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D E C I S I O N
of 28 October 1998

Case Number: T 1030/96 - 3.5.2

Application Number: 92114609.8

Publication Number: 0535369

IPC: H02P 8/00

Language of the proceedings: EN

Title of invention:
A control system of a motor

Applicant:
Canon Kabushiki Kaisha

Opponent:
-

Headword:
-

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step - no"

Decisions cited:
-

Catchword:
-

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Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 1030/96 - 3.5.2

D E C I S I O N
of the Technical Board of Appeal 3.5.2
of 28 October 1998

Appellant: Canon Kabushiki Kaisha
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 19 July 1996 refusing European patent application No. 92 114 609.8 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: W. J. L. Wheeler
Members: A. G. Hagenbucher
A. C. G. Lindqvist

Summary of Facts and Submissions

I. The appellant contests the decision of the examining division to refuse European patent application No. 92 114 609.8. The reason given for the refusal was that the subject-matter of the claims then on file did not involve an inventive step, having regard to document

D1: EP-A-257 473

and general knowledge in the art acknowledged in the present application.

II. With the statement of grounds new claims and description pages were filed. The appellant explained the terms "ramp-up" and "self-actuating mode" used in the new claims and sent an English translation of JP-A-5449026 (D2) mentioned in the description of the present application.

III. In a communication annexed to the summons to attend oral proceedings and in a telefax the Board drew attention to

D3: Takashi Kenjo "Stepping motors and their microprocessor controls", Clarendon Press, Oxford, pages 62 to 64 (first published 1984, paperback edition 1985, reprinted (with corrections) 1986 and 1990, reprinted 1992),

D4: EP-A-200 959 (cited in the European Search Report)

and

D5: GB-A-2 233 175

in order to show the relevant background terminology and drew attention to problems with the interpretation of the claims and the issue of inventive step.

IV. In a reply thereto dated 28 September 1998, the appellant filed new claims 1 to 3 and a revised description page 3.

V. Claim 1 is now worded as follows:

"1. A method of controlling a stepping motor, comprising the steps of:

- controlling the rotation of said stepping motor by giving driving pulses sequentially to respective magnetization phases of said stepping motor in accordance with a rotational quantity of said motor;
- maintaining the magnetization to hold a rotor of said stepping motor in a stable position with respect to the phase which has been magnetized last when the motor is stopped;

characterized by the steps of:

- determining the rotational quantity of said stepping motor in conformity with a rotation indicating command;
- judging whether or not rotation actuating control of said stepping motor is performed by a ramp-up in accordance with the rotational quantity of said

motor; and

- selecting a magnetization maintaining time in said step of maintaining the magnetization in accordance with the judgement in said judging step,

wherein said judging step involves judging whether rotation actuating control of said stepping motor is executed by ramp-up or in a self-actuating mode, and wherein said selecting step involves maintaining the magnetization maintaining phase for a short time when the rotation actuating control is executed by the ramp-up and maintaining the magnetization maintaining phase for a long time when said control is executed in said self-actuating mode."

Claims 2 and 3 depend on claim 1.

VI. Oral proceedings were held on 28 October 1998.

VII. The appellant argued essentially as follows:

The present invention related to the control of a stepping motor, such as e.g. a paper feed motor or the like in a printer. The object in such stepping motor design generally included to reduce noise, to shorten the time between start and stop, and to settle the rotor in a very short time at the target position.

The cited prior art dealt with solutions to the problems "reduction of noise" (D5) and "improving the accuracy of a final stop position of a stepping motor", (D1). According to D5 a control section discriminated

whether a short distance or long distance travelling was to be carried out by a stepping motor. It was clear from D5 that for short-distance travelling a through-up and through-down control could not be executed. During a self-starting operation in an initial processing operation, i.e. when the stepping motor was not yet fully accelerated, a smaller current was applied than that applied during operation with through-up and through-down control, in order to reduce noise.

D1 disclosed a control method for improving the accuracy of a final stop position of a stepping motor. The process of stopping the motor involved the application of a driving voltage, a holding voltage for a predetermined time period and a driving voltage to the final magnetization phase for a predetermined time period. The final time period was variably selectable and the voltage was applied in the form of a series of different pulses.

It emerged from the description of the present application that motor control was carried out by a ramp-up mode when a large rotational quantity (or feeding amount) of a stepping motor was ordered by a rotation indicating command. A ramp-up process required three phases, namely a ramp-up or acceleration phase, a high constant speed driving phase in a so-called through area and a ramp-down or deceleration phase. When the rotational quantity or feeding amount was small, a self-actuating mode was selected during which the rotor was accelerated. Figures 2A and 2B illustrated the known vibration behaviour upon stopping after the two different modes. A stop after a self-

actuation caused an abrupt change in the movement of the rotor and therefore long lasting vibrations. If the next operation command was given before such vibrations had stopped, it could result in out-of-synchronism. D2 taught maintaining the magnetization until all possible vibrations of the rotor had stopped in order to prevent out-of-synchronism. However, after a ramp-up mode the period of vibrations was short due to the smaller energy at the target position. The prior art (D2) did not distinguish between various stepping motor control modes and always used a long waiting time of the order of several 10 ms through several 100 ms to ensure that all vibrations of the rotor and the stator would have stopped, in order to avoid out-of-synchronism. The present invention aimed at preventing initiation of the next rotor driving step before the vibrations caused by a motor stop had ceased but nevertheless keeping the waiting time as short as possible.

