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**Datasheet for the decision
of 28 August 2008**

Case Number: T 0002/06 - 3.5.02

Application Number: 02258909.7

Publication Number: 1322027

IPC: H02K 41/03

Language of the proceedings: EN

Title of invention:

Moving-magnet linear motor, aligner and apparatus provided therewith, and method for manufacturing devices using the same

Applicant:

CANON KABUSHIKI KAISHA

Headword:

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Relevant legal provisions:

EPC Art. 56

Relevant legal provisions (EPC 1973):

-

Keyword:

"Main, first and second auxiliary requests - inventive step (no)"

"Third auxiliary request - remittal for further prosecution (yes)"

Decisions cited:

-

Catchword:

-



Case Number: T 0002/06 - 3.5.02

D E C I S I O N
of the Technical Board of Appeal 3.5.02
of 28 August 2008

Appellant:

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Representative:

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Decision under appeal:

Decision of the Examining Division of the
European Patent Office posted 25 July 2005
refusing European application No. 02258909.7
pursuant to Article 97(1) EPC 1973.

Composition of the Board:

Chairman: M. Ruggiu
Members: J.-M. Cannard
H. Preglau

Summary of Facts and Submissions

- I. The appellant contests the decision of the examining division to refuse European patent application No. 02 258 909.7. The reason given for the refusal was, *inter alia*, that the subject-matter of claims 1 to 14 of the main request filed with letter of 29 April 2005, claims 1 to 9 of the first auxiliary request filed with letter of 6 June 2005 and claims 1 to 9 of the second auxiliary request filed with letter of 9 June 2005 did not involve an inventive step, Article 56 EPC.
- II. The following documents of the state of the art, which have been cited in the first instance proceedings:
- D3: US-A-5 744 879 and
- D5: US-B-6 274 952,
- are relevant to the present decision.
- III. Oral proceedings before the Board were held on 28 August 2008.
- IV. With the statement of grounds of appeal dated 30 November 2005, the applicant filed sets of claims according to a main request, and first and second auxiliary requests. Claim 1 of the main request reads as follows:
- "A moving-magnet linear motor having an elongated stator (100) and a mover (112) movable along the stator in a movement direction, wherein the stator comprises:

a toothed core (100) having teeth (102) extending transversely of the stator and spaced in the movement direction by a tooth pitch distance; and

a plurality of coils (103) wound round respective teeth of the core;

and the mover (112) comprises:

at least one pair of elongate magnets (111) of opposite polarity each extending transversely relative to the movement direction, the pairs of magnets being spaced in the movement direction by a magnet cycle distance;

wherein at least one of the magnets (111) and the teeth (102) of the stator are relatively skewed so that one end of said at least one magnet (111) is offset from its other end in a direction perpendicular to the longitudinal direction of the teeth by an integral multiple of the tooth pitch distance."

Claim 1 of the first auxiliary request differs from claim 1 of the main request in that the last paragraph of the claim is amended to read:

"wherein both the magnets (111) of the mover and the teeth (102) of the stator are skewed relative to the movement direction, the arrangement being that one end of said each magnet (111) is offset from its other end in a direction perpendicular to the longitudinal direction of the teeth by an integer multiple of the tooth pitch distance."

Claim 1 of the second auxiliary request reads as follows:

"A moving-magnet linear motor having an elongated stator (100) and a mover (112) movable along the stator in a movement direction, wherein the stator comprises:

a toothed core (100) having teeth (102) extending in a direction perpendicular to the movement direction and spaced in the movement direction by a tooth pitch distance; and

a plurality of coils (103) wound round respective teeth of the core;

and the mover (112) comprises:

at least one pair of elongate magnets (111) of opposite polarity each extending transversely relative to the movement direction, the pairs of magnets being spaced in the movement direction by a magnet cycle distance;

wherein said pair of permanent magnets (111) is skewed so that the two longitudinal ends of each magnet are displaced with respect to each other in the travelling direction, substantially by a positive integer multiple of the tooth pitch distance of the toothed iron-core."

