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**Datasheet for the decision
of 15 March 2019**

Case Number: T 0504/14 - 3.2.05

Application Number: 02764452.5

Publication Number: 1436132

IPC: B29C45/27

Language of the proceedings: EN

Title of invention:

Tip assembly having at least three components for hot runner nozzle

Patent Proprietor:

Mold-Masters (2007) Limited

Opponents:

Husky Injection Molding Systems Ltd.
Günther Heisskanaltechnik GmbH

Relevant legal provisions:

EPC 1973 Art. 56

Keyword:

Inventive step - (yes)

Decisions cited:

T 1110/03



Beschwerdekammern

Boards of Appeal

Chambres de recours

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Case Number: T 0504/14 - 3.2.05

D E C I S I O N
of Technical Board of Appeal 3.2.05
of 15 March 2019

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Decision under appeal: **Interlocutory decision of the Opposition
Division of the European Patent Office posted on
20 January 2014 concerning maintenance of the
European Patent No. 1436132 in amended form.**

Composition of the Board:

Chairman M. Poock
Members: T. Vermeulen
 D. Rogers

Summary of Facts and Submissions

- I. Both opponent 1 and the patent proprietor lodged an appeal against the interlocutory decision of the opposition division that European patent No. 1 436 132 (hereinafter referred to as "the patent") as amended with the second auxiliary request (now: main request) met the requirements of the European Patent Convention.
- II. During the opposition proceedings, opponents 1 and 2 raised the grounds for opposition according to Article 100(a) EPC 1973 (lack of novelty and lack of inventive step). Opponent 2 also raised the ground for opposition according to Article 100(c) EPC 1973.
- III. With letter of 15 February 2019 the patent proprietor withdrew his appeal.
- IV. Oral proceedings were held before the board of appeal on 15 March 2019 in the absence of opponent 2, who did not make any submissions in appeal.
- V. The requests of the sole appellant (opponent 1) were to set aside the decision under appeal and to revoke the patent and not to admit the respondent's auxiliary requests I to V into the proceedings.

The requests of the respondent (patent proprietor) were to dismiss the appeal, or alternatively, to set the decision under appeal aside and to maintain the patent upon the basis of one of auxiliary requests I to V, all filed under cover of a letter dated 15 February 2019.
- VI. The documents referred to during the appeal proceedings include the following:

- A1 US 6,164,954;
- A2 WO 01/28750 A1;
- A3 US 5,569,475;
- A4 US 5,545,028;
- A5 Excerpts from "Hot Runners in Injection Moulds" by Frenkler and Zawistowski (Rapra Technology Ltd, 2001), pages i-v and 80, 81, 83, 94, 103.

VII. Claim 1 of the main request reads as follows (the feature numbering introduced by the board is given in square brackets):

"**[A]** A nozzle (16) for an injection molding apparatus (10), the injection molding apparatus (10) having a mold component (14) defining a gate (26) and a mold cavity (24) communicating with the mold gate (26), the nozzle (16) comprising: **[B]** a nozzle body (31), said nozzle body (31) defining a nozzle body melt passage (37) therethrough, wherein said nozzle body melt passage (37) is adapted to receive melt from a melt source; **[C]** a heater (32) that is thermally connected to said nozzle body (31) for heating melt in said nozzle body (31); **[D]** a tip (33), said tip (33) defining a tip melt passage (38) therethrough, wherein said tip melt passage (38) is downstream from and in fluid communication with the nozzle body melt passage (37), and said tip melt passage (38) is adapted to be upstream from and in fluid communication with said gate (26); **[E]** a tip surrounding piece (34) that is connected with respect to said nozzle body (31), characterized in that **[F]** said tip surrounding piece (34) is made of thermally conductive material so as to improve the heat flow from the heater (32) to the tip melt passage (38); and **[F']** the material of said tip surrounding piece (34) is selected from the following

group: copper, Be-Cu (Beryllium Copper), Beryllium-free Copper, Aluminium, and Aluminium-based alloys; and [G] a mold component contacting piece (35) located between said mold component (14) and said tip surrounding piece (34), [H] wherein the material of said mold component contacting piece (35) has a thermal conductivity that is less than the thermal conductivity of the material of the tip surrounding piece (34)."

Claim 12 of the main request defines an injection molding apparatus comprising, inter alia, a nozzle including all features of claim 1.

VIII. The appellant essentially argued as follows:

Common General Knowledge - Document A5

As to the publication date of document A5, reference is made to the section "Common General Knowledge" of the Case Law of the Boards of Appeal of the EPO, according to which documents of that kind, i.e. documents which contain indirect evidence, do not stand or fall by their publication date even on issues of novelty and inventive step.

