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D E C I S I O N
of 23 August 1994

Case Number: T 1016/92 - 3.2.4

Application Number: 90303432.0

Publication Number: 0390587

IPC: F02N 11/00

Language of the proceedings: EN

Title of invention:
Starter motor

Applicant:
Mitsubishi Denki Kabushiki Kaisha

Opponent:
-

Headword:
-

Relevant legal norms:
EPC Art. 56

Keyword:
"Inventive step - no"

Decisions cited:
T 0002/83, T 0004/83, T 0106/84, T 0063/86, T 0059/87,
T 0564/89, T 0049/90, T 0061/90, T 0184/91, T 0234/91

Catchword:
-



Case Number: T 1016/92 - 3.2.4

D E C I S I O N
of the Technical Board of Appeal 3.2.4
of 23 August 1994

Appellant: MITSUBISHI DENKI KABUSHIKI KAISHA
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Decision under appeal: Decision of the Examining Division of the European Patent Office dispatched on 1 July 1992 refusing European patent application No. 90 303 432:0 pursuant to Article 97(1) EPC.

Composition of the Board:

Chairman: C. A. J. Andries
Members: H. A. Berger
J. C. M. de Preter

Summary of Facts and Submissions

I. The Appellant (Applicant) lodged an appeal, received on 1 September 1992, against the decision of the Examining Division, dispatched on 1 July 1992, to refuse the application No. 90 303 432.0, published under the publication No. 0 390 587. The appeal fee also was paid on 1 September 1992. The statement setting out the grounds of appeal was received on 30 October 1992.

II. The Examining Division held that the application did not meet the requirements of Articles 52(1) and 56 EPC, having regard to the following prior art documents:

(D1): Patent Abstracts of Japan, vol. 9, no. 185
(E-332) (1908) 31 July 1985 & JP-A-60-55836;

(D2): Patent Abstracts of Japan, vol. 12, no. 498
(E-698) (3345) 26 December 1988 & JP-A-63-209447;

The closest state of the art was considered to be that described with regard to Fig. 2 in the refused application.

III. In a communication the Board drew attention to the additional document

(D3): EP-A-0 303 200

With a letter dated 27 July 1994 the Appellant filed new Claims 1 and 2.

Oral proceedings were held on 23 August 1994.

IV. The wording of Claim 1 is as follows:

"A starter motor of the overhang type comprising:

a) an electric motor including an armature shaft (1a, 2) and an armature (1b, 20) mounted on said armature shaft, said armature comprising a core extending in said armature shaft direction and defining a plurality of slots for accommodating armature windings;

b) an overrunning clutch including a clutch outer member (4b) with a reduced rear portion slidably engaging said armature shaft via helical splines (7) for rotation therewith, and a clutch inner member (4a) to which rotation of said clutch outer member is transmitted via rollers (4c);

c) a pinion displacement cylinder (3) integral with said clutch inner member and having at its front end a pinion (3a) adapted to engage and disengage a ring gear of an engine and defining at an intermediate portion thereof an outer sliding surface (3b) which is slidably supported in an outer bearing (8) mounted in a front frame (5); and

d) an inner sliding bearing (9) between the pinion displacement cylinder (3) and the shaft (2);

e) means (11) for displacing the pinion displacement cylinder and attendantly the pinion outwardly upon the energization of the starter motor;

f) the cylinder (3) and the shaft (2) being supported by the inner bearing (8) and the outer bearing (9), and the cylinder (3) being directly driven by the armature (16, 20) without intervening speed reduction; characterized in that it further comprises

g) means for preventing a delay in the inward, return displacement of the pinion displacement cylinder (3) and pinion (3a) upon the deenergization of the starter motor and when rotating at a high speed due to a radially inwardly directed reactive force applied to the cylinder by said bearing in response to a radially outwardly directed centrifugal force produced by an imbalance in the rotation of the armature (1b), said preventing means comprising armature balance restoration means (21) comprised a material removal zone (21) whereat core material creating an armature imbalance has been removed in said armature shaft direction and provided on said core between a pair of said slots in said armature shaft direction where an unbalanced portion is found, thereby establishing a balanced rotation of said armature to attendantly eliminate said centrifugal force and thus said reactive force."

