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D E C I S I O N
of 18 July 2000

Case Number: T 0382/99 - 3.5.1

Application Number: 88121118.9

Publication Number: 0322679

IPC: H04R 1/28

Language of the proceedings: EN

Title of invention:
Acoustic apparatus

Patentee:
YAMAHA CORPORATION

Opponent:
AIWA CO., LTD.

Headword:
-

Relevant legal provisions:
EPC Art. 52(1), 54

Keyword:
"Novelty (no)"

Decisions cited:
-

Catchword:
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Case Number: T 0382/99 - 3.5.1

D E C I S I O N
of the Technical Board of Appeal 3.5.1
of 18 July 2000

Appellant: (Opponent)
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Decision under appeal: **Decision of the Opposition Division of the European Patent Office posted 3 February 1999 rejecting the opposition filed against European patent No. 0 322 679 pursuant to Article 102(2) EPC.**

Composition of the Board:

Chairman: P. K. J. van den Berg
Members: A. S. Clelland
P. H. Mühlens

Summary of Facts and Submissions

I. This appeal is against the decision of the Opposition Division to reject an opposition against European patent No. 322 679.

II. The opposition proceedings were primarily concerned with the novelty of claim 1, the sole independent claim. The opponent had cited the following three documents:

O1: Journal of the Audio Engineering Society; Part I: Vol. 19, No. 5, May 1971, pages 382 to 392; Part II: Vol. 19, No. 6, June 1971, pages 471 to 483 (A.N. Thiele)

O2: Audio Engineering, Vol. 35, No. 8, August 1951, Pages 20 to 22, 54 and 55 (W. Clements)

O3: US-A-3 037 081

III. The Opposition Division held that claim 1 was novel. It additionally indicated, although the objection had not been raised by the opponent, that the subject-matter of claim 1 involved an inventive step. Consequently the opposition was rejected and the patent maintained unamended.

IV. The appellant (opponent) lodged an appeal against this decision and paid the prescribed fee; it was requested that the decision under appeal be set aside and the patent revoked. A statement of grounds of appeal was subsequently filed, maintaining the objection of lack of novelty on the basis of the documents considered by the Opposition Division. The respondent (patentee)

agreed with the findings of the Opposition Division and requested that the appeal be rejected and the patent maintained as granted. Both parties made auxiliary requests for oral proceedings.

In a communication the rapporteur, on behalf of the Board, *inter alia* queried the meaning of certain terms used in claim 1, in particular "active servo driving" and "counteraction force". In addition to the issues for discussion at the oral proceedings the communication drew attention to the "Guidance for parties to appeal proceedings and their representatives", OJ EPO, 1996, 342, point 3.3, which states that a party wishing to submit amendments to the patent documents in appeal proceedings should do so as early as possible and that the Board may disregard amendments not submitted in good time prior to oral proceedings, as a rule four weeks before the set date.

V. Oral proceedings were held on 18 July 2000. The parties maintained their requests until the closing moments of the proceedings, at which time the respondent requested permission to submit an auxiliary request containing an amended claim 1. He stated that this amended claim contained wording which made the technical effect achieved by the invention clearer and was intended to clarify the claim rather than limit its scope. The appellant objected that the respondent had had ample opportunity to amend the claims before the oral proceedings but had failed to do so; the summons to oral proceedings stated that amendments should be submitted in good time and this had not been done.

VI. The Board refused permission for the respondent to file an auxiliary request. The Board's decision was

accordingly taken on the basis of claim 1 as granted, which reads as follows:

"An acoustic apparatus comprising:

a resonator (10) having a resonance radiation unit (11, 12) for radiating an acoustic wave by resonance;

a vibrator (20) having a diaphragm (21) constituting a part of said resonator (10) and disposed in said resonator (10); and a vibrator drive means (30) for driving said vibrator (20), the vibrator (20) being in turn arranged for driving the resonator (10); characterized in that
the vibrator drive means (30) is arranged to exert an active servo driving of the vibrator (20) in such a way that the drive current is correspondingly increased or decreased in order to substantially cancel a counteraction force from air in the resonator (10) to the diaphragm (21), said counteraction force being caused in response to the driving of said resonator (10) by said vibrator (20), so that the resonator be assumed to receive a drive energy from a drive source in parallel with and independent of the vibrator in terms of the equivalent circuit."

Reasons for the Decision

1. *Late-filed amendment*

1.1 As noted in the summary of facts and submissions at point V, at the end of the oral proceedings the respondent sought permission to submit an auxiliary request with an amended main claim.

1.2 The Board exercised its discretion to refuse to admit the amended claim for two reasons: firstly, the amendment was said to be intended to clarify the claim rather than limit its scope; since the Board was able to construe claim 1 as granted further clarification was not considered necessary; and secondly, the amendment was as noted proposed in the closing moments of the oral proceedings rather than filed at least four weeks in advance as specified in the "Guidance for parties to appeal proceedings and their representatives" referred to in the rapporteur's communication. Consequently, neither the appellant nor the Board were in a position to study the amendments adequately. Given these circumstances the Board concluded that it should not exercise its discretion to admit the proposed auxiliary request.

