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D E C I S I O N
of 30 November 2005

Case Number: T 0069/04 - 3.2.06

Application Number: 96919437.2

Publication Number: 0885081

IPC: B23C 1/12

Language of the proceedings: EN

Title of invention:

Direct drive multiple axes rotary spindle head for milling machine

Patentee:

Klaus Dieter Klement Verwaltungs GmbH

Opponents:

DECKEL MAHO Pfronten GmbH
Siemens AG
IOBB Produktideen Vorausentwicklung

Headword:

-

Relevant legal provisions:

EPC Art. 123(2), 123(3), 56

Keyword:

"Added subject-matter (no)"
"Extension of protection (no)"
"Inventive step - (yes) after amendment"

Decisions cited:

-

Catchword:

-



Case Number: T 0069/04 - 3.2.06

DECISION
of the Technical Board of Appeal 3.2.06
of 30 November 2005

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Decision under appeal: Decision of the Opposition Division of the
European Patent Office posted 18 November 2003
revoking European patent No. 0885081 pursuant
to Article 102(1) EPC.

Composition of the Board:

Chairman: P. Alting van Geusau

Members: G. Pricolo
R. Menapace

Summary of Facts and Submissions

I. The appeal is from the decision of the Opposition Division posted on 18 November 2003 revoking European patent No. 0 885 081, granted in respect of European patent application No. 96 919 437.2.

In the decision under appeal the Opposition Division considered that the amendments made to claim 1 of the patentee's main, first and second auxiliary requests met the requirements of Article 123(2) and (3) EPC. However, the subject-matter of claim 1 of the main request was not novel in the light of the disclosure of document

E1: JP-A-63-295143;

and the subject-matter of claim 1 of the auxiliary requests did not involve an inventive step in view of the prior art disclosed by

D2: US-A-4 425 818; and

E3: DE-C-36 27 560.

II. The appellant (patentee) lodged an appeal, received at the EPO on 14 January 2004, against this decision. The payment of the appeal fee was registered on 16 January 2004. With the statement setting out the grounds of appeal, received at the EPO on 18 March 2004, the appellant filed amended claims forming the basis for new main and auxiliary requests.

III. In a communication accompanying the summons to oral proceedings pursuant to Article 11(1) of the Rules of Procedure of the Boards of Appeal, the Board expressed the preliminary opinion that the subject-matter of claim 1 of the main request did not involve an inventive step. Starting from the device known from E1, the skilled person would regard it as obvious to replace the motors of E1 with direct drive motors of the kind disclosed for instance by

E4: Seminar paper: "Entwicklungstendenzen bei Direktantrieben", pages 58 to 85; Selbstverlag FISW-GmbH, Stuttgart 1991;

E6: G. Pritschow, W. Philipp: "Servo-Direktantriebe für Fertigungseinrichtungen", Werkstattstechnik, Springer-Verlag 1989;

or

E9: R. Hagl: "Elektrische Direktantriebe für Werkzeugmaschinen und Industrieroboter", Antriebstechnik 31, 1992;

and thus arrive at the subject-matter of claim 1. As regards claim 1 of the auxiliary request, which differed from claim 1 of the main request essentially in that it was restricted to the presence of a pair of servo motors mounted in housings in each fork arm, it also lacked an inventive step because this additional feature was rendered obvious by D2.

IV. With letter of 31 October 2005 in response to the communication of the Board, the appellant filed an amended main request together with four auxiliary requests.

V. Oral proceedings, at the end of which the decision of the Board was announced, took place on 30 November 2005.

The appellant requested that the decision under appeal be set aside and that the patent be maintained on the basis of amended claims 1 to 4 and pages 1 to 7 of the description (with sheets of handwritten text containing inserts A and B) as filed during oral proceedings, together with figures 1 to 7 of the patent as granted. During oral proceedings, the appellant filed the original of the certified translation of E1.

The respondents I, II and III (opponents I, II and III) requested that the appeal be dismissed.

