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**Datasheet for the decision  
of 4 November 2010**

**Case Number:** T 0278/08 - 3.2.03  
**Application Number:** 01112818.8  
**Publication Number:** 1160522  
**IPC:** F25B 1/06, F04F 5/04  
**Language of the proceedings:** EN

**Title of invention:**  
Ejector cycle system

**Patentee:**  
DENSO CORPORATION

**Opponent:**  
Behr GmbH & Co. KG

**Headword:**

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**Relevant legal provisions:**  
EPC Art. 84, 54

**Relevant legal provisions (EPC 1973):**

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**Keyword:**

"Admissibility of late filed requests (no)"  
"Admissibility of late filed document (yes)"  
"Novelty (no)"  
"Referral to the Enlarged Board of Appeal (no)"

**Decisions cited:**

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**Catchword:**

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Case Number: T 0278/08 - 3.2.03

**D E C I S I O N**  
of the Technical Board of Appeal 3.2.03  
of 4 November 2010

**Appellant:** Behr GmbH & Co. KG  
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**Representative:** Wallinger, Michael  
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**Respondent:** DENSO CORPORATION  
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**Decision under appeal:** Decision of the Opposition Division of the  
European Patent Office posted 30 November 2007  
rejecting the opposition filed against European  
patent No. 1160522 pursuant to Article 102(2)  
EPC.

**Composition of the Board:**

**Chairman:** U. Krause  
**Members:** C. Donnelly  
I. Beckedorf

## Summary of Facts and Submissions

- I. The appeal lies from the decision of the opposition division, dated 30 November 2007, rejecting the opposition against the European Patent No. 1 160 522.
- II. The opponent (hereinafter "the appellant") filed a notice of appeal against this decision on 30 January 2008 and paid the fee the same day. The grounds of appeal were received on 19 March 2008.
- III. In support of its case for revocation of the contested patent the appellant referred to the following state of the art:

D1: US-A-4918937;

D2: US-A-3670519;

D3: EP-A-487002;

D4: DE-C-662250;

D6: M.N.V. Naduvath "Investigation of Single and Two-Phase Flow injectors", Dissertation, University of Maryland, College Park, 1999;

D7: T.K. Bunch, A.A.Kornhauser; M.A. Alexandrien: "Efficiency of a Flashing Flow Nozzle", Energy Conversion Engineering Conference, 1996, IECEC 96, Proceedings of the 31. Intersociety", volume 3, S. 1610-1615, ISBN 0-7803-3547-3;

D8: Peter Menegay: "A Computational Model for Two-Phase-Ejector Flow", Dissertation, Virginia Polytechnic Institute and State University, 1997;

D9: US-A-5343711;

D25 ("Greg S. Harrell "Testing and Modeling of a Two-Phase Ejector" Dissertation, Faculty of the Virginia Polytechnic Institute and State University, 1997.

- IV. The patentee (hereinafter "the respondent") replied to the arguments raised in the grounds by letter of 8 October 2008 and requested that the appeal be dismissed.
- V. In a communication dated 6 July 2010, pursuant to Article 15(1) RPBA annexed to the summons to oral proceedings, the board informed the parties of its provisional opinion. In particular, the board indicated that it was minded to admit D25 into the proceedings and that this document seemed relevant to the question of novelty of claim 1 as granted.
- VI. In letter of 4 October 2010 the respondent reacted to the board's provisional opinion by filing a new main request and an auxiliary request.
- VII. Oral proceedings were held on 4 November 2010.

At the close of the debate the parties made the following requests:

The appellant requested that the decision under appeal be set aside and European Patent No. 1160522 be revoked.

The respondent requested that in setting aside the decision under appeal, the patent be maintained in amended form on the basis of the main request or, alternatively, on the basis of the auxiliary request, both filed with letter of 4 October 2010, or that the appeal be dismissed.

VIII. After the board had indicated that the respondent's requests would either not be admitted into the appeal proceedings for having been late filed or not be allowable for lack of novelty, the respondent also requested that the following question be referred to the Enlarged Board of Appeal:

"Whether it is allowed to reject a clarification of claim 1 filed one month before oral proceedings, when the reason for clarification was raised the first time in the Annex to the summons to oral proceedings and the rejection of the clarification of claim 1 has the effect that claim 1 is then regarded as not novel in relation to a document which was not novelty destroying in the procedure up to the summons."

