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**D E C I S I O N**  
**of 30 March 2000**

**Case Number:** T 0912/95 - 3.4.3

**Application Number:** 88108499.0

**Publication Number:** 0292989

**IPC:** H01L 41/08

**Language of the proceedings:** EN

**Title of invention:**

Apparatus and method for effecting fine movement by impact force produced by piezoelectric or electrostrictive element

**Patentee:**

RESEARCH DEVELOPMENT CORPORATION OF JAPAN

**Opponent:**

GUIOT, Jean Paul

**Headword:**

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**Relevant legal provisions:**

EPC Art. 54, 56

**Keyword:**

"Novelty (no) clear and self-consistent teaching of an embodiment in the prior art"

**Decisions cited:**

T 0056/87

**Catchword:**

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Case Number: T 0912/95 - 3.4.3

**D E C I S I O N**  
**of the Technical Board of Appeal 3.4.3**  
**of 30 March 2000**

**Appellant:** RESEARCH DEVELOPMENT CORPORATION OF JAPAN  
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**Decision under appeal:** Decision of the Opposition Division of the  
European Patent Office posted 1 September 1995  
revoking European patent No. 0 292 989 pursuant  
to Article 102(1) EPC.

**Composition of the Board:**

**Chairman:** R. K. Shukla  
**Members:** G. L. Eliasson  
P. H. Mühlens

## Summary of Facts and Submissions

I. This appeal lies from the decision of the opposition division dated 1 September 1995 revoking the European patent No. 0 292 989.

The independent claims 1, 9, and 10 of the patent as granted read as follows:

"1. Apparatus for effecting a fine movement comprising

- a moving member (12, 32, 42, 46, 50, 51, 60, 65, 70, 74, 80, 90) and
- an impact force generating means having an inertia member (13, 33, 43, 47, 76, 82, 85, 87) and an inertia member driving means,

characterized in

that the inertia member driving means comprises

- a piezoelectric/electrostrictive element (11, 18, 31, 41, 45, 75, 81, 84, 86) one end of which is attached to the moving member and the other end of which is attached to the inertia member, and
- means (16, 17) for driving the piezoelectric/electrostrictive element."

"9. Method of effecting a fine movement of a moving member by an impact force provided by driving an inertia member, characterized by

- coupling a piezoelectric/electrostrictive

element between the moving member and the inertia member,

- quickly starting an extension or contraction of the piezoelectric/electrostrictive element by charging or discharging an electrical field applied thereto, and
- gently resetting it to its original length."

"10. Method of effecting a fine movement of a moving member by an impact force provided by driving an inertia member, characterized by

- coupling a piezoelectric/electrostrictive element between the moving member and the inertia member,
- continuously deforming the piezoelectric/electrostrictive element by charging or discharging an electrical field applied thereto, and
- abruptly stopping the deformation thereof."

II. An opposition was filed by the respondent (opponent) on the grounds of lack of novelty and lack of inventive step (Article 100(a) EPC) based on the prior art documents:

D1: US-A-3 957 162; and

D2: US-A-4 195 243.

III. The opposition division revoked the patent on the ground that the subject matter of claims 1, 5, and 6 lacked novelty with respect to document D1. The decision relied on the embodiment of Figure 6 in document D1 together with the information in the document that the resilient element shown in Figure 6 between the moving member and the piezoelectric element could be omitted. In this case, the piezoelectric element of the device of document D1 would be attached to the moving member, as is the case in claim 1 of the patent in suit.

IV. An appeal was filed on 6 November 1995 by the patent proprietor, paying the appeal fee the same day. A statement of grounds was filed on 8 January 1996 along with a new set of claims forming an auxiliary request.

V. During the oral proceedings held on 30 March 2000, the parties made the following requests:

The appellant requested that the decision under appeal be set aside and, as a main request, that the patent be maintained as granted, or, as an auxiliary request, the patent be maintained based on the claims 1 to 10 filed with the statement of grounds of the appeal.

Furthermore, the appellant requested the reimbursement of the appeals fee.

The respondent requested the revocation of the patent in its entirety.

VI. Claim 1 according to the auxiliary request differs from that of the main request in that the last line of claim 1 of the main request "means (16, 17) for driving

the piezoelectric/electrostrictive element." is replaced by:

"means (16, 17) for driving the piezoelectric/electrostrictive element by applying acceleration waveforms so as to quickly start an extension or contraction of the piezoelectric/electrostrictive element by charging or discharging an electrical field applied thereto and gently reset it to its original length, or

continuously deform the piezoelectric/electrostrictive element by charging or discharging an electrical field applied thereto and abruptly stop the deformation thereof."

Independent claims 9 and 10 of the auxiliary request are identical to those of the main request.