VI. The independent claim 1 of the appellant's request read as follows:

"1. A device consisting of a gearless direct drive two axes rotary head (10) and a spindle assembly (22), said rotary head (10) comprising: a fork (14) mounted for rotation about a first axis (C) and including a pair of spaced fork arms (18, 20), wherein the spindle assembly (22) is rotatably mounted between said fork arms (18, 20) for rotation about a second axis (A); first motor means (30) for directly driving and controlling the rotation of said fork (14) about said first axis (C); a support arm (32) to which said fork is mounted, said support arm (32) including a housing (48) for said

first motor means (30) and a rotatable sleeve (36) concentric with said first axis (C) and operably coupled to said fork (14) for rotation therewith; second motor means (90) for directly driving and controlling rotation of the spindle assembly (22) about said second axis (A); wherein the first motor means (30) comprises a high torque servo motor (31) mounted within the housing (48) of the support arm and surrounding said sleeve (36) concentric with the first axis (C), said servo motor (31) including a stator (66) and a rotor (70), said rotor (70) being coupled to said sleeve (36) for directly driving and controlling the rotation of said sleeve (36) about said first axis (C); wherein the second motor means (90) comprises at least one high torque servo motor (92, 94) mounted concentric with the second axis (A) in a hollow cylindrical member (96, 98) in the fork arms which includes inner and outer end faces (99, 100) and an inner cylindrical surface (101) therebetween which defines a hollow housing for the servo motor (92, 94), said servo motor (92, 94) including a stator (120) and a rotor (126), said rotor (126) being rotatable and concentric about said second axis (A) and coupled directly to one of the sides of the spindle assembly (22) for driving and controlling the rotation of said spindle assembly (22) about said second axis (A); said spindle assembly (22) comprising an elongate, motor driven spindle (24) mounted within a spindle housing (26), wherein the motor in the spindle (24) operates to rotate a milling tool (28) held in a tool holder secured within the distal end of the spindle (24)."

VII. The arguments of the appellant in support of its request can be summarized as follows:

Although only a rotary head was claimed in the application as filed and in the patent as granted, it was allowable to claim a device consisting of a rotary head and a spindle assembly, because the application as filed disclosed the combination of these two components. This amendment constituted a restriction of the protection as compared to the patent in suit, because the latter conferred protection for the rotary head independently of its use, whilst the patent as amended conferred protection for the rotary head only when it was in combination with a spindle assembly.

The problem underlying the patent in suit consisted in providing a device for milling three-dimensional contours having a simple construction, a high mechanical stiffness, and allowing precise displacement of the milling tool. E1, which represented the closest prior art, disclosed a rotary head having first motor means for driving the rotation of a fork about a first axis and second motor means for driving the spindle assembly about a second axis. E1 was silent about the kind of motor means used, and thus did not disclose direct drive motors. In fact, the skilled person would consider that motor means of the conventional type were used in E1, with a set of gears interposed between the output shaft and the rotor. Furthermore, there was no suggestion in the prior art to replace the motors of the device of E1 with direct drive motors. The available documents, including D2, E4, E6 and E9, disclosed the use of rotary direct drive motors exclusively for applications, e.g. robots, in which the forces applied to the motors were small and did not have large variations. Since the milling operation

generated high cutting forces with strong oscillations during the tool rotation, the skilled person would not consider the use of direct drive motors in a device which, as the one claimed, was intended for milling. Furthermore, there was no disclosure or suggestion in the prior art to provide, in the fork arms of the rotary head, a hollow cylindrical member including inner and outer end faces and an inner cylindrical surface therebetween which defined a hollow housing for the servo motor. This feature provided for easy accessibility to the electrical motors, and also for improved stiffness of the rotary head. Accordingly, the subject-matter of claim 1 involved an inventive step.