VIII. The appellant requested that the decision under appeal be set aside and that a patent be granted on the basis of

Claims: 1 to 3 as filed with the letter dated 28 September 1998;

Description: Pages 2 and 5 to 8 as originally filed, pages 1 and 4 as filed with the statement of grounds of appeal on 22 November 1996, page 3 as filed with the letter dated 28 September 1998; and

Drawings: Figures 1 to 3 as originally filed.

Reasons for the Decision

1. The appeal is admissible.

2. Novelty of the subject-matter of claim 1 is not in dispute.

3. *Inventive step*

3.1 Related Background Art

The description of the present application sets out under the heading "Related Background Art" that stepping motors are used as paper feed motors in a printer and that such stepping motors are controlled in two different modes, namely in a ramp-up mode and a self-actuating mode, in dependence on the paper feed quantity. A ramp-up mode is carried out when the paper feeding amount or rotational quantity has a high value. In accordance with explanations given by the appellant's representative a ramp-up mode comprises three phases, namely a ramp-up or acceleration phase, a high constant speed driving phase in a so-called through area and a ramp-down or deceleration phase. When the rotation quantity or the feeding amount is small, it is not possible to execute the three phases of the ramp-up mode and so a so-called self-actuating mode is carried out, in which the rotar is only accelerated. The paragraph "Related Background Art" in the application refers to Figures 2A and 2B, which

relate to general prior art, as confirmed in the letter dated 2 April 1998. Figure 2A shows a long lasting vibration period for a stop after a self-actuating mode and Figure 2B a short vibration period after a ramp-up mode (implied by the caption "stopped after a through-area"). The description explains that magnetization of the rotor windings should be maintained until the vibrations of the rotor and stator have stopped in order to avoid a premature start of the next operation command. Otherwise there would be an occurrence of out-of-synchronism. According to the paragraph "Related Background Art", hitherto a waiting time of the order of several 10 ms through several 100 ms was reserved, long enough to ensure that the vibrations of the rotor and the stator would always have stopped, in order to avoid an out-of-synchronism. This reduced the throughput unnecessarily.

3.2 Problem underlying the present invention

According to the description the present invention aims at obviating this disadvantage and at making the rotation of the motor controllable by setting a magnetization maintaining time of the motor that is matched with the behaviour characteristic of the motor.

3.3 Solution

According to claim 1 this object is achieved by determining the rotational quantity of the stepping motor in conformity with a rotation indicating command and judging whether or not rotation actuation control is performed in a ramp-up mode or self-actuating mode in accordance with the ordered rotational quantity of the motor. The magnetization maintaining time is short when the rotation actuating control is executed by a ramp-up and long when the control is executed in a self-actuating mode.

3.4 D1 relates to a method of controlling a stepping motor e.g. for rotating a print wheel. It hints at halting the stepping motor for a short time such that early start of a next start operation is possible for obtaining a high printing speed (see column 2, lines 20 to 25). For this purpose the magnetization maintaining phase has such a length that the oscillations caused by a stop operation are damped (see column 5, lines 1 to 10). Furthermore, D1 teaches choosing different magnetization maintaining times (especially the duration of t1) in dependence on rotation quantity and rotation speed so that "the oscillation becomes approximately damped", see column 5, lines 21 to 45. The fact that magnetization maintaining is implemented by a sequence of individually adapted voltage pulses is not significant because magnetization maintaining is effected by the current resulting from the smoothing effect of the inductance of the motor windings.

In D1 the underyling different rotation quantities and

rotation speeds (see column 5, lines 21 to 24) may only be explained by assuming different driving conditions due to respective driving instructions for fixed load conditions.

According to Figures 2A and 2B of the present application, which are prior art according to the application and the letter dated 2 April 1998, a stop after self-actuation causes a long period of vibrations and a stop after a through area (ramp-up control) a short period of vibrations. Hence it is clear that a stop after self-actuation requires a long magnetization maintaining time and a stop after a through area a short magnetization maintaining time. As set out in the paragraph "Related Background Art" of the present application, it is also clear that a ramp-up with its known three phases ramp-up, through area and ramp-down requires a minimum number of steps and is therefore only possible for a large rotational quantity defined by a rotation indicating command. Although D5 aims at reducing noise, this document mentions nevertheless distinguishing ramp-up modes from self-actuating modes at an early stage of process control in view of their different dynamic behaviour and to adapt the control parameters to the respective situation.

Hence, in view of the object known from D1 to start the next operation as early as possible but maintaining the magnetization phase until the oscillations are damped and the known different settling periods for a ramp-up and a self-actuation mode (see Figure 2A and 2B), a person skilled in the art will as a matter of course distinguish the different modes at an early stage in

conformity with the rotation indicating command and adapt the length of the magnetization maintaining phase to the respective necessary settling times. It is clear that the decision between the two different modes is to be made on the basis of the rotational quantity in conformity with the rotation indicating command because the choice of the mode depends on the required rotation amount.

3.5 For the above reasons, the Board finds that the subject-matter of claim 1 does not involve an inventive step as defined in Article 56 EPC. Consequently a patent cannot be granted under Article 52(1) EPC.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

M. Kiehl W. J. L. Wheeler