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Datasheet for the decision of 22 April 2021

Case Number: T 0547/17 - 3.5.02

Application Number: 02022908.4

Publication Number: 1331717

IPC: H02K1/24

Language of the proceedings: EN

Title of invention:
Pole Tips of a Claw Pole Alternator

Patent Proprietor:
Mitsubishi Denki Kabushiki Kaisha

Opponent:
Valeo Equipements Electriques Moteur

Relevant legal provisions:
EPC Art. 56

Keyword:
Inventive step - (no) - no synergy between distinguishing features

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Case Number: T 0547/17 - 3.5.02

D E C I S I O N
of Technical Board of Appeal 3.5.02
of 22 April 2021

Appellant: (Opponent)	Valeo Equipements Electriques Moteur 2, rue André Boulle 94046 Créteil Cedex (FR)
Respondent: (Patent Proprietor)	MITSUBISHI DENKI KABUSHIKI KAISHA 7-3, Marunouchi 2-chome Chiyoda-ku Tokyo 100-8310 (JP)
Representative:	Hoffmann Eitle Patent- und Rechtsanwälte PartmbB Arabellastraße 30 81925 München (DE)
Decision under appeal:	**Interlocutory decision of the Opposition Division of the European Patent Office posted on 20 December 2016 concerning maintenance of the European Patent No. 1331717 in amended form.**

Composition of the Board:

Chairman	R. Lord
Members:	F. Giesen
	J. Hoppe

Summary of Facts and Submissions

I. The present appeal by the opponent (appellant) lies from the interlocutory decision of the Opposition Division posted on 20 December 2016 concerning maintenance of the European Patent No. 1 331 717 in amended form.

The grounds for the impugned decision were *inter alia* that the subject-matter of claim 1 of then auxiliary request 2 involved an inventive step in view of the combination of documents

A5 *US 5,536,987*
A6 *EP 1 124 308 A2*
A8 *FR 2 616 278 A1.*

II. On 22 April 2021 oral proceedings before the Board took place. The final requests of the parties were as follows:

The appellant (opponent) requested
that the decision under appeal be set aside and
that the opposed patent be revoked.

The respondent (patent proprietor) requested
that the appeal be dismissed (main request),
or as an auxiliary measure
that the decision under appeal be set aside and the patent be maintained in amended form on the basis of the claims of the auxiliary request filed with the reply to the grounds of appeal.

The respondent further requested that simulations filed by the appellant with the statement of grounds of appeal not be admitted to the appeal proceedings.

III. Claim 1 of the **main request** (*i.e.* as maintained in opposition) reads as follows:

"*1. An alternator comprising:*
a rotor (7) in which north-seeking (N) and south-seeking (S) poles are formed alternately in a direction of rotation; and
a stator (8) surrounding said rotor (7),
said rotor (7) including:
a rotor coil (13) for generating a magnetic flux on passage of an electric current; and
a pair of pole core portions (20, 21) composed of:
a cylindrical portion (300) onto which said rotor coil (13) is wound;
disk portions (301, 302) extending radially outward from first and second end portions of said cylindrical portion (300); and
a plurality of claw-shaped magnetic poles (22, 23) extending axially from said disk portions (301, 302) so as to cover said rotor coil (13), said claw-shaped magnetic poles (22, 23) being magnetized with said north-seeking (N) and south-seeking (S) poles by said magnetic flux, and
said stator (8) including a stator core (8),
wherein:
the stator core (15) is provided with a plurality of slots (14) formed so as to extend axially and be spaced circumferentially; and the stator (8) includes a stator winding (16) installed in said stator core (15) by winding a conductor wire into said slots (14), and wherein
a ratio (t1/t2) between a radial thickness (t1) of a

tip of said claw-shaped magnetic poles (22,23) and a radial thickness (t2) of a root portion of said claw-shaped magnetic poles (22, 23) is within a range equal to or greater than 0.10 and equal to or less than 0.25 (0.10 ≤ t1/t2 ≤ 0.25)
characterized in that:
a ratio (A/B) between a dimension (A) of overlap between said stator core (15) and said disk portions (301, 302) when viewed from a radial direction and an axial dimension (B) of said disk portions (301, 302) is within a range equal to or greater than 0.2 and equal to or less than 1.0 (0.2 ≤ A/B ≤ 1.0), and
a ratio (Lp/Lc) between an axial length (Lp) of said claw-shaped magnetic poles (22, 23) overlapping said stator core (15) when viewed from a radial direction and an axial length (Lc) of said stator core (15) is within a range equal to or greater than 0.7 and equal to or less than 0.9 (0.7 ≤ Lp/Lc ≤ 0.9)."

