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# D E C I S I O N
## of 20 October 1994

**Case Number:** T 0068/92 - 3.2.4

**Application Number:** 84101862.5

**Publication Number:** 0117523

**IPC:** F04B 37/08

**Language of the proceedings:** EN

**Title of invention:**
Reduced vacuum cryopump

**Patentee:**
HELIX TECHNOLOGY CORPORATION

**Opponent:**
Leybold AG

**Headword:**
-

**Relevant legal provisions:**
EPC Art. 56

**Keyword:**
"Inventive step - yes"

**Decisions cited:**
T 0229/85

**Catchword:**

**Case Number:** T 0068/92 - 3.2.4

**D E C I S I O N**
**of the Technical Board of Appeal 3.2.4**
**of 20 October 1994**

**Appellant:** (Opponent)
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**Decision under appeal:** **Interlocutory decision of the Opposition Division of the European Patent Office dispatched on 27 November 1991 concerning maintenance of European patent No. 0 117 523 in amended form.**

**Composition of the Board:**

**Chairman:** C. A. J. Andries
**Members:** M. G. Hatherly
J. P. B. Seitz

## Summary of Facts and Submissions

I. European patent No. 0 117 523, granted on the basis of European patent application No. 84 101 862.5, was opposed on grounds of lack of novelty and lack of inventive step based inter alia on the following documents:

(D1) FR-A-2 436 269 and

(D2) US-A-4 240 262.

II. In the interlocutory decision dispatched on 27 November 1991 the Opposition Division found that the patent with amended documents met the requirements of the EPC.

III. The Appellant (Opponent) filed an appeal against this decision on 22 January 1992 and paid the appeal fee on the same day. The Statement of Grounds of Appeal was received on 1 April 1992.

The following documents were additionally cited in the course of the appeal proceedings:

(D1') US-A-4 285 710 (a family member of document D1),

(D7) DE-A-2 949 092,

(D8) Catalogue of Leybold-Heraeus GmbH, Cryogenics, 82.1.2, HV 250, section 12, 10/81: cover page, pages 12.2 and 12.8 and back cover, and

(D9) Leybold-Heraeus Drawing No. 892 66 B1.

IV. During oral proceedings on 20 October 1994 the Respondent (Proprietor) submitted amended independent Claims 1 and 7.

Claim 1 reads as follows:

"A cryopump (20) for differentially pumping water vapor and inert gases comprising:

a. a cryopump housing (22) incorporating a single cryopumping port (24) for attachment to any chambers to be evacuated, said single port being determined for attachment to a work chamber;

b. a refrigerator (45) within said housing (22) having first and second stages (62,52);

c. a second stage cryopanel (40,41) mounted directly to a low temperature heat sink (42) on the second stage;

d. a radiation shield (32) partially enclosing the second stage cryopanel (40,41), and in thermal contact with a higher temperature heat sink (44) on the first stage (62), said radiation shield (32) being in close proximity to the cryopump housing (22) so that it forms a flow restriction or a positive seal (68) is placed between the radiation shield (32) and the cryopump housing (22);

e. a frontal inlet orifice plate (34) extending across the pumping port (24) and in thermal communication with the radiation shield (32), so as to act as part of the radiation shield (32), the orifice

plate (34) restricting flow of low condensing temperature gas from the work chamber to the second stage cryopanel (40,41) in order to allow a moderate pressure of low condensing temperature gas in the work chamber while condensing higher condensing temperature gases;

**characterized by**

a gas flow path (38) provided through the radiation shield (32) at a position removed from the pumping port (24) such that the radiation shield (32) is surrounded by a vacuum at a lower pressure than the work chamber."

Claim 7 reads as follows:

"A method of establishing a moderate pressure of inert gas in a work chamber with a cryopump (20) comprising the steps of:

a. introducing an inert low condensing temperature gas into the work chamber;

b. selectively removing higher condensing temperature gases from a work environment through the use of a cold surface of a cryopump radiation shield (32,34);

c. shielding lowest temperature cryopump components (40,41) from direct thermal contact with the moderate vacuum inert gas environment;

d. restricting the flow between said radiation shield (32,34) and the cryopump housing (22) by

providing said radiation shield in close proximity to the cryopump housing (22) or by placing a positive seal (68) between the radiation shield (32) and the cryopump housing (22);

**characterized by**

evacuating a volume within a part (50) of the cryopump housing (22) having a single cryopumping port (24) to a higher vacuum than the work environment so as to minimize heat transfer between cryopump components through the use of a gas flow path (38) provided through the rear of said radiation shield (32)."

