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D E C I S I O N
of 31 May 2001

Case Number: T 0777/00 - 3.2.4

Application Number: 97108166.6

Publication Number: 0795688

IPC: F04D 29/66

Language of the proceedings: EN

Title of invention:
Centrifugal Fluid Assembly

Applicant:
Hitachi, Ltd.

Opponent:
-

Headword:
-

Relevant legal provisions:
EPC Art. 56, 84, 123(2)

Keyword:
"Main request: clarity (no)"
"First auxiliary request: amendments - added subject-matter (yes)"
"Second auxiliary request: inventive step (yes)"

Decisions cited:
-

Catchword:
-

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Case Number: T 0777/00 - 3.2.4

D E C I S I O N
of the Technical Board of Appeal 3.2.4
of 31 May 2001

Appellant: Hitachi, Ltd.
6, Kanda Surugadai 4-chome
Chiyoda-ku
Tokyo 101 (JP)

Representative: Finck, Dieter, Dr.Ing.
v. Füner Ebbinghaus Finck Hano
Mariahilfplatz 2 - 3
D-81541 München (DE)

Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 18 February 2000 refusing European patent application No. 97 108 166.6 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: C. A. J. Andries
Members: T. Kriner
H. Preglau

Summary of Facts and Submissions

I. The Appellant (Applicant) lodged an appeal on 29 February 2000, against the decision of the Examining Division posted on 18 February 2000, refusing the European patent application No. 97 108 166.6. The fee for the appeal was paid on 28 February 2000 and the statement of grounds was received on 13 June 2000.

II. The Examining Division held that the application did not meet the requirements of Article 84 EPC, because the expression "monotonously" describing an increase or decrease of the radial distance of the trailing edge of an impeller vane and of the leading edge of a volute tongue was not clear.

III. With respect to clarity, the following documents played a role during the appeal proceedings:

A2: The American Heritage Dictionary, Second College Edition, Houghton Mifflin Company, 1985, Boston, MA 02108, USA, page 812 (monotone);

A3: Langenscheidt's Encyclopaedic Dictionary of the English and German Languages "Der Große Muret-Sanders", Part I, English-German, First Volume, edited by O. Springer, Langenscheidt, Berlin, Munich, Vienna, Zurich, New York, 1986, page 866 (monotone);

A4: R. Walther: Technik-Wörterbuch: Polytechnisches Wörterbuch, Englisch-Deutsch, Verlag Technik Berlin, 1990, page 625 (monotone, monotonic, monotonous);

A5: Encyclopaedia of Mathematics, Volume 6, Kluwer Academic Publishers, Dordrecht, Boston, London, 1990, page 307 (monotone function);

A17: "Techniques of Mathematical Analysis", C.J. Tranter, "The English Universities Press LTD", London, 1961, pages 208 and 209 (monotonic function);

A18: Mathematik für Naturwissenschaftler, von J. Hainzl, 1974, B.G. Teubner Stuttgart, pages 26 and 27 (monotonic function).

Amongst these documents A2, A17 and A18 were cited for the first time during the appeal proceedings.

With respect to the prior art, the following documents were considered during the appeal proceedings:

D1: WO-A-93/10358

D2: US-A-2 362 514

D3: FR-A- 352 787

D4: US-A-2 160 666

D5: Revue Technique Sulzer 1/1980, pages 24 to 26

D6: JP-A-60 -50299 (Abstract)

D7: JP-A-51-91006 (Abstract)

D8: US-A-3 861 825

D10: WO-A-91/13259

D11: US-A-3 628 881

D12: GB-A- 112 292

D13: GB-A- 636 290

D14: JP-A-61 169696 (Abstract)

D15: JP-A-62 010495 (Abstract)

D16: JP-A-04 109098 (Abstract)

D17: JP-A-55 107099 (Abstract)

D18: US-A-5 228 832

IV. Oral proceedings took place on 31 May 2001.

The Appellant requested that the decision under appeal be set aside and a patent granted on the basis of

- claims 1 to 12 according to the main request filed with letter of 13 March 2001, or
- claims 1 to 11 according to the first auxiliary request filed during the oral proceedings on 31 May 2001, or
- claims 1 to 8 according to the second auxiliary request filed during the oral proceedings on 31 May 2001.

