (patent proprietor) on 15 November 1996; one document was published after the priority date of the patent in suit and could therefore not be considered in evaluating inventive step; the other documents referred to general technical knowledge already described in the specification of the patent in suit.

(ii) The appellant (opponent 2) requested that the decision under appeal be set aside and the patent revoked.

(iii) The respondent (patent proprietor) requested that the appeal be dismissed and the patent maintained in amended form on the basis of an amended claim 1 presented during the oral proceedings (main request) or on the basis of nine auxiliary versions of claim 1 filed on 16 November 1996.

(iv) Claim 1 of the main request reads as follows:

"1. A moulding process, which process comprises supplying molten, mouldable material to a mould cavity (17); subjecting at least a part of the supplied molten material to a shear force; causing the material to solidify while maintaining the shear force; and demoulding the moulding material;

characterised in that the supplied molten material is subjected to the shear force by applying a periodic force to each of a plurality of spaced-apart regions of the molten material

within the mould cavity, there being a phase difference in the periodic forces applied to at least two different such regions (via 14, 15) effective to cause oscillating shear of the molten material at least between the two such regions, the molten material in the mould cavity being sheared by repetitive injection of molten material at the said different regions, in order to orient the material."

(v) The appellant argued essentially as follows:

Documents D4 and D8 disclosed a moulding process, wherein a reciprocating piston acted on the entry gate of the mould and caused periodic compression and expansion of the melt resulting in shearing forces within the melt in the mould cavity. Given this knowledge concerning the use of a reciprocating piston acting on one entry gate for mouldable material, it would have been obvious for the person skilled in the art to try the same on more than one gate if a mould with multiple entry gates was to be used. Such a measure was also suggested by document D12 which taught the application of shear forces from more than one direction. Furthermore, in document D18 the patentee himself had shown how the displacement of molten material and hence shear force is effected by the difference in the phase of the applied force. It was thus clear to the person skilled in the art that, when the pistons were out of phase, the displacement of molten material and hence the shear and the orientation of the material was increased.

Therefore, the process of claim 1 of the main request did not involve an inventive step.

(vi) The respondent argued essentially as follows:

The documents D4 and D8 did not show the features that a periodic force should be applied to each of a plurality of spaced-apart regions and that there should be a phase difference between these periodic forces. Although D4 (D8) taught the generation of shear force, the shear was set up for a different purpose, namely to generate internal heat and thereby prevent premature freezing off of the molten material in the gate. Even if the skilled person were to duplicate the reciprocating piston of D4 (D8), there would have been no reason for him to take the additional step of reciprocating the pistons with a difference in phase to produce enhanced shear movement within the mould cavity.

Document D12 disclosed applying vibrations to the outer surface of a mould at certain places (cf. column 5, lines 25 and 26), in order to eliminate thermal stresses and/or orientation stresses (cf. column 18, lines 32 to 35). Document D12 did not disclose the characterising features of claim 1, and there was no disclosure in this document of the main advantageous results of the present invention - the elimination or reduction of weld lines and orientation of the material -, which results were achieved by the characterising features of claim 1, in particular by freezing-in the effects of oscillating shear movement in the material within the mould cavity.

Therefore, it was not obvious to add the characterising features of claim 1 to the disclosure of document D4 (D8) in the light of the disclosure of document D12.

Reasons for the Decision

1. *Amendments*

Amended claim 1 of the main request is based on the following disclosure of the originally filed application documents:

Claims 1, 9, 12 and 13; description, page 4, lines 4, 5 and 20; page 5, lines 4 and 5; page 8, lines 22, 26 and 27; drawings figures 2 to 5.

With respect to claim 1 of the patent as granted, the amended claim 1 has been restricted in scope by the incorporation of various additional features.

Claims 2 to 10 correspond to claims 2 to 9 and 11 of the claims as granted.

The description has been adapted to the amended claims.

The amendments to the claims and description are therefore not objectionable with respect to Article 123(2) and (3) EPC.

2. *Novelty*

None of the prior art documents referred to by the appellant discloses a process comprising all the features of claim 1 of the main request. Novelty, in fact, was not in dispute during the appeal proceedings.

Therefore, the process of claim 1 of the main request is novel.

3. *Inventive step*

3.1 Problem underlying the invention

The invention relates to a moulding process for moulding articles from molten mouldable material. As set out in the introduction of the patent specification, it is known that properties, notably mechanical properties such as tensile modulus and strength, may be enhanced in a given direction by causing the material to be oriented in that direction. It had not been possible to achieve this for thermoplastic materials moulded from the melt. It is also known that where in an injection moulding process molten material is injected into the mould cavity from a number of feeding gates, internal weld lines formed where the various melt flow fronts from the multiple gates met. The presence of such weld lines can cause undesirable discontinuities in the mechanical properties of the moulded article. It is also known that shear effects could be used in moulding processes, but that there were both advantages and disadvantages of said shear effects in injection moulding.

The problem underlying the invention is, therefore, to provide a moulding technique in which shear effects are generated in such a way as to achieve useful improvements in the structure of a moulded product (see EP-B-0 188 120, page 2, lines 4 to 38).