Inventive Step - Starting from Document A1

Starting point in document A1 would be one of the embodiments of figure 7 or figure 8. As claim 1 was directed to a nozzle for an injection moulding apparatus and the actual contact with the mould is not required, layers 37 and 21a were considered as mould component contacting pieces located between the mould component and the tip surrounding piece and made of a material with a thermal conductivity less than that of the material of the tip surrounding piece. Hence, the

material of the tip surrounding piece was the only feature not disclosed in document A1. The technical effect associated therewith was to have a high thermal conductivity, substantially improving the heat flow from the heater to the tip melt passage. The objective technical problem was therefore to modify the known nozzle in such a way that the heat flow from the heater to the tip melt passage was substantially improved. The tip surrounding piece 21 in both embodiments served the dual function of connecting the tip to the nozzle body and improving the heat flow from the heater to the tip melt passage. Instead of redesigning the entire nozzle apparatus, the skilled person would inevitably realise that changing the thermal conductivity of the material of both nozzle body and tip surrounding piece was the way to solve the problem.

Starting from the embodiment of figure 7, according to which the tip 22 was made of Beryllium-Copper (BeCu) and the tip surrounding piece 21, through an implicit reference back to columns 2 and 4, was made of TZM, the skilled person would solve the objective technical problem by turning to the common general knowledge as disclosed in document A5. The figure on page 80 of document A5 presented various materials with high thermal conductivity, such as BeCu, that were used to make nozzles. As the tensile strength of BeCu was sufficiently high (221 to 1300 MPA), this material could also be used for the tip surrounding piece with a high pressure resistance, as required by document A1. It was therefore inevitable to consider choosing this material for all parts of the nozzle. Document A1 mentioned three different methods of assembling the tip and tip surrounding piece, namely by press-fit, shrink-fit or through relative thermal expansion. It would be obvious to use a press-fit to mount a BeCu tip

surrounding piece onto the BeCu tip of figure 7. In view of the comment in column 8, lines 20-24, the skilled person would adapt the thickness of the insulating coating 37 as a way to accommodate the thermal coefficient in order to avoid possible cracking of this coating, the material of which was not limited in the claims of document A1. Based on the properties listed in the table presented on page 83 of document A5, the skilled person would for example opt for an insulating coating made of sintered steel.

Starting from the embodiment of figure 8, where the reference to the other embodiments in line 31 of column 8 pointed at the use of BeCu and TZM as the preferred materials for the tip and the tip surrounding piece, respectively, the skilled person would also turn to the common general knowledge disclosed by document A5. Pages 80 and 81 of that document taught that BeCu alloys were standard high thermal conductivity materials used for nozzle casings and tips. Thus, the skilled person would consider making both the nozzle housing 25 and the tip surrounding piece 21 of that material. By using the press-fit method, also disclosed in claims 2, 23, 45, 63 and 67 of document A1, to assemble the tip and the tip surrounding piece there was no obstacle for the skilled person to have both of them made of the same material. According to the description of the embodiment, the thermal insulating layer 21a was made of a ceramic, which had a low thermal conductivity. The claims 15, 17, 36, 39, 55 and 58 confirmed that said layer 21a was in contact with the mould component so that also claim feature H was known.

Inventive Step - Starting from Document A3

According to claim feature D, the tip melt passage did not need to be formed entirely by or in the tip itself. The description and the drawings should be used to interpret the claims accordingly. Also the embodiment of figure 5 of the patent featured a so-called torpedo/needle tip, where the tip melt passage was not formed entirely by or in the tip itself. Even if the tip 54 of the embodiment of figures 2 and 3 of document A3 would be supported inside the nozzle body 52 and the tip surrounding piece 70 through a set of longitudinal flow dividing spokes, it could not be excluded that these flow dividers were curved to form melt channels between the spokes, in which the molten plastic resin flowed. The insulator ring 82 served to reduce unwanted heat transfer between the tip surrounding piece 70 and the cavity plate, so that the tip surrounding piece 70 could only be made of material that is thermally conductive. Consequently the only distinguishing feature with respect to that embodiment was the material of the tip surrounding piece. The technical effect associated therewith was to have a high thermal conductivity, substantially improving the heat flow from the heater to the tip melt passage. The objective technical problem was therefore to modify the known nozzle in such a way that the heat flow from the heater to the tip melt passage was substantially improved. The tip surrounding piece 70 of figures 2 and 3 served to connect the tip to the nozzle body without the need to be machined with connection elements and to improve the heat flow from the heater to the tip melt passage. No specific material was mentioned for the nozzle body. The skilled person, who was a mechanical engineer, or a process engineer, or a material science engineer with several years of experience in the design and development of injection moulding machines and their components, would revert to the common general

knowledge as documented by the book excerpts according to A5. He would inevitably consider appropriate materials for the nozzle body and for the tip surrounding piece, since the latter was nothing more than an extension of the nozzle body. From document A5, in particular pages 80 and 81, the skilled person was aware that BeCu alloys were standard high thermal conductivity materials used for nozzle bodies. Page 103 showed that mini-torpedo nozzle tips received their heat from the nozzle casing inside which they were held. Thus, the skilled person would consider making both the nozzle body and the tip surrounding piece from that material. Any problem of cracking could be avoided by selecting an appropriate material for the insulator, as proposed in column 4, lines 10-13 of document A3.