VII. The appellant made essentially the following arguments in support of his requests:

- (a) The decision under appeal relied on the statement in column 4, lines 46 to 47 of document D1 which suggests that the resilient element 53 can be omitted and the first block 48 can be directly attached to the moving member 2. On the other hand, it is stated on column 4, lines 39 to 45 that when the piezoelectric element undergoes a shape change in response to an applied voltage pulse, the first block 48 will be given a mechanical impulse which in turn is transferred to the moving member 2. From the definition of "mechanical impulse" given in column 2, lines 65 to 68 in connection with the embodiment of

Figure 1, as well as in claims 1, 11, 12 and 23 of document D1, this means that the transfer of mechanical impulse from the first block 48 to the moving member 2 takes place when the first block 48 hits the moving member with an impact in order to bring the latter in motion. If however the first block is firmly attached to the moving member, the device cannot function in the manner explained in the above-mentioned passages of document D1. Thus, following the decision T 56/87 (OJ EPO 1990, 188), the feature of column 4, lines 46 to 47 cannot be considered as forming part of the teaching of document D1, since it is in contradiction with the rest of the technical teaching of document D1.

- (b) Regardless of whether the resilient element 53 is present or not, the device according to Figure 6 of document D1 cannot work, since the piezoelectric element and the first and second blocks are kept together by a bolt 51 with nut 52. The overall length of the assembly of the two blocks and the piezoelectric element does not change when the piezoelectric element receives a voltage pulse, although an internal pressure between the outer ends of the two blocks builds up as the nut and bolt prevent any expansion of the assembly when the piezoelectric element receives a voltage pulse. As a result, no net movement of the assembly held together by the bolt with nut will take place, and therefore no transfer of mechanical impulse to the moving member can occur. In other words, the skilled person would realize that the device of Figure 6 cannot work and would for this reason alone disregard the teaching given

in document D1 regarding Figure 6.

- (c) Even if one would assume, as the respondent does, that the bolt has some elasticity, a piezoelectric element of the kind disclosed in document D1 would only be able to cause a negligible deformation of the bolt, due to the orders of magnitude difference between the mechanical strain required to cause the necessary deformation of the bolt and the upper limits of mechanical strain that could be produced by a piezoelectric element. Thus, the minute deformation of the bolt would not allow for a transfer of mechanical impulse large enough to overcome the static friction between the moving member and the sliding surface. Furthermore, it is unclear what purpose the bolt and nut have in the embodiment of Figure 6.
  
- (d) Moreover, the frequencies at which the piezoelectric element of the device of document D1 is supposed to work (10 - 50 kHz) are three orders of magnitude larger than the frequency 25 Hz recommended for the embodiment of Figure 1 (cf. column 3, line 49 and column 4, lines 56 to 57). Thus, in the light of the apparent discrepancies between the embodiments of Figures 1 and 6, the skilled person reading the quoted frequency values for the embodiment of Figure 6 would not take these values seriously. For these reasons alone, the skilled person would arrive at the conclusion that the device of Figure 6 could not work.
  
- (e) In order that a device of the type presented in the patent in suit works, there has to be an asymmetry of forces, so that the movement of the



moving member during the first part of the cycle is not cancelled out by a reverse movement when the inertia member is returned to its initial position. Although document D1 discusses asymmetry of forces, this is only in connection with the embodiments of Figures 1 to 5 which function entirely differently from the embodiment of Figure 6. For the latter, it is merely stated that "a voltage pulse" is given to the piezoelectric element (cf. D1, column 4, lines 39 to 45). Thus, there is no teaching whatsoever in document D1 as to which properties such voltage pulses should have in order to produce the desired motion of the moving member.

Although document D2 gives detailed information about how to produce voltage pulses for a piezoelectric transducer, this document is not relevant, since the piezoelectric element is not attached to the moving member but to a base plate which remains at rest. Thus, documents D1 and D2 relate to completely different devices and the skilled person faced with the problem of finding a suitable voltage pulse for the device of document D1 would therefore not consider document D2.

- (f) The decision under appeal only considered claims 1, 5, 6 for their patentability and did not consider the independent method claims 9 and 10 at all. Thus, the decision is incomplete and therefore the reimbursement of the appeal fee is justified.

VIII. The respondent argued essentially as follows:

- (a) The embodiment of Figure 6 of document D1 is not in contradiction to the rest of the document as alleged by the appellant: In the embodiments of Figures 1 to 5, the transfer of mechanical impulse to the moving member is taking place through impact, whereas for the device of Figure 6 when the resilient member 53 is omitted, the transfer of impulse takes place through direct contact.
  
- (b) The function of the nut and bolt in the device of Figure 6 in document D1 is firstly to keep the piezoelectric element and the two adjacent blocks together, as stated in document D1. Secondly, this assembly allows for the possibility to give the piezoelectric element a pressure bias. This is known in the art to be necessary in order to prevent the piezoelectric element from cracking prematurely, and thereby to enhance the lifetime and the reliability of the device.
  