The wording of Claim 2 differs from the wording of Claim 1 by its characterising portion as follows:

"characterized in that it further comprises

g) means for preventing a delay in the inward, return displacement of the pinion displacement cylinder (3) and pinion (3a) upon the deenergization of the starter motor and when rotating at a high speed due to a radially inwardly directed reactive force applied to the cylinder by said bearing in response to a radially outwardly directed centrifugal force produced by an imbalance in the rotation of the armature (1b), said preventing means comprising armature balance restoration means (21) comprised balancing weight means attached to said unbalanced portion of the core in said armature shaft direction and provided on said core between a pair of said slots in said armature shaft direction where an unbalanced portion is found, thereby establishing a

balanced rotation of said armature to attendantly eliminate said centrifugal force and thus said reactive force."

V. The Appellant argued as follows:

The problem to be solved by the invention is to provide a starter motor free of delay in return of the pinion moving cylinder when current to the motor is cut off.

Although this problem was known as such, it was difficult to find the fault causing this problem. The reason for the fault could be failure in the installation, dirt or insufficient lubrication in the sliding area. The reduction of noise and the increased service life described in the application are only additional problems which were automatically solved by solving the above cited main problem.

The invention relates to a very limited technical field, to which the described problem is restricted. That is to say, the problem to be solved arises only in motors of the overhang type, in which the pinion has no support on the side remote from the motor, in which the bearing arrangement comprises an outer bearing (8) and an inner bearing (9), and wherein no speed-reduction mechanism between the rotor and the pinion is provided. Such a starter motor, for instance, is known from document D3 which comes close to the prior art already described in the refused application.

The same problem does not arise in a starter motor which has an outward bearing, on the side of the pinion further from the rotor, as is the case in the starter motor of document D2. Such a motor does not have an arrangement of inner and outer bearings between the pinion and the rotor, capable of interacting to prevent

or delay return of the pinion. It does not exist in starter motors with a reduction gear, such as known from document D2 and document D1.

Document D3 makes no mention of the problem which is solved by the present invention but has as one of its objects to reduce the bending moment applied to the extension of the armature shaft. A specific bearing arrangement is provided, which ensures that the distance between the inner bearing and the cut portion of the armature shaft extension is reduced. This also assists in centring the inner part of the clutch within the clutch device. The objects of document D3 are not achieved by taking any special measures to centre and avoid imbalance of the armature. Balancing of the armature is nowhere mentioned. The measures to be taken are concerned essentially with the placing of the inner bearing, close to the overrunning clutch. From this document the reader would not think it necessary to take any special measures about armature balancing, beyond what was conventional at the time.

The absence of a reduction gear in itself reduced noise very significantly, to such an extent that any further significant reduction of noise could be achieved only at high cost. The application of armature balance control for noise reduction or other reasons was also normally avoided, because the armature of such a starter has a small rotary disk and balance control measures would therefore be difficult and costly. Generally speaking, in a conventional starter motor without a deceleration mechanism, the rotation of the armature is not balanced. Reasons for this include the saving of money; the fact that the rotation speed of the armature is low, suggesting balancing is not required; and the fact that only a small amount of noise is generated by rotation, due to lack of a deceleration mechanism.

In recognising the non-obvious connection between the imbalance of the armature and the difficulty in the return of the pinion moving cylinder, a considerable inventive effort has been exercised. The result is a device which directly contradicts well-established trends in the prior art. Since the motors are mass produced the skilled person was prejudiced against extra balancing of the motors because of the expenses incurred.

It is not relevant that the skilled man realises that the non-vibrating shaft encounters less resistance than a vibrating shaft; what is important is that the skilled man would not have realised that the failure of overhang starter motors is caused by the vibrating output shaft.

To support his arguments the Appellant cited the following decisions: T 02/83, T 04/83, T 106/84, T 63/86, T 59/87, T 564/89, T 49/90, T 61/90, T 184/91, T 234/91.

VI. The Appellant requests that the decision under appeal be set aside and a patent be granted on the basis of the following documents:

Claims: 1 and 2 filed with the letter of
27 July 1994;

Description: Pages 1 to 5 as originally filed, with
the amendment on page 1, line 10
suggested with the letter of
27 July 1994;

Drawings: Sheets 1/2 and 2/2 as originally filed.

Reasons for the Decision

1. The appeal is admissible.

2. *Closest State of the Art*

Document D3 discloses a starter motor with all the features of the pre-characterizing portions of Claims 1 and 2.

Each of documents D1 and D2 describes a starter motor with a speed reduction gear between the pinion displacement cylinder and the starter motor shaft. Moreover, the starter motor of document D2 shown in the drawing comprises a bearing at the outer end of the pinion shaft and is therefore not of the overhang type.

Since document D3 discloses, in particular, a starter motor of the overhang type without intervening speed reduction gears and with an inner sliding bearing between the pinion displacement cylinder and the starter motor shaft, and therefore discloses a starter motor of the same type as that of the application, the Board considers document D3 to represent the closest state of the art.