V. The Appellant argued in writing and in the oral proceedings essentially that it was obvious to add an aperture known from prior art cryopumps to the cryopump known from document D1' and thus to arrive at a cryopump and method as set out in the claims. It was also obvious to arrive at the claimed subject-matter by modifying the high vacuum producing cryopump of document D2 using the teachings of document D1'.

VI. The Respondent argued in writing and in the oral proceedings essentially that a combination of the cited teachings was neither obvious nor would it lead to the claimed subject-matter.

VII. The Appellant requests the setting aside of the decision and the revocation of the patent.

The Respondent requests the setting aside of the decision and the maintenance of the patent:

- as the **main request** on the basis of the independent Claims 1 and 7 submitted during the oral proceedings, Claims 2 to 6 and 8 as granted, Figures 1, 1A and 2 as granted, and a description to be adapted; and

- as the **auxiliary request** on the basis of independent Claims 1 and 7 consisting of Claims 1 and 7 submitted during the oral proceedings but to each of which is added the subject-matter of the granted Claim 3.

## Reasons for the Decision

1. The appeal is admissible.

2. *Amendments - main request*

2.1 Claim 1 of the main request is the result of amending the granted Claim 1 in two respects.

The first amendment is that there is a **single cryo**pumping port (the cryopumping port being a port in the cryopump **housing** which provides in use a connection to a work chamber, that means to a chamber where vacuum is to be created and not a port in the radiation shield of the cryopump which has a different function e.g. the opening 38 in the base of the radiation shield 32). That there is a single cryopumping port can be seen in Figure 1 and is disclosed in column 4, lines 18 to 22 of the patent as granted.

The second amendment is that the radiation shield (32) is in close proximity to the cryopump housing (22) so that it forms a flow restriction or a positive seal is placed between the radiation shield (32) and the cryopump housing (22). This is taken from column 3, lines 29 to 37 of the patent as granted, see also Figures 1 and 1A.

2.2 Claim 7 of the main request is the result of amending the granted Claim 7 in the above two respects and also changing the wording "secondary pumping port (38) positioned in said radiation shield (32)" to "gas flow path (38) provided through the rear of said radiation shield (32)". The term "secondary pumping port" might have given rise to confusion now that it is specified that there is a single cryopumping port, so the new wording "gas flow path" is justifiable. That this path is through the **rear** of the radiation shield can be seen in Figure 1 and in column 6, line 23 of the patent as granted.

2.3 These amendments (see the above sections 2.1 and 2.2) further restrict the scope of the granted Claims 1 and 7.

2.4 During the oral proceedings the Appellant stated that he had no objection under Article 123 EPC to the Claims of the main request. The Board agrees with this statement.

3. *Novelty - main request*

No single document on file discloses all the features set out in either of independent Claims 1 and 7 of the main request. This is not disputed.

The subject-matter of each of Claims 1 and 7 of the main request is thus to be considered as novel within the meaning of Article 54 EPC.

4. *Closest prior art - main request*

4.1 For most vacuum work processes, a cryopump evacuates a work chamber to a high i.e. a great vacuum. An example of a high vacuum producing cryopump is shown in Figure 1 of document D2. The work chamber would be connected to opening 21. The lower temperature expansion chamber 14 is protected from oil or water vapour by a louver 19 (see column 2, lines 38 to 40).

4.2 For some vacuum work processes however, e.g. sputtering, intermediate vacuums are needed in the work chamber. The cryopump shown in Figure 3 of document D1' (or its family member D1) produces a moderate vacuum in the work chamber (this would be bolted to the top of the flange shown at the top of Figure 3) by having a flow restricting device 100 (the variable aperture valve shown in Figure 4) between the work chamber and the high vacuum chamber inside the cylindrical pumping structure (radiation shield) 23'.

4.3 As specified in the independent Claims 1 and 7 of the main request, the invention concerns a moderate vacuum producing cryopump and the Board considers this to be one reason why the correct starting point (or closest prior art) for assessing whether an inventive step is

present in the invention must be a moderate vacuum producing cryopump and not a high vacuum producing cryopump. A further reason will become apparent from section 5.3 below, i.e. the problem with which the invention is concerned is a problem which only arises with moderate vacuum producing cryopumps.

