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Bezeichnung der Erfindung: An improved ultrasonic transducer
Title of invention:
Titre de l'invention :

Klassifikation / Classification / Classement :

ENTSCHEIDUNG / DECISION
vom / of / du 12 January 1988

Anmelder / Applicant / Demandeur :

Patentinhaber / Proprietor of the patent /
Titulaire du brevet : Toray Industries, Inc.

Einsprechender / Opponent / Opposant : Siemens AG

Stichwort / Headword / Référence :

EPÜ / EPC / CBE Article 56

Kennwort / Keyword / Mot clé : Arbitrary as well as routine trial and error dimensioning of a conventional device part; inventive step (no)

Leitsatz / Headnote / Sommaire

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Case Number : T 48/86

D E C I S I O N
of the Technical Board of Appeal 3.4.1
of 12 January 1988

Appellant : (Opponent)
Siemens Aktiengesellschaft
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Representative :

Respondent : (Proprietor of the patent)
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Representative :
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Decision under appeal :
Decision of the Opposition Division of the European Patent Office dated 22 October 1985 dispatched on 21 January 1986 rejecting the opposition filed against European patent No. 0 014 693 pursuant to Article 102(2) EPC

Composition of the Board :

Chairman : J. Roscoe
Members : H. Reich
O. Bossung

Summary of Facts and Submissions

I. The Respondent is owner of European patent 0 014 693 (application number 80 850 016.9).

II. The grant of this patent was opposed on the ground of lack of inventive step with regard to documents:

US-A-3 969 927 (D1)
Electronics Letters 1976, pages 393 and 394 (D2)
Ultrasonics, Volume 14, No. 1, 1976, pages 15-23 (D3)
US-A-3 928 777 (D4)
DE-A-2 718 772 (D5)
US-A-3 798 473 (D6)
Bergman: "Der Ultraschall und seine Anwendung in Wissenschaft und Technik", Hirzel Verlag, Stuttgart, 1954, pages 14-21, 650, 651 (D7)
US-A-3 801 839 (D8), and
Journal of Applied Physics, Volume 47, No. 3, 1976, pages 949-955 (D9).

The Opposition Division, having examined documents D6 to D9, filed after the opposition period according to Article 114(1) EPC, introduced documents D6 and D7 as relevant into the proceedings. However, it rejected the opposition by a decision dispatched 21 January 1986.

III. The Appellant (Opponent) lodged an appeal against this decision. The Statement of Grounds contained arguments for lack of inventive step with regard to documents D3 and D7. In a subsequent letter the Appellant additionally based his argument on the document:

Ultrasonics Symposium Proceedings, New York, 25.09-27.09.1978, IEEE, New York, pages 122-155 (D10).

IV. The Respondent (Patentee) with a letter dated 16 December 1987 filed new Claims 1-3 and maintained Claims 4-11 of the impugned patent.

New Claim 1 reads as follows:

1. An ultrasonic transducer comprising a piezoelectric element (14; 24) with associated electrodes (12, 13; 22, 23) and a reflective layer (12; 22) coupled to the piezoelectric element, said piezoelectric element comprising a polymer film, c h a r a c t e r i z e d in that the reflective layer (12; 22) has a thickness in a range from $\frac{1}{32}\lambda$ to $\frac{3}{16}\lambda$, wherein λ is the wavelength of sound waves within the reflective layer at one half of the free resonant frequency of the polymer film.

Claims 2-11 are dependent on Claim 1.

V. Oral proceedings were held, during which the Appellant additionally based his attack of lack of inventive step on the following document, mentioned in the European Search Report:

Ultrasonics, Volume 12, No. 3, 1974, pages 100-105 (D11).

At the end of the oral proceedings the Appellant requested that the decision under appeal be set aside and the patent be revoked.

The Respondent requested that the appeal be dismissed and that the patent be maintained on the basis of the documents filed by letter from 16 December 1987.