3. *Problem and Solution*

3.1 Problem

With the type of starter motors known from document D3 it occasionally happened, according to the explanation of the Appellant, that the pinion moving cylinder did not return properly which had the effect of motor damage. This problem was known and appeared only in some

of these starters though the starter motors were to a certain extent balanced in the course of the usual manufacture.

Using document D3 as the most relevant prior art document, the objective problem is to provide a starter motor which is free of a delay in return of the pinion moving cylinder when current to the motor is cut off, and which furthermore prevents noise and increases service life (see page 1, line 30 to page 2, line 4 and page 5, lines 5 to 7 of the description of the application).

3.2 Solution

The above stated problems are solved by a material removal zone whereat core material creating an armature imbalance has been removed in the armature shaft direction according to the characterizing portion of Claim 1 and by balancing weight means attached to the unbalanced portion of the core in the armature shaft direction according to the characterizing portion of Claim 2.

4. *Inventive Step*

4.1 The extent to which electric motors, including starter motors, are balanced depends on weighing the pros and cons between the technical necessities on the one hand and economic considerations on the other hand. Particularly with mass production, as is the case with starter motors in vehicle combustion engines, reduction in manufacturing costs is of great importance. It is therefore obvious that the motor manufacturer sets the tolerances for balancing of the rotors as wide as possible in order to reduce the high costs of accurate balancing.

4.2 The effect of insufficient balance of a rotor becomes important at parts which are in contact with the rotor. Such parts are usually bearings. The problem of bearing wear and bearing damage caused by insufficient balanced rotors is generally known.

4.3 If it is realised that in a starter motor of the overhang type, as described in document D3, the pinion moving cylinder does not return correctly when current to the motor is cut off, then there may be several well known reasons therefor, as pointed out by the Appellant, i.e. incorrect installation, insufficient lubrication and dirt in the sliding area. The skilled person however also would consider, in view of his basic knowledge, the balanced running of the rotating parts.

The Board cannot accept the argument of the Appellant that the skilled person would be prejudiced against accurate balancing of the motors because of the high costs. If it is realised that there are deficiencies in the system, in particular in the bearing regions, then the skilled person would consider all the possible reasons upon which the difficulties might be based. One of these obvious reasons is eccentric running of the rotating parts. At least after realizing that an improvement in lubrication and in dirt avoidance could not bring the expected improvement, investigation of the running condition of the movable pinion cylinder and therewith the running condition of the rotor of the motor would be obvious.

4.4 Indeed, from document D3 it is known that the movable pinion cylinder is mounted on a bearing stretching along the motor shaft which is connected with the armature, so that imbalance of the armature affects the running condition of the slidable pinion cylinder. It is obvious from this construction with the inner bearing positioned

on one end of the pinion cylinder and the outer bearing positioned at a distance therefrom having the pinion cylinder slidably mounted with its outer portion in this outer bearing that eccentric running of the motor shaft must lead to difficulties, such as wear and damage of the bearings.

- 4.5 Since the skilled person knows that the rotor used in the motor of document D3 is only "reasonably" balanced, and that a further improved balanced rotor will positively influence the functioning of the contacting and surrounding parts, he would be guided by his basic knowledge to an improved balancing.

To achieve balancing by removing core material between a pair of the slots in the armature shaft direction where an unbalanced portion is found as stated in Claim 1 of the application, or by attaching balancing weight means to the unbalanced portion of the core between a pair of slots in the armature shaft direction as stated in Claim 2, is normal practice for the skilled person. This was not disputed by the Appellant.

Furthermore, it is even known from document D1 to balance the armature of a motor by bonding an epoxy putty to the armature of the motor or by cutting the armature core by a drill or a milling cutter. The Appellant argued that this motor and also the motor of document D2 are starter motors which are provided with a gear between the motor shaft and the shaft for the pinion and the problem of unreliable returning of the pinion shaft after deenergization of the starter motor would not exist therein because of the gear. This is not disputed by the Board, however document D1 shows that additional balancing of the electrical motors may be necessary and is taken into account even with mass produced motors.

- 4.6 A skilled person wishing to avoid the above mentioned problems therefore would be guided not only by his common general knowledge but also by the teaching of document D1 to improve the balancing of the starter motor according to document D3.
- 4.7 Even if the skilled person was unaware of the particular reason for the sliding problem for the pinion cylinder, i.e. the insufficient balancing of the electric motor, his interest would also be led by other considerations in order to improve the running condition and therewith balancing of the rotating parts of the starter motor.