V. Independent claim 1 of the main request reads as follows:

"A centrifugal fluid assembly comprising
- an impeller (3)
  - rotating together with a rotating shaft (2) within a volute casing (1a) about an axis of rotation and

- comprising at least one impeller vane (5) with an impeller vane trailing edge (7), and
- a volute tongue (13) of said volute casing, which volute tongue comprises a volute tongue leading edge,

characterized in that

- the radial distance between said axis of rotation and said impeller vane trailing edge (7), measured perpendicular to said axis of rotation, and the radial distance between said axis of rotation and said volute tongue leading edge, measured perpendicular to said axis of rotation, both either monotonously increase with increasing axial distance or monotonously decrease with increasing axial distance over their whole axial extension, but not including the case where the radial distance is constant over the whole axial extension, and
- projections of the impeller vane trailing edge (7) and of the volute tongue leading edge onto a meridional plane have the same orientation, and a shift occurs in the peripheral position between the impeller vane trailing edge (7) and the volute tongue leading edge."

Independent claim 1 of the first auxiliary request differs from claim 1 of the main request by its characterizing portion which reads as follows:

"characterized in that

- the radial distance between said axis of rotation and said impeller vane trailing edge (7) measured perpendicular to said axis of rotation, and the radial distance between said axis of rotation and said volute tongue leading edge, measured perpendicular to said axis of rotation, both either monotonously increase with increasing axial

distance or monotonously decrease with increasing axial distance over their whole axial extension, but not including the case where any of said radial distances is constant over the whole axial extension,

- projections of the impeller vane trailing edge (7) and of the volute tongue leading edge onto a meridional plane have the same orientation, and a shift occurs in the peripheral position between the impeller vane trailing edge (7) and the volute tongue leading edge, and
- the radial distance between the projections of said impeller vane trailing edge (7) and of said volute tongue leading edge (13) onto a meridional plane is substantially constant in the axial direction."

Claim 1 of the second auxiliary request reads as follows:

"A centrifugal fluid assembly comprising

- an impeller (3)
  - rotating together with a rotating shaft (2) within a volute casing (1a) about an axis of rotation and
  - comprising at least one impeller vane (5) with an impeller vane trailing edge (7), and
- a volute tongue (13) of said volute casing, which volute tongue comprises a volute tongue leading edge,

wherein

- the radial distance between said axis of rotation and said impeller vane trailing edge (7) measured perpendicular to said axis of rotation, and the radial distance between said axis of rotation and said volute tongue leading

edge, measured perpendicular to said axis of rotation, both either monotonously increase with increasing axial distance or monotonously decrease with increasing axial distance over their whole axial extension, but not including the case where any of said radial distances is constant over the whole axial extension,

- projections of the impeller vane trailing edge (7) and of the volute tongue leading edge onto a meridional plane have the same orientation, and a shift occurs in the peripheral position between the impeller vane trailing edge (7) and the volute tongue leading edge, due to the fact that the projections of these edges onto a circular cylinder (A-A: Figures 3 and 11) coaxial to said axis of rotation are inclined in opposite directions with respect to said axis of rotation (Figures 3, 4, 11, 12, 13, 27), and
- the radial distance between the projections of said impeller vane trailing edge (7) and of said volute tongue leading edge onto a meridional plane is constant in the axial direction."

VI. In support of its request, the Appellant relied essentially on the following submissions.

In the technical context of the present application, a person skilled in the art would have interpreted the wording "monotonously increase or monotonously decrease" in no other way than "increase or decrease as a monotonic function". This interpretation was supported by documents A3 and A4 which showed that the terms "monotonous", "monotonic" and "monotone" were used as synonyms in the fields of mathematics and technology. Furthermore, document A2 gave evidence that

the term "monotonic" as synonym for the term "monotonous" did not only correspond to a strictly monotonic increase or decrease but also to an increase or decrease comprising sections without any increase or decrease.

Consequently, the meaning of the wording "monotonously increase or monotonously decrease" gave a clear mathematical teaching, and claim 1 met the requirements of Article 84 EPC.

The feature of claim 1 of the main request according to which the case where "the radial distance" is constant over the whole axial extension was excluded, had to be read within the overall content of claim 1. The feature "monotonously increase or monotonously decrease" from the first part of the characterizing portion taken together with the feature of the second part of the characterizing portion that both projections had the same orientation clearly resulted in the fact that "the radial distance" could be any of the radial distances mentioned at the beginning of the characterizing portion.

The last feature of claim 1 of the first auxiliary request that the radial distance between the projections of said impeller vane trailing edge and of said volute tongue leading edge onto a meridional plane was substantially constant in the axial direction, essentially corresponded to the originally filed claim 12. Merely the expression "substantially" had been added to the wording of this claim. This was allowable, because the feature "substantially constant" was implicitly disclosed in the originally filed description on page 8, lines 17 to 30 in connection with page 13, line 29 to page 14, line 23.

