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# D E C I S I O N
## of 14 January 1997

**Case Number:** T 0825/93 - 3.4.1

**Application Number:** 89120821.7

**Publication Number:** 0369331

**IPC:** G01P 3/36

**Language of the proceedings:** EN

**Title of invention:**
Speed detector for a vibration wave driven motor

**Applicant:**
CANON KABUSHIKI KAISHA

**Opponent:**
-

**Headword:**
-

**Relevant legal provisions:**
EPC Art. 56

**Keyword:**
"Inventive step (no)"
"Late filed submissions"

**Decisions cited:**
T 0015/81, T 0032/81, T 0153/85, T 0164/92

**Catchword:**
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**Case Number:** T 0825/93 - 3.4.1

# D E C I S I O N
## of the Technical Board of Appeal 3.4.1
## of 14 January 1997

**Appellant:** CANNON KABUSHIKI KAISHA
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**Decision under appeal:** **Decision of the Examining Division of the European Patent Office posted 17 June 1993 refusing European patent application No. 89 120 821.7 pursuant to Article 97(1) EPC.**

**Composition of the Board:**

**Chairman:** G. D. Paterson
**Members:** Y. J. F. van Henden
U. G. O. Himmler

## Summary of Facts and Submissions

I. European patent application No. 89 120 821.7 (publication No. 0 369 331) was refused by a decision of the Examining Division.

II. The Examining Division cited the documents

D1: US-A-4 510 411
D2: US-A-4 525 068
D3: US-A-3 419 330 and
D4: Patent Abstracts of Japan, volume 10, No. 250 (P-491)[2306], 28 August 1986 & JP-A-61-77764

against that patent application and grounded its decision substantially as follow:

Document (D1) discloses a vibration wave motor according to the pre-characterising part of Claim 1, as well as a way of controlling the rotational speed of such a motor. The claimed subject-matter thus differs from that illustration of prior art in the provision of optical means for controlling said speed.

Trying to obviate the disadvantages of electrical sensors or merely to improve the accuracy of a speed measurement is the normal task of the competent person and, therefore, may not be regarded as inventive. To solve this problem, said person would consider the devices described in documents (D2) to (D4). Contrary to the applicant's submissions, these documents do indeed disclose systems for measuring the velocity of rotating elements. Stress being laid there on the advantages of optical systems, the skilled person would envisage to replace the means mentioned in document (D1) by such an optical system for measuring the rotational speed of the motor, for instance that

described in document (D2) in relation to Figures 2 and 3. For this purpose, he would have to provide a grating on the movable part of the motor, a laser, light sensing means and an optical system comprising beam splitters and lenses or mirrors, such that the beams impinging on the grating be symmetrical with respect to a normal to said grating. The use of mirrors is indeed a known alternative to that of lenses. Furthermore, the idea of providing the grating on a top surface of a moving disk-like element is not new, as can be seen from document (D4) and, anyway, the skilled person would arrange the components of his device in accordance with the practical requirements.

The applicant objected that, according to document (D2), the diffracted beams would not be emitted perpendicularly from the grating. Nevertheless, the only teaching that can be drawn from document (D2) is that high diffraction orders could be of interest, but not that they must be different. As no particular teaching is given in this respect, choosing the symmetrical arrangement, which is also disclosed in documents (D3) and (D4), would be the most evident solution to the skilled person.

The applicant also argued that, since a plurality of different methods for measuring velocities are known, choosing one of them would involve an inventive step. Document (D2), however, gives the skilled person a clear hint that, if problems are related to the environment of the sensor, using an optical sensor of the kind described there can be appropriate. Furthermore, the measurement of a torque is only one particular application of the system known from document (D2).

In a communication issued on 3 September 1991, the Examining Division furthermore explained that, from documents (D2) and (D3), it was also known to provide two light sensitive elements, beam splitters for dividing light beams and mirrors for directing light beams towards selected points.