- (c) Contrary to the arguments of the appellant, a bolt with nut has the elastic properties to allow very small elongations resulting from the periodical elongations of the piezoelectric element. Regarding the frequencies stated in document D1 for the embodiment of Figure 6, it is known in the art that the range of frequencies depends on the masses involved. Thus, the skilled person would not see any contradiction between the stated frequencies for the embodiments of Figures 1 and 6.
  
- (d) In the technical field of the patent in suit and the document D1, the asymmetry of forces is fundamental. The basic principles are described in

column 3, lines 30 to 35 of document D1. For the device of Figure 6, the asymmetry comes from the shape of the electric pulses given to the piezoelectric element. An explicit example of how the electric pulses can be arranged is shown in document D2. This document deals with a device which merely represents the kinematic reversal of that of document D1. Thus, the teaching of document D2 could be directly transferred to the device of document D1.

## **Reasons for the Decision**

1. The appeal meets the requirements of Articles 106 to 108 and Rule 64 EPC, and is therefore admissible.
2. *Main request*
  - 2.1 Novelty
    - 2.1.1 Document D1 discloses a device for displacing a moving member in a given direction to a good accuracy. In the embodiment of Figure 6, a piezoelectric element 49 has one end attached to a first block 48 and the other end attached to a second block 50. The first block 48, the piezoelectric element 49, and the second block 50 are kept together by bolt 51 and nut 52 (cf. D1, column 2, lines 49 to 55). For driving the piezoelectric element 49, a voltage source is connected thereto (cf. D1, column 2, lines 54 to 55; column 4, lines 52 to 56).

In Figure 6, the first block 48 is joined to the moving member 2 by a plate spring 53, but it is pointed out that the first block 48 can also be directly attached

to the moving member (cf. D1, column 4, lines 45 to 47). In this case, the moving member 2 and the first block 48 form a single piece, and the second block 50 acts as an inertial member. Thus, all the features of claim 1 according to the main request are known from document D1.

2.2 The Board finds that the appellant's arguments VII-(a) to (d) referred to above in respect of the embodiment of Figure 6 in document D1 are not convincing for the following reasons:

2.2.1 The appellant argued that the embodiment of Figure 6 was in contradiction to the other embodiments of document D1 (cf. point VII-(a) above). The Board finds that the device of Figure 6 functions differently from the other embodiments when the option of omitting the resilient element is chosen, but it does not mean that the teaching of the device of Figure 6 is unclear in itself. As the respondent pointed out, the transfer of mechanical impulse to the moving member takes place in the embodiment of Figure 6 without the resilient element, but only in a different manner from that of the other embodiments. In so far as the embodiment of Figure 6 is concerned, in the Board's opinion, it is self-consistent and clear.

Although the Board agrees in principle with the position held in T 56/87 cited by the appellant, that decision dealt with a situation where a feature was derived from a schematic Figure and this feature was in contradiction to the teaching given in the written description. Thus, the situation treated therein is different from that in the present case, where the entire teaching is taken from the description of a

single embodiment, which in itself does not appear to contain any contradictions.

2.2.2 The Board furthermore agrees with the respondent that the function of the bolt and nut is firstly to hold the assembly of first and second blocks and the piezoelectric element together, and secondly, to give a pressure bias to the piezoelectric element. The first function is explicitly disclosed in column 2, lines 49 to 52 of document D1. The second function, which has not been disputed by the appellant, appears plausible since piezoelectric ceramics are known to be fragile against tensile stress whilst being resistive to compressive stress.

2.2.3 As to the degree of elasticity required for the bolt, in the Board's opinion the function of the embodiment of Figure 6 is relatively independent of the elastic properties of the bolt for the following reasons:

In the device of Figure 6 with one end face of the first block 48 directly attached to the moving member 2, it is clear from the Figure that the bolt is provided in a recess in the end face. When the piezoelectric element receives a voltage pulse rising sharply, it will suddenly tend to expand and thereby provide mechanical impulse at the interfaces with the first and second blocks, which will be transmitted through the same. The mechanical impulse through the first block 48 will then be transmitted through the peripheral portion of the end face of the first block to the moving member in direct contact with the peripheral portion.

2.3 For the foregoing reasons, in the Board's judgement,

the subject matter of claim 1 according to the main request is not new with respect to document D1 (Article 54 EPC).

3. *Auxiliary request*

3.1 *Amendments*

Claim 1 of the auxiliary request contains the features of claims 1, 9, and 10 of the patent as granted, which correspond to the features of claims 1, 2, 10, and 11 of the application as filed. Thus, the Board finds that the requirements of Article 123(2) and (3) EPC are met.