Should feature D not be considered to be known from the embodiment of figures 2 and 3 of document A3, there would be a further difference. As possible effects related to the fluid flow and the energy flow inside the nozzle would also depend on further features not included in the claim, the technical effect of the second difference would be limited to the supply of the molten material to the gate in a different manner. The objective technical problem associated therewith was to modify the known nozzle so that an alternative nozzle arrangement was provided. The common general knowledge on page 103 of document A5 taught that there were basically three alternative nozzle arrangements. It would therefore be obvious to select the open nozzle alternative of figure 4.20c. In view of the particular configuration of the insulation chamber in the lower half of figure 4.20c, the skilled person would opt to retain the tip retainer 70 of document A3. Its material would be selected as BeCu, in line with the teaching on pages 80 and 81 of document A5.

IX. The submissions by the respondent may be summarised as follows:

Common General Knowledge - Document A5

Other than "2001", no information was given as to when the publication of the book actually took place. In view of the priority date of 3 October 2001, it was left up to the board to decide if the content of document A5 was acceptable as common general knowledge.

Inventive Step - Starting from Document A1

The nozzle tip of document A1 was formed by the inner portion 22 and the outer portion 21. Hence, the outer portion 21 of the tip of document A1 could not be considered as a tip surrounding piece. A compressive preload was needed for assembling the inner and outer portions, so that the inner portion alone could not function as a tip. In figure 3 of the patent in suit a nozzle was also disclosed with a two-component tip 202, which was, however, combined with a separate tip surrounding piece 34. Such an arrangement was typical when the tip melt passage was required to be wear resistant. In document A1, a tip surrounding piece was not a structural necessity for the proper functioning of the nozzle tip. Hence, the prior art document did not disclose a tip surrounding piece. There was therefore more than one difference with the claimed subject-matter.

In the embodiment of figure 7, the thermal insulating coating 37 could perhaps contact the mould around the gate. In contrast, the embodiment of figure 8 did not disclose any portion contacting the mould. Contact between the nozzle housing 25 and the outer portion 21

of the nozzle tip was avoided as much as possible. Claims 17, 39 and 58 were ambiguous without clear support by the description. The thermal insulating layer 21a of figure 8 was not suitable for coming into contact with the nozzle housing. The pure allegation that such a contact could be possible was not sufficient. The layer 21a covered the entire lower portion of the outer portion 21 and prevented heat transfer from the outside into the tip melt passage. Consequently, the embodiment of figure 7 was a more appropriate starting point.

When trying to solve the objective technical problem of modifying the nozzle assembly in such a way so that the heat flow from the heater to the tip melt passage was improved, the skilled person was bound by the context of the entire document A1. The object of the invention set out in the 'Summary of the Invention' related to high pressure injection moulding. The reader of the document must always keep in mind the requirement of using materials with different characteristics, cf. column 2, lines 26-28. In particular, the materials used for the outer portion 21 were steel, TZM, AerMet and Inconel and should be high pressure resistant. The outer portion should have a good thermal conductivity, compared to the high thermal conductivity of the inner portion 22, which was preferably made of a wear resistant material such as BeCu or carbide, tungsten carbide or various ceramics. In addition, the thermal expansion coefficient of the outer portion must be lower than that of the inner portion in order to increase the interference between the components through heating. The skilled problem was therefore not prompted to use the same material for the inner and outer portions. In case the tip were made of BeCu, the outer portion should be made from a high pressure

resistant material. From column 8, lines 8-12 of document A1 it followed that, unlike the outer portion, BeCu was not a high pressure resistant material. In general, TZM and BeCu maybe had intersecting ranges of tensile strength, important was to consider the specific alloys commonly used in the specific technological field. TZM had a thermal expansion coefficient two or three times lower than that of BeCu. Replacing one by the other was therefore critical when fitting the parts together. Furthermore, the statement in document A5 that Copper/Beryllium alloys were used only up to around 280°C would not incite the skilled person to use these materials in the design of document A1, where temperatures up to 600-800°F (315.56°C) were mentioned. According to column 6 of document A1, the different methods of assembly only achieved high pressure resistance in some applications, which meant that the teaching was restricted. The requirement that the bodies 21 and 22 had rather thin walls further prejudiced the skilled person against the materials of claim 1.