2. *Background to the invention*

2.1 In loudspeaker systems it is known to improve the performance by providing a resonant cavity adjacent the sound transducer. One example of such a resonant cavity is a bass reflex box, which the patent refers to as a "Helmholtz resonator". Such a device, in its simplest form, consists of a cavity with a sound transducer forming part of one wall and with an opening connected to the outside world by way of a neck portion; by adjustment of cavity volume, area of the opening and length of the neck the resonant frequency can be adjusted. In the patent the sound transducer may be a known moving coil speaker but various other transducers are also described; the patent refers, as does the claim, to a "vibrator" rather than a transducer.

2.2 The problem said to be solved by the claimed invention

is that of making the resonant cavity as compact as possible; the patent seeks to decouple the transducer from the cavity such that the two can be considered as separate entities and the design of one has no effect on the other.

2.3 In order to achieve this decoupling the patent considers the equivalent electrical circuit of the system comprising the transducer and cavity; Figure 1b shows the basic equivalent circuit, comprising the internal impedance of the transducer Z_v, said to consist primarily of the resistance of the voice coil in the case of a moving coil speaker, and impedances Z_1 and Z_2 respectively representing the physical characteristics of the transducer and the resonator. The impedance Z_1 is a parallel tuned circuit whilst impedance Z_2 is a series-resonant circuit. It is apparent that in such an arrangement any change in current in either Z_1 or Z_2 will necessarily influence the current in the other, i.e. a change in the physical characteristics of the transducer will influence the resonator and vice versa.

2.4 In accordance with the patent this problem is overcome by the provision of a driving arrangement having a negative impedance, ideally perfectly matching the internal impedance Z_v of the transducer. It will be apparent that if such a match can be achieved the equivalent circuits Z_1 and Z_2 will be fed by a constant voltage source, so that a change in one circuit will have no effect on the other circuit. In other words, by providing a negative impedance matching the transducer internal impedance, the physical characteristics of the transducer and resonator can be decoupled, allowing easier design of each.

2.5 In the patent the negative impedance is generated by means of an amplifier circuit incorporating a current proportional positive feedback loop. Although positive feedback runs the risk of giving rise to oscillation, the patent makes clear that so long as the negative impedance generated by this circuit is less than the impedance of the transducer, oscillation will not occur. In the example given in the patent, see column 10, lines 14 to 39, the preferred value of negative resistance for a transducer in the form of a moving coil speaker having an internal resistance of 8Ù is -4Ù, i.e. the compensation provided is 50%.

3. *Interpretation of claim 1*

3.1 The characterising part of claim 1 includes expressions which are not apparently terms of art and which are not clear in themselves. It has accordingly been necessary for the Board to interpret these expressions in the light of the description, Article 69 EPC.

3.2 The claim states that the "vibrator drive means", i.e. the transducer power source, is arranged to exert an "active servo driving" of the vibrator, i.e. transducer, "in such a way that the drive current is correspondingly increased or decreased in order to substantially cancel a counteraction force from air in the resonator to the diaphragm". The expression "active servo driving" is not used elsewhere in the patent other than in the introductory statement of invention. The Board understands a "servo" to be a system in which the response is determined by the difference or error between a set point and the driving signal; the patent nowhere refers to a set point or reference. However, at column 11 lines 4 to 12 the expression "active servo"

is used in brackets after a statement to the effect that the transducer is perfectly damped and its response to a driving signal is not affected by any external force; in other words, the transducer is decoupled from its surroundings, in particular the resonator. This passage occurs immediately after the discussion of the use of a negative impedance to effect decoupling between the transducer and resonator, so that the reference to "active servo driving" should apparently be interpreted as meaning that the vibrator drive means is arranged to drive the vibrator in such a way that the drive current to the vibrator is independent of the effects of the resonator, i.e. the vibrator is decoupled from the resonator.

3.3 The remaining features of the claim do not appear to define additional limitations but rather to describe in other words what is implicit in the "active servo driving". Thus, the statement in the claim that the "counteraction force" is "caused in response to the driving of said resonator by said vibrator" again seems to be referring to a coupling between the resonator and the vibrator which it is desired to avoid.

3.4 The final clause of the claim, namely that the resonator is "assumed to receive a drive energy from a drive source in parallel with and independent of the vibrator in terms of the equivalent circuit" has caused the Board some difficulty. It is not possible to identify any further source of drive energy in either the preferred embodiments or the equivalent circuit. This wording appears rather to be intended to emphasise that the acoustic transducer is fed in such a way that compensation is provided for the effects caused by the resonator. In other words, it repeats in different

wording the reference to the drive current being "correspondingly increased or decreased in order to substantially cancel a counteraction force from air in the resonator to the diaphragm".