4.4 Accordingly the Board considers the state of the art closest to the invention to be the moderate vacuum producing cryopump shown in Figure 3 of document D1'.

5. *Differentiating features, problem and solution - main request*

5.1 The independent Claims 1 and 7 of the main request are divided using the embodiment according to Figure 3 of document D1'. Although the alternative of a positive seal is not disclosed by document D1', it is placed in the pre-characterising portion of each of the independent claims to avoid complicating and confusing the wording.

5.2 The invention's differentiating features are contained in the characterising portion of each of these claims. A gas flow path is provided through the radiation shield removed from the pumping port (Claim 1), namely at the rear of the radiation shield (Claim 7), such that **either** the radiation shield is surrounded by a vacuum at a lower pressure than the work chamber (Claim 1) **or** a volume within a part of the cryopump housing is at a higher vacuum than the work environment so as to minimise heat transfer between cryopump components (Claim 7).

5.3 The Board sees the objective problem as being to provide, with a moderate vacuum producing cryopump and in a method of producing a moderate vacuum using a cryopump as is disclosed by Figure 3 of document D1', operation at maximum efficiency for long periods of time (see column 2, lines 40 to 45 of the patent as granted). This problem only arises with moderate vacuum producing cryopumps since a high vacuum producing cryopump already exhibits a high vacuum around its radiation shield so that heat radiation is already minimised which results in its efficiency and time before regeneration being maximised.

5.4 It can be seen from Figure 3 of document D1' that the space between the housing structure 160 and the cylindrical pumping structure (radiation shield) 23' cannot be at a greater vacuum than the moderate vacuum produced in the work chamber. Accordingly the heat transfer from the housing structure 160 to the cylindrical pumping structure or radiation shield 23' is not at an optimal minimum.

By providing a gas flow path through the radiation shield removed from the cryopumping port, namely the openings 38 at the rear of the radiation shield (see Figure 1 of the present patent), gas can flow from above the orifice plate 34 through the annulus 50 between the housing 22 and the radiation shield 32 downwardly to the openings 38. However due to the flow restriction in the annulus and the fact that the cryopump can create in an undisturbed manner a high vacuum in the rear plenum of the cryopump housing, the rear plenum 54 and the annulus 50 between the cryopump housing 22 and the radiation shield 32 lie at a greater

vacuum than that in the work chamber. The result is a lower heat transfer from the housing structure 22 to the radiation shield 32 giving longer operation of the cryopump at maximum efficiency before regeneration is needed (see column 5, lines 51 to 64 and column 7, lines 4 to 18 of the granted patent). When a seal is present in the annulus an even higher vacuum is obtained in the rear plenum of the cryopump housing and in that part of the annulus which is below the seal.

5.5 The features of Claims 1 and 7 of the main request, and in particular the features of the characterising portions, therefore solve the problem presented by the cryopump shown in Figure 3 of document D1'.

6. *Inventive step - main request*

6.1 The Appellant argues that the skilled person when faced with the problem of reducing the pressure in a cryopump housing would find it obvious to solve the problem by providing a hole in the rear of the radiation shield as is taught by each of documents D2 and D7 to D9. He reasons that an opening cannot prevent gas passing therethrough and the skilled person seeing holes in the prior art radiation shields would realise that they could be used in the cryopump and in the method according to the pre-characterising portions of Claims 1 and 7 of the main request to achieve a reduction in heat loss by radiation.

6.2 This presupposes that the problem is seen as being to retain a low (i.e. great) vacuum in the cryopump housing so as to maintain cryopump efficiency (see column 5, lines 51 to 54 of the patent as granted).

However the Board considers that this problem formulation impermissibly contains direct pointers to the solution (see decision T 229/85, OJ EPO 1987, 237). The skilled person must first realise that cryopump efficiency can be improved by a reduction of pressure in the cryopump housing before he can commence considering how to achieve this reduction of pressure. That this is not so obvious can be seen from the disclosure of the embodiments according to Figures 1 and 3 of document D1', where although it is stated that the passage of gas through the restrictive space is negligible, there is no suggestion of either the vacuum in that space or the problem of heat transfer by radiation in that space or cryopump efficiency linked with that space.

Thus the realisation that cryopump efficiency can be improved by a reduction of pressure in the cryopump housing around the radiation shield is part of his inventive activity.

