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D E C I S I O N
of 5 December 2001

Case Number: T 1090/99 - 3.5.1

Application Number: 90117801.2

Publication Number: 0421176

IPC: 05B 19/23

Language of the proceedings: EN

Title of invention:
Spindle drive system of machine tool

Patentee:
MITSUBISHI DENKI KABUSHIKI KAISHA

Opponent:
Siemens AG

Headword:
Spindle drive system/MITSUBISHI

Relevant legal provisions:
EPC Art. 52(1), 54(2), 56

Keyword:
"Novelty and inventive step (yes)"

Decisions cited:
-

Catchword:
-

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Case Number: T 1090/99 - 3.5.1

D E C I S I O N
of the Technical Board of Appeal 5.1
of 5 December 2001

Appellant: (Opponent)
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Representative:
-

Respondent: (Proprietor of the patent)
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Decision under appeal: **Decision of the Opposition Division of the European Patent Office posted 7 October 1999 rejecting the opposition filed against European patent No. 0 421 176 pursuant to Article 102(2) EPC.**

Composition of the Board:

Chairman: S. V. Steinbrener
Members: R. Randes
P. H. Mühlens

Sachverhalt und Anträge

I. This appeal is against the decision of the Opposition Division rejecting the opposition against the European patent 0 421 176.

Claim 1 as granted and upheld by the Opposition Division (with features K1 to K6 as identified in the appealed decision) reads as follows:

K1 A spindle drive system of a machine tool comprising a motor (3) which drives a spindle (5) of said machine tool, and

K2 a control unit (2) for controlling rotational speed and rotational position of said spindle (5) through said motor (3), said control unit (2) having a speed loop means (4, 24, 25, 26) for a negative feedback control of the rotational speed of said spindle (5),

K3 a position loop means (7, 21, 22, 24, 25, 26) for negative feedback control of the rotational position of said spindle (5),

K4 a control mode changeover means (23) for selecting one of both the speed control mode or the position control mode,

K5 a gain changeover means (29, 27, 28) for changing the loop gain of each of said speed and position loops in accordance with operation modes of said machine tool, wherein,

K6 in a cutting feed mode for cutting of a workpiece, said gain changeover means (29, 27, 28) changes each loop gain of said speed and position loop means to a higher loop gain value than that in other operation modes.

II. The **Appellants** (Opponents) **requested** that the contested decision be set aside and that the **patent be revoked**, arguing that, having regard to the teaching of document D1 (US-A-4 342 950), the subject-matter of claim 1 was not novel or, having regard to the teaching of D1 in combination with D2 (EP-A-0 032 312), it did not involve an inventive step. Both documents had already been cited in the opposition proceedings.

The **Respondents** requested that the **appeal be dismissed** and that the patent be maintained and "as an auxiliary measure" they requested oral proceedings.

III. In an annex to a summons to oral proceedings the Board expressed the preliminary opinion that the appealed decision appeared to be correct, although the Board did not agree with all details of the reasoning of the Opposition Division.

IV. Oral proceedings were held before the Board on 5 December 2001.

V. The Appellants argued before the Board of Appeal along the lines they had done before the Opposition Division. They considered that D1 represented the closest prior art and that this document disclosed features K1 to K5. Having regard to feature K5, they cited two passages (D1, column 6, lines 10 to 41 and column 7, lines 59 to

61) which in their view showed that the gain in the position loop as well as in the speed loop could be varied. Having regard to feature K6, they referred to the paragraph bridging columns 3 and 4 in D1. They also referred to the last part of the one sentence paragraph at lines 18 to 30 in column 4, relating to "the stability of the system to be maintained while the spindle is rotating", and expressed the opinion that the problem to be solved by the present invention as well as the key feature K6 could be derived from this part of D1. It was true that D1 was concerned mainly with the problem of how to stop a spindle at a desired position with a high accuracy and how to increase the rigidity with which the spindle was held at rest. However, D1 was not only concerned with how to avoid overshoot when stopping the spindle, but also mentioned the general problem of system stability and hinted at how to avoid hunting during rotation of the spindle. Thus D1 was in principle concerned with the same problem as the present invention which tried to avoid vibration and noise in the C-axis operation mode. In particular, the Appellants pointed out the following passage in D1 (column 3, line 68 to column 4, line 5):

"Furthermore, if the spindle orientation control circuit is applied to an apparatus such as a turning center that has a spindle indexing function, the spindle is likely to move during a cutting operation owing to the low rigidity of the spindle. This makes it impossible to machine a workpiece accurately."