3.2 Solution

This problem is solved by the process according to claim 1 of the main request, i.e. by the features that the supplied molten material solidifies while it is subjected to the shear force by applying a periodic force to each of a plurality of spaced-apart regions of the molten material within the mould cavity, there

being a phase difference in the periodic forces applied to at least two different such regions effective to cause oscillating shear of the molten material at least between the two such regions, the molten material in the mould cavity being sheared by repetitive injecting of molted material at the said different regions, in order to orient the material.

Since the forces for creating the shear force are applied periodically and out of phase to each of a plurality of spaced-apart regions of molten material within the mould cavity, a significant sliding movement of one part of the melt relative to another contiguous part (shear movement) is produced between the said regions. Thus, the oscillating shear movement within the molten material generated by the process of claim 1 has the effects that the molecules of the material are oriented while the material solidifies and the weld lines are reduced or eliminated. Therefore, the mechanical properties of the moulded article, such as tensile modulus and strength, are improved.

3.3 The aforementioned solution is not rendered obvious by the prior art referred to by the appellant, for the following reasons:

3.3.1 Documents D4 and D8 disclose a moulding process, wherein a molten, mouldable material is supplied to a mould cavity, at least a part of the supplied molten material is subjected to a shear force, the material is caused to solidify while maintaining the shear force, and the moulded material is demoulded. In this known process the periodic force is applied only to a single region of the molten material, namely by an oscillating piston provided between the extruder and the sprue of the mould. There is no significant oscillating shear movement of material in the mould because the movement by the single oscillating piston depends upon

compression and expansion of the material in the mould when the mould is full. At this stage any movement in the sprue is limited to the small movement which can take place by compression and expansion of the material.

Although documents D4 and D8 mention the generation of shear force, the shear is set up for the purpose of generating internal heat and thereby preventing premature freezing off of the molten material in the gates (see D4, page 34, column 3, and D8, page 8, first paragraph). This purpose is different from the purpose of the invention which aims at an improvement of the internal structure of the moulded article.

Therefore, documents D4 and D8 do not suggest the essential features of the process of claim 1, notably

- providing a phase difference in the periodic forces applied to each of a plurality of spaced-apart regions,
- causing an oscillating shear within the molten material at least between two regions and
- shearing the molten material in the mould cavity by repetitive injection of molten material at the spaced-apart regions.

3.3.2 Document D12 gives the general teaching that the physical characteristics of a moulded product can be improved by varying, as a function of time, at least two rheological parameters, like mechanical vibration or shear stress, during the moulding operation. The

specific embodiment of document D12 (cf. Figure 6) teaches to apply mechanical vibration to the outside of the mould. As to the application of shear stress, no specific embodiment or instruction can be found in document D12.

There is only one single mention made in the whole specification of D12 that the vibration may be "applied in certain places of the contour around the moulded material via bulges and cavities in the wall of the mould" (see column 5, lines 24 to 27). The meaning of this is to apply the same vibration technique as in Figure 6, but in more than one place.

Therefore, D12 teaches applying a vibration, i.e. a series of mechanical shockwaves, to the outer surface of a mould in certain places.

With regard to purpose, there is no disclosure in D12 of reduction or elimination of weld lines and of orientation of material molecules for enhancement of product strength.

Document D12 does also not disclose or suggest the essential features of the process of claim 1, notably

- providing a phase difference in the periodic forces applied to each of a plurality of spaced-apart regions,
- causing an oscillating shear within the molten material at least between two regions, and
- shearing the molten material in the mould cavity by repetitive injection of molten material at the spaced apart regions.

Therefore, also a combination of the disclosures and teachings of documents D4(D8) and D12 would not lead the person skilled in the art to the process of claim 1 of the main request.

3.3.3 Document D13 is a general textbook describing the fundamentals of plastic moulding and has been cited only because it discloses multiple gating. Multiple gating is used to balance the pressure in the mould sections of a moulded product having fragile mould sections with restricted flow (see page 443, 3rd paragraph of D13). Therefore, the person skilled in the art would use multiple gating in a process according to document D4, D8 or D12 in the case of moulded products having fragile mould sections with restricted areas. However, there is nothing in document D13 to suggest applying a periodic force to each of the multiple gates, the periodic forces being out of phase to cause oscillating shear between the various gates, in order to eliminate the formation of weld lines and to orient the material molecules.

3.3.4 Document D18 was filed by the patentee only for the illustration of how the invention was operated. This document does not disclose a prior art.

3.3.5 For the reasons set out above, the process of claim 1 involves an inventive step in the meaning of Article 56 EPC.

4. Therefore, claim 1 of the main request is allowable with respect to Article 52(1) EPC.

The same applies to the depended claims 2 to 10 of the main request.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.
2. The case is remitted to the first instance with the order to maintain the patent in amended form in the following version:

Claims: 1 to 10 as presented as main request during oral proceedings of 17 December 1996,

Description: page 2 as presented during oral proceedings of 17 December 1996, pages 3 to 7 as granted,

Drawings: as granted.

The Registrar:



A. Townend

The Chairman:



G. Gall