III. The applicant lodged an appeal against the decision of the Examining Division.

IV. With its statement of grounds of appeal, the appellant filed a new set of six claims to replace those underlying the impugned decision. Claim 1 of that set reads:

"A vibration wave driven motor including vibration means (2) to which a signal is applied to produce a travelling vibration wave which causes a relative movement between said vibration means (2) and a contact member (6) being in frictional contact with said vibration means (2), characterized by
a diffraction grating (7) provided on a top surface of said contact member (6) along a moving direction of said contact member (6),
a coherent light source (8) emitting a laser beam,
light sensitive means (12) for generating a signal, which is used as an input for adjusting a rotational condition of said motor, and
an optical system (9, 10, 11; 13, 14, 15, 16) for generating at least two light beams from said laser beam of said coherent light source (8) which are directed to said diffraction grating (7) and diffracted at said diffraction grating (7) and for generating and interfering light to be detected by said light sensitive means (12) from the two diffracted light beams, wherein

optical paths in the vicinity of said diffraction grating (7), along which said two light beams to be diffracted pass, are symmetrical to each other relative to a normal line of a surface on which said diffraction grating (7) is provided and wherein said coherent light source (8), said light sensitive means (12) and said optical system (9, 10, 11; 13, 14, 15, 16) are arranged opposite to said vibration means (2) relative to said contact member(6)."

The remaining claims 2 to 6 of the set are dependent claims.

V. The Board summoned the appellant to oral proceedings which were held on 14 January 1997.

VI. During the oral proceedings, the appellant filed three further sets of claims forming the respective bases of a first, a second and a third auxiliary request.

Disregarding minor changes in the formulation which do not affect the substance, claim 1 according to any of the appellant's auxiliary requests differs from claim 1 as filed with the statement of grounds of appeal in that the mention of light sensitive means (12) is replaced by that of two light sensitive elements ($12_1$, $12_2$), and in that the optical system for generating and interfering light comprises a first beam splitter (13) for dividing the beam emitted by the light source (8), a mirror member (11) arranged so as to direct each of the divided light beams from said first splitter on the same point on the diffraction grating (7), and a second beam splitter (15) for splitting the two diffracted and interfered beams toward each light sensitive element ($12_1$, $12_2$).

Claim 1 according to the second or third auxiliary request furthermore states that a quarter wavelength plate (14) is arranged in the optical path before the second beam splitter (15) for rectilinearly polarizing the two diffracted and interfered light beams. Finally, claim 1 according to the third auxiliary request still narrows the scope of protection by stating that two polarizing plates ($16_1$, $16_2$) are arranged in the optical path behind the exit of the second beam splitter (15), the polarization azimuths thereof being mutually deviated by a predetermined angle in order to enable the discrimination of the rotating direction of the contact member (6).

To these alternative versions of claim 1 are respectively appended four, three and two dependent claims.

VII. The appellant requested that the decision under appeal be set aside and that a patent be granted on the basis of the main request filed with the statement of grounds of appeal or, in order of preference, on the basis of the first, second or third auxiliary request as filed during the oral proceedings.

VIII. In support of its request, the appellant argued in substance as follows:

According to document (D1), the relative rotation between the vibration member and the contact member of a motor driven by a vibration wave is derived from the measure of an AC voltage at a terminal of said motor. However, this method is not suitable if the load varies.

According to the invention, the diffraction grating of an optical encoder is formed on the surface of the rotating contact member turned away from the vibrating

member and, likewise, the coherent light source, the light sensitive means and the optical system are arranged on that side of the contact member. External vibration influence is prevented owing to the symmetrical incidence of the laser beam with respect to a normal to the surface of the grating, and owing to the fact that the latter does not undergo the direct action of the vibrating means. The rotational speed can thus be measured with high accuracy.

The claimed subject-matter is novel, since document (D1) does not disclose any optical measuring means and, for the same reason, it is also inventive. Besides, the problem underlying the invention was in itself no indication of the technical field in which its solution could be found. The skilled person seeking how to solve it would not have come across references (D2) to (D4) for they belong to completely different technical fields. Moreover, optical encoders are very sensitive to vibrations and there are numerous possibilities of detecting rotational speeds. Documents (D2) discloses an arrangement for measuring a torque and in which a grating is disposed on the cylindrical surface of a shaft. Said document thus does not teach the skilled person to arrange a diffraction grating on the contact member of a vibration driven motor rather than on the vibrating means of said motor, and on the plane surface of said contact member rather than on its side surface, nor to arrange all further optical means on the side of the contact member remote from the vibrating means. As a matter of fact, the solution known from document (D2) would lead to an increase in external diameter of the motor. Furthermore, combining the teachings of documents (D1) and (D2) is only possible on the basis of considerations ex post facto. Document (D3) does not give any suggestion going beyond the teachings of document (D2). Document (D4) shows an optical encoder

where the diffraction grating is arranged on an end surface of a rotating body, but does not reveal where the co-operating optical means shall be located. Finally, none of the documents (D2) to (D4) teaches to use the signal outputted by an optical encoder for feedback purpose.