IX. Claim 1 as granted reads:

"An ejector cycle system comprising:

a compressor (100) for sucking and compressing refrigerant;  
a radiator (200) for cooling refrigerant discharged from the compressor;  
an evaporator (300) in which refrigerant is evaporated by absorbing heat;  
an ejector (400) having a nozzle (410) which decompresses high-pressure side refrigerant from the radiator (200) so that a pressure energy of high-pressure side refrigerant flowing from the radiator is converted to a speed energy so that refrigerant is decompressed and expanded, and a pressure-increasing portion (420,430,423) in which gas refrigerant evaporated in the evaporator is sucked by a high-speed

flow of refrigerant so that the pressure of refrigerant is increased while the refrigerant discharged from the nozzle and refrigerant sucked from the evaporator are mixed; and

a gas-liquid separator (500) for storing refrigerant and for separating refrigerant into gas refrigerant and liquid refrigerant, wherein:

the nozzle is a divergent nozzle (410) having therein a throat portion (410a) at which a passage sectional area becomes smallest in a refrigerant passage of the divergent nozzle;

the divergent nozzle has a first dimension (B) between the throat portion and an outlet of the nozzle, and a second dimension (A) between the throat portion and an upstream portion upstream from the throat portion, from which the passage sectional area becomes smaller in the refrigerant passage of the divergent nozzle, the first dimension being larger than the second dimension, characterised in that

the pressure-increasing portion has a length (L') in a refrigerant flow direction and a smallest equivalent diameter (D2), and a ratio (L'/D2) of the length to the smallest equivalent diameter is equal to or smaller than 120; and

a ratio (D2/D1) of the smallest equivalent diameter of the pressure-increasing portion to an equivalent diameter at the outlet of the nozzle is in a range of 1.05 - 10."

Claim 1 according to the main request filed with letter of 4 October 2010 is identical to claim 1 as granted except that the phrase "characterised in that" has been replaced with "wherein" and the following text has been added at the end:

"and wherein the nozzle decompresses and expands liquid refrigerant flowing into the upstream portion of the nozzle and the refrigerant flowing between throat portion and outlet of the nozzle is a gas-liquid two phase refrigerant."

Claim 1 according to the first auxiliary request of 4 October 2010 is identical to the main request with the addition of the following text:

"wherein the refrigerant is carbon dioxide; and the ratio of the equivalent diameter of the mixing portion to the equivalent diameter at the outlet of the nozzle is in a range of 1.3 - 5.3, or the refrigerant is flon(sic); and the ratio of the equivalent diameter of the mixing portion to the equivalent diameter at the outlet of the nozzle is in a range of 1.05 - 4.5."

X. *Arguments of the parties*

(a) *Admissibility of the respondent's main and first auxiliary requests.*

*Appellant*

The requests filed with letter of 4 October 2010 should not be admitted into the proceedings since they were late filed. Also, they were not made in immediate response to the summons to oral proceedings, but three months later.

Further, the characteristic:

"and wherein the nozzle decompresses and expands liquid refrigerant flowing into the upstream portion of the nozzle and the refrigerant flowing between throat portion and outlet of the nozzle is a gas-liquid two phase refrigerant."

added to claim 1 of both these requests is prima facie unclear since it relates to the operation of the system rather than to any constructional feature of the apparatus. Without a full specification of the other operating parameters the feature is any case unclear.

Furthermore, this amendment does not exclude the possibility that a mixed phase refrigerant enters the nozzle since it just specifies "liquid refrigerant flowing into the upstream portion of the nozzle" and not that the refrigerant flowing into the upstream portion of the nozzle is entirely liquid which would have been possible in a concise manner by amending the feature already present in claim 1 relating to the decompression and expansion in the nozzle.

Therefore, the amendment is prima facie unclear and the requests should not be admitted.