Claim 1 of the **auxiliary request** had in addition to the features of claim 1 of the main request the feature

"*and an inclined surface (22a, 23a) inclined radially inward starting from outside an end surface of said stator core (15) is formed on a shoulder portion of a claw-shaped magnetic pole (22, 23).*"

at the end of the claim.

IV. The arguments of the appellant insofar as they are relevant to the present decision can be summarised as follows:

The subject-matter of claim 1 of the main request did not involve an inventive step.

Document A5 was the closest prior art. It disclosed a ratio *t1/t2* = 0.2 in figures 2 and 3. The ratio *A/B* as defined in the opposed patent was necessarily confined to be in the range 0 to 1 because *A* was defined to be an overlap. The claimed range 0.2 to 1 was not narrow in view of the geometrically possible range. Hence a ratio *A/B* satisfying the relationship $0.2 \leq A/B \leq 1.0$ was not a distinguishing feature. A5 did not disclose the ratio *Lp/Lc* satisfying the relationship $0.7 \leq Lp/Lc \leq 0.9$. Even assuming that the ratio *A/B* as claimed was a distinguishing feature, and further assuming that the chosen ratios lead to increasing the current output - which the appellant contested - the subject-matter did not involve an inventive step. The ratio *A/B* as claimed caused a high output current. The same was true for the ratio *Lp/Lc* as claimed. However, the ratios did not have any synergy. The first partial problem - choosing *A/B* so as to increase the output current - was solved in document A6, which disclosed $A/B \geq 0.3$, see paragraph [0044]. The second partial problem - choosing the ratio *Lp/Lc* so as to also increase the output current - was solved in document A8, which disclosed *Lp/Lc* = 0.88, see page 7, line 11. The new arguments concerning the assertions that A6 and A8 would not be combined in an obvious manner because they contained contradictory teachings and that the combination A5 with A6 taught away from the claimed ratio *A/B* were late-filed without justification and should not be admitted.

Concerning the auxiliary request, the added feature concerning an inclined surface was not a distinguishing feature in view of document A5, which showed a radially inward inclined surface in figure 1 and figure 3. The figures were not merely schematic.

V. The arguments of the respondent insofar as they are relevant to the present decision can be summarised as follows:

The subject-matter of claim 1 according to the main request involved an inventive step. A5 disclosed neither the ratio *A/B* satisfying the relationship $0.2 \leq A/B \leq 1.0$ nor the ratio *Lp/Lc* satisfying the relationship $0.7 \leq Lp/Lc \leq 0.9$. The technical effect associated with these distinguishing features was to promote a high output current of the electric machine. This was supported by figures 8 and 9, which showed experimental data, and paragraphs [0044] and [0050] of the opposed patent. The simulation results adduced by the appellant could not put these experimental results into question. The different simulation results may have been caused by the choice or omission of details of the simulation (such as a change in copper resistivity with temperature) which the appellant had not communicated to the respondent. The ratios were interrelated. Varying one pair of parameters such as *A/B* also influenced the other parameter *Lp/Lc*, and *vice versa*. For example, increasing *A* in relation to *B* by making the stator core 15 longer would result in a concomitant change of the the ratio *Lp/Lc*. The subject-matter of claim 1 of the opposed patent therefore could not possibly be rendered obvious by any of the combinations of cited prior art references for the reason that there is no combination of two prior art references disclosing both distinguishing features in combination. Furthermore, the teachings of A6 and A8 were contradictory. A8 suggested making the pole claws shorter to avoid vibration in use. In a contradictory manner, A6 suggested providing an overlap of the stator core and the root portion of the poles. Therefore A8 suggested making the pole claws longer and A6 suggested

