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D E C I S I O N
of 23 August 2000

Case Number: T 0087/98 - 3.5.1

Application Number: 89901301.5

Publication Number: 0356522

IPC: G05B 19/415

Language of the proceedings: EN

Title of invention:
Involute Interpolating Method

Applicant:
FANUC LTD.

Opponent:
-

Headword:
Involute Interpolating/FANUC

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

Keyword:
"Inventive step - (no)"

Decisions cited:
-

Catchword:
-

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Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 0087/98 - 3.5.1

D E C I S I O N
of the Technical Board of Appeal 3.5.1
of 23 August 2000

Appellant: FANUC LTD
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Minamitsuru-gun
Yamanashi 401-05 (JP)

Representative: Brunner, Michael John
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 2 October 1997 refusing European patent application No. 89 901 301.5 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: P. K. J. van den Berg
Members: R. Randes
S. C. Perryman

Summary of Facts and Submissions

I. This appeal is against the decision of the examining division to refuse the application on the ground that the subject-matter of the independent claim 1 lacked an inventive step (Articles 52(1) and 56 EPC) having regard to

D4: Werkzeugmaschinen by Manfred Weck, VDI Verlag, Düsseldorf, Volume 3:"Automatisierungs und Steuerungstechnik", 2nd Edition, 1982, ISBN 3-18-400484-8, pages 177 - 179;

D4a: The same book as D4, pages V- XIV, 1 and 122.

D6: DE-A-3 151 173

Refused claim 1 reads as follows:

"A numerical control apparatus for controlling a machine (9) having a rotational axis (C), and first (X) and second (Z) orthogonal linear axes for machining an involute curve on a workpiece, the apparatus comprising:

reading means (2) for reading a machining program, having involute interpolation instructions, which includes a G-code (G02.2, G03.2) for instructing involute interpolation, a rotational direction of the involute curve in the plane defined by the first axis (X) and a third linear axis (Y) orthogonal to said two linear axes, the end point of the involute curve, a center position of the base circle and the radius of the base circle for the involute curve;

means (3,4) for decoding from said interpolation instructions the involute interpolation data of a two dimensional involute curve and for obtaining from said interpolation data a sequence of points on the two-dimensional involute curve by incrementing a rotational angle (È) of the involute curve, and

pulse distribution means (5) for distributing corresponding output pulses for the first linear axis (X) and the third linear axis (Y);

coordinate converting means for converting said output pulses for the first linear axis (X) and the third linear axis (Y) in the orthogonal coordinate system (X,Y) to second output pulses (r,c) in the polar coordinate system; and

servo control circuits (7) for controlling servo motors (8) for driving the machine (9) from said second output pulses.

II. In the notice of appeal the appellants requested to set aside the decision and that the application be granted on the basis of claim 1 refused by the examining division. Auxiliarily they requested oral proceedings.

III. After the summons to oral proceedings by the Board, these proceedings were held on 16 December 1999.

III.1 The representative of the appellants argued as follows:

The teaching of D4 (page 177) was not appropriate as a starting point for the invention. That teaching only concerned the theoretical interpolation of the involute curve in the orthogonal coordinate system and did not

give any guidance in respect of how the practical machining should be performed. The examining division itself had agreed that several features in the single claim of the present application were not found in D4 (see examining division's decision, page 6, point 1.2).

The invention, in fact, was developed from the problem that before the priority date the general practice was to interpolate an involute curve with a computer (or an NC programming device) separate from a computerized numerical control apparatus, convert the interpolated data to linear data on tape, and machine a workpiece under numerical control using the tape, thereby using commands in the polar coordinate system. The appellants had, however, found that the calculation of the interpolation could be easily done with the aid of commands in an orthogonal coordinate system. Since interpolation in a polar system was very complicated they had arrived at the invention, which provided that the output pulses from the interpolation in the orthogonal system were converted into pulses in the polar coordinate system.

Even if a skilled man had started from the teaching of D4, he would not have thought of using the polar coordinate system if designing an apparatus for machining involute curves, since the two different interpolation methods in the different coordinate systems had never been used together, instead they had always been used totally independently of each other. Since D4 disclosed a method for interpolation in the orthogonal coordinate system a skilled man would never be minded or even imagine using it in combination with a polar coordinate system.

III.2 During the oral proceedings, the Board referred to document DE-A-31 51 173 which had been mentioned superficially before the examining division and which in the decision of the examining division was identified as document D6. However, the Board had not referred to that document in the annex to the summons for oral proceedings. At first sight, at least, this document appeared to be very relevant to the Board, because it appeared to disclose the core feature of claim 1, i.e. the conversion of data of a curve, interpolated in the orthogonal system, into data of a polar coordinate system, whereafter the converted data was input to a control unit.

III.3 The preliminary view of the representative of the appellants was that the transformation of the orthogonal coordinates into polar coordinates according to D6 was not performed in a numerical control apparatus, but was possibly performed in a separate computer and transferred to a tape for further use. However, since the appellants had never considered this new document in the course of the appeal proceedings the representative needed time to get instructions from the appellants how to act further in this case.

IV. After deliberation by the Board, the Chairman gave the following decision:

1. The proceedings are continued in writing.

2. The appellants are given four months from the date of these oral proceedings to present their comments on document D6 (DE-A-31 51 183).

V. The appellants did not file any comments on document D6

in response to the Board's decision.