3.2 *Novelty and inventive step*

3.2.1 The device of claim 1 according to the auxiliary request differs from that of document D1 in that the means for driving the piezoelectric element is specified either to start quickly an extension or contraction of the piezoelectric element followed by gently resetting it to its original length, or to deform continuously the piezoelectric element and abruptly stop the deformation. In document D1, it is merely disclosed that the piezoelectric element is connected to a voltage source which is capable of applying voltage pulses to the piezoelectric element (cf. D1, column 2, lines 54 to 55; column 4, lines 39 to 45 and 52 to 56). The information given in document D1 as to how the devices disclosed therein are to be operated is only with respect to the embodiments of Figures 1 to 5.

Thus, the subject matter of claim 1 according to the auxiliary request is new (Article 54 EPC).

3.2.2 The technical problem derivable from the above difference with respect to document D1 thus relates to producing suitable voltage pulses which will effect the desired movement of the moving member.

3.2.3 As agreed by both parties, this problem is intimately connected with the construction of the device in Figure 6 itself, and document D1 contains a detailed information how the devices embodied in Figures 1 to 5 are to be operated in order to effect the desired movement (cf. D1, column 3, lines 7 to 35). Although the embodiments of Figures 1 to 5 differ from that of Figure 6 in respect to the manner how the mechanical impulse is transferred to the moving member, the Board finds that the principle of operating the devices for all the embodiments is common and is disclosed in document D1: At the stage where the inertial member is given a mechanical impulse though a voltage signal, the mechanical impulse transferred to the moving member has to be large enough to overcome the static friction between the moving member and the sliding surface so that the moving member is brought in motion. When the inertial member is reset to its original position or dimension, any transfer of mechanical momentum should be smaller than the static friction so that the moving member remains at rest. Both parties to the proceedings agreed that this principle of "asymmetry of forces" is fundamental for the operation of the devices of the patent in suit and document D1. The Board furthermore agrees with the argument made by the respondent that the skilled person faced with the above-mentioned problem would realize that the teaching in document D1 relating to Figure 1 also applies to the embodiment of Figure 6.

3.2.4 Document D2 relates to a device for moving a wafer using a piezoelectric element (cf. D2, abstract). A piezoelectric element (transducer) 17 has one end mounted on a base plate 16 and the other end is attached to a wafer support 24 which can freely move along the base plate. A wafer 15 is put on the wafer support and is frictionally coupled to the latter. A net movement of the wafer with respect to the wafer support is effected by applying voltage pulses to the piezoelectric element in such a manner that an asymmetrical acceleration of the piezoelectric element is achieved, i.e., the same principle of asymmetry of forces as described in document D1 (cf. D2, column 5, lines 10 to 21). It is furthermore described in great detail using Figures 5a to 5e and 6a to 6f how such asymmetry of forces can be implemented in practice using a full-wave rectifier (cf. D2, column 5, line 21 to column 7, line 56). Thus, in agreement with the respondent's view, the Board finds that whereas in the device of document D1 the piezoelectric element with inertial member is attached to the moving member itself, these components are in the device of D2 attached to the base plate which stays at rest. As the device of document D2 operates according to the same principles of asymmetry of forces as the device of document D1, the Board finds that the teaching given in document D2 as to how to produce suitable voltage pulses for obtaining the asymmetry of forces can also be directly applied to the device of document D1 without major modifications. These similarities in structure and mode of operation shared by the devices of documents D1 and D2 would therefore encourage the skilled person faced with the above-mentioned technical problem to consider the teaching of document D2 on this issue, and arrive at the claimed subject matter in an



obvious manner.

- 3.2.5 For the above reasons, the Board finds that the subject matter of claim 1 according the auxiliary request does not involve an inventive step as required in Articles 52(1) and 56 EPC.
4. Consequently, the European patent cannot be maintained in any of the forms requested by the appellant (Article 102(1) EPC).
5. The appellant had requested a refund of the appeals fee on the ground that the decision under appeal was incomplete. The appeal fee can only be reimbursed when the appeal is allowable, and the reimbursement is equitable by reasons of a substantial procedural violation (Rule 67 EPC). In the present case, none of the two criteria are met. In particular, when deciding to revoke a European patent, it is sufficient for the opposition division under Article 102(1) EPC to state only one ground which in their opinion prejudice the maintenance of the European patent, since the EPC does not contain any provision which would allow a European patent to be partially maintained. The decision under appeal was based on the ground that the subject matter of claims 1, 5, 6 lacked novelty which was discussed in the opposition proceedings and in the decision under appeal, so that the appellant's right to be heard before the issue of an adverse decision, according to Article 113(1) EPC, was not contravened. The appellant's request for the refund of the appeal fee is therefore not well founded and is accordingly rejected.

**Order**

**For these reasons it is decided that:**

The appeal is dismissed.

The Registrar:

The Chairman:

D. Spigarelli

R. K. Shukla