making them shorter. A combination of the teachings was therefore not obvious. Furthermore, A6 disclosed that if the lap ratio (which corresponds to the claimed overlap *A/B*) was too large, then the rotor coil resistivity ("copper losses") would increase thus lowering the output current. A5 shows an especially densely packed rotor coil cavity, so that a skilled person would, when starting from A5, not consider increasing the ratio *A/B* as much as suggested in A6, because the point at which copper losses kicked in occurred at lower lap ratios for the alternator of A5.

Concerning the auxiliary request, figures 1 and 3 of A5 were schematic figures. A5 did not contain any other disclosure of inclined surfaces. A5 therefore did not contain any direct and unambiguous disclosure of the added feature.

Reasons for the Decision

1. *Admissibility of the Appeal*

The appeal complies with the formal and substantive requirements for admissibility of Article 108 and Rule 99 EPC and is therefore admissible.

2. *Main Request - Inventive Step*

2.1 The subject-matter of claim 1 of the main request does not involve an inventive step within the meaning of Article 56 EPC.

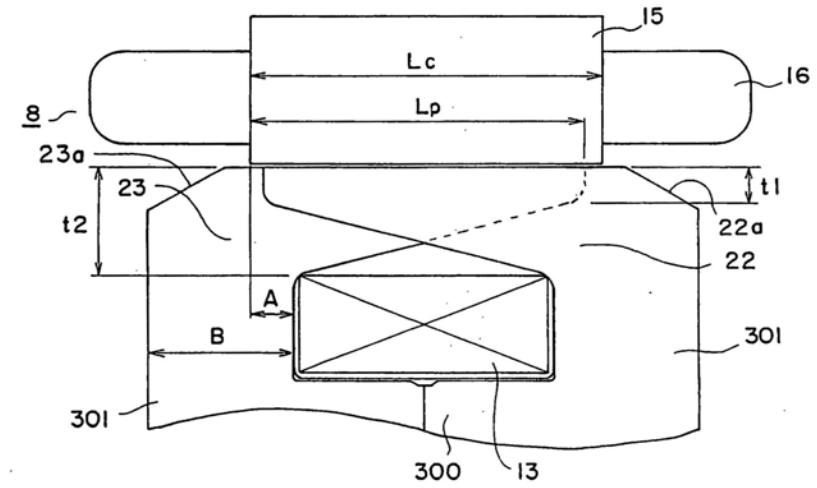
2.2 Closest Prior Art

The Board is satisfied that document A5 is a suitable choice as a starting point for the examination of inventive step, which is not contested by the respondent.

2.3 Distinguishing Features

2.3.1 For the discussion of the distinguishing features the Board considers it useful to reproduce figure 7 of the opposed patent in order to illustrate some of the features of claim 1 relevant for the present discussion.

FIG. 7



Reproduction of figure 7 of the opposed patent

Claim 1 requires the ratio *A/B* to satisfy the relation $0.2 \leq A/B \leq 1.0$. Here, *A* denotes the overlap between said stator core (15) and the disk portions (301, 302) when viewed from a radial direction and *B* denotes the axial length of said disk portions. The radial direction is from top to bottom in figure 7 and the axial direction is from left to right.

Furthermore, claim 1 requires the ratio *Lp/Lc* to satisfy the relation $0.7 \leq Lp/Lc \leq 0.9$. *Lp* denotes the axial length of the overlap of the claw-shaped magnetic poles (22, 23) and the stator core (15) when viewed from a radial direction (i.e. from above in figure 7). *Lc* denotes the axial (i.e. from left to right) length of the stator core (15).

2.3.2 The following discussion will be based on the following distinguishing features of claim 1:

- the ratio *A/B* is in the range $0.2 \leq A/B \leq 1.0$, and
- the ratio *Lp/Lc* is in the range $0.7 \leq Lp/Lc \leq 0.9$.

