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(C)  To Chairmen

**D E C I S I O N**  
of 3 March 1995

**Case Number:** T 0008/93 - 3.2.4

**Application Number:** 85101569.3

**Publication Number:** 0166851

**IPC:** F04C 18/16

**Language of the proceedings:** EN

**Title of invention:**  
Screw type vacuum pump

**Patentee:**  
HITACHI, LTD.

**Opponent:**  
ALCATEL CIT  
LEYBOLD AKTIENGESELLSCHAFT

**Headword:**  
-

**Relevant legal provisions:**  
EPC Art. 56  
EPC R. 55(c)

**Keyword:**  
"Admissibility of opposition - yes"  
"Inventive step - yes"

**Decisions cited:**  
T 0289/91

**Catchword:**  
-



Case Number: T 0008/93 - 3.2.4

**D E C I S I O N**  
**of the Technical Board of Appeal 3.2.4**  
**of 3 March 1995**

**Other party:**  
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**Decision under appeal:**

Decision of the Opposition Division of the  
European Patent Office dated 8 October 1992 with  
written reasons posted on 26 October 1992  
rejecting the oppositions filed against European  
patent No. 0 166 851 pursuant to Article 102(2)  
EPC.

**Composition of the Board:**

**Chairman:** C. A. J. Andries  
**Members:** P. Alting van Geusau  
J. P. B. Seitz

## Summary of Facts and Submissions

- I. European patent No. 0 166 851 was granted on the basis of European patent application No. 85 101 569.3.

Independent Claims 1 and 8 of the patent read as follows:

"1. A screw vacuum pump comprising:  
a male rotor (11, 31) having a plurality of spiral lands and grooves and a shaft portion and operative to rotate about said shaft portion;  
a female rotor (12, 32) having a plurality of spiral lands and grooves and a shaft portion and operative to rotate about said shaft portion while being maintained in meshing engagement with said male rotor (11);  
casings (13, 33, 34) defining a space for containing said two rotors (11, 12, 31, 32) and providing a suction port (14, 55) and a discharge port (15, 57) communicating with said space; and  
a plurality of working chambers (16f to 26f, 16m to 26m, 52, 60, 62, 63) defined by said two rotors (11, 12, 31, 32) and said casings (13, 33, 34) including a plurality of sealed working chambers (17f to 22f, 17m to 22m, 52, 60, 62, 63) out of communication with both the suction port (14, 55) and the discharge port (15, 57), said plurality of sealed working chambers (17f to 22f, 17m to 22m, 52, 60, 62, 63) comprising a plurality of working chambers (17f to 20f, 17m to 20m, 62, 63) having their volume reduced when the two rotors (11, 12, 31, 32) rotate while being in meshing engagement with each other; and said two rotors (11, 12, 31, 32) each having a wrap angle related to the position of said suction port (14, 55) and the position of said discharge port (15, 57); characterized in that said plurality of sealed working chambers (17f to 22f, 17m to 22m, 52, 60, 62,

63) further comprises a plurality of working chambers (21m, 22m, 21f, 22f, 52, 60) having their volumes kept substantially constant when the two rotors (11, 12, 31, 32) rotate while being maintained in meshing engagement with each other, said working chambers (17f to 20f, 17m to 20m, 62, 63) having their volumes reduced and said working chambers (21m, 22m, 21f, 22f, 52, 60) having their volume kept substantially constant being separated from each other by meshing portions (K, 58, 59, 61) of said two rotors."

"8. A screw vacuum pump comprising:  
a male rotor having a plurality of spiral lands and grooves and a shaft portion and operative to rotate about said shaft portion;  
a female rotor having a plurality of spiral lands and grooves and a shaft portion and operative to rotate about said shaft portion while being maintained in meshing engagement with said male rotor;  
casings defining a space for containing said two rotors and providing a suction port and a discharge port communicating with said space; and  
a plurality of working chambers defined by said two rotors and said casings including a plurality of sealed working chambers out of communication with both the suction port and the discharge port, said plurality of sealed working chambers comprising at least one working chamber having its volume varied as the two rotors rotate while being maintained in meshing engagement with each other and

said two rotors each having a wrap angle related to the position of said suction port and the position of said discharge port; characterized in that - with said lands of said female rotor being more by one land than those of said male rotor - said sealed working chambers are at least two in number for one of said grooves of each said rotor and located along each said groove and

one of said at least two sealed working chambers is a working chamber having its volume varied as said two rotors rotate while being in meshing engagement with each other and the rest of said at least two sealed working chambers are working chambers undergoing substantially no change in volume when said two rotors rotate, said one sealed working chamber having its volume varied as said two rotors rotate and said rest of sealed working chambers undergoing substantially no change in volume as said two rotors rotate being separated from each other by meshing portions of said two rotors."

