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

Case Number: T 1023/92 - 3.2.4

Application Number: 84101396.4

Publication Number: 0119451

IPC: F04B 37/08

Language of the proceedings: EN

Title of invention:
Multiport 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:
-

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Case Number: T 1023/92 - 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 14 September 1992 concerning maintenance of European patent No. 0 119 451 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. 0 119 451, granted on the basis of European patent application No. 84 101 396.4, was opposed on grounds of lack of novelty and lack of inventive step based inter alia on the following document:

(D2) US-A-4 240 262

During the course of the opposition proceedings the Proprietor cited the document:

(D6) Report No. 3 of the Semiconductor Equipment Group of Varian, entitled "Individual Wafer Metallizing System - A Case History" and reprinted from "Industrial Research and Development", March and April 1981; and a sketch of a "Varian VK 12" cryopump said to be used in the system shown on page 7 of the report.

II. In the interlocutory decision dispatched on 14 September 1992 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 16 November 1992 and paid the appeal fee on the same day. The Statement of Grounds of Appeal was received on 14 January 1993.

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

(D1') US-A-4 285 710,

(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,

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

(D10) Theorie und Praxis der Vakuumtechnik - Wutz, Adam and Walcher, Friedr. Vieweg & Sohn, Braunschweig/Wiesbaden, second edition, 1982, page 347.

IV. During oral proceedings on 20 October 1994 the Respondent (Proprietor) submitted amended Claims 1 to 9.

Claim 1 reads as follows:

"A cryopump system comprising:

(a) a housing (101) enclosing a first and second stage cryogenic refrigerator (102, 105);

(b) a work chamber (12) in fluid communication with both stages of said refrigerator (102, 105) through a first port (99) in the housing (101);

(c) a second chamber (14) in fluid communication with both stages of said refrigerator (102, 105) through a second port (112) in said housing (101) and another opening (108);

(d) a frontal cryopanel (106) extending across said first port (99) and in thermal communication with the first stage (102) of said refrigerator (102, 105);

(e) a radiation shield (103) in thermal contact with the first stage (102) of the refrigerator (102, 105) within the cryopump housing (101) surrounding the second stage cryopumping surface (104) and having a frontal opening (99) for providing gas communication from the work chamber to the second stage cryopumping surface (104) and said other opening (108) for providing gas communication from said second chamber to the second stage cryopumping surface (104);

characterized in that

(1) the frontal cryopanel (106) restricts the flow of inert and low temperature gases to the second stage so that the cryopump creates merely a moderate, not a high vacuum in the work chamber;

(2) the radiation shield (103) is in close proximity to the cryopump housing (101) and/or seal means (121) is positioned between the cryopump housing (101) and the radiation shield (103) to provide a flow restriction therebetween;

(3) said other opening (108) is through the rear of the radiation shield (103) into a plenum (120); and

(4) said second port (112) opens into the plenum (120) positioned between the radiation shield (103) and the base of the cryopump housing (101)

to keep the greater part of the cryopump (including the plenum) at a vacuum pressure lower than that of the work chamber.

Claim 8 reads as follows:

"A method of continuously processing material in a work chamber (12) comprising the steps of:

(a) reducing work chamber pressure to a system operating pressure by bringing said work chamber (12) in fluid communication with both stages of a cryogenic refrigerator (102, 105) of a work chamber cryopump (20);

(b) introducing material into a load lock (14);

(c) reducing the load lock pressure to an intermediate pressure by means of a roughing pump (25);

(d) isolating the load lock (14) from said roughing pump (25);

(e) reducing said load lock intermediate pressure to about work chamber pressure by opening the load lock (14) to both stages of the work chamber cryopump (20);

(f) connecting said work chamber (12) to said load lock (14); and

(g) transferring said material from the load lock (14) to the work chamber (12),

characterized by

(1) restricting the flow of inert and low temperature gases to the second stage by the frontal cryopanel (106) so that the cryopump creates merely a moderate, not a high vacuum in the work chamber (12);

(2) providing a flow restriction between the radiation shield (103) and the cryopump housing (101) by arranging the radiation shield in close proximity to the cryopump housing (101) and/or providing seal means (121) between the cryopump housing (101) and the radiation shield (103); and

(3) opening said load lock to the second stage of the work chamber cryopump (20) through a plenum (120) positioned between the radiation shield (103) and the base of the cryopump housing (101) and through a rear opening (108) in the radiation shield (103);

to keep the greater part of the cryopump (20) (including the plenum) at a vacuum pressure lower than that of the work chamber (12).

