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D E C I S I O N
of 22 May 2003

Case Number: T 0616/00 - 3.5.2

Application Number: 94104869.6

Publication Number: 0618661

IPC: H02K 15/09

Language of the proceedings: EN

Title of invention:

Methods and apparatus for winding armatures with improved balance

Patentee:

AXIS S.p.A.

Opponent O1: ATOP S.p.A.

Opponent O2: Globe Products Inc

Headword:

-

Relevant legal provisions:

EPC Art. 123(2), 56

Keyword:

"Amendments - added subject-matter (no)"
"Inventive step (yes)"

Decisions cited:

-

Catchword:

-



Case Number: T 0616/00 - 3.5.2

D E C I S I O N
of the Technical Board of Appeal 3.5.2
of 22 May 2003

Appellant: Globe Products Inc
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Decision under appeal: Interlocutory decision of the Opposition Division
of the European Patent Office posted 24 March
2000 concerning maintenance of European patent
No. 0 618 661 in amended form.

Composition of the Board:

Chairman: W. J. L. Wheeler
Members: F. Edlinger
P. H. Mühlens

Summary of Facts and Submissions

I. The appellant (opponent 02) filed this appeal against the interlocutory decision of the opposition division concerning maintenance of European patent No. 618 661 in amended form.

II. The appellant referred to the following documents in support of the grounds of appeal:

D1(OII): "Digital Closed Loop Tensioning System";
G. Dutt; 1986 International Coil Winding
Association, Inc.; pages 30 to 35;

D2(OII): "Proper wire tension can have big impact on
productivity"; J. Moody; Techevents;
Statomat-Globe;

D3(OII): EXACTROL Electronic Wire Tensioner; Globe,
product leaflet;

D4(OII): Exactrol-FMTM Control Module; Statomat-Globe,
product leaflet.

These documents will be referred to as D1 to D4,
respectively.

III. Oral proceedings were held before the Board on 22 May
2003.

IV. The appellant requested that the decision under appeal
be set aside and that the patent be revoked.
Opponent 01, party as of right, refrained from
presenting its own submissions but was represented in
the oral proceedings and also requested that the patent

be revoked.

V. The respondent (patentee) requested that the appeal be dismissed and that the patent be maintained as amended with Claims 1 to 7 as filed in the oral proceedings on 22 May 2003 and the description and drawings as approved by the opposition division.

VI. Claim 1 is worded as follows:

"Apparatus for simultaneously winding two coils (20, 21) of wire on a rotor for use in a dynamo electric machine comprising:

- first and second wire supplies (36, 37) for respectively supplying first and second wires (34, 35),
- first and second winders (30, 31) for respectively winding said first and second wires on said rotor
- first and second means for respectively guiding said first and second wires (34, 35) to said first and second winders,

said first and second means for guiding respectively comprising first and second means for monitoring consumption (60, 60') or tension (120, 120') of the respective one of said first and second wires (34, 35) which is passing through the respective one of said first and second means for guiding, and

first and second means (66, 66') for applying tension to the respective one of said first and second wires (34, 35) which is passing through the respective

one of said first and second means for guiding to the respective one of said first and second winders (30, 31)

the apparatus being characterised in that said means for guiding further comprises means for modifying the mass condition of the coils in order to improve the balance result of the rotor, and wherein said means for modifying the mass condition of the coils comprises:

means (100, 101, 102, 104) responsive to said first and second means for monitoring (60, 60', 120, 120') for determining differences of said consumption or tension existing between said first and second wires (34, 35) and for adjusting the tension applied by at least one of said first and second means for applying tension (66, 66') in order to reduce the differences in consumption or tension existing between said first and second wires (34, 35)."

Claim 6 is worded as follows:

"Method for simultaneously winding two coils of wire (20, 21) on a rotor for use in a dynamo electric machine wherein each of said coils is being wound by a respective one of first and second winders respectively supplied with first and second wires from first and second wire supplies, said method comprising the steps of:

- guiding said wires from said wire supplies to respective ones of said winders and winding said wires to form said coils of said rotor;
- monitoring consumption or tension of each one of

said first and second wires (34, 35) passing from the respective one of said first and second wire supplies (36, 37) to the respective one of said first and second winders (30, 31);

- applying tension to each one of said first and second wires supplied from said first and second wire supplies;

the method being characterised in that during said guiding step it further comprises the step of modifying the mass conditions of said coils in order to improve the balance result of the rotor by:

- determining differences of said consumption or tension existing between said first and second wires (34, 35), and
- adjusting tension of at least one of said first and second wires (34, 35) in order to reduce the differences in consumption or tension existing between said first and second wires."