It has not been disputed that the remaining features of the claim are known from A5, in particular that this document discloses in the passage from column 5, line 60 to column 6, line 9 values for the claw dimensions which fall within the claimed range for *t1/t2*.

The appellant contested that $0.2 \leq A/B \leq 1.0$ could be considered a distinguishing feature since the claimed range was not narrow in view of the geometrically possible range, which was necessarily confined to be between 0 and 1 due to the fact that *A* was defined to be an overlap. It was not necessary for the Board to decide this question, because even assuming that the claimed range for the ratio *A/B* was a distinguishing feature, the Board comes to the conclusion that the subject-matter of claim 1 does not involve an inventive step.

It further appears from the passage of A5 cited above that the axial length of the stator core L_x is 5% longer then the length of the pole claw *A*. This would

mean that the ratio *Lp/Lc* (which is the same as A/L_x in A5) equals 1/1.025 = 0.98, which is outside the claimed range of 0.7 to 0.9. The parties did not contest this.

2.4 Technical Effect and Technical Problem

2.4.1 Concerning the technical effects associated with the distinguishing features, the respondent argued, adducing figures 8 and 9 of the opposed patent, that the claimed ranges maximised the output current of the electric machine. Furthermore, the ratios were interrelated. Varying one pair of parameters such as *A/B* also influenced the other parameter *Lp/Lc*, and *vice versa*. For example, increasing *A* in relation to *B* by making the stator core 15 longer would result in a concomitant change of the the ratio *Lp/Lc*. The appellant, based on their simulation results, contests the assertion that the choice of parameter ranges leads to an optimum output current and asserted that the two parameters did not have any synergy.

The Board notes that neither the opposed patent nor the respondent nor the appellant supply sufficiently detailed information so as to put the Board in a position to find fault with either the experiment or the simulation. For the following discussion, the Board assumes, to the benefit of the respondent, that their experimental results were correct. Since the appellant's simulations are not decisive for the Board's conclusions, the Board did not have to take a decision (and hence discuss) whether to admit them.

For the sake of the argument, the Board therefore concurs with the respondent that the choice of ratios *A/B* and *Lp/Lc* in the claimed range both contributed to maximising the output current (rather than just

increasing it or causing it to have some arbitrary value). Concerning the technical effect associated with the first distinguishing feature, according to column 9, lines 30 to 40 of the opposed patent in connection with figure 12, the ratio *A/B* influences the flux linkage between the root portions of the pole claws and the stator core. If the overlap *A* between them is too small not all flux enters the stator core. The appellant argued that an "overlap" *A* larger than 1 was geometrically impossible. The Board would agree that *A* larger than 1 would mean that the axial length of the stator core must be longer than the axial length of the rotor. In that case, clearly some portion of the stator core extending beyond the rotor would not be linked to the magnetic flux emanating from the rotor. Therefore, the technical effect of the first range for the ratio *A/B* is to maximise the flux linkage at the root portion of the pole claws.

Similarly, the technical effect associated with the second distinguishing feature, according to figure 7, and column 9, line 47 to column 10, line 4 of the opposed patent is to maximise the magnetic flux linkage at the tip of the pole claws. If the pole claw tips protrude too much (i.e. $Lp/Lc > 0.9$) too high a portion of the flux emanating from the pole claws cannot enter the stator core and is lost as stray flux. If the pole claws are too short and thus their tips are too far away from the edge of the stator core large parts of the latter are not linked. The Board thus agrees that both distinguishing features contribute to maximising the output current.

However, this does not mean that the resulting output current was more than the sum of the individual contributions of the two ratios. The mere fact that

both features contribute to maximising the same physical quantity (here the output current) is not sufficient to conclude that there is synergy between them. The flux linkages at the pole claw tips and roots are largely independent of one another. This last point was not contested by the respondent. This, however, shows that the output current produced by both distinguishing features in combination is not higher than the sum of the individual contributions of each ratio. There is therefore no synergy between them.

