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D E C I S I O N
of 6 March 2001

Case Number: T 0189/98 - 3.2.5

Application Number: 90914289.5

Publication Number: 0431150

IPC: B29C 45/77

Language of the proceedings: EN

Title of invention:
Injection molding machines having a brushless DC drive system

Patentee:
Milacron Inc.

Opponent:
Arburg GmbH + Co.

Headword:
-

Relevant legal provisions:
EPC Art. 56
EPC R. 67

Keyword:
"Inventive step (yes)"
"Reimbursement of appeal fee (no)"

Decisions cited:
-

Catchword:
-

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Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 0189/98 - 3.2.5

D E C I S I O N
of the Technical Board of Appeal 3.2.5
of 6 March 2001

Appellant: (Opponent)
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Respondent: (Proprietor of the patent)
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Decision under appeal: **Decision of the Opposition Division of the European Patent Office posted 23 December 1997 rejecting the opposition filed against European patent No. 0 431 150 pursuant to Article 102(2) EPC.**

Composition of the Board:

Chairman: R. E. Michel
Members: W. R. Zellhuber
M. Tardo-Dino

Summary of Facts and Submissions

I. The appellant (opponent) lodged an appeal against the decision of the Opposition Division maintaining the patent No. 0 431 150 as granted.

In addition to documentation establishing prior use of an injection molding machine incorporating a brushed DC motor, such prior use not being contested by the respondent (patentee), the following documents were inter alia referred to:

E1: US-A-4695237

E2: "Drehstrommotoren als Servo- und Spindelantriebe", maschine + werkzeug 18/1985

E8: "Getting the most from expanding motor technology", Murphy, 1985

E9: "Motor Selection", Ford, OEM Design, June 1989

E11: "Brushless Permanent-Magnet and Reluctance Motor Drives", Miller, 1989

E12: "Designer's Update Motors & Drives", April 1990

E13: "Control Techniques worldwide", 1995

II. Oral Proceedings were held before the Board of Appeal on 6 March 2001.

(i) The appellant requested that the decision under appeal be set aside and the patent be revoked. A refund of the appeal fee was also requested.

(ii) The respondent requested as a main request that the appeal be dismissed, or, as auxiliary requests, that the decision under appeal be set aside and that the patent be maintained on the basis of sets of claims filed with a letter dated 2 February 2001.

III. The main request of the respondent includes a single independent claim, which reads as follows:

"1. An injection molding machine for producing a molded part by injecting a molten material into mold elements having a mold cavity defining the molded part, the machine comprising:

(a) clamp means (100) for supporting the mold elements;

(b) injection means (102) for injecting the molten material into the mold cavity, said injection means including a screw member (142) rotatably and translatably carried in a tubular barrel (140), said tubular barrel having an end in communication with the mold cavity;

(c) first drive means (124,126,128) mechanically coupled to the clamp means for imparting relative motion between the mold elements;

(d) second drive means (148) mechanically coupled to the injection means for rotating the screw member;

(e) third drive means (156,158,162) mechanically coupled to the injection means for translating the screw member within the tubular barrel; and

(f) machine control means (104) for controlling the drive means; characterised in that

(g) at least one of the first drive means, the second drive means and third drive means further includes:

(i) a brushless DC motor (20) producing an electromotive force having an approximately trapezoidal waveform, said motor comprising a rotor (28) having permanent magnets (30,32) and stator windings (22,24,26) surrounding said rotor, detecting means (34,36,38) for detecting angular positions of the rotor, and

(ii) motor controller means for controlling the brushless DC motor, said motor controller means connected to the brushless DC motor and responsive to a motor command signal, said motor controller means including:

(1) supplying means (50) for supplying positive and negative DC signals;

(2) switching circuit means (56) for applying the positive and negative DC signals to the stator windings, said switching circuit means connected between the stator windings and the supplying means; and

(3) control circuit means (60,62,64,66,67,68,72) connected to the switching circuit means and the detecting means for

activating the switching circuit means to selectively apply the positive and negative DC signals in a predetermined phase relationship to the stator windings to produce a commutation effect thereby creating a torque on the rotor to produce rotor rotation; and

(h) the machine control means (84,104) is connected to the motor controller means for producing the motor command signal."

IV. The appellant argued essentially as follows:

Injection molding machines having brushed DC motors, such as the machine of the appellant, were known at the priority date of the patent in suit, as were brushless DC motors. The choice of a brushless DC motor results from economic considerations. It is thus obvious to use such a motor in an injection molding machine. An invention cannot lie in the use of a brushless DC motor in an injection molding machine, but in the way the motor must be adapted for use in an injection molding machine. This is indicated in the declaration of Mr. Sparer, one of the inventors of the patent in suit, at paragraphs 8 and 9. As stated in paragraph 10 of the declaration, the breakthrough involved the use of process variable feedback. This is not specified in claim 1.