Claims 2 to 5 and 7 are dependent on Claims 1 and 6, respectively.

VII. The appellant (opponent 02) essentially argued as follows:

Claims 1 and 6 of the opposed patent each specified monitoring and determining differences in wire consumption or tension as two separate alternative subject-matters. The application as filed did not directly and unambiguously disclose that the first and second wire tensions were compared to determine and

reduce differences, as it was in fact the case for the wire consumption measurements. The passage of the description saying that brakes "can additionally or alternatively be controlled on the basis of feedback from optional wire tension sensors" (column 7, lines 54 to 58, of the patent specification) referred to "extremely fine regulation" of the wire tensions which had been initially set to ideal conditions (column 6, lines 15 to 17, of the patent specification). Differences of the wire tensions could not be determined and reduced in the same way as described for the wire consumptions if the tension signals were used "additionally" because this would lead to competing control signals. But the tension sensor signals and fine regulation could be used instead of ("alternatively") comparing the wire consumptions for fine control of each of the brakes (patent specification, column 8, lines 20 to 28). Since there was no unambiguous disclosure in the application as filed of one of the alternatives specified in claims 1 and 6, the opposed patent contained subject-matter which extended beyond the content of the application as filed and infringed Article 123(2) EPC.

Coil winding machines equipped with the Exactrol-FM wire tension control system which formed the subject of documents D1 to D4 had been made available to the public. This tension control system enabled the wire tensions to be set independently, but it would be preferable to set the same value of tension for both flyers of a double-flyer winding machine. Constant tension of both wires was maintained by virtue of a closed loop control of the force applied to each of the wires (D4). The Exactrol-FM undoubtedly improved the balance result of the rotor and thus modified the mass

condition of the coils because it maintained equal tension in both wires during the winding process. It did not directly compare the tensions of the first and second wires, but reduced differences therebetween by virtue of a common set point. The known system was advantageous in some aspects because it was possible to set different tension levels (for instance to take account of different wire properties) and each of the wires could then be controlled at its ideal tension value while claims 1 and 6 of the opposed patent only specified that the differences were reduced. The subject-matter of the present claim 1 (and similarly that of claim 6) only differed from this prior art in that it had means for monitoring for determining differences of tension existing between said first and second wires.

The technical problem solved by the opposed patent had to be seen as finding an alternative control regime to the independent control of the wire tensions in said prior art.

In reality, this was no problem at all for the person skilled in the art and its solution was merely a routine workshop modification because it was obvious to control one wire tension at a set point and to compare the measured tension of the second wire with that of the first wire. Additional control of the absolute value of the tension of one wire was necessary anyway to obtain uniform windings and to avoid slack zones. This obvious solution would be equivalent in many ways to the master/slave control disclosed in the description of the opposed patent. The subject-matter of claims 1 and 6 did not involve an inventive step (Article 56 EPC).

VIII. The respondent essentially argued as follows:

The opposed patent described two different embodiments of the same invention. The description of the first embodiment disclosed in detail how the consumptions of the two wires were compared and equality of the wire consumptions restored if a difference was determined. The measurements of the wire consumptions were used as an indication of the wire elongations. The objective was to avoid different elongations in order to improve the balance result of the wound rotor. It was clear from the description, column 8 of the patent specification, that this could be obtained in the alternative embodiment by determining differences of the wire tensions and by ensuring that both wires always had substantially the same tension. The wire tensions of the simultaneously wound coils of prior art apparatus were only supposed to be the same and supposedly maintained at the ideal set value, but they were not so in practice. Determining differences in elongation, either by comparing the wire consumptions or the wire tensions, made it possible to avoid variation in the masses being deposited in the simultaneously wound first and second coils.