Inventive Step - Starting from Document A3

The embodiment of figures 2 and 3 of document A3 showed a nozzle with a mini-torpedo type nozzle tip 54, according to page 103 of document A5. The torpedo configuration referred to the cone shape of the central needle at its downstream end. Usually three or four radially extending spokes or vanes extended from the central portion of the axial needle to hold it in place inside the melt channel. One of those was shown in cross-section in figures 2 and 3. Hence, feature D, which implied that a portion of the melt passage extending between the inlet and outlet was completely surrounded by tip material, was not disclosed by

document A3. The skilled person would not have any incentive to change that nozzle arrangement.

Furthermore, the material of the tip surrounding piece was not disclosed in document A3. The objective technical problem associated therewith was to modify the known nozzle apparatus in such a way that the heat flow from the heater to the tip melt passage was improved.

The specific nozzle of figures 2 and 3 of document A3 provided for a controlled thermal closure of the nozzle gate based on the interaction of the heater 56, the nozzle body 52, the tip 54, the tip assembly 70 and the insulator ring 82, as well as on the cooling of the cavity plate 32. An alternative nozzle arrangement could have a dramatic influence on the thermal balancing of the entire system. As potential cracking of the ceramic ring 82 might be a problem, the material of the tip surrounding piece 70 must also have a thermal expansion coefficient similar to that of the insulator ring 82, so that both expanded at a similar rate (cf. column 4, lines 38-43). Simply substituting the material of the tip surrounding piece 70 would create problems with regards to the temperature window and would lead to a failure of the insulator ring 82. A material for improved heat flow from the heater to the tip melt passage was not disclosed in document A3, which only mentioned materials such as steel and ceramics. As the tip surrounding piece typically contacted the cavity plate, it was normally made from a material with good heat insulating properties, such as titanium. In addition, also the wear resistance and a certain amount of mechanical rigidity of the tip surrounding piece were important in order to protect against the abrasive melt which also passes through the

tip surrounding piece and in order to hold the tip. The passage in column 4, lines 10-13 referred to the embodiment of figure 1 of document A3, rather than to figures 2 and 3.

Even if the teaching of document A5 was consulted, this would not result in a lack of inventive step. The tip surrounding piece was not part of the nozzle casing, as followed clearly from page 94 of document A5. Hence, the materials of pages 80-81 could not be used for a tip surrounding piece. The thermal properties of some materials were listed on page 83 of document A5. In order to improve heat transfer while avoiding cracking, the skilled person would rather use one of the steel materials, which have a fairly high thermal conductivity and a similar coefficient of thermal expansion as ceramic sinters. Furthermore, the skilled person would not consider using BeCu in an environment as mentioned in document A3, where temperatures over 800°F (426°C) could be reached. Page 81 of document A5 indicated that the mechanical strength of BeCu rapidly fell as the temperature rose, so that BeCu was only used up to temperatures of around 280°C. The same would apply to aluminium alloys, which had similar properties compared to BeCu.

Reasons for the Decision

Inventive Step

1. Starting point

In order to assess the inventive merit of the claimed subject-matter, the appellant started either from one of the embodiments according to figures 7 and 8 of

document A1, or, alternatively, from the embodiment of figures 2 and 3 of document A3.

It is undisputed that both prior art documents concern nozzle assemblies for use in injection moulding apparatus, whereby a heater is thermally connected to a nozzle body for heating melt flowing in a melt passage through the nozzle body. Similarly, the parties do not contest that feature F' is not disclosed by the documents A1 or A3.

1.1 Document A1

1.1.1 Tip surrounding piece

In all embodiments of document A1 the melt exits the nozzle through a two-component tip arrangement formed by an inner portion or body 22 and a co-axial outer portion or body 21 assembled with an interference fit on the inner portion. The respondent disputes that these portions form a tip and a separate tip surrounding piece, respectively.

Contrary to the view of the respondent, document A1 does not contain any passage from which it would follow that the tip arrangement disclosed therein must be regarded as a single, indivisible entity defining both a melt passage therethrough and a connecting portion for fastening it to the nozzle body. On the contrary, the description of the document A1 repeatedly points out that the respective materials of the inner and outer portions must be different or have different characteristics (cf. column 2, lines 28-30 and column 3, lines 25-28 and 35-38), which means that the constituents of the tip arrangement are and remain

different constructional entities both before and after the assembly of the nozzle.