X. At the conclusion of the oral proceedings, it was announced that the appeal is dismissed.

## Reasons for the Decision

1. The insertion of reference numeral (2) in the pre-characterising part of claim 1 according to any of the appellant's request could give the impression that, in a vibration wave driven motor embodying the invention, the electrostrictive element (2) would be in direct contact with the rotor (6). The description of the patent application, however, refers exclusively to embodiments in which a vibrating member (1) made of an elastic material is interposed between said electrostrictive element (2) and rotor (6) - see: Figures; column 1, lines 20 to 22; column 4, lines 45 to 56. Bearing in mind that, pursuant to Rule 29(7) EPC, reference signs shall not be construed as limiting claims, the Board consequently takes the view that said vibrating member (1) also forms part of the vibration means. This, however, entails that the vibration wave driven motor covered by the first claim of US patent specification (D1) exhibits, in combination, all the features recited in the pre-characterising part of claim 1 according to any of the appellant's requests.

The appellant never contested these findings, so that the only matter at issue was that of inventive step.

2. *Main request*

2.1 The vibration means of the motor described in document (D1) comprises a ring shaped piezoelectric member (3), an electrode (4) coated on a plane surface of said member (3) and a group (5) of segment electrodes (501-516) coated on an opposite plane surface of the piezoelectric member (3) - see Figure 3B and column 2, lines 54 to 63. A driving alternating voltage is applied to the segment electrodes (503-516) - see the column 3, lines 17 to 27, and disregard the improper use of the word "current" in document (D1). The segment electrode (502) is connected to a terminal (S) and outputs a signal used for maintaining the frequency of the input power source "at an optimum value conforming to the extraneous conditions" - see: Figures 3A and 4; column 3, lines 35 to 41; from the line 62 of column 3 to the line 10 of column 4. Therefore, it may not be denied that the signal received from the segment electrode (502) is representative of the rotational speed of the motor, nor that this signal is used for speed regulation purposes.

As appears from the statement of grounds of appeal - see page 3, second and third paragraphs of point 2 -, this conclusion is in agreement with the appellant's own findings.

2.2 A skilled person starting from the teachings of document (D1) does not need any incentive to seek how to improve the regulation of rotational speed in the case of a surface wave driven motor. The jurisprudence of the Technical Boards of Appeal states indeed that achieving improvements is a constant preoccupation in technical circles - see the decision T 15/81 (OJ EPO 1982, page 2), point 3 of the Reasons. Said person furthermore knows that, for achieving an accurate

regulation of any speed whatsoever, a crucial requirement is that the signals to be compared in the regulation loop be as accurately as possible representative of the desired and actual values of that speed, respectively.

Therefore, contrary to what the appellant submitted, the skilled person will not exclude from his considerations any kind of speed sensors, in particular optical ones, on the mere ground that the documentation he has at his disposal does not lay stress on their suitability for achieving an accurate speed regulation.

2.3 The intensity of the current supplied by the energizing source to a surface wave driven motor is determined by the voltage of said source and the capacitive coupling between the electrodes coated on both sides of the piezoelectric member of said motor. This capacitive coupling being at most in the range of a few tens of pF, however, said intensity is very small and, consequently, so is also the torque of the motor. As a matter of fact, the Appellant did not contest that during the oral proceedings of 14 January 1997

Therefore, a skilled person starting from the teachings of document (D1) readily understands that, in order to improve speed regulation when operating a surface wave driven motor, any transfer of energy from the rotating member of the motor to the speed sensing means or conversely shall be reduced to a minimum.

2.4 In the present case, the skilled person is an electrical engineer, i.e. a person having received his education at a technical university. He consequently knows that energy transfers between light beams having a moderate intensity or a small cross-section and

macroscopic material bodies are anyway limited, and that they even may be neglected when the beams are so directed that the light pressure exerted on the surface of such bodies is counterbalanced by some appropriate mechanical linkage means, e.g. a bearing or a thrust-block.

Therefore, despite the availability of numerous possibilities of detecting rotational speeds which the appellant pointed out, the skilled person attempting to improve the regulation of the rotational speed in the case of a surface wave driven motor would seek for a solution to his problem in the field of optical sensors. Thereby, contrary to the appellant's submission, he would inevitably come across references (D2) to (D4) and learn from these documents as well particular embodiments of such sensors as general teachings relating to their advantages and operating conditions.