It was common practice to correct unbalances produced during the winding process by adding masses to, or removing masses from, the finished rotor. In high speed armatures, it was not practicable to add masses. But milling grooves in a finished rotor at the end of a production line where the balance had to be checked was difficult. The present invention was based on the insight that unbalances resulting from the winding operation could be substantially eliminated if differences in the elongation of a first wire and that

of a second simultaneously wound wire were avoided.

The apparatus equipped with the Exactrol-FM wire tension control system controlled the wire tension of each of the coils independently. In practice, this led to different wire elongations and rotor unbalances. There was no hint in the prior art that winding unbalances could be eliminated by determining differences in wire consumption or tension of simultaneously wound coils.

Reasons for the Decision

1. *Amendments*

- 1.1 The claims as granted, except for the reference signs and linguistic corrections, are identical with the corresponding claims of the application as filed. Also the passages of the description to which the parties referred have their counterparts in the application as filed. For ease of comprehension, references will likewise be made to corresponding passages of the patent specification.
- 1.2 Claims 1 and 6 are substantially a combination of claims 1 to 5 and claims 11 to 15 as granted, respectively. The only amendment objected to by the appellant is concerned with "determining differences of ... tension existing between said first and second wires", as an alternative to determining differences of wire consumption, in each of claims 1 and 6.
- 1.3 The patent specification (column 1, lines 45 to 48; column 2, lines 2 to 9) describes simultaneously

winding the same number of turns of two wires in two pairs of symmetrically opposite slots as creating a known theoretical basis for avoiding rotor winding unbalance. Tensioner devices (eg hysteresis brakes) for each of the wires are supposed to guarantee in these prior art winders that predetermined tensions are maintained on the wires during the various winding operations (column 2, lines 24 to 29; column 5, lines 20 to 24). In practice, however, a difference between the tension of the wires "can result in different elongation of the wires" with the result that, in certain instances, different masses of wire are supplied into symmetrically opposite pairs of slots of the armature and the armature becomes unbalanced (column 2, lines 40 to 48). Substantially eliminating these "differences" is described as a particular object of the invention (column 3, lines 21 to 27). This can be achieved by measuring the consumptions or tensions as an indication of wire elongation (column 5, lines 40 to 47; column 8, lines 4 to 11 and lines 20 to 24), and by increasing or decreasing the tension of one of the wires "relative to" the tension of the other wire to restore substantial equality of the consumptions or tensions (column 3, lines 31 to 46; column 5, line 47 to column 6, line 14). The description of the first embodiment contains a more detailed disclosure of how the wire consumptions are compared with each other and how differences are determined (column 6, lines 19 to 24; column 7, lines 45 to 47; Figures 9 and 10). The description of the second embodiment (column 8, lines 20 to 32; Figure 11) discloses an alternative determination of wire elongation and the supply of the output signals of two wire tension sensors to the same control apparatus (Figure 9) to substantially equalize wire consumptions.

1.4 In the judgement of the Board, the description of the application as filed taken as a whole in the light of the stated objects vis-à-vis the acknowledged prior art leaves no doubt that determining and reducing differences of wire consumption or tension (by comparing the respective quantities to each other) constitute two alternative solutions disclosed in the application as filed, to avoid differences in elongation of the wires which would otherwise lead to the supply of different masses to symmetrically opposite slots. It would be inconsistent with this teaching if the wire tensions of the simultaneously wound pair of coils were adjusted independently of each other because it aimed at eliminating instantaneous differences in elongation by adjusting the tension of one wire relative to that of the other wire. Therefore, the subject-matter of claims 1 and 6 does not extend beyond the application as filed (Article 123(2) EPC).

1.5 The dependent claims 2 to 5 and 7 correspond to claims 6, 8 to 10 and 16, respectively. The description has been adapted to the amended claims 1 and 6 and statements of prior art were included. All the claims have been restricted in scope by the inclusion of originally disclosed features as set out above. The amendments thus do not infringe Article 123(2) or (3) EPC.