The most relevant state of the art was disclosed in D4. This document showed a centrifugal fluid assembly where only the radial distance between the impeller vane trailing edge and the axis of rotation changed with increasing axial distance, while the volute tongue leading edge was arranged in parallel to the axis of rotation. D4 was silent on the peripheral position between the impeller vane trailing edge and the volute tongue leading edge. Consequently D4 could not disclose any of the claimed features concerning the arrangement of the impeller vane trailing edge and of the volute tongue leading edge with respect to each other. Since the combination of these features was also not suggested by the remaining available prior art documents, the subject-matter of claim 1 according to all present requests was new and involved an inventive step.

Reasons for the Decision

1. The appeal is admissible.

2. *Interpretation of the claims*

2.1 According to the impugned decision, the section of claim 1 defining the increase or decrease of the radial distance of the trailing edge of the impeller vane and the leading edge of the volute tongue was not clear due to the use of the word "monotonously" to describe this increase or decrease. The Examining Division stated that this word did not have any technical meaning and thus could not clearly describe the type of increase or decrease.

Although the word "monotonously" as such has no technical meaning, it is obvious that it has been used in the present case to describe in a mathematical way the course of the increase or decrease of the radial distance between the axis of rotation and the impeller vane trailing edge or between the axis of rotation and the volute tongue leading edge (see for example page 8, lines 17 to 30 of the originally filed description). Hence the expressions "monotonously increasing" and "monotonously decreasing" have to be interpreted with respect to their mathematical meaning.

2.2 As for example shown in documents A3 and A4, the expression "monotonous" is a synonym for the expressions "monotonic" and "monotone" which both have a clear mathematical meaning. According to A2, each of the expressions "monotone" and "monotonic" is used in mathematics to designate sequences the successive members of which either consistently increase or decrease but do not oscillate in relative value, each member of a "monotone increasing" sequence being greater or equal to the preceding member and each member of a "monotone decreasing" sequence being less or equal to the preceding member. In other words an "increasing monotone" function is defined by $f'(x) \geq 0$ and a "decreasing monotone" function is defined by $f'(x) \leq 0$, wherein f' defines the differentiation of the function f and x defines the axial distance. This is confirmed for example by documents A5, A17 and A18.

Consequently, the skilled person prepared to understand the present application will interpret the feature "the radial distance between the axis of rotation and the impeller vane trailing edge and the radial distance between the axis of rotation and the volute tongue

leading edge, both either monotonously increase with increasing axial distance or monotonously decrease with increasing axial distance" so that each function describing the course of these radial distances meets the requirements of either $f'(x) \geq 0$ or of $f'(x) \leq 0$.

In connection with the feature excluding the case where any of said radial distances is constant over the whole axial extension, this means that each of the radial distances has either to increase or decrease over the whole axial distance and that at best in a section of that axial distance the radial distance may be constant. This includes the case where the function defining any of the radial distances is strictly monotone ($f'(x) > 0$ or $f'(x) < 0$). However, it is not restricted to this case.

2.3 With respect to the above assessments the Board came to the conclusion that the expression "monotonously" at least implicitly unequivocally describes the intended increase or decrease of the radial distance of the impeller vane trailing edge and of the volute tongue leading edge, and that the present claims in this respect meet the requirements of Article 84 EPC.

3. *Main request*

3.1 Claim 1 of the main request comprises a feature excluding the case where "the radial distance" is constant over the whole axial extension. However, since this claim defines two different radial distances, ie the radial distance between the axis of rotation and the impeller vane trailing edge and the radial distance between the axis of rotation and the volute tongue leading edge, it is not clear which of these radial distances is meant by the expression "the radial distance".

3.2 The Appellant's argumentation that the overall content of claim 1 of the main request clearly showed that "the radial distance" could be any of the radial distances defined in this claim, is not convincing.

The feature, according to which the radial distance between the axis of rotation and the impeller vane trailing edge and the radial distance between the axis of rotation and the volute tongue leading edge both either monotonously increase or monotonously decrease with increasing axial distance over their whole axial extension, includes the case where one or both of these distances is constant over the whole axial extension, and the feature that projections of the impeller vane trailing edge and of the volute tongue leading edge onto a meridional plane have the same orientation is not restricted to cases where these projections are parallel but includes cases where they extend in slightly different directions although having the same orientation. Consequently the features mentioned by the Appellant do not necessarily exclude the case where one of the radial distances defined in claim 1 is constant over the whole axial extension and the other one slightly increases or decreases over at least a portion of the whole axial extension. This finding is supported by the last feature of claim 1 according to the second auxiliary request which explicitly restricts the orientation of the impeller vane trailing edge and of the volute tongue leading edge to such cases where their projections on a meridional plane are parallel. Therefore, the information that "the radial distance" is not constant over the whole axial extension is ambiguous.