The similarities between the tip arrangement of document A1 and the tip arrangement shown in figure 3 of the patent in suit do not necessarily require the board to use the same terminology for describing similar features in each document. The fact that the two-component tip arrangement of figure 3 of the patent is referred to as "tip 202" in the description thereof does not prevent the board from regarding the inner portion of such an arrangement as a tip and the outer portion as a piece surrounding that tip.

Therefore, the board regards the inner portion 22 as a nozzle tip defining a tip melt passage 23 therethrough and the outer portion 21 as a piece surrounding the tip, that is connected with respect to the nozzle body (claim features D and E).

1.1.2 Mould component contacting piece

In point 2.2.1 of the reasons for the impugned decision the opposition division held that it was not clear from document A1 that the insulating layer 21a of figure 8 was intended to contact the mould component, so that claim features G and H were not disclosed therein.

The board notes that a nozzle *per se* is claimed. For a feature in a prior art document to fall within the meaning of the noun chain "mold component contacting piece" it would be sufficient to ascertain its *suitability* for making contact with a mould component. As long as there is no clear disclosure that such a contact must be excluded because of technical constraints, any piece provided on the outer surface of

the tip or the tip surrounding piece, that could come into contact with a mould component when assembled in an injection moulding apparatus and that has a lower thermal conductivity than the tip surrounding piece must fall within the ambit of features G and H. In the embodiment of figure 7 of document A1 a thermal insulating coating 37 is applied around the lower tapered end of the nozzle tip 22 below the tip surrounding piece 21. In use, the layer 37 is located in the gate area of the mould plate so that at least the lower end of the layer 37 contacts the mould

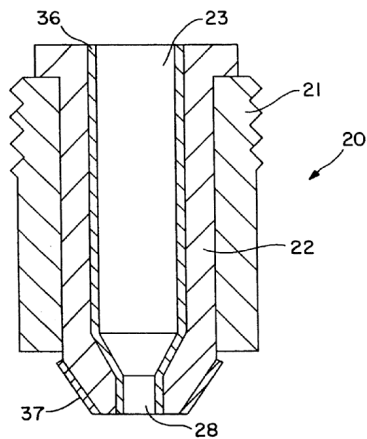


FIG. 7

plate. In this position, the layer 37 is located between the mould plate and the tip surrounding piece 21. It is noted that claim 1 does not strictly require a direct connection between the mould component contacting piece and the tip surrounding piece (cf. dependent claim 10 of the patent in suit).

These considerations also apply to the embodiment of figure 8. A thermally insulating layer 21a covers the unthreaded part of the outer surface of the tip surrounding piece 21. Depending on the shape of the nozzle housing, at least part of the layer 21a may come into contact therewith. The board concurs with the appellant that the wording of claims 17, 39 and 58 of document A1 also applies to the embodiment of

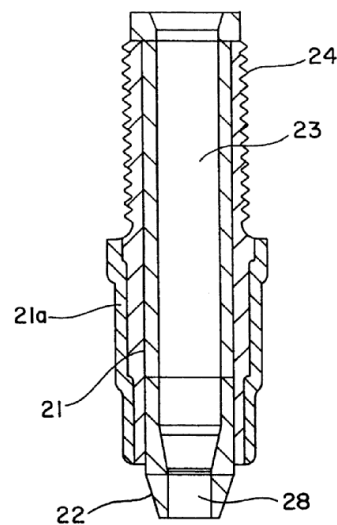


FIG. 8

figure 8. In use, the thermal insulating layer 21a will therefore function as a mould component contacting piece in accordance with features G and H.

In view of paragraph [0028] of the patent in suit, according to which the mould component contacting piece may be a coating as well as a separate piece, the board is persuaded that both the coating 37 of figure 7 and the layer 21a of figure 8 can be regarded as mould component contacting *pieces*.

1.1.3 Conclusion - document A1

Both the embodiment of figure 7 and the embodiment of figure 8 of document A1 disclose a nozzle having all features of claim 1 except feature F'. As the embodiments of figures 1-6 of document A1 are not conclusive on features G and H, they are considered less relevant.

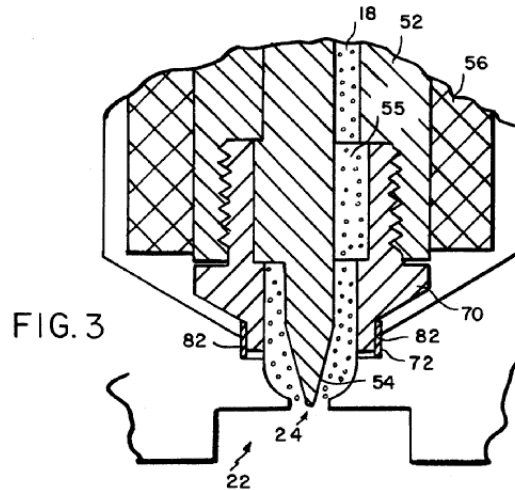
1.2 Document A3

1.2.1 Tip melt passage

The board is in agreement with the respondent that the embodiment according to figures 2 and 3 of document A3 fails to disclose directly and unambiguously a tip defining a tip melt passage therethrough, as required by claim feature D.