Reasons for the Decision

1. The appeal is admissible.

2. The only issue to be dealt with is, whether the subject-matter of claim 1 involves an inventive step or not.

2.1 The Board notes that the examining division considered that document D4 did not explicitly disclose the following features of claim 1:

(a) reading means,

(b) involute interpolation instructions which include a G-code,

(c) means for decoding,

(d) pulse distribution means,

(e) coordinate conversion means and

(f) servo control means.

The Board agrees to this finding. However it also agrees to the examining division's view that the features, with the exception of feature (e) and the part of feature (b) which requires that the interpolation instructions include a G code, are implicitly disclosed to a skilled person having regard

to D4 who is familiar with machine tools. It is self-evident to any skilled person that the involute interpolation described in D4 is aimed to be performed with the aid of a machine tool having those features. D4 and D4a are parts of the same handbook dealing with machine tools. Having regard to the teaching of D4a the Board, like the examining division, is therefore of the opinion that the use of G codes in the interpolation application disclosed in D4 is obvious to a skilled person, since in D4a it is made clear that G codes can be used at interpolation.

Thus it appears that a numerical control apparatus having all features of claim 1 except the feature (e) which concerns "coordinate conversion means" is (in connection with D4a) implicitly disclosed in D4 or at least derivable therefrom in a straight-forward way.

2.2 The appellants stated in the oral proceedings that a skilled person, starting out from the arrangement of D4, would not have thought of using the polar coordinate system for interpolation in order to convert the pulses derived from the orthogonal coordinate interpolation into output pulses in the polar coordinate system, since the two different coordination systems had never been used together in interpolation methods. D4 disclosed a method for interpolation in the orthogonal coordinate system and there did not appear to be any reason for the skilled person to introduce polar coordinates in this method.

2.3 The Board notes that the problem to be solved by the present invention has been identified in the introductory part of the present application. This problem has also been taken into account by the

examining division in assessing inventive step in its decision. The problem is derived from the situation or starting point that concerns a known three-axis machine tool having a rotational C-axis, which involves a polar coordinate system and is adapted to operate on the basis of such a polar coordinate system. According to the prior art such NC machine tools had an insufficient computing power and therefore required that the interpolation points were calculated beforehand and registered e.g. on tape. According to the description of the application, known involute interpolation on the basis of orthogonal coordinates could not be applied to such a machine.

However, the appellants found that the calculation of the interpolation could be easily done in the orthogonal system and thus arrived at the solution, i.e. to make the interpolation in the orthogonal system and to convert the resulting pulses into pulses corresponding to the polar coordinate system. Thus the invention provides a more effective numerical control apparatus than the one of the prior art which required precalculated interpolation points.

2.4 In the oral proceedings, however, the Board referred to document D6 which the examining division had hinted at and which the Board considered to be a very relevant document having regard to the coordinate conversion feature of claim 1. It may be concluded from the fact that the appellants have refrained from the possibility of filing comments on that document, that they conceded that this document is very relevant.

Document D6 appears to disclose a machine tool of the same kind as the one referred to in the introductory

part of the present application description, i.e. a machine tool that works on the basis of polar coordinates. This is because the machine tool normally works on workpieces having a rotational symmetry. However, according to D6, if the workpiece has parts which do not have a rotationally symmetrical cross-section, it is advantageous to interpolate in the orthogonal coordinate system. Therefore, according to D6 the surface curves of the non-symmetrical parts are interpolated on the bases of the orthogonal coordinates, but the coordinate signals are converted into polar coordinates before they are fed to the controller of the machine tool. Thus, it appears to the Board that the teaching of D6 makes clear that in a machine which normally works on the basis of the polar coordinate system, it can nevertheless be interpolated on the basis of the orthogonal coordinate system, if the signals from this interpolation are converted into signals corresponding to a polar coordinate system.

The representative of the appellants suggested in the oral proceedings before the Board that the conversion according to D6 was probably not made in the numerical control apparatus of the machine tool itself, but was made outside the apparatus whereat the data was e.g. stored on a tape. However, nowhere in the text of D6 can the Board find that this is the case. Figure 3 of D6 appears to show schematically the computerized numerical control apparatus, wherein the conversion means appears to make up a part of the apparatus and feeds data to the summing point of the controller to which also data from the feed back loop is supplied.

Even if the appellants should be right in that a precalculation is made in D6, the Board, nevertheless,

is of the opinion that the skilled person gets the advantageous idea from D6 to interpolate the non symmetrical involute curve in the orthogonal system. It is of course self-evident to a skilled person to make the interpolation and the conversion in the numerical control apparatus itself if the processor concerned is sufficiently powerful. Thus the Board is of the opinion that the skilled person, starting from the problem identified above, would arrive at the invention according to claim 1 having regard to the teaching of D4 (and D4a), which document discloses most of the features of claim 1 and in particular the feature that the interpolation of the involute is made on the basis of orthogonal coordinates, and the teaching of D6, which document discloses that the data of the orthogonal interpolation must be converted to data based on polar coordinates, since the controller of the numerical control apparatus of D6, like the controller of the NC machine according to the applicant's starting point, functions only in the polar coordinate system.

3. The subject-matter of claim 1 accordingly does not involve an inventive step and claim 1, therefore, does not meet the requirements of Articles 56 and 52(1) EPC.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

M. Kiehl P. K. J. van den Berg