VIII. The respondents essentially argued as follows.

The claims of the application as filed and of the patent as granted were directed to a gearless rotary head for a machine tool spindle whilst claim 1 according to the appellant's request was directed to a device consisting of a rotary head and a spindle assembly. The general term "device" was however very general and encompassed devices, such as a robot or a machine tool in combination with a numerical control, which were neither disclosed in the application as filed nor included in the scope of protection of the patent as granted. Moreover, it was not derivable from claim 1 of the patent as granted that the rotary head and the spindle assembly belonged to a same device. Accordingly, the amendments made infringed Article 123(2) and (3) EPC.

The figures of E1 showed that the motors for the controlled axes of the rotary head were coupled in the

absence of gears, i.e. directly coupled, to the fork and the spindle assembly. Thus E1 already disclosed the provision of rotary direct drive motors. Anyway, rotary direct drive motors were known in the art and their use for obtaining a more compact device was obvious, as documented by E4, E6 or E9. The manner in which cutting forces varied depended on the kind of milling operation which was performed. If high speed milling. i.e. milling with low cutting depth and fast rotation of the milling tool, was performed, then the average value of the cutting force and the oscillations thereof were very low. Therefore, the skilled person would certainly not be prevented from using direct drive motors in the rotary head of E1 if the objective was to perform high speed milling. In fact, high speed milling was contemplated by the patent in suit, since the latter referred to milling of three-dimensional contours, i.e. to an operation for which high speed milling was normally used in the art. Moreover, the skilled person would not be prevented from using direct drive motors in E1 by the fact that rotary direct drive motors were specifically disclosed for robots in the prior art. Indeed, robots belonged to the same general technical field of milling machines, namely the technical field of machine tools. Moreover, the purpose of direct drive motors, consisting in controlling the displacement of rotary axes, was the same in a robot and in a rotary head for a milling machine. In any case, E6 related to rotary direct drive motors for machine tools in general. As regards the feature concerning a hollow cylindrical member in the fork arms of the rotary head, including inner and outer end faces and an inner cylindrical surface therebetween which defined a hollow housing for the servo motor, it could not support the

presence of an inventive step. This feature did not result in any technical effect related to the problem underlying the patent in suit, but was a mere constructional detail suggested by the embodiment shown in Fig. 4 of D2. Although in this embodiment the motor was arranged over the outer surface of the hollow cylindrical member, rather than inside it as shown in Fig. 4 of the patent in suit, the claim left open where the motor was arranged with respect to the hollow cylindrical member.

Reasons for the Decision

1. The appeal is admissible.
2. *Amendments*
 - 2.1 Basis for the subject-matter of claim 1 is found in claims 1, 3, 6 and 7; and in the description, page 5, lines 24 to 27; page 6, lines 3 to 8; page 8, line 30 to page 9, line 4; page 9, lines 9 to 15 and 27 to 35, of the application as filed.

Since claim 1 as amended is directed to a device consisting of (i.e. comprising only) a gearless direct drive two axes rotary head and a spindle assembly, and the combination of these two components is unambiguously disclosed in the application as filed (see e.g. page 5, lines 24 to 26) the respondents' objections that the general term "device" encompassed also devices which were not disclosed in the application as filed, and that there was no disclosure

of the rotary head and the spindle assembly belonging to a same device, are unfounded.

- 2.2 The features of dependent claims 2 to 4 can be found in dependent claims 7 to 9 of the application as filed.

The description is amended to bring it into conformity with the amendments made to the claims and to acknowledge the prior art known from E1 and D2.

- 2.3 Thus, there arise no objections under Article 123(2) EPC.

- 2.4 The amendments made to claim 1 restrict the scope of protection because they consist in the inclusion of further features to the subject-matter of granted independent claims 1.

Contrary to the respondents' view, the fact that claim 1 is now directed to a device consisting of a rotary head and a spindle assembly, rather than to a rotary head only as in the granted patent, does not broaden the scope of protection. Claim 1 of the patent as granted could either be seen as conferring protection for the rotary head only, i.e. independently of the particular use thereof, or as conferring protection for the combination of rotary head and spindle assembly (due to the wording "second motor means **coupled to said spindle**"). Whilst in respect of the first meaning the amendment constitutes a restriction of the scope of protection, because the rotary head is only protected when it is in combination with a spindle assembly, the amendment does not affect

the scope of protection in respect of the second meaning.

