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D E C I S I O N
of 21 January 1998

Case Number: T 0150/96 - 3.5.2

Application Number: 88307897.4

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Language of the proceedings: EN

Title of invention:
Rotor balancing

Patentee:
Copeland Corporation

Opponent:
Kabushiki Kaisha Toshiba

Headword:
-

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step - yes (after amendment)"

Decisions cited:
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Catchword:
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Case Number: T 0150/96 - 3.5.2

D E C I S I O N
of the Technical Board of Appeal 3.5.2
of 21 January 1998

Appellant: (Proprietor of the patent)
Copeland Corporation
Campbell Road
Sidney
Ohio 45365 (US)

Representative:
Senior, Alan Murray
J.A. Kemp & Co.
14 South Square
Gray's Inn
London WC1R 5LX (GB)

Respondent: (Opponent)
Kabushiki Kaisha Toshiba
72 Horikawa-cho
Saiwai-ku, Kawasaki-shi
Kanagawa-ken
Japan (JP)

Representative:
Görg, Klaus, Dipl.,Ing.
Hoffmann Eitle
Patent- und Rechtsanwälte
Arabellastrasse 4
81925 München (DE)

Decision under appeal: **Interlocutory decision of the Opposition Division of the European Patent Office posted 29 November 1995 concerning maintenance of European patent No. 0 317 056 in amended form.**

Composition of the Board:

Chairman: W. J. L. Wheeler
Members: R. G. O'Connell
A. C. G. Lindqvist

Summary of Facts and Submissions

I. In the decision under appeal the opposition division rejected the proprietor's main request to reject the opposition, and granted the proprietor's auxiliary request to maintain the patent with claims 1 to 6 filed in the oral proceedings held before the opposition division.

II. The following prior art documents were considered in the first instance proceedings:

D1: JP-A-60 70953

D2: JP-U-58 181992

D3: English translation of D1

D4: English translation of D2.

III. The reason given in the impugned decision for rejecting the proprietor's main request was that the subject-matter of claim 1 was not new in view of D2 and its translation D4.

IV. The patent proprietor appealed against the decision of the opposition division and, in the notice of appeal, requested that the impugned decision be set aside and that the patent be maintained as granted (main request), or in amended form on the basis of claims 1 to 5 filed with the notice of appeal (auxiliary request).

The opponent did not appeal.

V. Following a communication from the board accompanying the invitation to oral proceedings, the appellant filed a new set of claims 1 to 5 with the letter dated 18 December 1997 to be considered as the auxiliary request.

VI. At the beginning of the oral proceedings held before the Board on 21 January 1998, the appellant withdrew the main request and promoted the auxiliary request to be the single request.

VII. Claim 1 is now worded as follows:

"A rotor for use in a rotary machine having a rotatable shaft (16) to which the rotor (18) is attached, the rotor including a counterweight secured to an end face of the rotor, the counterweight comprising: a main body portion (48) of substantial mass, said main body portion extending generally circumferentially along the end face(40) of the rotor (18) through an arc not exceeding 180° of said end face (40) and being positioned on one side of an imaginary plane (P) incorporating the rotor axis (A) and dividing the rotor into two imaginary halves; and mounting flanges (52) extending outwardly from opposite ends of said main body portion (48) and extending generally circumferentially along said end face (40) of said rotor, said flanges (52) including means (54) by which they are secured to the rotor end face (40); and wherein said main body portion comprises a section (48) which extends axially outwardly from said rotor end face (40) to beyond the flanges, characterised in that the flanges (52) extend to the other side of said plane (P), that said securing means are positioned on said other side of said plane (P) and that said securing

means comprise an aperture (54) in each said mounting flange (52), each said aperture (54) receiving fastening means (34) securing said counterweight (36) to the end face (40) of said rotor (18) against axial and radial movement."

Claims 2 to 5 are dependent on claim 1.