II. Oppositions were filed against the patent by the other party (Opponent O1) and by the Appellant (Opponent O2).

The oppositions were based on alleged lack of novelty and of inventive step (Article 100(a) EPC). The other party further submitted that the patent did not disclose the invention in a manner sufficiently clear and complete for it to be carried out by a person skilled in the art (Article 100(b) EPC).

In the opposition proceedings in particular the following prior art documents were relied upon:

- D1: H. Pfaff, "Die Verdrängermaschinen" published in Volumes 5 (pages 177 to 182) and 6 (pages 209 to 217) of the magazine "Ölhydraulik und Pneumatik", 1958
- D3: FR-A-1 528 286
- D4: US-A-1 708 891
- D5: Dubbel, "Taschenbuch für den Maschinenbau", 13th Edition, Volume II, 1974, pages 256 to 261;
- D6: A.J.R. Lysholm, "A new Rotary Compressor", Journal of Mechanical Engineering, 1942, pages 11 to 16,

III. With decision announced at oral proceedings held on 8 October 1992, with written reasons posted on 26 October 1992, the Opposition Division rejected the oppositions. The Opposition Division considered that the common concept on which the subject-matter of the independent Claims 1 and 8 was based, i.e. the use of sealed working chambers which keep their volume constant when the rotors rotate in combination with the other features of these independent claims, was neither disclosed nor hinted to in the relevant prior art and that therefore the subject-matter of the patent was not only novel but was also based on an inventive activity.

In respect of the objection based on Article 100(b) EPC the Opposition Division was the opinion that, taking into account the disclosure of the patent as a whole as stipulated in Article 100(b) EPC, no deficiency could be observed in this respect.

IV. The Appellant lodged an appeal against this decision on 22 December 1992 and paid the appeal fee on the same day. With the Statement of Grounds of Appeal, filed on 3 March 1993, the Appellant cited the further prior art document:

D2: CH-A-487 343.

V. In a communication for preparation of oral proceedings the Board expressed the provisional opinion that the newly cited document appeared to describe the closest prior art in relation to the subject matter of the independent Claims 1 and 8 of the opposed patent and also related to the same underlying problem mentioned in the present patent i.e. achieving a high vacuum with a screw vacuum pump. In view of its relevance it was considered to be justified to introduce this document in the appeal proceedings.

VI. With his response dated 3 February 1995, in addition to giving arguments in regard of the patentability of the subject-matter of the patent, the Respondent questioned the admissibility of the Appellant's opposition, arguing that the opposition was not sufficiently substantiated.

VII. With letter dated 1 March 1995 the Appellant filed the document

D7: G. Hoffmann: "Einführung in die Hydraulik",  
Pages 1, 36 to 43, VEB Verlag Technik Berlin, 1953,

and requested that this document be considered for the assessment of inventive step of the subject-matter of the patent in suit.

VIII. Oral proceedings were held on 3 March 1995 in the presence of both the Appellant and Respondent. The other party had given notice with letter dated 21 November 1994 that he would not attend the oral proceedings. The proceedings were continued without him in accordance with the provisions of Rule 71(2) EPC.

IX. The Appellant requested setting aside of the decision under appeal and revocation of the patent in its entirety.

In support of his request the Appellant submitted the following arguments:

**Admissibility of the opposition**

In the Notice of Opposition document D5 was cited against the subject-matter of the patent in its entirety so that the requirements of Rule 55(c) EPC were complied with.

**Inventive step**

The closest prior art in relation to the subject matter of the independent Claims 1 and 8 is disclosed in D2. This document shows a vacuum pump of the type disclosed in the patent in suit which, in accordance with the indications in column 2, lines 26 to 29, is able to achieve a vacuum of  $10^{-3}$  Torr with a single stage screw type vacuum pump. Such vacuum pressure lies in the range indicated in the patent in suit so that the idea of generating a vacuum of this pressure with a single stage pump instead of two pumps mounted in series is void of any inventive merit.