In contrast with the embodiment of figure 1 of document A3, the tip 54 of figures 2-3 is a solid needle-like object held inside the nozzle body 52 by means of a tip surrounding piece 70. In the absence of a cross-sectional view showing the details of the arrangement in a transverse cutting plane, it is not possible to

infer without doubt from figures 2 or 3 how the tip is shaped in three dimensions and, in particular, how the melt passage 55 is formed therein. Even if it would be reasonable to assume that figures 2 and 3 depict a central tip portion held in place in the nozzle body 52



through a set of vanes (the cross-hatched extension towards the left of the tip 54 in figure 3 would be the cross-section of one of the vanes), the board can only guess how the passage 55 is arranged with respect to the central tip portion and the vanes. Therefore, a direct and unambiguous disclosure of a melt passage extending *through* the tip 54 is missing from document A3.

The argument of the appellant that figure 5 of the patent also discloses a so-called torpedo/needle tip, where the tip melt passage is not formed entirely by or in the tip itself, cannot be followed. The tip 402 of figure 5 has a compound construction: a main portion 405 of a highly thermally conductive material and a wear resistant tip end 404. A tip melt passage is provided inside the main portion 405 running from the upper surface all the way to the lower, tapered surface. Therefore, similar to the other embodiments of the patent in suit, figure 5 discloses an open nozzle with a tip melt passage defined through the nozzle tip.

1.2.2 Tip surrounding piece

According to column 4, lines 33-38 of document A3, a (thermal) insulator is provided over the tip assembly 70. In the embodiment of figure 1 of document A3, the entire nozzle assembly 10 including the tip 12 is made of steel (cf. column 3, line 63). As the heat generated in the heating coil 56 of the second embodiment of figures 2 and 3 must be conducted to the resin in the entire melt passage, it is plausible to assume that the tip assembly 70 of the second embodiment is also made of steel. In any case, for the placement of an insulator ring on the tip assembly 70 to make technical sense, the tip assembly must be made of a thermally conductive material (feature F).

1.2.3 Conclusion - document A3

The embodiment of figures 2 and 3 of document A3 discloses a nozzle having features A-C, E-F and G-H. Features D and F' are not disclosed.

The board concludes that the additional difference with respect to the embodiments of document A1 makes the embodiment of document A3 less appropriate as a starting point for determining inventive step.

2. Objective technical problem

Starting from the embodiments of figure 7 or of figure 8 of document A1, it is common ground that the technical effect of feature F' is to have a high thermal conductivity, substantially improving the heat flow from the heater to the tip melt passage. The objective technical problem is therefore to modify the

known nozzle in such a way that the heat flow from the heater to the tip melt passage is improved.

3. Obviousness

3.1 Common general knowledge - document A5

3.1.1 With the statement setting out the grounds of appeal the appellant submitted pages 80 and 81 of the text book "Hot Runners in Injection Moulds", the English translation of which was published in 2001, i.e. the same year the first priority application CA2358148 of the patent in suit was filed. With his letter of 15 February 2019 filed in preparation for the oral proceedings, the respondent questioned whether the content of document A5 reflected the common general knowledge before the priority date.

Although the exact time at which the textbook in the English translation or in the original version was made available to the public cannot be retrieved from the documents filed, the board is satisfied that the book is an account of the common general knowledge of the skilled person in the technical field of injection moulding prior to its own publication. Document A5 bundles some excerpts of a reference work, which provides indirect evidence for the common general knowledge well known in the art before 2001 and hence before the priority date of the patent in suit. Such a document does not stand or fall merely by its publication date (cf. T 1110/03, OJ EPO 2005, pages 302-311, reasons point 2).

The fact that the respondent submitted four pages of the same textbook (pages 81, 83, 94, 103) in support of his inventive step argument strikes the board as a

further indication that its content concerns the common general knowledge.