*Respondent*

The requests should be admitted since they had been submitted in response to the board's provisional opinion. In particular, the amendments clearly express that there is a change from a single phase to a dual phase such that a system employing a bubble flow



generator is now clearly excluded by the claims. Thus, the amendment makes a clear constructional distinction with respect to such systems.

(b) *Admissibility of late filed document D25*

*Appellant.*

Document D25 should be admitted into the proceedings since it was filed with the grounds of appeal and was highly relevant to the subject-matter of claim 1 of all requests.

*Respondent.*

Document 25 should not be admitted into the proceedings since it was late filed and concerned a system using a bubble generator. Therefore, it was not prima facie relevant to the claimed subject-matter since it did not disclose that liquid refrigerant only exists at the throat of the nozzle.

(c) *Article 123(2) EPC*

*Appellant*

Should it be decided that claim 1 of both requests means that liquid only enters the throat of the nozzle then the claims would not meet the requirements of Article 123(2) EPC since it is not possible to determine the state of the refrigerant at the throat from the originally filed application. In particular, it must be remembered that whether the refrigerant is liquid or vapour depends also on the temperature. Also,

whilst the Mollier diagram of figure 3 shows that the refrigerant is expanded from a liquid state at point C2 to a mixed phase at point C3, it does not indicate what the conditions at the throat are since the corresponding physical position along the nozzle is not given.

*Respondent*

The basis for the feature added to the main request is to be found in paragraph [0023] of the published application which reads "a nozzle 410 which decompresses and expands refrigerant by converting a pressure energy (pressure head) of high-pressure side refrigerant flowing from the radiator..." The skilled reader would recognise that only liquid flows from the radiator, thus making it clear that liquid is introduced into the nozzle and that, as a result of the inevitable expansion after the throat, two phases must exit. The Mollier diagram of figure 3 clearly shows this change occurring between points C2 and C3.

(d) *Novelty - Further auxiliary request - dismissal of the appeal, claim 1 as granted.*

*Appellant*

D25 discloses all the features of claim 1 as granted.

At page 9, 2.1 "Introduction" it is stated that "The test rig is sized to allow the analysis of ejectors which would be used in refrigeration systems ranging in size from 10 to 25 ton (33 to 86kW). The ejector that is currently being tested is sized for a 25 ton (86kW)

system". Thus, the ejector described in figures 2-2 and 2-7 corresponds to an ejector usable in a refrigeration system depicted in figure 1-2.

The specification in claim 1 of the nozzle dimensions covers all divergent nozzles with a recognisable throat area.

Figure 2-7 shows a radius of 4.76mm (3/16") at the entry to the nozzle which is used to bridge the gap between the two diameters i.e. 8.128mm inner diameter of the bubbly tube down to 6.528mm at the throat; this distance does not constitute a negligible quantity in terms of the nozzle geometry.

The skilled person reading the claim would also understand that the motive nozzle is a separate component and not integrated with the bubble tube. Some embodiments of the system of the contested patent also comprises a throttle valve e.g. valve 454 in figures 11A and 11B.

The ratios  $L'/D_2$  and  $D_2/D_1$  defining the geometry of the ejector in relation to the nozzle are derivable from table 2-2 and figure 2-7 of D25 as being 25 and 2.2, respectively.

The wording of the claim does not in any case exclude the presence of a bubble generator.

*Respondent*

D25 is not relevant for novelty since the ejector shown in figures 2-2 and 2-7 does not correspond to the

ejector nozzle used in the refrigeration system of figure 1-2.

Further, figure 2-7 shows a radius of 4.76mm (3/16") at the entry to the nozzle which is used to bridge the gap between the 8.128mm inner diameter of the bubbly tube to the 6.528mm at the throat. Thus, in the device of D25 the presence of the bubbly flow tube means that the length of the converging part of the nozzle would be considerably less than 0.8mm which cannot be equated to the converging part of a converging-diverging nozzle.

There is also no change of phase in the motive nozzle of D25 which cannot be compared directly with the nozzle of the contested patent. In D25, liquid passes from the condenser to the throttle valve to produce bubbles and then to the motive tube. Thus, when comparing nozzle dimensions, the corresponding length in the device of D25 should be taken from where there is a change of phase i.e. inclusive of the bubble generator length.