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 and a flow restricting baffle known from the cryopump of document D1' to the cryopump system known from document D6 and thus to arrive at a cryopump system and method as set out in the Claims.

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 on the basis of the Claims 1 to 9 filed during the oral proceedings and a description as well as drawings to be adapted.

Reasons for the Decision

1. The appeal is admissible.

2. *Amendments*

2.1 The present Claim 1 is the result of amending the granted Claim 1 in the following respects:

The reference numerals for components of cryopump systems which no longer fall within the scope of the Claim have been deleted.

Features have been moved from the characterising portion to the pre-characterising portion.

The newly added section (1) of the characterising portion is taken from column 8, line 56 to column 9, line 1 of the patent as granted referring to the embodiment of Figure 4.

The newly added section (2) is taken from column 3, lines 36 to 43 and column 7, lines 17 to 26 of the patent as granted or from Claims 5 and 10 as granted.

Regarding the newly added sections (3) and (4), the plenum's position, opening and port can be seen unequivocally from Figure 4, Claim 6 as granted and column 6, lines 48 and 49 of the description as granted, and the result that the greater part of the cryopump (including the plenum) is at a vacuum pressure lower than that of the work chamber is taken from column 9, lines 28 to 31 of the patent as granted.

2.2 Corresponding amendments have been made to the granted Claim 12 to arrive at the present Claim 8.

2.3 The qualification of the chamber being high vacuum is removed which is permissible since the qualification "high vacuum" was misleading in so far as it was clearly intended to encompass not only high vacuum (see the embodiments according to Figures 1 to 3) but also moderate vacuum (see the embodiment according to Figure 4). Indeed the granted Claim clearly was intended to cover also methods involving work chambers wherein the vacuum, although not as high as in the chambers shown in Figures 2 and 3, was still high enough for sputtering processes or the like to be carried out, as shown in Figure 4 (see column 8, lines 50 to 55). This amendment therefore does not contravene Article 123 (3) EPC.

2.4 The present Claims 2 to 7 and 9 correspond to the granted Claims 2 to 4, 8, 9, 11 and 13 respectively.

2.5 The Board thus has no objection under Article 123 EPC to the present Claims.

3. *Novelty*

No single document on file discloses all the features set out in either of independent Claims 1 and 8. This is not disputed.

The subject-matter of each of Claims 1 and 8 is thus to be considered as novel within the meaning of Article 54 EPC.

4. *Closest prior art*

Like the parties, the Board considers the state of the art closest to the invention to be document D6 and in particular the vacuum system disclosed on page 7 (last paragraph and drawing) and page 8 (the left hand column). A second chamber, namely a load lock, can be connected to the cryopump housing at the side below the high vacuum valve HVV, namely "below the throttle valve" (see page 8, left hand column, second to last paragraph) but the precise connection point as well as the specific construction of the cryopump are unspecified. The sketch forming the last page of document D6 of "Varian VK 12" cryopump also shows a tube from the second chamber (load lock) entering the cryopump housing at the side.

5. *Differentiating features, problem and solution*

5.1 The independent Claims 1 and 8 are divided using the teaching of document D6.

5.2 The invention's differentiating features are contained in the characterising portion of each of these Claims.

In particular it is not disclosed that the vacuum system according to pages 7 and 8 of document D6 has an opening in the rear of the radiation shield between the plenum and the second stage cryopumping surface. Moreover there is no disclosure of a flow restriction between the cryopump housing and the radiation shield. Accordingly the functional restriction that the greater part of the cryopump (including the plenum) is at a vacuum pressure lower than that of the work chamber (sputter chamber - see the Figure on page 7) is not satisfied by the system of document D6.