The respondent argued that, in addition to solving the same problem, the two ratios according to the distinguishing features were interrelated. The Board agrees that the ratios *A/B* and *Lp/Lc* are geometrically interrelated. However, whether there is synergy between two features is a matter of whether their technical effects produce a combined technical effect which is greater than the sum of their individual technical effects, and not simply a matter of geometrical interrelation.

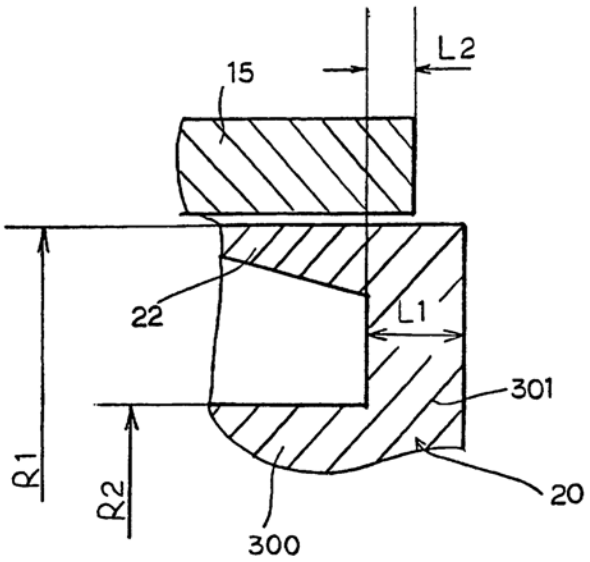
In conclusion, both distinguishing features are aimed at maximising the flux linkage but without influencing each other because the flux linkages at the pole claw roots and at their tips are independent of each other. The Board therefore agrees with the appellant, that there is no synergy.

It follows that the first and second partial technical problems addressed by the two distinguishing features are both to maximise the output current.

2.5 Assessment of the Solution

Since there is no synergy, the solutions to the partial problems can be assessed separately.

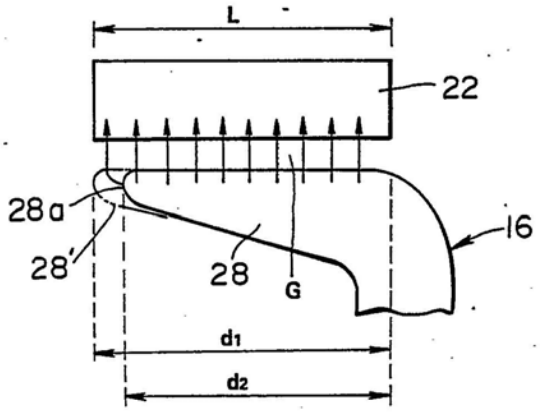
2.5.1 If a skilled person starting from A5 wanted to increase the output current, they would consult document A6 because it deals with maximising the output current of electric machines according to claim 1.



Reproduction of figure 16 of document A6

Document A6 suggests in figure 16 and column 10, lines 13 to 48, that the ratio *L2/L1*, which corresponds to *A/B* according to claim 1, should be 0.3 or greater in order to maximise the flux link at the at the disk portion, i.e. at the pole claw roots. According to column 10, lines 25 to 48 and figure 17, this also maximises the output current for a given field current.

2.5.2 The skilled person would also consult A8 because it also deals with the same problem.



Reproduction of figure 4 of A8

In can be seen in the reproduction of figure 4 above that the ratio of d_2/L (also called overlap α in A8) is equal to the ratio *Lp/Lc* according to the opposed patent. According to A8, figure 7 and page 6, line 35 to page 7, line 11, a particularly preferred value is 0.88, which falls in the claimed range of $0.7 \leq Lp/Lc \leq 0.9$.

2.5.3 In the absence of any synergy, the Board cannot see that combining the teachings of all three documents, i.e. choosing a thickness ratio *t1/t2* according to the closest prior art A5, an overlap ratio *A/B* according to document A6, and a length ratio *Lp/Lc* according to A8, required inventive activity. It may be true that these ratios are somehow geometrically related and need simultaneous adaption so that each individual ratio remains within the range prescribed by the relevant prior art document. However, in the Board's opinion, such simultaneous adaption, when the desired ratios are already given, does not require any understanding of the mechanism of magnetic flux linkage but merely the skill to geometrically dimension the rotor and stator cores according to the prescribed ratios. The Board would concede that inventive activity may lie in recognising in which places the magnetic flux linkage

can be improved to increase the output current. However, the individual influences of the two ratios according to the distinguishing features on the current output is already known and described in a detailed manner in the state of the art as demonstrated by documents A5 to A8.