2. *Novelty and inventive step*

2.1 According to the appellant, coil winding machines equipped with the Exactrol-FM wire tension control system which formed the subject of documents D1 to D4 constituted the closest prior art. The respondent did not contest that such machines constituted prior art

and had all the features of the pre-characterising part of the present claim 1, nor that they performed all the method steps of the pre-characterising part of the present claim 6. In a force control mode of operation of these machines, a closed loop control maintains a selected constant wire tension (D1, page 32, right-hand column, paragraph 3 and page 34, left-hand column, paragraph 2; D4, paragraph headed "Control"). If two coils were wound simultaneously on a rotor, as it was common practice to do, these machines would control the tension of each of the wires independently and maintain the tensions at values which may be the same or independent values to accommodate special situations (D4, paragraph headed "Control").

2.2 Novelty was not contested because this prior art, at least, did not disclose determining differences of consumption or tension between the wires in order to reduce these differences.

2.3 Stating the problem as "finding an alternative control regime to the independent control of the wire tensions in said prior art" as suggested by the appellant would imply that the control should be other than independent for obtaining the same effect. However, this is not justified by the teaching of the closest prior art. Neither is the effect the same if differences between two wire tensions are determined instead of individual differences of each of the wire tensions with respect to predetermined values. Nor is it excluded on an objective analysis that independent control is kept as a key element of Exactrol-FM force control and that other measures are taken to substantially eliminate rotor unbalance. The objective problem solved by the opposed patent is rather "to reduce or substantially

eliminate the unbalance of an armature that may be due to the coils wound on the armature" as stated at column 3, lines 17 to 20, of the patent specification.

2.4 There is no indication in any of the cited documents D1 to D4 that simultaneous winding of theoretically balanced coils may, in practice, introduce unbalance of the finished rotor. There is in fact no reference to problems of unbalance at all in D1 to D4 and no suggestion either that simultaneously wound coils should be considered as a pair and deviations of individual process variables should be judged by reference to the respective other of the pair. The Exactrol-FM control modules as evidenced by D1 to D4 maintain precise control over wire tension to compensate for environmental changes and to achieve tight, uniform windings (D1, page 30, left-hand column; page 32, right-hand column; page 34: "Summary"; D2, page 1; D4, left-hand column). But there is no hint in D1 to D4 that differences in tension or consumption between the wires of the pair which is being wound should be determined and that the tension applied by at least one of said first and second means for applying tension should be adjusted in order to reduce such differences.

2.5 The Board does not accept the appellant's argument that the subject-matter of claims 1 and 6 is merely a routine workshop modification and equivalent in many ways to the master/slave control disclosed in the description of the opposed patent. Although it is true that the individual precise control of the wire tension in the prior art may be considered as a means for modifying the mass condition of the coils to improve the balance result of the rotor, it does not take into

account actual instantaneous differences existing between the two wires and has a different dynamic behaviour. For example, error signals of equal amplitude and opposite sense would normally lead to the same corrective effort (in absolute terms) in each of the feedback controllers as would error signals of equal amplitude and like sense. This is not the case in the embodiment of the opposed patent where "the other flyer, together with its respective tensioner, acts as a "slave" and tries to follow the wire consumption of the "master" in order to reduce differences in the winding conditions" (patent specification, column 6, lines 27 to 34). Even if the master provided only a low quality control of the wire tension of one wire, winding unbalance would nevertheless be reduced if the other wire tension controlled by the slave closely followed these variations to modify the mass conditions of the (pair of) coils to improve the balance result of the rotor as set out in claims 1 and 6.

2.6 Without knowledge of the opposed patent, determining and reducing differences of tension in the first and second wires as specified in claims 1 and 6 thus cannot be considered as an obvious modification of the Exactrol-FM system as evidenced by D1 to D4. This is likewise true for the other alternative contained in these claims because differences in consumption are not mentioned at all in D1 to D4. The subject-matter of claims 1 and 6 and of their dependent claims shall therefore be considered as involving an inventive step (Article 56 EPC).

3. No other objections having been raised, the Board considers that the amended patent and the invention to which it relates meet the requirements of the

Convention (Article 102(3) EPC).

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 maintain the patent as amended in the following version:

Claims 1 to 7 as filed in the oral proceedings,
description and drawings as approved by the opposition
division.

The Registrar:

The Chairman:

R. Schumacher

W. J. L. Wheeler