V. Claim 1 of a third auxiliary request filed with a letter dated 28 July 2008 differs in substance from claim 1 of the main request in that it comprises the following features at the end of the claim:

"wherein a second stator is provided and the mover is sandwiched between the two stators, and the magnets on

the mover facing one of the stators are skewed in a direction opposite to a direction of the magnet on the mover (110) facing the lower stator (100)."

Claims 2 to 13 of the third auxiliary request are dependent on claim 1.

VI. The appellant (applicant) requests that the decision under appeal be set aside and that a patent be granted on the basis of claims 1 to 13 of the main request filed with letter dated 30 November 2005 or, if that is not possible, on the basis of claims 1 to 8 of the first auxiliary request filed with the letter dated 30 November 2005, claims 1 to 8 of the second auxiliary request filed with the letter dated 30 November 2005, or claims 1 to 13 of the third auxiliary request filed with letter dated 28 July 2008.

VII. The arguments of the appellant can be summarized as follows:

Document D5 disclosed a moving-magnet linear motor in which a moveable stage comprised magnets which were skewed in order to reduce cogging. However, the moveable stage moved along a curved path and D5 did not specify at all how the magnets were skewed relative to the motor stator, or relative to the movement direction.

Document D3 disclosed a moving-coil linear motor in which the end faces of the metal packet of the mover were bevelled by the width of the magnetic poles of the stator to reduce pole forces which adversely affected the operation of the motor. D3 explained that the magnet poles in synchronous linear motors could be bevelled

across the width of a groove of the wound primary section to reduce the groove-induced force waviness. However, D3 did not relate to a moving-magnet linear motor in which the magnets were skewed by a tooth pitch of the stator. Nor was the teaching of D3 directly applicable to a moving-magnet linear motor.

It was the merit of the present invention to have discovered that, only in case of a moving-magnet linear motor, the periods of the cogging force and the flux linkage waveforms could be designed independently of each other, and that cogging did not occur in a polar pitch cycle, but in a tooth pitch cycle. The invention was based on a technical principle different from those described in the cited prior art documents, which neither anticipated the claimed moving-magnet linear motor, nor rendered it obvious.

Reasons for the Decision

1. The appeal is admissible.

Claim 1 of the main request

2. Since the word "transversely" may describe something that is in a position at right angle to something else, claim 1 of the main request covers a moving-magnet linear motor in which core teeth extend in a direction perpendicular to the movement direction of the mover and the magnets of the mover are skewed so that one end of each magnet is offset from its other end in the movement direction by a tooth pitch distance, as exemplified for instance by the first embodiment described in the

description of the application with reference to figures 1A and 1B. Such a moving-magnet linear motor is obvious having regard to the teaching of documents D5 and D3 taken in combination.

3. D5 disclose a moving-magnet linear motor which comprises armature windings 16A, 16B, 16C and a movable stage 12 that has elongated magnets 160 tilted in a conventional fashion to reduce cogging (figures 1B and 3; column 7, lines 38 to 40). The skilled person starting from D5 would thus look for prior art documents describing more precisely a conventional fashion of reducing cogging in a linear motor.

4. The skilled person would in particular consider the teaching of document D3 which is concerned with the compensation of cogging forces in synchronous linear motors and a moving-coil linear motor. D3 explains more precisely that two kinds of parasitic forces deteriorate the position accuracy in a linear motor. Firstly, as in a rotating synchronous motor, periodic variations in force, referred to as groove-induced force waviness, are caused in linear motors by the interaction between the edges of the magnetic poles and the grooves of the wound primary section. This groove-induced force waviness, whose periodicity thus depends on that of the grooves, can be reduced according to the conventional measures by skewing the magnets in the movement direction by a groove, or tooth pitch distance (column 1, lines 13 to 29 and 63 to 65; column 2, lines 31 to 34 and 52 to 54). Following the common knowledge referred to in D3, it is immediately apparent that, in a moving-magnet linear motor, the cogging which is caused by the groove-induced force waviness depending on the interaction between the

edges of the stator teeth and the magnets would be reduced in a conventional way by skewing the magnets in the movement direction by a tooth pitch distance. Accordingly, the skilled person starting from D5 and considering the teaching of D3 would arrive in an obvious way at a moving-magnet linear motor comprising all the features of claim 1 of the main request.