5.3 Starting from the cryopump system and method disclosed by document D6 concerning evacuating a work chamber (sputter chamber) and a second chamber (load lock), the Board sees the objective problem addressed by the invention as being to provide operation at maximum efficiency despite the work chamber being operated at a moderate vacuum.

5.4 It can be seen from the sketch on the last page of document D6 that the space between the housing structure and the radiation shield is at the pressure in the work chamber and, with this at a moderate vacuum, the heat transfer from the housing structure to the radiation shield is not at an optimal minimum.

By providing in the present invention (see Figure 4) an opening 108 in the rear of the radiation shield 103, gas can flow in a throttled manner from above the baffle plate 106 through the restricting annular air gap 123 between the cryopump housing 101 and the radiation shield 103 downwardly to the opening 108. Then the plenum 120 and the annular air gap 123 between the cryopump housing 101 and the radiation shield 103 lies at a higher vacuum than that in the work chamber. Alternatively when said annular air gap is sealed the opening 108 permits the creation of a higher vacuum in the lower part of the cryopump. The result is a lower heat transfer from the cryopump housing 101 to the radiation shield 103 giving maximum efficiency of the cryopump (see column 9, lines 31 to 35 of the patent as granted) for longer periods before regeneration is needed.

5.5 Thus the Board considers that the features of Claims 1 and 8, and in particular the features of the characterising portions, solve the problem presented by the cryopump system disclosed by document D6.

6. *Inventive step*

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 prior art cryopump system and method to achieve a reduction in heat loss by radiation. To provide a moderate vacuum in the work chamber is obvious in view of the cryopump shown in Figure 3 of document D1'.

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. 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.

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 the rear of radiation shields.

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 are thus 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 14 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 vapour 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 D6 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 D6 by providing a gap in the rear of the radiation shield around the first stage expansion chamber, 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 to produce the required effect. Furthermore he would still need to connect the second chamber directly to the plenum.

Neither document D6 nor document D2 discusses 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 are no suggestions in this direction in the documents.

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 system, 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 system 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 system to produce the required effect.

6.8 Moreover the Board does not agree that it would be obvious to modify the cryopump system of document D6 using the teachings of both document D2 (comprising a

low gas resistance louver 19 and whose object is to produce a strong vacuum - column 1, lines 49, 50) and document D1' (whose Figure 3 discloses a high resistance flow restricting device 100 of Figures 3 and 4 of document D1' to produce a moderate vacuum in the work chamber) since the teachings of these two latter documents are incompatible. Even if the combination were made, the Board does not see that the resultant cryopump system 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.

The document D10 proving merely that cryopumps have both a main inlet and a connection for a roughing pump cannot alter the Board's view.

6.9 Accordingly the Board finds that a modification of the cryopump system according to document D6 using the teachings of documents D2 and D1' would neither be obvious to the skilled person nor lead to a cryopump system as specified in Claim 1. Analogous reasons apply to Claim 8.

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

8. Therefore, the subject-matter of independent Claims 1 and 8 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 7 and 9 which concern preferred embodiments of the cryopump system of Claim 1 and method of Claim 8, and a description as well as drawings to be adapted.

The description and drawings are at present still in the version set out in the Opposition Division's interlocutory decision but will need adaptation to the new independent Claims e.g. where parts thereof are recited in the description. Moreover the systems other than that shown in Figure 4 do not produce a moderate vacuum in the work chamber and so do not fall within the scope of the independent Claims. It needs to be made clear in the description that the other Figures are present to explain the basic construction and operation of the cryopump system and method without implying that protection is being sought also for systems and methods which do not produce a moderate vacuum in the work chamber. Thus it must be ensured that the other Figures and the corresponding parts of the description do not cast doubt on the scope of the independent Claims 1 and 8.

The case is therefore remitted to the Opposition Division to have this adaptation carried out before maintaining the patent.

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 to 9 filed during the oral proceedings and a description as well as drawings to be adapted.

The Registrar: The Chairman:

N. Maslin C. Andries