VI. The Appellant (Opponent) supported his request essentially by the following arguments:

(a) It would be obvious for a skilled person in order to increase the flexibility of a conventional polymer ultrasonic transducer with a reflective layer and to improve the etching of the reflective layer to make this layer thinner. There was no prejudice against reducing the thickness of the known reflective layer. Therefore, a skilled person would arrive at the subject-matter of Claim 1 without any inventive step. Were the skilled person to measure the efficiency of a transducer with a reflective layer having a thickness in the range claimed in Claim 1, he would automatically find the lower peak transition losses associated with thinner reflective layers represented in Figure 7 of the impugned patent. According to the decision T 21/81, OJ EPO 1983, 15, in particular page 20, paragraph 2, such extra (possibly surprising) effect could be disregarded in the event of an obvious subject-matter of a claim.

(b) Figure 7 of the impugned patent showed only a small, practically linear decrease of the peak transfer loss values with decreasing layer thickness, for instance from 15.3dB for the conventional $\lambda/4$-layer to 14.7dB for the preferred embodiment of the invention with a $\lambda/16$-layer. The relatively small decrease of the loss of only 4% as well as its continuity both inside and outside the claimed layer thickness region showed that the transducer according to Claim 1 has no special advantage.

(c) Figure 4 of document D11 disclosed a ceramic transducer with a copper backing layer, the thickness of which, from the information in Figure 5, could be

shown to be 1/9 of the sound wavelength within the reflective layer at one half of the free resonant frequency of the piezoelectric element. Figure 5 of document D11 represented operating characteristics which were comparable with those represented in Figures 5 and 7 of the impugned patent. In particular, the left-hand side of Figure 5 of D11 showed that the peak transducer efficiency for a $\lambda/9$ backing-layer was greater than for a $\lambda/4.5$-backing layer. Since the peak transducer efficiency was inversely related to the peak transfer loss, document D11 would teach the expert that the peak transfer loss gets smaller with decreasing backing layer thickness.

VII. The Respondent's submissions were essentially as follows:

(a) The prior art statement in the impugned patent, column 1, lines 46-53 was affirmed: An ultrasonic transducer according to the first part of Claim 1 with a reflective layer which has a thickness of $\lambda/4$, wherein λ is the wavelength of sound waves within the reflective layer at one half of the free resonant frequency of the polymer film, was known. However, exclusively $\lambda/4$-reflective layers had been used in the prior art.

(b) It was only with hindsight that it could be considered obvious to reduce the thickness of the known $\lambda/4$-reflective layer of a polymer transducer. Nowhere in the prior art was it stated to be possible to reduce the reflective layer thickness without ruining the operation of the transducer. To overcome the prejudice that only $\lambda/4$-reflectors would work, had in itself required an inventive step. Moreover, it was surprising that the transducer efficiency even

improved when the reflective layer thickness was reduced.

(c) Figure 6 of document D7 related not to a transducer with a reflective layer but to a single aluminium plate in water. The thickness range for a reflective layer as claimed in Claim 1 was not derivable from document D7. Figure 6 of document D7 showed that any deviation of the aluminium plate thickness from $\lambda/4$ resulted in a higher transmission of the plate and only taught that lowering the ratio m of the sound impedance of the surrounding medium to that of the plate material would lead to a lower transmissibility.

(d) Figure 5 of document D11 represented the theoretical frequency response of Tibalit 12 and contained no information on how to dimension the thickness of a reflective layer of a polymer transducer.

Reasons for the Decision

1. The appeal is admissible.

2. There is no objection to the present version of Claim 1, since its subject-matter is adequately based on the original disclosure.

3. Novelty.

3.1 None of the documents referred to in II above describes an ultrasonic transducer comprising a polymer piezoelectric film with a reflective layer, the thickness of which lies in the range claimed in the characterising part of Claim 1. The conventional transducer mentioned in the

impugned patent, column 1, lines 46-53, comprises a $\lambda/4$-reflector, whereas the thickness range claimed in Claim 1 extends from $3\lambda/16$ to $\lambda/32$.