VIII. The appellant argued essentially as follows:

The preamble of claim 1 was based on the prior art according to document D1 and its translation D3. In this prior art the securing means (holes 47) were not on the other side of a notional diameter, but straddled it, see D1, Figure 7. In each embodiment disclosed in D2/D4, the counterweight was flat. At least for these reasons the subject-matter of claim 1 was new.

According to D2/D4, in the embodiments of Figures 4 to 6 the flat balance weight 15 was secured to the end ring 14 of the rotor solely by means of two pounding rivets 28 inserted through mounting holes 27 and 23 in the separating plate 25 and balance weight 15 respectively into depressed portions 20 of the end ring 14 of the rotor (see D4, paragraph bridging pages 7 and 8). The depressed portions 20 were spaced apart by 180° (D4, five lines from the bottom of page 6) and therefore lay on a plane passing through the axis of rotation.

The mounting pins 21 were pure cylinders projecting from the face of end ring 14 and extending axially through engaging holes 22 in the balance weight 15. As they did not have heads, they did not secure the balance weight 15 against axial movement. This could only be done by the rivets 28, whose splayed ends engaged the walls of the depressed portions 20. D2/D4 did not disclose how the balance weight 15c shown in

Fig. 9 was secured to the end face of the rotor. But there was no reason to suppose that it was secured in a manner different from the other embodiments.

In each embodiment disclosed in D2/D4, centrifugal force on the balance weight produced a shear load on the fastening means, with little or no tensile loading. As the main forces to be resisted by the fastening means were shear forces in the radial direction, placing the fastening means on the other side of an imaginary diametral plane would not be beneficial, but rather counterproductive because weight would be added to the "wrong" side of the rotor.

Documents D1 and D2 did not recognise that the fastening means could be under a tensile load when centrifugal force acted on a counterweight of relatively large axial extent, tending to tip it outwards, and did not suggest the importance of a longer moment arm for reducing this tensile load. The recognition of this tensile load problem was part of the present invention. In view of the lack of recognition in D1/D3 and D2/D4 of the problem solved by the present invention, it was pure ex post facto analysis to allege that the subject-matter of claim 1 followed plainly and logically from the prior art.

IX. The respondent's arguments can be summarised as follows:

The subject-matter of claim 1 as filed with the letter of 18 December 1997 was new but did not involve an inventive step. Starting from the prior art known from D1/D3 the problem underlying the patent in suit was already solved by the prior art known from D2/D4. According to D4, page 7, lines 3 to 5, the stop pins 21 were on the opposite side of the diameter from the balance weight 15 and they "fitted" in the engaging

holes 22. That meant there was no clearance so that engagement of the stop pins in the holes 22 provided resistance to radial movement of the balance weight. The pounding rivets 28 served only to secure the separating plate 25 to the balancer 15, see page 8, lines 6 and 7. This could also be seen in Figures 7 and 9 of D2.

The balance weight 15 of D2 had an aperture 22 in each of the mounting flanges on the other side of the imaginary diametral plane of the rotor. The apertures 22 received the mounting pins 21 for securing the balance weight against radial movement, which was in fact also an important feature of the subject-matter of the patent in suit. The securement against axial movement taught by the opposed patent was of minor importance and did not involve an inventive step. It belonged to the knowledge of an average expert to achieve securement against axial movement by swaging the ends of the mounting pins, if he noticed there was a need for that.

The essential feature provided by the opposed patent was therefore known from D2/D4, namely the position of the securing elements on the other side of an imaginary diametral plane in order to provide a better retention of the balance weight on the rotor.

X. The appellant requested that:

- the decision under appeal be set aside and that the patent be maintained in amended form on the basis of:

- Claims 1 to 5, as filed with the letter of 18 December 1997;

- Columns 1 and 2 of the description, as filed in the oral proceedings of 21 January 1998;

- Column 3 of the description of the patent specification; and

- Drawings of the patent specification.