In order to arrive at the subject-matter of claim 1 and thus solve the objective technical problem of maximising the output current, a skilled person can draw on existing knowledge about the geometric rotor and stator parameters which influence the flux linkage and output current as well as the optimum starting values taught in the closest prior art. Systematically varying more than one parameter (i.e. three in the present case), even though some of them might be geometrically interrelated, when given the understanding about the output current in the prior art, can, in the Board's opinion, be characterised as routine experimentation but not as inventive activity.

2.5.4 In the respondent's opinion, the teachings of A6 and A8 were contradictory. A8 suggested making the pole claws shorter with respect to the stator core in order to avoid vibrations, whereas A6 suggested making the pole claws longer in order to have more overlap at the root portion. The Board is not persuaded by this argument. While it is true that A8 suggests employing shorter pole claws in order to avoid vibrations and centrifugal deformation of the pole claws, it can be seen in figure 4 of A8, reproduced above, that A8 suggests making the pole claws shorter at the tip without thereby also decreasing the overlap of the stator core and disk portions at the root of the pole claw tips. The same is true for A6, which shows in figure 16, also reproduced above, that the lap ratio, i.e. the overlap at the root

portion of the pole claw, is independent of the overlap at the tip.

2.5.5 The respondent also argued that A6 showed that copper losses, i.e. increased resistivity of the rotor winding due to heating, had to be taken into account when varying the lap ratio, and in particular that if the lap ratio was too large, one could not achieve a maximum current output as shown in figure 17 of A6. The respondent argued further that, since the cavity made by the pole claws of the rotor according to A5 was particularly densely packed with the rotor winding, the above mentioned copper losses would start to negatively affect the output current at smaller lap ratios than the value 0.3, which was applicable only to the particular rotor according to A6.

The Board is also not persuaded by this argument. According to figure 17 of A6 the output current plateaus in the range from 0.3 to 1 because copper losses compensate for the increased flux linkage. The teaching of A6 is therefore merely that there is no gain in increasing the lap ratio (corresponding to *A/B*) much beyond 0.3. However, figure 17 also clearly teaches that there is no harm in doing so if the aim is to maximise the output current as the latter remains largely constant over the entire range of 0.3 to 1. It has to be borne in mind that claim 1 of the main request is directed to nearly the entire geometrically possible range, starting at an overlap of 0.2 and going up to a full overlap *A/B* = 1, still claiming that a "maximum" output current could be verified experimentally. The Board notes that claim 1 does not specify what proportion of the pole claw cavity is occupied by the rotor winding. This means, given the knowledge of A6, that the inventors of the opposed

patent merely accepted the copper losses which are correctly predicted by A6 and found that they do not appear to influence the output current in an inacceptable manner. The Board is not persuaded that merely accepting a correctly predicted adverse effect from the prior art could be seen as inventive activity. It has also to be borne in mind that if the respondent's argument were correct and in A5, due to the higher degree of packing of the pole claw cavity with the rotor winding, copper losses did appear earlier, a skilled person had a clear motivation due to the teaching of A6 to choose the lap ratio somewhat smaller than the value of 0.3, which is optimal for the rotor of A6. The exact value of the lower boundary will clearly be dependent on details of the alternator, to which the claim is not restricted. The skilled person is given detailed explanations in A6 of the various effects of dimensioning the overlap. In view of this, the Board is convinced that choosing a range that covers nearly the entire range from no overlap to full overlap, and in particular merely accepting that copper losses occur as correctly predicted in the prior art, does not amount to inventive activity.