## **Reasons for the decision**

1. The appeal is admissible
2. *Admissibility of main and auxiliary requests*
  - 2.1 Both the main and auxiliary request dated 4 October 2010 have been amended by introduction of the feature:  
  
"and wherein the nozzle decompresses and expands liquid refrigerant flowing into the upstream portion of the

nozzle and the refrigerant flowing between throat portion and outlet of the nozzle is a gas-liquid two phase refrigerant."

2.2 This feature does not clearly define that only liquid enters the nozzle. Thus, it is not excluded that the liquid refrigerant which is decompressed and expanded might be mixed with vapour. The second aspect of the amendment excludes the possibility that there is vapour only at the outlet.

2.3 The respondent has argued that it is clear from paragraph [0023] of the published application that the refrigerant entering the nozzle can only be liquid since it flows from the radiator. However, this aspect of refrigerant flow from the radiator is already defined in the claim by the feature reading:

"an ejector (400) having a nozzle (410) which decompresses high-pressure side refrigerant from the radiator (200) so that a pressure energy of high-pressure side refrigerant flowing from the radiator is converted to a speed energy so that refrigerant is decompressed and expanded"

2.4 The respondent has also argued that it is clear from figure 3 that refrigerant leaving the radiator is entirely liquid. However, figure 3 is one example of a possible cycle and is not limiting for the claim. Whether it would have provided a basis for defining that only liquid refrigerant enters the nozzle does not need to be discussed since the respondent has chosen not to make a clear claim to this effect.

2.5 Thus, in essence, the amendment does not add anything and as such does not meet the requirements of Article 84 EPC since it repeats subject-matter already defined. The requests are therefore not admitted into the proceedings.

3. *Admissibility of D25*

3.1 The board does not accept the arguments put forward by the respondent against the admission of D25. In D25, at page 9, 2.1 "Introduction" it is stated that "The test rig is sized to allow the analysis of ejectors which would be used in refrigeration systems ranging in size from 10 to 25 ton (33 to 86kW). The ejector that is currently being tested is sized for a 25 ton (86kW) system". Thus, the ejector described in figures 2-2 and 2-7 corresponds to an ejector usable in a refrigeration system depicted in figure 1-2.

3.2 Further, the claim specifies a "divergent nozzle" (and not a converging-diverging nozzle), which has:

3.3 "a first dimension (B) between the throat and an outlet of the nozzle, and a second dimension (A) between the throat portion and an upstream portion upstream from the throat portion, from which the passage sectional area becomes smaller in the refrigerant passage of the divergent nozzle, the first dimension being larger than the second dimension". This specification covers all divergent nozzles with a recognisable throat area. Figure 2-7 shows a radius of 4.76mm (3/16") at the entry to the nozzle which is used to bridge the gap between the two diameters i.e. 8.128mm inner diameter of the bubbly tube down to 6.528mm at the throat; this

distance does not constitute a negligible quantity in terms of the nozzle geometry. In addition, figure 9a of the contested patent shows a similar type of nozzle wherein the whole of the dimension A is made up by the radius leading into the throat.

3.4 Thus, D25 cannot be dismissed as being prima facie irrelevant.

3.5 D25 was first presented at a late stage in the opposition proceedings, however, the opposition division made a thorough appraisal of the document before deciding against its admittance. The objections raised by the opposition division were taken up by the appellant in the grounds of appeal, indeed the bulk of its case was based on this document. Thus, the respondent must have been aware of its potential relevance at least from the beginning of the appeal proceedings. Also, the admittance of D25 would not mean a totally fresh case is created since the opposition division has given an opinion regarding its content.

3.6 For these reasons it is decided that D25 should be admitted into the proceedings.

4. *Further auxiliary request - Dismissal of appeal:  
Novelty, claim 1 as granted.*

4.1 Regarding the further objections made by the respondent concerning novelty beyond those relating to the prima facie relevance of D25, the board does not accept that the corresponding nozzle length in the device of D25 should be taken from where there is a change of phase and should therefore be inclusive of the bubble

generator length. The motive nozzle of D25 is a clearly identifiable component as shown for example in figure 2-7. As explained above in paragraphs 2.2 to 2.4 the claim does not exclude the provision of a bubble generator.