6.3 It will now be examined what the discussed prior art teaches about apertures in radiation shields removed from the work chamber entrance.

6.4 A wire 13 passes through the rear of the inner housing 5 (radiation shield) shown in the Figure of **document D7** and through the housing 1. No further information is given by document D7 either on the presence of holes or on the purpose of such holes. While it is clear that holes must be provided to allow the passage of the wire, sealing of some sort would have to be provided around the wire where it passes through outer housing 1 otherwise the pump would be flooded by the ambient air.

It seems likely that the wire would be similarly sealed in the hole in the radiation shield 5 so that there would remain no space around the wire for gas to pass through the radiation shield. At least, it is not proven that there is a hole in the radiation shield which remains open and through which gas could pass.

Moreover the high vacuum producing cryopump of document D7 is not subject in the area under consideration either to efficiency problems or to heat radiation problems because these problems occur only in moderate vacuum producing cryopumps.

The Board accordingly considers that the document D7 would not be consulted by the skilled person wishing to solve the problem which the present invention addresses.

6.5 Regarding the high vacuum producing cryopump of Figure 12.8 on page 12.8 of **document D8**, there is no disclosure at all of a hole in the radiation shield 6 opposite the fore-vacuum connection 8. The continuation of the centre line of the connection 8 to cross the line depicting the radiation shield 6 is conventional draughting practice and does not imply that there is a hole in the radiation shield 6 at the crossing point.

The Appellant cites **drawing D9** to support his view of there being a hole in the cryopump according to document D8 in the radiation shield 6 opposite the fore-vacuum connection 8. Certainly drawing D9 shows a hole in the radiation shield but cannot be evidence of a hole in the cryopump according to document D8 because of three facts, each of which facts is not disputed by

the Appellant. Firstly, document D9 was drawn on 22 April 1983 and is thus not prior art under Article 54 (2) EPC since the validly claimed priority date of the present patent is 28 February 1983. Secondly the drawing carries a notice partly visible on the right hand side to show that is an internal and not a public document. Thirdly the drawing concerns the RPK 1500 S pump which is a special version of the RPK 1500 pump shown in document D8. Thus a hole shown on the pump on drawing D9 does not mean that one must be present in the pump according to Figure 12.8 of document D8.

Thus the Board finds that the document D8 would not (and drawing D9 could not) be consulted by the skilled person at the priority date of the present patent and would moreover not lead him to the claimed solution.

6.6 Figure 1 of **document D2** shows a first gap between the housing 22 and the radiation shield 17 and a second gap between the radiation shield 17 and the expansion chamber 11 so that they are out of contact with each other (see column 2, lines 35 to 37).

A louver 19 "may be provided in the open end 18 in order to protect the panel 16 from oil or vapor of water" (see column 2, lines 38 to 40). A louver is something which has a low resistance to flow. Moreover since the louver "may be provided", there is an implication that its presence or absence does not essentially affect operation of the cryopump, i.e. it must have a low flow resistance.

The size of the first and second gaps is not discussed in document D2, perhaps because with the louver 19

being of low resistance to flow the gap size is unimportant, approximately the same pressure existing in the space 20, inside the radiation shield 17 and in the gap between the housing 22 and the radiation shield 17, moreover the pressure being very low giving good heat insulation. Furthermore the second gap is provided only to permit extremely low temperatures (e.g. 20°K) to be obtained at the condensation panel 16.

A person skilled in the art wishing to increase efficiency in the moderate vacuum cryopump according to document D1' would not, and even could not, find in document D2 any suggestion of, or pointer towards, the claimed solution particularly since the problem to be solved does not arise in document D2. Moreover it must be borne in mind that the second gap (around the expansion chamber 11) is provided to permit extremely low temperatures to be obtained at the condensation panel 16 for the purpose of producing a high vacuum but that this, because of the need for two first stage expansion chambers, results in a more complicated pump construction. The person skilled in the art would be very reluctant to start from such a pump, which is complicated in construction in order to produce a high vacuum, and modify it to produce a moderate vacuum. Such an approach can only be considered as a consequence of an ex post facto analysis.

Indeed, even if the skilled person were to use the teaching of document D2 to modify the cryopump according to document D1' by providing a gap in the rear of the radiation shield around the first stage expansion chamber 20, then he would need to keep the radiation shield in place, modifying thereby the

cryopump completely and he would also need to carefully consider firstly the size of the gap between the housing and the radiation shield and secondly the size of the gap around the first stage expansion chamber 20 to produce the required effect.