3.2 In the ultrasonic transducers known from documents D1, D2 and D3 the polymer film is backed with a metallic layer, which is only stated to serve as an electrode and in D1 and D2 is of unspecified thickness. In D3, where the transducer is mounted on a brass rod, the thickness, 1000Å, of the metallic layer is well below $\lambda/32$ and the rod is said to be of arbitrary length.

3.3 Documents D4 and D11 are exclusively concerned with ultrasonic transducers with ceramic piezoelectric elements. In the transducer known from D4 the electrodes and potting material of the ceramic element are structured to provide for impedance matching and damping. In document D11, theoretical and experimental values are indicated for the sound emission from the oscillating ceramic element at various frequencies as a function of the influence of the damping effect of a backing layer.

3.4 Document D7 theoretically describes the reflectivity and transmissibility of a plate in dependence on its thickness and the ratio of its acoustic impedance to that of various neighbouring media.

3.5 The other documents cited by the Appellant or in the European Search Report do not come closer to the subject-matter of Claim 1 and need not be discussed for an assessment of novelty. Therefore, the subject-matter of Claim 1 is considered novel.

4. Inventive step.

4.1 The prior art which comes nearest to the subject-matter of Claim 1 is that indicated in the description of the impugned patent, column 1, lines 46-53 and covers the preamble of Claim 1. Starting thus from the Respondent's own prior art statement, which was expressly confirmed to be valid in the oral proceedings, the objective problem underlying the impugned patent is to provide an ultrasonic transducer which retains the flexibility of its polymer piezoelectric film and the reflective layer of which is easy to etch; see the impugned patent column 1, line 53 to column 2, line 4. A person skilled in the art, who used the conventional $\lambda/4$-transducer in practice, would automatically become aware of the fact that the provision of the $\lambda/4$-reflective layer, although improving the conversion efficiency and broadening the frequency-band characteristic, seriously reduces the flexibility of the piezoelectric polymer film. Difficulties in etching the conventional $\lambda/4$-layer would also appear during processing in practice. Whenever a problem consists solely in eliminating deficiencies of an object, which come to light when it is in use, the posing of such problem is obvious and cannot be considered to contribute to the inventive merit of its solution; see also the decision T 109/82, OJ EPO 1984, 473, point 5.1.

4.2 It remains to investigate whether it is obvious to a skilled person to solve the above-mentioned problem by reducing the conventional reflective layer thickness from $\lambda/4$ to the claimed values in between $3\lambda/16$ ($\lambda/5.3$) and $\lambda/32$.

4.2.1 Competent for one part of the above-mentioned problem, is the person skilled in the mechanical flexibility of composite material layer systems. The Board considers that such a person would know that the stiffening of a flexible polymer film by a backing layer becomes less with

decreasing rigidity of the backing. The fact that the rigidity of the layer decreases with its thickness by no means represents an inventive finding but belongs to the normal general knowledge of the skilled person. Thus, simply by applying his routine abilities the skilled person would arrive at the finding that much of the flexibility of a polymer film can be retained if a reflective layer of thickness less than the conventional value of $\lambda/4$ layer is used.

Furthermore, it is considered to form part of the general knowledge of the processing engineer, who is competent for the remaining part of the above-mentioned problem, that thinner material layers can be etched more easily and precisely.

For the above reasons the Board is convinced that it is obvious for a skilled person to find out in which direction he has to work in order to overcome the disadvantages of the prior art. Therefore, the Respondent's argument of hindsight - cf. point VII-b above - does not appear relevant and no inventive step can be seen in the skilled man's solution to reduce the conventional $\lambda/4$-thickness of the known reflective layers of polymer piezoelectric films.

4.2.2 In the Board's view the skilled person considering such a reduction in thickness would be aware that this might significantly alter the operating parameters of the transducer and would proceed with caution by trial and error, measuring these parameters at the different reflective layer thicknesses to assure himself that they suffered no radical deterioration.