Furthermore, the skilled person is well aware of the fact that for achieving an higher vacuum the sealing of the rotors against each other and against the housing is the determinant constructional factor for limiting the leakage losses in screw type pumps.

In this respect it is indicated on page 216 of D1 that the use of more working chambers would improve the sealing because the pressure difference is distributed over more chambers. It would therefore be obvious to the skilled person to lengthen the spindle of the screw pump known from D2 in order to provide more working chambers. In doing so the skilled person would arrive in an obvious manner at the subject matter of the independent Claim 1 which therefore cannot be considered to be based on an inventive activity.

It is true that the paragraph on page 216 of D2 concerns a screw pump which only transports the fluid, thus without internal compression. However the two types of screw pumps and compressors, those with only transport of the fluid and those in which the fluid is transported and compressed, are well known to the skilled person and no prejudice against the incorporation of more chambers



i.e. a longer screw in order to provide more chambers for improved sealing is derivable from the cited prior art. In this respect D7 shows that even the designation of the types of screw compressors is not coherent in the prior art.

- X. The Respondent requested that the appeal be dismissed. He relied essentially on the following submissions:

**Admissibility of the opposition**

The Appellant's opposition, in contrast to the opposition lodged by the other party, was not substantiated and therefore does not comply with Rule 55 (c) EPC. Already for this reason the opposition is not admissible and the appeal must therefore be dismissed.

**Inventive step**

The screw pump disclosed in D2 must be considered to describe the closest prior art. However, that a pressure of  $10^{-3}$  Torr can be achieved by this known pump is a rather speculative statement. In fact throughout the description of the preferred embodiments it is indicated that a second pump is necessary to achieve a high vacuum and that working without oil-sealing internal leakage would be detrimental for achieving a high vacuum.

The teachings of D2 are clearly related to the different types of screw pumps disclosed in the prior art. The screw pump with internal compression differs from the screw pump with transport of the fluid only in that it has an additional sealing surface with the end of the housing and therefore the two types of screw pumps indeed have a different constructional basis.

Furthermore it is indicated in D2 that, due to the increased friction when using more chambers the overall efficiency improves only at pressure higher than about 100 Bar. Such teaching is of no help to the skilled

person when trying to solve the underlying problem of the present patent which relates to achieving a high vacuum.

Anyhow, no teaching is derivable from D2 or any other cited document to combine features of the different types of screw pumps with each other.

It is further to be noted that D2 essentially relates to screw pumps to be used as compressors and that the screw pump with internal compression disclosed in D2 has only a small pressure ratio of 3,5 to 5, a ratio not suitable for use in a vacuum pump in accordance with the present patent.

XI. The other party did not bring forward any request or argument.

#### **Reasons for the Decision**

1. The appeal is admissible.

2. *Admissibility of the opposition*

2.1 It is to be noted that the Respondent challenged the admissibility of the Appellant's opposition not until the appeal proceedings were under way.

Although rather late the Board considers that it is nonetheless possible at any stage of the proceedings to object that the opposition was inadmissible (see also T 289/91, OJ EPO 1994, 649).

2.2 It appears from the file that the Appellant's short Notice of Opposition contained not only a statement of the extent to which the European patent was opposed, and of the opposition grounds, but also a reference to the prior art document D5 as well as arguments as to why the subject-matter of Claim 1 would be derivable from this citation. The Notice of Opposition contained furthermore submissions why the subject-matter of the remaining claims should be considered to lack an inventive activity. According to the Board, these arguments could be properly understood by a person skilled in the art, so that the Appellant's Notice of Opposition fulfilled at least the minimum substantive requirements of Rule 55(c) EPC.

Therefore, the Respondent's allegation that the Notice of Opposition does not, in these aspects, fulfill the requirement of Rule 55(c) EPC is not in agreement with the facts.

2.3 The Respondent also argued that, although some reasons were given in the Notice of Opposition, these reasons were insufficient for proper understanding of the relevant facts, evidence and arguments.

However, there is no indication derivable from the file that in the opposition proceedings either the Opposition Division or the Respondent did not fully understand the basis of the Appellant's argumentation. The fact that the Appellant's interpretation of the claimed subject-matter and of the teaching of D5 could not be followed by both the Opposition Division and Respondent is in itself not a prerequisite for the admissibility of the appeal in accordance with Rule 55(c) EPC.