3.3 Consequently the Board came to the conclusion that claim 1 of the main request lacks clarity and does therefore not meet the requirements of Article 84 EPC.

4. *First auxiliary request*

Claim 1 of the first auxiliary request includes a feature according to which the radial distance between the projections of said impeller vane trailing edge and of said volute tongue leading edge onto a meridional plane is substantially constant in the axial direction.

As agreed by the Appellant, there is no explicit disclosure in the originally filed application that this distance is "substantially" constant. In contradiction to the appellant's view, this feature is, however, also not implicitly disclosed in the originally filed application.

The sections of the description on pages 8, 13 and 14 of the originally filed description cited by the appellant do not refer to the radial distance between the projections of the impeller vane trailing edge and of the volute tongue leading edge, but to the individual orientation of each of the impeller vane trailing edge and the volute tongue leading edge, without any link between these orientations. Consequently there is no basis for an implicit disclosure of the feature that the distance between the projections of said impeller vane trailing edge and of said volute tongue leading edge onto a meridional plane is substantially constant in the axial direction.

Therefore, claim 1 of the first auxiliary request contains subject-matter which extends beyond that which was disclosed in the application as filed and so it does not meet the requirements of Article 123(2) EPC.

5. *Second auxiliary request*

5.1 Amendments

Claim 1 according to the second auxiliary request refers to a centrifugal fluid assembly as shown in Figure 16 of the originally filed application. The features of this claim concerning the radial distance between the axis of rotation and the impeller vane trailing edge, the distance between the axis of rotation and the volute tongue leading edge, and the orientation of the projections of the impeller blade trailing edge and of the volute tongue leading edge onto a meridional plane are disclosed in originally filed Figures 2, 5, 6, 9, 10 and the corresponding description. The features concerning the shift in the peripheral position between the impeller vane trailing edge and the volute tongue leading edge are disclosed in originally filed Figure 3 in combination with originally filed Figure 4, or in originally filed Figure 13 in combination with any of originally filed Figures 14, 15, 30 and in the corresponding description. Although originally filed Figures 2 - 6, 9, 10, 13 - 14 refer to diffuser pumps which do not form part of the claimed fluid assembly, it is clear from the context of the originally filed application (see in particular page 6, lines 19 - 27, and page 14, lines 18 - 23) that the features shown in these Figures are also relevant with respect to the centrifugal fluid assembly of the volute type claimed in the present application.

Claims 2, 4, 6, 7, 8 correspond to originally filed claims 3, 7, 10, 11, 16; claim 3 corresponds to a portion of originally filed claim 4, and claim 5 corresponds to a clarified originally filed claim 8.

The description and the drawings have been adapted to the claims of the second auxiliary request.

Therefore, the second auxiliary request does not contain subject-matter which extends beyond the content of the application as filed and the claims are not amended in such a way as to extend the protection conferred.

5.2 Novelty

5.2.1 The most relevant state of the art is shown in D4. This document discloses a centrifugal fluid assembly comprising an impeller (23) rotating together with a rotating shaft (to be fixed to the hub 24, see Figures 1 and 5) within a volute casing (20, 40) about an axis of rotation and comprising at least one impeller vane (25, 34) with an impeller vane trailing edge (43), and a volute tongue (29) of said volute casing, which volute tongue comprises a volute tongue leading edge (see Figure 4).

As to be seen in Figures 4 and 14 which both are side views of the fan and casing with a part of the casing shown in section, the distance between the axis of rotation and the front end of the cut-off (29) is greater than the distance between the axis of rotation and the rear end of the cut-off. Hence, the Appellant's opinion that the cut-off is arranged in parallel to the axis of rotation cannot be followed by the Board. This would only be true, if Figures 4 and 14 were perspective drawings. However, these Figures are technical drawings which usually do not include any perspective presentation.