4.2 The ratios  $L'/D_2$  and  $D_2/D_1$  defining the geometry of the ejector in relation to the nozzle are also derivable from D25. In the embodiment described in table 2-2 and figure 2-7 of D25 the pressure-increasing portion has a length of 635mm (see table 2-2 "mixing section and diffuser length") in a refrigerant flow direction and a smallest equivalent diameter of 25.4mm (see "mixing section diameter"), resulting in a value of 25 for the ratio  $L'/D_2$ , which is smaller than 120. Figure 2-7 shows that an equivalent diameter at the nozzle outlet is 11.43mm which results in a ratio for the smallest equivalent diameter of the pressure-increasing portion to the equivalent diameter at the nozzle outlet of 2.22 ( $25.4/11.43$ ) which is in a range between 1.05 and 10.

4.3 Taking these remarks into consideration, D25 shows

"An ejector cycle system comprising:

a compressor (see figure 1-2) for sucking and compressing refrigerant;  
a radiator ("condenser" see figure 1-2) for cooling refrigerant discharged from the compressor;  
an evaporator (see figure 1-2) in which refrigerant is evaporated by absorbing heat;  
an ejector (see figure 1-2) having a nozzle ("motive nozzle" in figure 1-3) which decompresses high-pressure side refrigerant from the radiator so that a pressure



energy of high-pressure side refrigerant flowing from the radiator is converted to a speed energy so that refrigerant is decompressed and expanded, and a pressure-increasing portion ("Diffuser" see figure 1-3 and 2-2) in which gas refrigerant evaporated in the evaporator is sucked by a high-speed flow of refrigerant so that the pressure of refrigerant is increased while the refrigerant discharged from the nozzle and refrigerant sucked from the evaporator are mixed (see "mixing section" figure 1-3 and 2-2); and a gas-liquid separator (see figure 1-3 "separator") for storing refrigerant and for separating refrigerant into gas refrigerant and liquid refrigerant, wherein:

the nozzle is a divergent nozzle (see figure 2-2 and 2-7) having a throat portion at which a passage sectional area becomes smallest in a refrigerant passage of the divergent nozzle;

the divergent nozzle has a first dimension between the throat and an outlet of the nozzle, and a second dimension between the throat portion and an upstream portion upstream from the throat portion, from which the passage sectional area becomes smaller in the refrigerant passage of the divergent nozzle, the first dimension being larger than the second dimension (see figure 2-7,

characterised in that

the pressure-increasing portion has a length ( $L'$ ) in a refrigerant flow direction and a smallest equivalent diameter ( $D_2$ ) and a ratio ( $L'/D_2$ ) of the length to the smallest equivalent diameter is equal to or smaller than 120; and

a ratio ( $D_2/D_1$ ) of the smallest equivalent diameter of the pressure-increasing portion to an equivalent

diameter at the outlet of the nozzle is in a range of 1.05 - 10 (see- table 2-2)".

- 4.4 Thus, the subject-matter of claim 1 according to the main request is not new.
5. Request for referral to the Enlarged Board of Appeal.
- 5.1 As explained above, the first amendment made to the claims does not constitute a clarification rather on the contrary; it compounds the shortcomings in this respect by introducing repetition and a lack of conciseness. Thus, the respondent's question has no basis in the present proceedings. Furthermore, the reason for prompting the amendment to claim 1 was raised by the appellant in the grounds of appeal. It is to the issues raised in these grounds that the respondent should reply without waiting for a provisional opinion from the board which it is, in any case, not obliged to provide.
- 5.2 Consequently, the request for referral to the Enlarged Board of Appeal is rejected since it does not relate to a fundamental legal matter, but rather to one of procedure which lies entirely within the board's discretion.

**Order**

**For these reasons it is decided that:**

1. The request for referral to the Enlarged Board of Appeal is rejected.
2. The decision under appeal is set aside.
3. The patent is revoked.

Registrar:

Chairman:

A. Counillon

U. Krause