XI. The respondent requested that the appeal be dismissed.

Reasons for the Decision

1. The appeal is admissible.

2. *Allowability of the amendments*

No objection was raised in the opposition based on the ground specified in Article 100(c) EPC. The amendments made to the claims and description of the patent after grant comply with the requirements of Articles 123(2) and (3) EPC.

2.1 All the features in the present claim 1 can be found in the patent specification as granted: see claims 1, 2 and 5, the description, column 3, lines 10 to 15, and the drawings. The other amendments made are consequential adaptations of the dependent claims and description.

2.2 The dropping of the words "for a rotor (18) of a dynamoelectric motor" from the preamble of claim 1 was not objected to by the respondent. The board considers that this does not extend the scope of protection, which would be contrary to Article 123(3) EPC, because

granted claim 1 was directed to the counterweight per se and granted claim 5 to a rotor for use in a rotary machine (i.e. not restricted to a rotor of a dynamoelectric motor).

3. Novelty of the subject-matter of the present claim 1 is not in dispute.

4. *Inventive step*

4.1 D1 (understood with the help of the translation D3) is the closest prior art: it discloses a rotor 2 with a balance weight 5 in accordance with the preamble of claim 1. In particular, it is noted that the main body portion of the balance weight extends axially outwardly from the end face of the rotor to beyond the flanges.

4.2 According to D1/D3, the balance weight 5 has a semicircular shape (D3, sentence beginning six lines from the bottom of page 2), and the two mounting pins 4 fixed to the end ring 3 of the rotor pass through the holes 47 in the flanges of the balance weight and are caulked to secure the balance weight in place. The pins 4 appear to lie on a diameter of the end ring (D1, Figure 1). There is no disclosure or suggestion that the main body portion of the balance weight and the securing means could be on opposite sides of an imaginary plane incorporating the rotor axis. It is true that it is stated on page 7 of D3 that the cross-section of the pins 4 and holes 47 may have an elliptical shape which extends in a tangential direction in order to withstand a centrifugal force acting on the balance weight. However, it is noted that as Figure 7 of D1 does not show the juxtaposition of the balance weight on the end ring, it is not safe to assume that the flanges extend to the other side of said plane. Indeed, as shown in Figure 7, the

enlargement of the cross-section of the pins 4 and holes 47 in the tangential direction appears to be achieved at the expense of the circumferential length of main body portion of the balance weight.

4.3 In agreement with the description at column 1, lines 23 to 30, of the opposed patent, starting from the prior art according to D1, the relevant technical problem for the purpose of assessing inventive step is to provide a better retention of the counterweight.

4.4 This problem is solved in accordance with the teaching of the opposed patent by positioning the securing means on the other side of said imaginary plane, the securing means comprising an aperture in each mounting flange, each aperture receiving fastening means securing the counterweight to the end face of said rotor against axial and radial movement.

4.5 The question which therefore falls to be decided by the board boils down to whether it would be obvious to the skilled person, starting from D1, to position the main body portion and the securing means on opposite sides of an imaginary diametral plane.

4.6 The board shares the appellant's view that documents D1/D3 and D2/D4 do not mention that the main load in the fastening means might be a tensile load in the case of a counterweight having a relatively large axial length, and do not suggest the idea of reducing the tension acting upon the counterweight securing means by providing a longer moment arm to resist outward tilting of the counterweight.

4.7.1 In each of the embodiments disclosed in D2/D4, the main body portion of the counterweight does not extend axially outwardly from the rotor end face beyond the flanges where the apertures 22, 23 are positioned (see

Figures 4, 5, 9 and 10). The main load on the mounting pins 21 due to centrifugal forces on the counterweight is therefore a shear load. The fact that the mounting pins 21 do not have enlarged heads means that they cannot secure the counterweight against axial movement. At least in the embodiment described with reference to Figures 4 to 6 it is clear that the flat balance weight 15 is secured to the end ring 14 of the rotor by means of the two pounding rivets 28 inserted through the holes 27, 23 in the separating plate 25 and balance weight 15 respectively into the depressed portions 20 of the end ring 14. The method of assembly is described in the paragraph bridging pages 7 and 8 of D4, from which it is clear that the lower ends of the pounding rivets spread within the depressed portions 20 to positively mount the separating plate and balance weight. Shavings are sealed into the depressed portions. As disclosed near the bottom of page 6 of D4, the depressed portions 20 are spaced by 180° and therefore lie on an imaginary plane incorporating the rotor axis.