2.4 Since the Appellant's Notice of Opposition also complied with the provisions of Article 99, paragraph 1, and of Rule 1, paragraph 1 EPC, the Appellant's opposition was admissible.

3. *Novelty*

Novelty of the subject matter of the independent Claims 1 and 8 can be concluded for the reason that none of the cited documents discloses a screw type vacuum pump comprising the combination of different stages of the claimed screw pump i.e. suction stage, transfer stage including a plurality of sealed working chambers having their volumes kept substantially constant, internal compression stage and discharge stage (in the Claims "spiral" should read "helical").

Novelty of the subject-matter of the independent Claims was not any longer disputed by the Appellant.

4. *Inventive step*

4.1 The Board and parties are in agreement that Figure 1 of document D2 discloses the closest prior art. Although the rotors of this known screw type vacuum pump are not shown in detail, considering its functioning, the known screw vacuum pump comprises the combination of precharacterising features of Claims 1 or 8 of the present patent and additionally shows the characterising feature relating to the reduction of working chamber volume to compress the gas therein (see explications in column 4, lines 20 to 59 of D2).

4.2 The screw type vacuum pump in accordance with Claims 1 and 8 of the present patent differs from this known vacuum pump essentially in that there are a plurality of working chambers having their volumes kept substantially

constant, these working chambers being separated from each other by meshing portions of the rotors.

In accordance with the explanation given in the patent in suit the resulting increased wrap angle of the screws ensures that the inlet pressure at the compression stage of the screws i.e. that part of the screw where the working chambers have their volume reduced, is sufficiently low so that the existing clearances between the screws and the housing are substantially smaller than the mean free path of the pumped gas molecules with the result that the flow of gas in the preceding vacuum pump stages become intermediate or molecular flows. In these stages, the molecules of the gas leak with difficulty through the clearances, so that it is possible to perform a satisfactory pumping action merely by catching the gas molecules and transferring the same (see page 4, lines 37 to 52 of the description of the patent).

The improved pumping action allows vacuum pressures of 0.013 Pa ( $10^{-4}$  Torr) to be achieved by a single stage pump (see page 2, line 52 to 54 of the patent).

- 4.3 Starting from D2 (Figure 1) as the closest prior art the problem to be solved by the subject-matter of Claim 1 cited in the description of the patent on page 2, lines 44 to 46, thus still applies in so far as vacuum pressures of 0.013 Pa are aimed at.

As regards the issue of inventive step the question to be answered is thus whether an inventive activity was necessary to increase the wrap angle to arrive at a plurality of (at least two) working chambers between the suction and compression parts in order to obtain a single stage pump suitable for achieving a vacuum of 0.013 Pa.

4.4 In accordance with the description in column 2, lines 26 to 29 a vacuum of  $10^{-3}$  Torr (0.13 Pa) can be achieved with the known single stage screw pump disclosed in Figure 1 in D2.

D2 also discloses that, in order to obtain low pressures, the pressure at the pump outlet should not be higher than the pressure at which the mean free path of the gas molecules is still greater than the clearances of the pump parts (see column 4, line 65 to column 5, line 11) and suggests in order to achieve such vacuum to add another pump in series with the first pump whereby the latter should be of the oil sealed type (see column 5, lines 10 and 50, 51). Such an arrangement is essentially in accordance with the arrangement described in relation with the prior art arrangement shown in Figure 1 of the present patent.

In Figure 3 of D2 another embodiment is disclosed by which pressures of  $10^{-5}$  Torr (0.0013 Pa) can be achieved (see column 7, line 66) but which is also a two stage arrangement with an oil tight pump as the last stage.

Considering these disclosures of D2 no constructional modifications of known screw vacuum pumps are suggested in case pressures lower than 0.13 Pa are desired. On the contrary it is advised to add another vacuum pump, which suggestion is in line with the common knowledge of a skilled person.

4.5 Although not disclosed for use as a vacuum pump, the screw type compressors disclosed in Figures 7, 8, 39 and 40 of D1 are considered relevant in that the properties of the different types of screw compressors such as those with working chambers having unaltered volume or those with working chambers having their volume reduced to compress the fluid therein are explained.

It is to be noted that, this document does not contain any direct indication as to improve the functioning of a screw type pump to be used as a vacuum pump so as to achieve a higher vacuum.