2.5 Document (D2) admittedly relates to the measurement of a torque applied to a rotating shaft. Nevertheless, the determination of the torque is achieved by comparing surface velocities measured at two axially spaced sections of the shaft. Furthermore, document (D2) teaches that non-contacting velocity sensors are desirable in industrial applications where (inter alia) vibration makes the use of contact sensors undesirable - see column 1, up to line 17, and would note that "non-conducting" is obviously in error in that passage.

In the wording of claim 1 according to the appellant's main request, the apparatus described in relation with Figure 3 of document (D2) comprises:

- a diffraction grating (38) provided on the surface of the shaft along the moving direction of said shaft (i.e. surface) - see column 5, lines 6 and 7;

- a coherent light source (42) emitting a laser beam (43) - see column 5, lines 16 to 18;

- light sensitive means (70) for generating a signal - see column 5, lines 35 to 45;

- an optical system (46, 47, 52) for generating two light beams (48', 50') from said laser beam (43) of said coherent light source (42), which are directed to said diffraction grating (38) and diffracted at said diffraction grating - see: column 5, lines 21 to 26 and 53 to 58 -, and for generating and interfering light to be detected by said light sensitive means (70) from the two diffracted light beams (48', 50') - see column 5, lines 35 to 37.

Finally, as appears from Figure 2 and the related part of the description in document (D2), it is also a feature of the invention disclosed there that the two light beams to be diffracted be symmetrical with respect to the surface of the shaft at the point where said beams impinge - see column 3, lines 15 to 17, and column 4, lines 41 to 66.

2.6 The Examining Division did not accept the appellant's submission that, while envisaging to apply the method taught by document (D2) for measuring the circumferential speed of the ring shaped rotor of a surface wave driven motor, the skilled person would provide the diffraction grating on the outer

cylindrical surface of said rotor, whereby the dimension of the motor in a direction normal to the axis of rotation would be unacceptably increased. Concerning that point, the Board does not perceive any reason to deviate from the judgement of the Examining Division.

The jurisprudence of the Technical Boards of Appeal states that there may be instances where it is more appropriate to think of an expert in terms of a group of persons rather than a single person - cf. decision T 164/92 (OJ EPO 1995, page 305), point 8.1 of the Reasons. This applies to the present case, for the field of surface wave driven motors is unconnected to that of optical tachometers and, just as the latter, belongs to an advanced technology - see also the decision T 32/81 (OJ EPO 1982, page 225), Abstract and point 4.2. of the Reasons stating that, if the problem prompts the person skilled in the art to seek its solution in another technical field, the specialist in that field is the person qualified to solve the problem. In the present case, the latter person is not the designer of surface wave driven motors but the specialist of optical tachometers.

If envisaging to use an optical tachometer of the kind disclosed in document (D2) for measuring the rotational speed of any motor whatsoever, the designer readily perceives that, if the arrangement of the elements forming the tachometer remains the same as described in that document, the transversal dimension of the motor will be considerably increased. To any person educated in the field of optics, however, it is clear that, in order to derive from such tachometer an output signal as strong as possible, the main conditions to be met

are only that the grating lines be oriented in a direction perpendicular to that of the movement, and that the incident light beams lie in the plane which, at the point were they impinge, is normal to said grating lines.

Therefore, the increase in transversal dimension of a surface wave driven motor that would be achieved when providing the latter with the same speed measuring arrangement as known from document (D2) was, contrary to the appellant's submission, not liable to deter a person having competence in optics to further investigate the possibility of measuring the speed of such a motor by means of a similar system comprising a diffraction grating fastened to the rotor. As a matter of fact, above objection of the appellant appears the less convincing in the light of the teachings gained from document (D4).

2.7 During the oral proceedings of 17 January 1997, the appellant also submitted that speed measurement systems comprising a diffraction grating would be very sensitive to vibrations, this being a further reason for the skilled person not to use them for measuring the speed of a surface wave driven motor. Nevertheless, document (D2) implicitly teaches that such systems are suitable for industrial applications where, inter alia, vibrations make the use of contact sensors undesirable - see column 1, lines 15 to 17. Furthermore, as can be inferred from Figure 1 of document (D1), the vibrations to which the rotor of a surface wave driven motor is subjected in its operative condition are substantially axial, as they are induced by the approximately trochoidal movement of the points forming the contacting surface of the vibrating member. If a diffraction grating is provided on a surface of said rotor normal to the axis of rotation, therefore, these vibrations do not affect the difference in optical path

of the rays received by the light sensitive means and consequently have no effect upon the accuracy of the measure. As a matter of fact, to the person skilled in optics and attempting to solve the problem set to the invention, this is a further strong incentive to take into consideration the teachings of document (D4).