If the graphs of Figure 7 of the impugned patent apply for all transducers having the features of Claim 1, as is

tacitly assumed by the respondent in his argument that these properties are surprising and thus form the basis for a finding that the subject-matter of Claim 1 is inventive, the skilled person would, as a matter of course, find that these properties, far from deteriorating, showed a modest improvement with decreasing thickness. All the properties plotted in Figure 7 show only a slow progressive change with thickness rather than an improvement restricted to a narrow range of thicknesses.

No inventive merit can be attributed to selection of the end values of the range quoted in Claim 1. The upper limiting value is clearly quite an arbitrary value at which no sudden change in operating parameters or flexibility has been shown to occur.

Figure 7 of the impugned patent furthermore shows that a skilled person, continuing to work in the obvious direction and testing transducers with still thinner reflective layers, will realise both the continuing decrease of the peak transfer loss down to about $\lambda/32$ and its increase beyond this value. Thus, a skilled person continuing the obvious reduction of the reflective layer thickness for optimum transducer flexibility will find the disadvantageous transducer properties for thicknesses smaller than $\lambda/32$ by routine trial and error. For this reason also the definition of the lower limiting value $\lambda/32$ of the claimed thickness region does not imply an inventive step.

Any skilled person performing the investigation discussed above would recognise that values between these limits would provide satisfactory results and that the best choice for a given application would depend on whether flexibility, precise etching or excellent electro-acoustic performance was the most important property.

4.2.3 A party, who wishes to rely on a prejudice, which might have diverted the skilled man away from the alleged invention has the onus of demonstrating the existence of such prejudice; see also the decision T 119/82, OJ EPO 1984, 217, point 14. The Respondent, however, has submitted no evidence, that in the prior art a real prejudice existed against any deviation from the conventional $\lambda/4$-reflective layer thickness. For this reason, the Respondent's statement in point VII-b, that the skilled person hitherto believed that only reflective layers with $\lambda/4$ thickness would result in a workable transducer, has to be assessed as a mere allegation.

A prejudice against the reduction of the conventional $\lambda/4$ thickness of a reflective layer can also not be derived from any cited prior art document, in particular not from document D7, Figure 6. The Board agrees with the Respondent's view in point VII-c above with regard to the fact that Figure 6 of document D7 represents in particular the sound transmissibility of an aluminium plate in water at various plate thicknesses. However, the Board takes the view that a skilled person knows that there is an inverse relationship between transmissibility and reflectivity as shown in Bild 5 of D7 and that he will thus derive from the extremely flat minimum of the aluminium curve in Figure 6 of D7 the information that, in particular for a plate material with relatively high sound impedance, i.e. for small m-values, the plate is highly reflective not only at a thickness of $\lambda/4$ but also at thicknesses well within the thickness region claimed in Claim 1. Equation 33 of document D7, which allow transmissibility values for a reflective layer in between two different media to be determined, leads to essentially the same results for a material combination used in a conventional ultrasonic transducer, for instance the polymer-reflective-layer-

holder substrate materials of the preferred embodiment of the alleged invention. If an aluminium plate were only reflective at $\lambda/4$, the transmissibility curve in Figure 7 would have the form of an extremely narrow minimum or even show a singularity.

4.3 The question as to whether a skilled person is able to derive from the transmitter behaviour of the transducer in Figures 4 and 5 of document D11 - i.e. from the conversion efficiency of electric energy into mechanical sound energy for a damped ceramic oscillator - any information about the sensor behaviour of such structure - i.e. about the conversion efficiency of mechanical sound energy into electric energy or about the amount of unconverted and thus transmitted sound energy - can be left open in view of points 4.1 to 4.2.3 above; cf. also point VI-c above.

4.4 For the reasons set out in points 4.1 to 4.2.3 above, the subject-matter of Claim 1 does not involve an inventive step within the meaning of Article 56 EPC and consequently the maintenance of the impugned patent with Claim 1 is prejudiced by Article 100(a) EPC. Claims 2-11 cannot be maintained because of their dependence on Claim 1.

Order

For these reasons, it is decided that:

1. The decision under appeal is set aside.

2. The European patent is revoked.

The Registrar: The Chairman:

F.Klein J.Roscoe

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