There can be derived from page 216, left-hand column that internal sealing of the compressor of the type with transfer of the fluid but without internal compression thereof, can be improved by increasing the number of working chambers either by increasing the screw length or by using a steeper screw pitch. However, it is also stated that increased friction is a problem and that, dependent upon the viscosity of the fluid, a satisfactory overall efficiency is achieved for this type of screw compressor at pressures of more than 100 Bar.

In so far as screw compressors with internal compression are concerned only very small pressure ratios are disclosed (see left-hand column on page 217) which lie far away from the pressure ratios involved in the screw vacuum pumps disclosed in D2 or the present patent.

Document D1 provides a person skilled in the art only with common general knowledge. It is even doubtful to consider the given information (for compressors) in the framework of vacuum pumps. Anyway, apart from indicating general principles, document D1 does not suggest at all how and why constructionally and functionally different embodiments could be combined together, let alone how a single stage vacuum pump for achieving a high vacuum could be obtained.

4.6 The Appellant argued that, an important factor for achieving very low pressures is the avoidance of back flow of fluid from the outlet to the inlet stages of the pump and that therefore obviously the sealing should be

improved. In this respect the skilled person had nothing else to do than to apply the teachings of D1 and lengthen the rotors of the screw vacuum pump known from D2. He would then arrive in an obvious manner at the screw vacuum pump claimed in Claim 1 of the patent in suit.

However, it is to be noted that the screw vacuum pump disclosed in D2 relates to a screw pump with internal compression, which has therefore in addition to sealing surfaces between the screws and the housing also sealing surfaces between the screws and the end plate of the housing. In view of the disclosure in D1, that friction is negatively affected when providing more working chambers, and in view of the lack of any indication to combine features of the two different kind of screw compressors there is no objective teaching given in D1 to increase the length of the screw compressor of the type with internal compression let alone a hint to extent the screws so far that a plurality of working chambers having their volume kept constant during rotation of the screws are formed.

In regard of this matter the argumentation given by the Opposition Division in the decision under appeal is supported by the Board. In view of the fact that the pressure at the inlet of the compressor is already low enough so that the remaining molecules can pass only with difficulty through the clearances it would not be logical to provide more sealing gaps in the direction of the inlet opening. Rather the skilled person would provide further compression chambers in order to divide the main pressure differential between more single chambers.



4.7 The Appellant further relied on the screw compressor shown in Figure 7 of D1. Although this known screw compressor is of the type with constant volume for the working chambers thus without internal compression of the fluid, the Appellant considered that the compression step was not essential and anyhow obvious to the skilled person so that this difference would not substantiate an inventive activity. In this respect D7 shows that designation of the different types of screw pumps is not coherent.

In the Board's opinion, these conclusions are not based on facts. Internal compression, already known from the screw vacuum pump in accordance with D2, provides the effect that pumping efficiency can be substantially improved (see page 6, lines 9 and 10 of the patent) which is an important operating factor for vacuum pumps. Moreover, as is already stated above a combination of the two types of screw compressors discussed in D1 is unique and not hinted to in any of the documents relied upon by the Appellant. The non-uniform designation in the prior art of the different screw pumps types is without importance and cannot lead to a different result in the present case because the skilled person is well aware of the constructional and working differences between the types of pumps.

4.8 In the Board's opinion there is no need to give a detailed discussion of the other cited documents which were not any longer relied upon by the Appellant. These documents clearly are less relevant than the prior art disclosed in D1 and D2.

4.9 Summarising the Board considers that, having regard to the common general knowledge as outlined above and the cited relevant prior art, the skilled person would not be in the position to foresee any success in solving the

underlying problem of the patent by combining features of the two screw compressor types discussed in D1 or using information provided in D1 for modification of the screw vacuum pump known from D2. Therefore the subject-matter of the independent Claims 1 and 8 is considered to be based on an inventive activity.

5. The independent Claims 1 and 8 as well as the dependent Claims 2 to 7 and 9 to 14, relating to particular embodiments of the invention in accordance with Rule 29(3) EPC, are therefore allowable.
6. In view of the above conclusions the grounds of opposition do not prejudice the maintenance of the patent as granted.

### Order

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

The appeal is dismissed.

The Registrar:



N. Maslin

The Chairman:



C. Andries