Document D2 does not discuss the size of the gaps and the Board does not consider that it would be obvious to the skilled person to make the gaps just big enough to produce the required effect, particularly since there is no suggestion in this direction in the document.

6.7 Speaking generally and without restriction to any particular state of the art document, even if an aperture is provided in the rear of a radiation shield of a prior art cryopump, it is not certain that the required reduction of pressure around the radiation shield and the required reduction of heat radiation is achieved. Only when the skilled person knows what is to be achieved, i.e. only when he knows the purpose of the aperture in the radiation shield, can he design the cryopump to have an appropriately sized aperture and an appropriately sized gap between the cryopump housing and the radiation shield to produce the required effect.

The Board considers it neither certain that an aperture present in a cryopump radiation shield for some other purpose would provide the required effect nor that the presence of an aperture for some other purpose would lead the skilled person to the modifications needed in the cryopump to produce the required effect.

7. *Document D2 as the closest prior art - main request*

7.1 The Appellant also considers that the closest prior art or starting point for the invention can be taken to be the cryopump disclosed by document D2. He argues that this prior art cryopump has most of the features of Claim 1 of the main request including the characterising portion and the only difference provided by the invention is feature e, namely the orifice plate for providing the moderate pressure in the work chamber. He sees the problem starting from this state of the art cryopump to be to provide a element (louver or orifice plate) with a greater throttling effect so that a higher pressure suitable for sputtering is maintained in the work chamber. He maintains that the skilled person would find it obvious to replace the louver 19 of the cryopump according to document D2 with the flow restricting device 100 of the cryopump according to document D1' and would thus arrive at a cryopump satisfying the definition in Claim 1 of the main request. He uses similar reasons to argue the obviousness of the method of Claim 7 of the main request.

7.2 The Board however cannot agree that the functional restriction contained in the characterising portion of Claim 1 of the main request is or even can be satisfied by the cryopump of document D2. No single suggestion in that direction can be found in document D2.

7.3 Moreover the Board does not agree that it would be obvious to replace the low gas resistance louver 19 of document D2 with the high resistance flow restricting device 100 of Figures 3 and 4 of document D1' since the

object clearly set out in document D2 (to produce a strong vacuum - column 1, lines 49, 50) would then no longer be achieved. It would make no technical sense first of all to modify a normal cryopump into a more complicated embodiment merely to obtain a strong vacuum and then in turn to modify the complicated embodiment to obtain a moderate vacuum. Such a procedure must be considered to be the result of an ex post facto analysis.

7.4 Further, the Board considers document D2 to be the wrong starting point - the skilled person wishing to produce a moderate vacuum in the work chamber, e.g. for sputtering, would start from a moderate vacuum producing cryopump e.g. that known from document D1'. The Board does not see as obvious a combination of the teachings of document D2 (strong vacuum) and document D1' (moderate vacuum) and, even if the combination were made, the Board does not see that the resultant cryopump would achieve the result achieved by the present patent, i.e. a lower pressure in the gap around the radiation shield than in the working chamber.

7.5 Accordingly the Board finds that a modification of the cryopump according to document D2 using the teachings of document D1' would neither be obvious to the skilled person nor lead to a cryopump as specified in Claim 1 of the main request. Analogous reasons apply to Claim 7 of the main request.

8. The Board considers that the cryopump and the method according to Claims 1 and 7 of the main request thus involve an inventive step within the meaning of Article 56 EPC.

9. Therefore, the subject-matter of independent Claims 1 and 7 of the main request is patentable within the meaning of Article 52 EPC, so that the patent may be maintained amended, based on these allowable independent Claims, dependent Claims 2 to 6 and 8 which concern preferred embodiments of the cryopump of Claim 1 and method of Claim 7, a description to be adapted and the drawings as granted.

The description is at present still in the version set out in the Opposition Division's interlocutory decision but will need adaptation to the new independent claims, in particular where parts thereof are recited in the description. The case is therefore remitted to the Opposition Division to have this adaptation carried out before maintaining the patent.

10. Since the main request can be granted, it is not necessary to consider the auxiliary 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 with Claims 1 and 7 filed during the oral proceedings and Claims 2 to 6 and 8 as granted, Figures 1, 1A and 2 as granted, and a description to be adapted.

The Registrar: The Chairman:

N. Maslin C. Andries