4.7.2 As regards the variants partially illustrated in Figures 7 to 10 of D2/D4, the board notes that although Figure 7 as drawn does not appear to show a positive engagement of the pounding rivet in the side wall of the depression 20 in the end ring 14, the accompanying text at page 9, lines 4 to 7, states that "The pounding rivet is secured to the lower balancer 15b and the end ring 14". Given that the specific subject-matter of the Figure 7 variant is the double balancer the board attaches more weight to the words of the text than the fine detail of the drawing. Figure 8 does appear to show a positive engagement of the pounding rivet in the side wall of the depression 20, whereas neither the drawings nor the text relating to Figures 9 to 10 allow any conclusions to be drawn about the mounting of the balancers depicted therein to the end ring 14 other

than that in the case of the Figure 9 variant the pounding rivets would need to be longer to engage the end ring 14. The board is not persuaded by the respondent's argument that the silence of D2/D4 in relation to this engagement is indicative of its absence; such a reading would be inconsistent with the teaching of the document as a whole and cannot plausibly be based on a mere absence of information.

4.8 The board agrees with the appellant that in each of the embodiments disclosed in D2/D4, centrifugal force on the balance weight produces predominantly a shear load on the fastening means, with little or no tensile loading. As the main forces to be resisted by the fastening means are shear forces in the radial direction, the skilled person would not contemplate placing the fastening means on the opposite side of the imaginary diametral plane, because he would not expect this to be beneficial. He would regard it as counterproductive, as it involves adding weight to the "wrong" side of the rotor.

4.9 Documents D1/D3 and D2/D4 do not suggest the fundamental insight underlying the present invention, namely that the fastening means could be under a tensile load when centrifugal force acts on a counterweight of relatively large axial extent, tending to tip it outwards, nor do they suggest the importance of a longer moment arm for reducing this tensile load. There is also no disclosure in any of them of any means on the opposite side of the imaginary diametral plane capable of securing the counterweight against axial movement.

4.10 The board regards the respondent's argument that the skilled person would know how to secure the balancer in D2/D4 against axial movement by swaging the ends of the mounting pins 20, if increased balancer mass involving

axial extension created a need for that, as based on hindsight. To transfer the function of axial securement from the pounding rivets 28 to the mounting pins 20 would, in the judgement of the board, involve a rethinking of the principles on which the D2/D4 design was based in a way which could not be fairly described as routine activity for the skilled person.

4.11 In view of the lack of recognition in D1/D3 and D2/D4 of the problem solved by the present invention, and the lack of a mention of means on the opposite side of the imaginary diametral plane for securing the counterweight against axial movement, the board concludes that the subject-matter of claim 1 is not derivable in an obvious way, from a combined consideration of documents D1/D3 and D2/D4. Therefore, the subject-matter of claim 1 involves an inventive step within the meaning of Article 56 EPC.

5. The description and dependent claims have been adapted to the present claim 1. The prior art according to D1 was already acknowledged in the description of the patent as granted.

6. The board judges that, taking into consideration the amendments made by the proprietor during the appeal proceedings, the patent and the invention to which it relates meet the requirements of the EPC.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the department of first instance with the order to maintain the patent in the following version:

   - Claims 1 to 5, filed with the letter of 18 December 1997;

   - Columns 1 and 2 of the description filed in the oral proceedings of 21 January 1998;

     Column 3 of the description of the patent specification;

   - Drawings of the patent specification.

The Registrar:

S. Fabiani

The Chairman:

W. J. L. Wheeler