This passage had not been mentioned in the proceedings before the Opposition Division, but could be so understood that the tools in fact could be changed during rotation of the spindle and that it therefore

was extremely important to also maintain the exact position during rotation of the spindle. Moreover the last sentence in the quotation appeared to hint at the working mode. Thus, according to D1, in the prior art machines the gain in the speed loop was low when the rotational speed was high and the document, like the invention, proposed increasing the gain when the rotational speed was decreased and external forces applied to the spindle. According to D1, this situation occurred during the stopping operation of the spindle and also when the spindle was in its rest position. However, as could be understood from the cited quotation, the gain could already be increased at a low rotational speed before the spindle had to be stopped, since a change of a tool could apparently be performed during rotation. Thus, having regard to the teaching of D1, it appeared that, if it was not considered that D1 was novelty destroying, then it was obvious anyway for a skilled man to arrive at the invention.

Moreover documents D1 and D2 could be combined in order to arrive at the invention, since D2 disclosed the principle that a low spindle speed (reduction ratio high) requires a high gain to avoid spindle hunting and that a low gain is used at a higher speed (reduction ratio low).

VI. The Respondents in their argumentation expressed the opinion that D1, as a whole, was concerned with the problem of how to bring the spindle into a precise rest position and how to maintain it safely in this position. It should thus not be possible to move the spindle from the rest position by external forces accidentally applied to it, so that a desired tool change was safeguarded. The quotation cited by the

Appellants did not give the skilled man any hint in the direction of the present invention. Also D2 had nothing to do with the present invention, since it also related to the stopping phase of a spindle.

VII. At the end of the oral proceedings, the Chairman announced the decision of the Board.

Reasons for the Decision

1. The appeal meets the requirements of Rule 65 EPC and is therefore admissible.

2. The prior art machine tools at the time of the design of the machine disclosed in D1 (cf. column 1, lines 33 to 59) had spindle pins for fixing the spindle at the rest position. Such a pin projected from the spindle and was engaged with a keyway to fix the spindle at rest. However, it could be easily damaged and such damage made the change of tools impossible. The machine tool according to D1 was designed to be able to perform the stopping operation of the spindle so exactly that the pin could be dispensed with. The object of D1 was therefore to provide a spindle rotation control system which would not allow a spindle of a machine tool to be rotated by an externally applied force (for example by the operator of the machine) when the spindle was at rest at a predetermined position. One of the solutions to this task was to increase the feedback loop gain when the spindle was at rest (cf. D1, column 4, lines 18 to 23).

It is true that D1 can be said to disclose a negative speed feedback loop (Figure 5, reference numerals 3,

111, 112, 114, 113, 2) and also a negative position feedback loop (9,4,10, 111, 112, 114, 113). However according to D1 the position loop, including the orientation control circuit 4, is only used during the stopping operation of the spindle. Thus it starts its function only after the machining operation is completed (cf. the paragraph bridging columns 5 and 6) and after that the speed command signal CV is decreased to zero volts. Only then at a predetermined time t1, immediately before the motor comes to rest, does the orientation command circuit 102 provide the orientation signal CPC which actuates the position control feedback loop. After that, at the moment when the actual speed signal AV falls to substantially zero and when also the position deviation signal RPD drops below a predetermined level, the in-position signal INPOS is transmitted from the orientation control circuit 4 to the phase compensating circuit 112 and raises its gain two to threefold. When the INPOS signal is generated it is preferred that the spindle is within a range of +-3° to +-5° with respect to a predetermined stopping position.