The term " brushless DC motor" as used in claim 1 could be construed so as to include a brushless AC motor.

V. The respondent argued essentially as follows:

The statements of Mr. Sparer as to where the invention lies cannot be relied on, since the approach of the practical skilled man is inevitably more concrete than that of patent law.

The closest prior art is the prior use of the machine of the appellant, which uses a brushed DC motor. The presence of brushes gives rise to disadvantages arising from brush wear, including frequent maintenance, dust and sparking.

Brushless DC motors had been available since 1985. It is not correct to say that the choice of such a motor is made merely on economic grounds, since such motors are between 50 and 100% more expensive than brushed DC motors.

The cited prior art, including documents E8, E9, E11, E12 and E13 indicates a prejudice against the use of brushless DC motors on the basis of their performance, such motors being seen as basic "workhorse" motors which are unsuitable for precision machinery. Document E9 for example suggests a preference for brushed DC motors over brushless DC motors. Not only the rotation and translation of the screw member, but also the movement of the clamp means for opening and closing the mold requires precise motion.

Reasons for the Decision

1. *Main Request*

1.1 Novelty

The novelty of the subject-matter of claim 1 was not disputed by the appellant and, in fact, the cited prior art does not disclose an injection molding machine incorporating a brushless DC motor. The subject-matter of claim 1 is thus novel. Claims 2 to 10 are directly or indirectly appendant to claim 1 and are similarly novel.

2.1 Inventive step

2.1.1 Closest prior art

The closest prior art is the prior use of the injection molding machine of the appellant, which uses a brushed DC motor.

2.1.2 Object of the invention

The presence of brushes gives rise to disadvantages arising from brush wear, including frequent maintenance, dust and sparking. The object of the invention is to avoid such disadvantages.

2.1.3 Solution

According to claim 1, the above problem is solved by the use of a brushless DC motor.

The solution according to the invention is not

suggested by the cited prior art documents.

Document E1 discloses the use of a brushless AC motor. This thus represents one alternative to the brushed DC motor which was available to the person skilled in the art at the priority date of the patent in suit which would overcome the problems associated with brushes.

Documents E2, E8, E9 and E11 can be regarded as indicating the factors which would be taken into account by the person skilled in the art seeking an electrical motor as an alternative to a brushed DC motor. It may be noted in this connection that conventional injection molding machines are driven by hydraulic systems. The person skilled in the art is thus not restricted to electric motors and the use of an electric motor is not inevitable. Whilst these references can be seen as encouraging the use of brushless AC motors, they cannot be seen as an encouragement to use brushless DC motors in an injection molding machine. Thus, for example, document E9 states at page 89 that "trapezoidal motors are difficult to produce and, in practice, frequently generate a kick at the commutation point."

Documents E12 and E13 were published after the priority date of the patent in suit.

It was suggested by the appellant that the term "brushless DC motor" as used in claim 1 could be construed as including brushless AC motors. This cannot be accepted. Claim 1 specifies that the motor produces "an electromotive force having an approximately trapezoidal waveform", that the supplying means is "for supplying positive and negative DC signals" and that

the "control circuit means connected to the switching circuit means and the detecting means for activating the switching circuit means to selectively apply the positive and negative DC signals in a predetermined phase relationship to the stator windings to produce a commutation effect thereby creating a torque on the rotor to produce rotor rotation". The claim itself thus recites the essential characteristics of a brushless DC motor and makes it clear that the claim cannot be construed so as to extend to a brushless AC motor which uses a sinusoidal drive current.

It also cannot be accepted that an inventive step could only be seen in a claim specifying that the motor controller means is responsive to a process feedback signal. It is accepted that it is desirable to minimise periodic torque variations in order to provide satisfactory results. Nevertheless, the inventive step is seen as lying in the use of a brushless DC motor in an injection molding machine. The problem of reducing torque pulsations only arises once it has been decided to use a brushless DC motor in an injection molding machine.

The subject-matter of claim 1 according to the main request thus involves an inventive step. Claims 2 to 10 are appendant to claim 1 and similarly involve an inventive step.

3. *Reimbursement of the appeal fee*

In view of the fact that the appeal is not allowable, the requirements of Rule 67 EPC are not fulfilled and the request for reimbursement of the appeal fee must accordingly be refused.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

M. Dainese P. Michel