With respect to Figures 4, 14 and 5, D4 therefore additionally discloses that the radial distance between said axis of rotation and said impeller vane trailing edge measured perpendicular to said axis of rotation, and the radial distance between said axis of rotation and said volute tongue leading edge, measured

perpendicular to said axis of rotation, both monotonously decrease with increasing axial distance over their whole axial extension. Additionally, these Figures do not disclose the case where any of said radial distances is constant over the whole axial extension. Furthermore, the projections of the impeller vane trailing edge and of the volute tongue leading edge onto a meridional plane (inevitably) have the same orientation.

However, D4 neither discloses a shift in the peripheral position between the impeller vane trailing edge and the volute tongue leading edge, nor a constant radial distance between the projections of said impeller vane trailing edge and of said volute tongue leading edge onto a meridional plane.

5.2.2 Since all further documents considered by the Board show less than D4, the subject-matter of claim 1 according to the main request is new.

5.3 Inventive step

5.3.1 Starting from the state of the art disclosed in D4, the main object of the claimed invention may be regarded as to further abate noise and pressure pulsation (see description of the application, page 3, last paragraph).

According to claim 1, this object is achieved by such an arrangement of the impeller vane trailing edge and the volute tongue leading edge that

(a) a shift occurs in the peripheral position between these elements, due to the fact that the projections of these edges onto a circular cylinder coaxial to said axis of rotation are inclined in opposite directions with respect to said axis of rotation, and

(b) the radial distance between the projections of said impeller vane trailing edge and of said volute tongue leading edge onto a meridional plane is constant in the axial direction.

5.3.2 Although the provision of a shift in the peripheral position between an impeller vane trailing edge and a volute tongue leading edge in order to reduce vibrations due to pressure pulsations is known from the state of the art (see for example D10, D11 or D16), there is no suggestion to provide the shift in such a way that the projections of these edges onto a circular cylinder coaxial to the axis of rotation of the corresponding centrifugal fluid assembly are inclined in opposite directions with respect to the axis of rotation.

According to the state of the art disclosed in documents D10, D11 or D16, only the projection of the impeller vane trailing edge is inclined with respect to the axis of rotation, while the projection of the volute tongue leading edge runs in parallel to this axis.

In such an arrangement there is still a force acting periodically upon the volute tongue and thus creating vibrations (see F_1 in Figure 29 of the originally filed drawings of the present application). This force is reduced when both the impeller vane trailing edge and the volute tongue trailing edge are arranged so that their projections onto said cylinder are inclined with

respect to the axis of rotation. In case where these projections are perpendicular to each other, the force is even reduced to zero (see Figure 30 of the originally filed drawings of the present application).

Since this effect and thus a teaching has not been described in this available state of the art, the provision of the specific shift described in claim 1 according to the second auxiliary request cannot be regarded as an obvious measure to suppress pressure pulsations and to reduce the noise due to such pulsations.

5.3.3 D2 describes a centrifugal compressor which instead of a volute tongue has a plurality of diffusor vanes (23). This document suggests (see Figure 4 and claim 1, lines 15 to 19) the specific shift between an impeller vane trailing edge and a diffuser vane leading edge as claimed in claim 1 according to the second auxiliary request, in order to reduce vibrations. This configuration is however necessarily linked to the feature that the adjacent edges of the impeller and diffuser vanes are bevelled in opposite directions toward the axis of rotation (see claim 1 of D2). Consequently if a person skilled in the art wanted to apply the teaching of D2, he would never arrive at a centrifugal fluid assembly comprising adjacent edges of the impeller and diffuser vanes which have a constant radial distance between them along their whole axial direction.

5.3.4 With respect to these findings, the Board comes to the conclusion that the subject-matter of claim 1 according to the appellant's second auxiliary request involves an inventive step. Claim 1 together with claims 2 to 8 (which all refer to claim 1), the amended description and drawings, therefore form a suitable basis for the grant of a 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 grant a patent on the basis of the following documents:

Claims: 1 to 8 of the second auxiliary request filed during the oral proceedings on 31 May 2001.

Description: pages 1, 1a filed with letter of 24 November 1998,
page 1b filed with letter of 30 April 2001,
pages 2, 4 to 6, 12, 14 to 16, 21 filed during the oral proceedings on 31 May 2001,
page 3 as originally filed,
pages 7 to 11, 13, 18 - 20, 22 filed with letter of 23 June 1998, and
page 17 filed with letter of 13 March 2001.

Drawings: Figures 1 to 6 as originally filed,
Figures 7 to 19 filed with letter of 23 June 1998, and
Figures 20 to 23 filed during the oral proceedings on 31 May 2001.

The Registrar: The Chairman:

G. Magouliotis C. Andries

18/06/01