Accordingly, the amendments are allowable under Article 123(3) EPC.

3. *Novelty*

After examination of the cited prior art, the Board is satisfied that the subject-matter of Claim 1 is novel. Since novelty has not been in dispute there is no need to expand on this matter.

4. *Inventive step*

4.1 The problem underlying the patent in suit consists in providing an operating spindle head which can be rotated at high speeds in response to the abrupt and continuous changes in the contour of a surface being machined so as to maintain the required angular relationship between the spindle head and such surface (see par. [0004] of the patent in suit), and in improving tool stiffness and reducing power losses (see par. [0011]).

4.2 As pointed out by the Board in the communication accompanying the summons to oral proceedings, document E1, rather than D2 as stated by the Opposition Division, is considered to represent the closest prior art. This view was not disputed by the parties.

D2 relates to a robotic manipulator. In order to arrive at the subject-matter of claim 1 in the manner outlined by the Opposition Division in the decision under

appeal, the skilled person would have to replace an intermediate arm (arm 4a) of the robotic manipulator of D2 with a spindle assembly carrying a milling tool. This, however, represents an unrealistic approach, as the skilled person wishing to use a milling tool in the robotic manipulator of D2 would rather provide a spindle assembly on the end point (working implement 17) of the manipulator. Accordingly, D2 does not represent an appropriate starting point for arriving at the device of claim 1.

- 4.3 Using the wording of claim 1, the closest prior art E1 discloses (see the figure) a device consisting of a two axes rotary head and a spindle assembly (3), said rotary head comprising: a fork (5) mounted for rotation about a first axis (vertical axis in the figure) and including a pair of spaced fork arms, wherein the spindle assembly (3) is rotatably mounted between said fork arms for rotation about a second axis (horizontal axis); first motor means (10) for driving and controlling the rotation of said fork (14) about said first axis; a support arm (9) to which said fork is mounted; second motor means (6) for driving and controlling rotation of the spindle assembly about said second axis; wherein the first motor means (10) comprises a high torque servo motor, said servo motor including a stator and a rotor,; wherein the second motor means (6) comprises at least one high torque servo motor mounted concentric with the second axis, said servo motor including a stator and a rotor, said rotor being rotatable and concentric about said second axis and coupled to one of the sides of the spindle assembly for driving and controlling the rotation of said spindle assembly about said second axis; said

spindle assembly (3) comprising an elongate, motor driven spindle (3) mounted within a spindle housing (1), wherein the motor in the spindle operates to rotate a tool held in a tool holder secured within the distal end of the spindle.

Since E1 is silent about the construction of the motors 6 and 10 (see in particular the certified translation filed during the oral proceedings before the Board), it cannot be established whether the rotors of these motors are directly coupled to the fork and spindle assembly, respectively, or whether the motor housings shown in the figure of E1 additionally include a set of gears. In fact, it is generally known that some of the motors that are available on the market include a set of (reduction) gears within their housing. Therefore, the respondents' view that E1 clearly and unambiguously discloses gearless, direct drive motors for driving the first and second axes of the rotary head cannot be followed.

4.4 Accordingly, the subject-matter of claim 1 differs from the device of E1 by the following features:

(i) the rotary head is a gearless direct drive rotary head; the first motor means is for directly driving and controlling the rotation of the fork; the second motor means is for directly driving and controlling the rotation of the spindle assembly and has a rotor coupled directly thereto;

(ii) said support arm includes a housing for said first motor means and a rotatable sleeve concentric with said first axis and operably coupled to said fork for

rotation therewith; the high torque servo motor of the first motor means is mounted within the housing of the support arm and surrounds said sleeve concentric with the first axis;

(iii) said rotor of the first motor means is coupled to said sleeve for directly driving and controlling the rotation of said sleeve about said first axis;

(iv) the high torque servo motor of the second motor means is mounted in a hollow cylindrical member in the fork arms which includes inner and outer end faces and an inner cylindrical surface therebetween which defines a hollow housing for the servo motor;

(v) the tool is a milling tool.