3.1.2 Figure 4.4 on page 80 of document A5 gives an overview of some materials used to make hot runner nozzles, plotted according to their thermal conductivity and hardness. In respect of these materials, page 81 points out the following:

- "Hot-work tool steel ... [is used] for nozzle casings and bodies",
- "Sintered molybdenum ... [is used] for nozzle casings and tips in applications up to 360°C ... and for melts with an abrasive action (five times greater durability than that of copper/beryllium alloys)",
- "Copper/beryllium alloys ... [are used] for nozzle casings and tips in applications up to around 280°C ... (because of the mechanical strength of the alloy, which rapidly falls when the temperature rises)",
- "Copper alloys ... and aluminium alloys [are used] for heating jackets with embedded or wound heater element" and
- "the choice of a material with a high thermal conductivity necessarily brings with it a loss of hardness (Figure 4.4) and strength".

The table on page 83 gives an overview of the thermal properties of the materials referred to on pages 80 and 81, from which it follows that Beryllium-Copper (BeCu) has a very high thermal expansion coefficient and an excellent thermal conductivity, which is roughly double the conductivity of sintered molybdenum (TZM).

3.2 Document A1 and the common general knowledge

The skilled person will be prompted by the common general knowledge to choose an appropriate material for the tip surrounding piece known from figure 7 or from figure 8 of document A1 in an attempt to solve the objective technical problem, while expecting some improvement or advantage. In doing so, it should be borne in mind that the technical disclosure in (an embodiment of) a prior art document should be considered in its entirety by the person skilled in the art and that it is not justified to arbitrarily isolate or delete parts of the document from their context in order to derive from them technical information which would be distinct from the integral teaching of the (embodiment of the) document (cf. Case Law of the Boards of Appeal, 8th edition 2016, point I.D.9.4).

3.2.1 In the embodiment of figure 7 the only material mentioned for the tip 22 is BeCu (column 8, line 10), whereas the tip surrounding piece 21 is *made of a high pressure resistant material* in accordance with previous mentions thereof (column 8, line 12: "As mentioned"). This back-reference can only concern the general description in column 2, lines 29-31 and 45-47, and the description of the first embodiment in column 4, lines 65-66 and in column 6, lines 19-25 of document A1, which put forward steel, TZM, AerMet and Inconel as suitable materials for a high pressure resistant tip surrounding piece. According to claims 11, 32 and 52 Ti/Zr-Carbide or TZM is a suitable material for the tip surrounding piece. The context of the above-mentioned passages emphasizes the importance of using materials for the tip and the tip surrounding piece, that have different characteristics. The reasons behind this lie in the different roles the components play in the

nozzle: the tip is exposed to the abrasive high temperature environment in the melt passage, whereas the tip surrounding piece must resist the harsh mechanical conditions exerted between the nozzle body and the tip while preserving the preload with the tip also at high temperatures.

In this context the skilled person will be incited to select a suitable material for the tip surrounding piece 21 that has both a high thermal conductivity and a high pressure resistance, without ignoring the requirement that its thermal and the mechanical characteristics must differ from those of the tip. Both page 81 and page 83 of document A5 include various pointers that would prompt the skilled person to opt for sintered molybdenum (TZM), which is known to be used for nozzle tips in high-temperature applications, which has a good thermal conductivity (115 W/mK) and a high pressure resistance in comparison to BeCu, and which is already mentioned in the context of the embodiment of figure 7 in document A1. Alternatively, the skilled person would contemplate the use of a hot-work tool steel in order to combine a low thermal expansion coefficient with a high pressure resistance when compared to the BeCu used for the tip. An example of such a steel is the heat-treated AerMet alloy mentioned in column 5, lines 1-14 of document A1.

The board acknowledges that a tip surrounding piece made of BeCu would also solve the thermal conduction problem between the heater and the tip, as alleged by the appellant. However, such a choice would go against the gist of document A1, i.e. to use different material characteristics for the tip and the tip surrounding piece. This condition not only prevails when the tip surrounding piece is mounted onto the tip through a

shrink-fit or through a relative thermal expansion, but also when a press-fit is used for assembling the components (cf. column 5, lines 56 - column 6, line 12). This follows from the dependence of claims 63 and 67 of document A1 ("interference fit ... at room temperature") on claim 62 ("made of different materials") resp. claim 66 ("material having different characteristics"). For those reasons, the skilled person will not mount a BeCu tip surrounding piece by press-fit onto the BeCu tip.

In addition, document A5 actually dissuades the skilled person from selecting BeCu as the material for the tip surrounding piece. Even if the tensile strength of some BeCu alloys could reach values as high as 1300 MPA, for which no proof was provided by the appellant, the person skilled in the art knows from page 81 of document A5 that the mechanical strength of BeCu alloys rapidly falls when temperature rises above around 280°C. This may be problematic if the maximum temperature in the nozzle reaches 600-800 °F or 315-426 °C (column 2, lines 39-41 of document A1).