Indeed, although the Board accepts the Appellant's point that car manufacturers are mainly led by cost considerations, it should not be forgotten that the same manufacturers are sometimes also led by quality considerations rather than by cost considerations, especially when it concerns their top quality cars. Therefore, considerations with respect to further noise reduction and further increased service life time are undoubtedly of real importance in appropriate cases, so that it cannot be accepted that these considerations are of minor importance and never could lead a person skilled in the art to improve the closest state of the art starter motors in these respects. Even in the application (see page 1, lines 30 to 32) noise is stated as an additional problem.

It may be true that the noise problem is not as severe in starter motors of the overhang type as in starter motors with a gear between the motor shaft and the pinion shaft, however a low noise level is part of vehicle satisfaction and it is a matter of weighing cost against quality of the engines and therewith of the vehicles.

With the demands for reducing noise and increasing service life time it is obvious to take into consideration, in particular, correct balancing of the rotating parts of the starter.

Indeed, not only does document D1 give a clear hint that noise is produced by insufficient balance of the rotor and the vibration of the shaft of the starter motors but it is common general knowledge that service life time of a rotating device is increased by high balancing quality of the rotating parts of that device. Again, it is an obvious matter of weighing cost and quality of the device, in particular in the field of vehicle combustion engines in which commercial interest exists not only in low price products but also for higher priced, higher quality products.

Furthermore, it cannot be accepted that there was a prejudice against starter rotor balancing better than that needed for a normal "reasonably balanced starter rotor" used in current cars. Indeed, the arguments brought forward in this respect are economical rather than technical. On the contrary, a person skilled in the art knew that a "reasonably balanced starter rotor" which is acceptable in certain circumstances could be technically improved without any major technical difficulties if a higher quality standard was required. Although this higher quality standard was not used by standard manufacturers, the improvement was obvious for each skilled person.

4.8 The Appellant cited several decisions to support his arguments.

4.8.1 With regard to his argument that balancing discussed in the prior art is for a completely different purpose and that the skilled reader would have no reason at all to

refer to documents D1 and D2 for information likely to help in the solution to the problem, the Appellant cited the decisions T 4/83, T 2/83, T 49/90, and T 564/89.

Beside the fact that noise also was part of the problem described in the present application (see section 4.7 above) and a hint for solving this noise problem is given in document D1, the Board is convinced that it is general knowledge for the skilled person to consider the quality of balancing of rotating parts of a device, if difficulties occur in the region of the bearings. In the present case dealing with a starter motor of the overhang type, the pinion moving cylinder slides along the outer bearing (see document D3). The skilled person therefore **would** have improved the running condition of the rotating parts and therewith balancing of the motor if he had realized sliding problems of the pinion cylinder. Document D1 already discloses how to balance the rotors of starter motors. The above cited decisions therefore cannot be compared with the present case.

- 4.8.2 The Appellant furthermore cited decision T 59/87 with the argument that a new use for a known material can be allowed in a claim.

This is not denied by the Board but depends on the particular case. In the present case the outcome of balancing was predictable.

- 4.8.3 To support the argument that the inventive step lies in understanding the reasons underlying the problem, the Appellant cited the decisions T 564/89 and T 61/90. He furthermore cited the decisions T 106/84 and T 234/91 to support the argument that an unexpected solution has been found to a long existing problem wherein the result while appearing simple is however not obvious.

These arguments are not relevant for the present case, since it is generally known that bearing problems are highly dependent on the quality of balancing of the supported rotating parts. Furthermore, with regard to the noise problem, document D1 gives a clear hint for the solution by balancing of the rotor.

- 4.8.4 With regard to the statement in the letter of 27 July 1994 (page 1) "considering that significant amendments of the claims are now submitted, the Board may consider it proper to remit the case to the Examining Division for further examination at first instance on the basis of the amended claims" the Appellant cited the decisions T 63/86 and T 184/91.

In the present case Claims 1 and 2 proposed during appeal have not been substantially amended, so that it is not necessary for the Examining Division to carry out a substantial further examination. The question of remittal to the first instance was no longer mentioned by the Appellant during the oral proceedings.

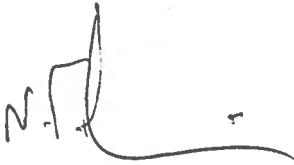
5. Claims 1 and 2 do not involve an inventive step (Art. 56 EPC) and are therefore not allowable under Article 52(1) EPC.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:



N. Maslin

The Chairman:



C. Andries

Bry