2.8 Document (D4) shows a tachometer comprising a diffraction grating provided on a plane surface of a disk shaped member. To the skilled person, it is immediately clear that, in the case of a surface wave driven motor, this disposition of the grating would not result in an unacceptable increase of the transversal dimensions.

It could be objected that, according to the teachings of document (D4), only one laser beam is directed towards the grating, that this beam is normal to the rotating surface, that the diffracted rays are symmetrical with respect to the incident laser beam - this being exactly the opposite of what the invention teaches - and that the diffracted rays are reflected towards the grating by means of mirrors ($8_1$, $8_2$), whereby they undergo a second diffraction. Nevertheless, any person having only elementary notions of optics knows that the travel of light rays is not influenced by their direction of propagation. Therefore, the skilled person is not deterred from providing, instead of the means disclosed in document (D4), a beam splitter to generate two coherent light beams from a laser beam, means to direct said two beams towards a point of the grating and symmetrically with respect to the normal to said grating at that point, and means for detecting the interfering light rays diffracted normally to said surface, as taught by

document (D2). Finally, no inventive step can be perceived in arranging the optical system "opposite to the vibration means (2)" of the claimed motor, for otherwise no light beams could be directed towards the diffraction grating or collected therefrom.

2.9 In the Board's judgment, therefore, the subject-matter of claim 1 according to the appellant's main request lacks an inventive step and is consequently not patentable - EPC, Article 52(1) in conjunction with Article 56.

3. *First auxiliary request*

The use of beam splitters (46, 47) for dividing laser beams (43, 44) is known from document (D2) - see Figure 3. In the device represented on this drawing, beams (48, 50) resulting from the division of the beam (44) are made to converge to a spot (54) on the diffraction grating (38) by means of a lens (52) - see column 5, lines 16 to 26. Nevertheless, the use of mirrors for directing light beams towards a selected point on a surface is a widely known equivalent to that of a lens. For its part, document (D3) discloses the use of a mirror (7) and a beam splitter (8) for splitting coherent light beams (A, B) diffracted by the lines (4) of a moving diffraction grating, and for directing thereafter said beams towards two light sensitive elements (9, 10) - see the Figure and from column 2, line 32, to the line 6 of column 3. However, selecting any of such arrangements lies in the discretion of the skilled person and, either alone, in combination with one another or in combination with any of the reamining features of claim 1 - i.e. with any feature of claim 1 according to the main request - they are not liable to provide any unexpected effect.

In the Board's judement, therefore, the subject-matter of claim 1 according to the appellant's first auxiliary request also lacks an inventive step and, for this reason, is not patentable - EPC, Article 52(1) in conjunction with Article 56.

4. Therefore, the appellant's main and first auxiliary request are rejected.

5. *Second and third auxiliary request*

According to each of the second and third auxiliary request, claim 1 states that a quarter wavelength plate (14) is arranged in the optical path before the second beam splitter (15). Claim 1 according to the third request furthermore states that two polarizing plates ($16_1$, $16_2$) are arranged in the optical path behind the exit of said second beam splitter, the polarization azimuths of these plates being mutually deviated by a predetermined angle in order to discriminate in which direction the contact member (6) rotates. None of these additional features, however, had ever been mentioned in any claim submitted prior to the oral proceedings before the Board and, consequently, none of them had been taken into consideration during the European novelty search and during the procedure of examination of the patent application. Therefore, it may not be submitted that claim 1 according to either of the second and third auxiliary request would clearly be allowable. Furthermore, these versions of claim 1 were filed during the oral proceedings of 14 January 1997 without any proper justification for such late filing.

Therefore, pursuant to the jurisprudence of the Technical Boards of Appeal - see in particular point 2.1 of the Reasons for the earlier decision T 153/85 (OJ EPO 1988, page 1) -, the second and third auxiliary requests are also rejected.

## Order

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

The appeal is dismissed.

The Registrar: The Chairman:

M. Beer G. D. Paterson

25.2.97

26/02/97