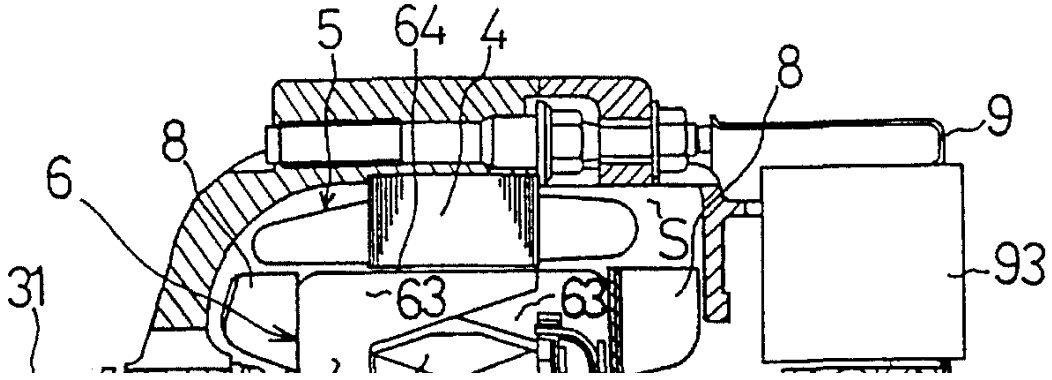
The Board notes that the respondent's argument concerning allegedly contradictory teachings of A6 and A8 and concerning A6 allegedly teaching away from the claimed ratio *A/B* were presented for the first time at the oral proceedings before the Board. Given that the Board comes to the conclusion that they are not convincing, it was not necessary to decide whether the argument contained also new facts and whether or not the Board should admit them.

3. Auxiliary Request - Inventive Step

3.1 The subject-matter of claim 1 of the auxiliary request does not involve an inventive step within the meaning of Article 56 EPC.

3.2 The feature added to claim 1 concerns an inclined surface (22a, 23a) inclined radially inward starting from outside an end surface of said stator core (15) which is formed on a shoulder portion of a claw-shaped magnetic pole (22, 23).

A5 discloses in figures 1 and 3 an inclined surface on the magnetic pole claw rotor as shown in the following partial reproduction of figure 1 of A5.



Partial reproduction of figure 1 of A5.

The rotor is shown to have chamfers, i.e. surfaces which are inclined radially inwards, which start outside the stator core (4). As can be seen in figure 3 of A5, the surfaces are indeed inclined surfaces (chamfers) although they may appear somewhat rounded in the above figure 1. As can be seen in figure 7 of the opposed patent, the expression "start outside the stator core" is supposed to mean that the shoulders lie

axially outside of the stator core, as is the case in A5.

The added feature of claim 1 of the auxiliary request is therefore not a distinguishing feature over the closest prior art A5. Therefore, the conclusions concerning lack of inventive step of the main request also apply to the auxiliary request.

3.3 The respondent argued that figures 1 and 3 of A5 were mere schematic figures. As there was no other disclosure of inclined surfaces, A5 did not contain a direct and unambiguous disclosure of this feature.

This does not persuade the Board. What can be considered directly and unambiguously disclosed by a figure has to be decided in each individual case. A skilled person will not necessarily consider a figure to be either entirely schematic or exact in every detail. Figure 1 contains details typical for a technical drawing, such as hatched areas or grooves on the belt pulley (not shown in the above reproduction). As such this figure appears to the Board to be not merely a schematic representation. The respondent failed to explain why a technical draftsman would consistently draw chamfers in figure 1 and 3 of A5, if the rotors did not have chamfers in reality. The Board also finds the respondent's position inconsistent. The respondent argued in the context of the main request that a skilled person could recognise from figure 1 of A5 that the degree of packing of the pole claw cavity (reproduced above) with the rotor winding was particularly dense. However, a skilled person would not recognise from the same figure that the rotor had inclined surfaces on its shoulders.

4. Conclusions

Since neither the subject-matter of claim 1 of the main request nor that of claim 1 of the auxiliary request involves an inventive step, the Board accedes to the respondent's request.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The patent is revoked.

The Registrar: The Chairman:

U. Bultmann R. Lord

Decision electronically authenticated