4.5 E1 already partially solves the above-mentioned problem underlying the patent in suit, as it discloses a device in which the spindle can be rotated at high speeds in response to the abrupt and continuous changes in the contour of a surface being machined so as to maintain the required angular relationship between the spindle and such surface. However, since there are no gears in the claimed device (see the groups of distinguishing features (i) and (iii)), the latter can effectively achieve improved tool stiffness and reduction of power losses.

Furthermore, the distinguishing features (ii) and (iv) result in that the motors means are integrated in the fork arms and in the support arm, rather than being mounted externally thereof (see Fig. 1 of E1).

Distinguishing feature (v) allows to use the device for milling.

Therefore, the objective problem solved over the device of E1 consists in improving tool stiffness, reducing power losses, integrating the motors within the constructional elements of the device, and using the device for milling.

4.6 In respect of distinguishing feature (iv) the respondents referred to document D2, which, in Fig. 4, shows (using the wording of claim 1 of the patent in suit) a fork (25) which defines a hollow housing for a pair of servo motors (21d) mounted therein (see column 3, lines 51 to 61). The stator (19d) of each servo motor is attached to the inner cylindrical surface of the frame of the fork (25) and the rotors (20d) are mounted onto the outer cylindrical surface of bearing portions (26).

In accordance with the wording of claim 1 of the patent in suit, the housing for the servo motor is provided as a hollow cylindrical member in the fork arms, i.e. as an additional element which can only be distinct from the outer frame of the fork (25) shown in Fig. 4 of D2. Such a distinct hollow cylindrical member can only be seen in E1 as consisting of the bearing portions (26) of the fork, which bearing portions however carry the motors (21d) on their outer surfaces. It is noted in this respect that, contrary to the respondents' view, it is a requirement of claim 1 that the motor must be inside the hollow cylindrical member, since the claim defines that it is the inner cylindrical surface of the

hollow cylindrical member which defines a housing for the motor.

Accordingly, D2 discloses a manner of housing the servo motors in the fork which is different from that according to claim 1 of the patent in suit. Thus, even if the skilled person would consider applying direct drive motors in the manner disclosed by D2 to the device known from E1 in order to solve the problem of integrating the motors within the device, he would still not arrive at the subject-matter of claim 1. In this respect it is noted that the constructional modifications of the robotic joint shown in Fig. 4 of D2 which are necessary to provide direct drive motors within the bearing portions (26) of the fork (25) are of such nature that the skilled person would not immediately take them into consideration when (hypothetically) applying the teaching of D2 to the device of E1, in particular in the absence of any apparent reason, as in the present case, for such modifications.

Furthermore, the manner of housing the servo motors in the fork according to the definition of claim 1 is not disclosed or suggested by the remaining available prior art.

- 4.7 For these reasons the subject-matter of claim 1 is found to involve an inventive step. It is therefore unnecessary to examine whether the features which distinguish the subject-matter of claim 1 from the device of E1, other than the above mentioned distinguishing feature (v), are, or not, obvious.

- 4.8 The subject-matter of claims 2 to 4, which are dependent on claim 1, likewise involves an inventive step.
5. Accordingly, claims 1 to 4 together with the description as amended during the oral proceedings and Figures 1 to 7 of the patent specification, forms a suitable basis for the maintenance of the patent in amended form.

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 with claims 1 to 4 and the amended description pages 1 to 7, both as submitted during the oral proceedings before the Board of appeal; Figures 1 to 7 as granted.

The Registrar:

The Chairman:

M. Patin

P. Alting van Geusau