3.5 The Board accordingly concludes that claim 1 is in fact merely characterised by driving the transducer in such a way as to "substantially cancel" or decouple interaction between the transducer and resonator. This is done in the preferred embodiments by the provision of a negative impedance; the patent as a whole contains no other manner in which such cancellation or decoupling might be effected. Although it is apparent from the description, see in particular column 6 at lines 7 to 39, that perfect decoupling is only obtained when the negative impedance of the source is equal to the real impedance of the transducer, in view of the conclusions on novelty reached below the Board has not found it necessary to decide whether "substantially cancel" includes a partial cancellation as disclosed at column 10 lines 14 to 39.

4. *Novelty of claim 1*

4.1 In the Board's view the single most relevant document is O2, published in 1951. O2 is concerned with providing a high damping ratio, in effect a low output impedance, in a loudspeaker amplifier without the requirement for a large degree of negative feedback. Page 20, left hand column, states that the described method permits a damping ratio "right up to infinity and beyond" in order to provide "theoretically perfect speaker diaphragm control". The Board understands this to mean that the speaker responds perfectly to the driving signal, which implies that its output is not

influenced by factors such as the cavity to which it is coupled. Page 21, left hand column states that this is achieved by providing a negative impedance at the amplifier output terminals which subtracts from the speaker voice-coil impedance; matching the two impedances is said to eliminate the effects of the latter. Such negative impedance is said at page 21, left hand and central columns, to be obtainable by the provision of current-proportional positive feedback, with the result that "the voice-coil impedance is exactly matched by the negative impedance of the amplifier and theoretically perfect damping is achieved". From pages 54 and 55 it can be seen that the use of positive feedback with a bass-reflex cabinet is envisaged.

4.2 Turning now to the wording of claim 1, O2 discloses acoustic apparatus comprising a resonator in the form of a bass-reflex cabinet for radiating an acoustic wave by resonance. A vibrator in the form of one or a plurality of loudspeakers is provided, the standard arrangement being that the speaker or speakers are mounted on the bass reflex cabinet so that they in effect constitute part of the cabinet and are disposed in it. The Board therefore considers that the conventional arrangement of bass-reflex cabinet and speakers implied by O2 satisfies the preamble of claim 1.

4.3 As noted at points 3.2 to 3.5 above, the characterising part of claim 1 can be reduced to the requirement that the vibrator is driven in such a way as to decouple it from the resonator. The only means disclosed in the patent for achieving this is negative resistance at the drive amplifier output. O2 provides a negative

resistance at the drive amplifier output in order to obtain "theoretically perfect speaker diaphragm control" with perfect damping. The Board accordingly concludes that if the skilled person were to provide a negative resistance for the speaker drive amplifier of a conventional bass reflex system so as to substantially cancel the speaker voice coil resistance he would arrive at the claimed arrangement. Nothing can be identified in claim 1 which constitutes a limitation distinguishing the subject-matter of the claim from the disclosure of O2. The subject-matter of claim 1 accordingly lacks novelty having regard to the disclosure of document O2, Articles 52(1) and 54 EPC.

4.4 The same result could have been obtained starting out from document O1. This document is also concerned with bass-reflex speaker systems and discloses at page 385, see Figure 4, an equivalent electrical circuit in which the transducer physical characteristics are represented by a parallel tuned circuit and the resonator characteristics by a series tuned circuit, in other words the same electrical equivalent circuit as in Figure 1B of the patent. O1 is particularly concerned with control of frequency response and refers at page 386, right hand column to a parameter which "can cause trouble if space is limited". The same passage states that if a high Q is required "a negative output impedance (i.e. of the amplifier) will be required". Page 475 discusses how this can be achieved and suggests in the right-hand column a cancellation of 60% of speaker impedance. The Board concludes that the arrangement of O1 is that claimed in claim 1.

4.5 The respondent took the view that the wording of claim 1 should be read in a much more specific sense.

It was argued that the invention was based on an appreciation not present in the cited art, namely that the vibrator and resonator could be designed as completely separate systems, without reference to each other, by the provision of the means set forth in the claim. This was in the context of a system having a very low resonator volume, the cited documents having little to say about the solution to this problem. Indeed, the discussion of bass reflex speakers at page 54 of O2 referred to "six 15 inch speakers in a bass-reflex cabinet". This was quite different to the arrangement of the invention.

4.6 The Board accepts that the problem which the claimed invention is said to solve is that of making the resonator as compact as possible; this is not however reflected in the wording of claim 1. Moreover, although it may be an effect of the technical means used that the design of the vibrator and resonator can be decoupled from each other, this decoupling is merely a result of the use of a negative drive impedance.

4.7 In essence, the Board takes the view that whatever the wording of the claims all that is disclosed in the patent is the use of means which are known in the prior art, namely the provision of a negative drive impedance to compensate for the transducer internal impedance. There is no teaching in the patent as a whole which goes beyond this.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The patent is revoked.

The Registrar: The Chairman:

M. Kiehl P. K. J. van den Berg