The Board agrees with the Opposition Division and the parties that features K1 to K4 are disclosed by D1. From the first embodiment disclosed in D1 (corresponding to Figures 5 and 6) it is clear that the system described is designed to stop the spindle at a predetermined rotational position and to keep it safely in this rest position by increasing the gain in the position feedback loop. The Board can see no purpose in discussing whether the gain of the speed control feedback loop in D1 is, as suggested by the Appellants, also increased as required by feature K5 of claim 1. It appears that the system of D1 is not identical to the

invention and functions quite differently. As has been shown above, the position feedback loop of D1 is operated only during the stopping of the spindle and in its rest position. The Respondents have even expressed the opinion that the speed loop is not operated at all during the time the spindle is in its rest position. The Board however considers that it is not necessary to go into whether the first embodiment of D1 discloses feature K5 in full. This feature must be seen in connection with feature K6 of claim 1, since these features together form the core of the invention.

The second embodiment (cf. Figure 7) described in D1 is also concerned with the stopping of the spindle, the main difference to the first embodiment being that the position deviation signal generating circuit 142 of the orientation control circuit 4 is differently designed from that of the first embodiment.

Having regard to the two embodiments of D1, the Board cannot agree with the suggestion by the Appellants that feature K6 of Claim 1 of the present patent is disclosed in D1. The system of D1 is not concerned with the cutting mode at all; in fact D1 is not concerned with a working mode, rather it suggests increasing the gain when the spindle is in the rest position, thus in principle when it is not rotated at all.

The neutralisation of external forces applied to a spindle by increasing the gain, as proposed in D1, could, however, according to the Appellants, very well be compared with the idea of the invention that requires a higher gain during the working period when external forces are applied to the spindle. The Board is however of the opinion that the skilled person, if

turning to D1 at all, would not find a solution to the resonance problems mentioned in the introductory part of the patent, since these problems are in principle related to C-axis position control in a rapid feed mode and in the cutting feed mode (cf. the present patent, the paragraph bridging columns 2 and 3) and cannot be compared with the problem of stopping the rotation of the spindle and maintaining it safely in the rest position. According to claim 1 of the patent, the gain of the feedback loops in other operation modes than the cutting feed, apparently also for example in the rapid feed mode, is decreased in relation to the cutting feed. This cannot be derived from D1.

The Board cannot agree with the Appellants that the quoted passage of D1 (cf. point V above) points towards the invention. Neither in the passage hinted at nor in the document as a whole is there a hint that a tool change could be performed during rotation, as suggested by the Appellants. Moreover the passage could well mean that during a cutting period of a spindle of the turning center another spindle waiting for its operation could be moved out of its correct rotational position because of vibrations in the whole turning arrangement.

Therefore, having regard to the teaching of the closest prior art document D1, the Board is of the opinion that the subject-matter of claim 1 is novel over D1 and also that it is not obvious to a skilled person to arrive at the invention.

3. Also, having regard to document D2, the Board cannot agree with the Appellants that the teaching of D1 in combination with this document would deprive the

subject-matter of claim 1 of inventive step.

It is true that the paragraph referred to by the Appellants in D2 (page 23, lines 9 to 23) relates to changeover switches 102 and 103 for switching gain in accordance with gear ratio. However they are only used during the positioning and stopping phase of the spindle (cf. D2, Figure 12, see diagrams "S2 or S3" at t1 and "S7 or S8" at t2). They are included in the "rotational position deviation signal generating circuit 11a" which is part of the "orientation control circuit 11", the orientation control circuit 11 forming part of a kind of a position feed back loop (cf. Figures 5, 11(a) and 11(b)). However, as far as D2 can be understood, and, in particular, the specific paragraph referred to, this position loop in D2 is in operation only after the rotation of the spindle is started again after its rotation speed in a working phase has fallen to zero (cf. Figure 10(b) in D2, see VZR, AV at t1) and is only used to position the spindle in the correct rest position, i.e. it is only slowly rotated (turned) until it reaches the correct angular position. Therefore it appears to the Board that the change of gain according to D2 is unrelated to the speed in the sense of the invention, but is only dependent of the high/low settings of the gears at the stopping operation of the spindle. Consequently the Board is unable to see how the teaching of D2 would help the skilled man starting from D1 to arrive at the invention.

4. The subject-matter of Claim 1 is therefore novel (Articles 52 and 54(2) EPC) and also involves an inventive step (Articles 52(1) and 56 EPC).

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

M. Kiehl S. V. Steinbrener