Further, there is no incentive to revert to any of the other material options of claim feature F'. The person skilled in the art knows that copper has the best thermal conductivity of all but would be a poor choice for a pressure resistant material. According to document A5, aluminium alloys are mainly suggested for heating jackets. In addition, their very high coefficient of thermal expansion can negatively affect the preload existing between the tip and the tip surrounding piece.

3.2.2 When starting from the embodiment shown in figure 8 of document A1, several of above-mentioned arguments also

apply. Although no materials are given in the description in column 8, lines 30-44 of document A1, the back-reference "As in the other embodiments" suggests that the tip should be made of a high thermally conductive material such as tungsten carbide or BeCu and the tip surrounding piece of a high pressure resistant material such as TZM, AerMet or Inconel (see point 3.2.1 above).

The negative effect caused by high operating temperatures on the mechanical strength of BeCu alloys already discourages the skilled person from considering these materials for the tip surrounding piece. Should the tip 22 be made of BeCu provided with an inner ceramic coating to protect against the abrasive melt, a tip surrounding piece 21 made of BeCu would go against the gist of the disclosure of document A1, as set out in point 3.2.1 above. On the other hand, should the tip 22 be made of tungsten carbide (cf. column 5, lines 23-29) there is no incentive to pick a material such as BeCu for the tip surrounding piece, as the substantially higher thermal expansion rate of BeCu will eliminate any preload existing between the components during the operation of the nozzle at high temperatures.

3.3 Document A1 in combination with document A2 or A4

In document A2 a nozzle is disclosed with a completely different thermal balancing caused by the direct contact between the tip surrounding piece 16 and the mould. The only materials proposed for the tip surrounding piece 16 are titanium and H-13 tool steel (cf. page 6, lines 28-31).

The tip surrounding piece 62 of document A4 is made of a low thermal conductivity material such as titanium (cf. column 10, lines 55-57).

Hence, neither document A2 nor document A4 discloses claim feature F' so that they cannot render obvious the claimed solution when starting from document A1.

3.4 Thus, when starting from the nozzle according to figure 7 or figure 8 of document A1 and attempting to solve the objective technical problem posed, the claimed solution involves an inventive step.

4. Inventive step - starting from document A3

The appellant presented a further attack against the inventive step of claim 1 starting from the embodiment shown in figures 2 and 3 of document A3. As established in point 1.2 above, the tip defining a tip melt passage therethrough (claim feature D) and the material of the tip surrounding piece (claim feature F') constitute the differences with respect to claim 1. The board concurs with the appellant that the technical effect of the first difference can be considered as the supply of the molten material to the gate in a different manner, so that the first part of the objective technical problem is to provide an alternative nozzle arrangement. In accordance with the conclusion made in point 2 above, the second part of the objective technical problem is to modify the known nozzle in such a way that the heat flow from the heater to the tip melt passage is improved.

In agreement with the respondent, the board judges that the skilled person, faced with the second part of the objective technical problem of improved heat flow,

would not have an incentive to select a material for the tip surrounding piece 70 from the alternatives given in claim feature F'. In document A3 no specific material other than steel is mentioned in conjunction with the conductive part of the nozzle assembly (cf. column 3, lines 25 and 63, and column 4, line 8). Based on the information taken from the textbook excerpts of document A5 the skilled person has several options for selecting a material with high thermal conductivity. The selection of a material is subject to the condition that its thermal expansion rate should be similar to that of the thermally insulating mould component contacting piece 82 pressed over the tip surrounding piece 70 (cf. column 4, lines 33-43 of document A3). As ceramic sinters and zirconia oxides typically have a thermal expansion coefficient of 9 to 11 $\times 10^{-6}/K$, the skilled person would opt for one of the hot work tool steels DIN 1.2311 - DIN 1.1730 listed in the table on page 83 of document A5, rather than any of the copper or aluminium alloys included therein, which combine an excellent heat conductivity with a very high thermal expansion coefficient.

As is the case in document A1, the maximum operating temperature of the nozzle of document A3 can become very high, reaching 800°F or 426°C (cf. column 2, lines 39-41). In view of the deteriorating mechanical properties of copper/beryllium alloys above 280°C, BeCu is not a suitable material and a hot work tool steel would be a better alternative.

The remarks to documents A2 and A4 made in point 3.3 above also apply here.

Therefore, even if the solution to the first part of the objective technical problem of providing an

alternative nozzle arrangement were obvious, starting from the embodiment of figures 2 and 3 of document A3 the claimed solution to the problem of improved heat flow involves an inventive step.

5. Conclusion

As the subject-matter of claim 1 is not obvious to the person skilled in the art having regard to the state of the art, it involves an inventive step pursuant to Article 56 EPC 1973.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:

The Chairman:



N. Schneider

M. Poock

Decision electronically authenticated