5. Moreover, according to D3, the ends of the mover in a moving-coil linear motor generate parasitic end forces which have the same periodicity as the magnetic poles of the magnets and can be compensated by skewing the motor ends by the width of a magnetic pole (column 1, lines 36 to 56; column 2, lines 34 and 35). It would thus be obvious from the teaching of D3 that the end forces generated by the mover of a moving-magnet linear motor would by analogy have the same periodicity as the stator teeth. In this respect, D3 would give the skilled person an additional obvious reason for considering skewing the magnets of a moving-magnet linear motor by a tooth pitch. The main request is thus not allowable (Article 56 EPC).

First and second auxiliary requests

6. The moving-magnet linear motor specified in claim 1 of the first auxiliary request only differs from the moving-magnet linear motor defined in claim 1 of the main request (which covers a motor with stator teeth extending perpendicularly to the movement direction (see paragraph 2)) in that the teeth are skewed relative to the movement direction, so that so that one end of each magnet of the mover is offset from its other end in a direction perpendicular to the longitudinal direction of the teeth by a tooth pitch distance. Having regard to

this feature of claim 1 of the first auxiliary request, the Board notes that, according to the teaching of D3, the groove-induced force waviness can be reduced not only by skewing the magnets by a tooth pitch distance, as explained in columns 1 and 2 and shown in figure 2 of D3, but alternatively by skewing the teeth as shown in figure 3 and in column 3, lines 11 to 14, or by skewing the magnets and the teeth concurrently (see column 5, lines 14 to 16). Therefore, in view of this teaching and of the foregoing paragraphs 4 and 5, the subject-matter of claim 1 of the first auxiliary request covers an obvious possibility and thus lacks an inventive step for reasons similar to those given in respect of claim 1 of the main request. Thus, the first auxiliary request is not allowable (Article 56 EPC).

7. The moving-magnet linear motor specified in claim 1 of the second auxiliary request is identical to the moving-magnet linear motor covered by the wording of claim 1 of the main request when the teeth extend perpendicularly to the movement direction. Accordingly, in view of the foregoing paragraphs 4 and 5, the subject-matter of claim 1 of the second auxiliary request lacks an inventive step for the same reasons as those given in respect of claim 1 of the main request. Therefore, the second auxiliary request is not allowable (Article 56 EPC).

Third auxiliary request

8. Claim 1 of the third auxiliary request comprises all the features of claim 1 of the main request and in addition the feature recited in claim 7 as originally filed and the feature according to which "the magnets on the mover

facing one of the stators are skewed in a direction opposite to a direction of the magnet on the mover (110) facing the lower stator (100)", which seems to be based on figure 8 and the passage at page 21, lines 15 to 18, of the description of the application as filed. The Board notes that no examination of claim 1 of the third auxiliary request has been made by the examining division, in particular no assessment of novelty or inventive step. In such circumstances, the Board finds it appropriate to remit the case to the department of first instance for further prosecution.

9. In order to avoid a possible misunderstanding, the Board wishes to make clear that it has not examined whether the amendments made to the claims in accordance with the third auxiliary request are in agreement with the EPC, in particular with Article 123(2) and Rule 137(4) EPC.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.
2. The case is remitted to the first instance for further prosecution.

The registrar:

The Chairman:

U. Bultmann

M. Ruggiu