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File Number: T 554/90 - 3.5.1
Application No.: 84 300 592.7
Publication No.: 0 117 654
Title of invention: Multistage amplifier

Classification: H04B 1/64

D E C I S I O N
of 27 June 1991

Proprietor of the patent: FUJITSU LIMITED
Opponent: Wandel & Goltermann GmbH & Co

Headword:

EPC Article 56

Keyword: "Inventive step (yes) after amendments"

Headnote



Case Number : T 554/90 - 3.5.1

D E C I S I O N
of the Technical Board of Appeal 3.5.1
of 27 June 1991

Appellant :
(Opponent)

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Representative :

Respondent :
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Decision under appeal :

Decision of Opposition Division of the European
Patent Office dated 11 May 1990 rejecting the
opposition filed against European patent
No. 0 117 654 pursuant to Article 102(2) EPC.

Composition of the Board :

Chairman : P.K.J. van den Berg
Members : R. Randes
M.V.E. Lewenton

Summary of facts and submissions

- I. European patent No. 0 117 654, claiming priority of 31 January 1983, was granted on 17 September 1986 on the basis of European patent application 84 300 592.7, filed on 31 January 1984.
- II. An opposition was filed on 3 June 1987 on the grounds that the subject-matter of the patent was not new and did not imply an inventive step (Article 100(a) EPC). The Opponent referred to 13 prior art documents.
- III. By its decision of 11 May 1990 the Opposition Division rejected the opposition. According to the decision, the prior art documents did not disclose an amplifier having a linear relationship between output signal and input signal and containing a compressor stage and an expander stage where the amounts of level compression and level expansion were complementary.
- IV. The Appellant (Opponent) filed a Notice of Appeal against this decision on 9 July 1990. The appeal fee was paid on the same day. The statement of Grounds was received on 24 August 1990. The appeal relied primarily on a prior art document not previously cited,

D14 = FR-A-1 602 358.
- V. A communication according to Article 11(2) RPBA was issued on 27 March 1991. The Rapporteur understood from the description of the application that the technical problem to be solved was to provide a multistage amplifier, in particular for telecommunication equipment, with linear input/output characteristics over a wide range of input signal levels, which amplifier prevented saturation of an interstage amplifier and at the same time offered low

noise performance. Since these features were not derivable from Claim 1 it appeared that the claim did not specify all the essential features of the invention.

VI. The Respondent (Patent Proprietor) filed an amended set of claims on 27 May 1991. Claim 1 was a combination of Claims 1, 3 and 4 as originally filed and granted, with one feature added from the description.

VII. Oral Proceedings were held on 27 June 1991.

The Respondent argued essentially in the following way. An important feature of the claimed amplifier is that, as stated in Claim 1, "the amount of level-compression provided by the level compressor means and the amount of level-expansion provided by the level expander means are each continuously variable and proportional to the amount by which the level of the signal detected by said level detecting means exceeds a preset signal level, said preset signal level being set in correspondence to a saturation signal level of the signal processing means". D14 contains no suggestion to replace the described discrete gain levels by a continuous characteristic. This feature brings about the advantage that spikes in the output signal due to imprecise synchronisation of the compressor and expander can be avoided. This may not present a serious problem at low frequencies but would be critical at the high frequencies normally used in telecommunication systems. Furthermore, the amplifier described in D14 can not be regarded as linear because the processing circuit 5 introduces non-linearity. Also, the passage on page 1, line 37, to page 2, line 7, suggests that complementary compression/expansion would be of no use unless a circuit such as the processing circuit 5, which normally lowers the amplitude of the signal, is provided. This statement

would have dissuaded the skilled man from considering the teaching of D14 in telecommunication applications.

VIII. The Appellant's arguments can be summarised as follows. The invention concerns a multistage amplifier containing compressor means, an interstage amplifier and expander means. The level of signal compression/expansion is determined by the signal level and is complementary in the compressor and expander stages to achieve a total amplification which is linear over all expected input signal levels. Such an amplifier is also known from D14. The differences existing between the invention and the prior art amplifier are such as to lie within the skills of a worker in the art. In particular, it would have been an obvious modification to replace the discrete amplification levels of the known compressor/expander stages by a continuously varying gain characteristic. If the number of amplification levels - four in the example described in D14 - were increased, the resulting gain characteristic would in fact be approximately continuous. Furthermore, although Claim 1 specifies an amplifier "suitable for telecommunication" this constitutes no true limitation of the scope of the claims.

IX. At the conclusion of the Oral Proceedings the Appellant requested the cancellation of the impugned decision and the revocation of the patent in its entirety.

The Respondent requested the dismissal of the appeal and the maintenance of the patent on the basis of:

- Claim 1 as filed on 27 May 1991 and incorporating the characterising features of Claim 2 filed on the same day;
- Claims 3 to 7 as filed on 27 May 1991 and renumbered 2 to 6;
- a description adapted to the claims.

X. Claim 1 as filed on 27 May 1991 reads:

"A multistage amplifier, comprising:

level compressor means for level-compressing a signal supplied thereto;

signal processing means, operatively connected to the level compressor means, for processing the level-compressed output signal provided by the level compressor means;

level expander means, operatively connected to the signal processing means, for level-expanding the amplified level-compressed output signal provided by the signal processing means, operable so that an amount of level-expansion effected by the level expander means corresponds to an amount of level compression effected by the level compressor means, and

level detecting means for detecting a level of a signal in the multistage amplifier, and operable in dependence thereupon to control the level compressor means and the level expander means so that complementary amounts of level compression and level-expansion are provided;

characterised in that:

a) first-stage amplifying means are provided for amplifying an input signal of said multistage amplifier and supplying an output signal linearly related in level to the input signal, to said level compressor means;

b1) in that the amount of level-compression provided by the level compressor means and the amount of level-expansion provided by the level expander means are each continuously variable and

- b2) proportional to the amount by which the level of the signal detected by said level detecting means exceeds a preset signal level,
- c) said preset signal level being set in correspondence to a saturation signal level of the signal processing means; and in that
- d) said signal processing means is an interstage amplifier means for linearly amplifying the level-compressed output signal of the level compressor means; whereby
- e) the output signal from the multistage amplifier is linearly related to the input signal thereof and free from distortion generated in said interstage amplifier means, and thus suitable for use in telecommunications."

Claim 2 as filed on 27 May 1991 reads:

"A multistage amplifier as claimed in Claim 1, wherein

- f) the signal a level of which the level detecting means are for detecting is a signal associated with the interstage amplifying means, for example the level-compressed output signal or the amplified level-compressed output signal."

The numbering of the characterising features has been added by the Board.

Grounds for the decision

1. The appeal is admissible.

2. Admissibility of the amendments

The requested Claim 1 (see IX) is based on Claims 1 to 4 as originally filed and granted. The characterising feature b1) introduces that the said level compressor - and expander means are continuously variable, which is derivable from the original description (see Figure 5c). Thus no additional subject matter has been added to the original disclosure (Article 123(2) EPC), and the scope of the claims as granted has not been extended (Article 123(3) EPC). The amendments are therefore admissible.

3. Novelty

Although the novelty of the patented subject matter was questioned in the Grounds of Opposition, the Appellant has in the course of the proceedings admitted that certain features of Claim 1 are not known from the closest prior art document (D14, against which Claim 1 is delimited). Novelty is therefore no longer at issue (Articles 52(1) and 54 EPC).

4. Inventive step

In the communication issued by the Board it was stated that the technical problem to be solved by the invention was not only to prevent saturation of an intermediate amplifier, but also to maintain the noise at a low level - cf. column 3, lines 5 to 11 of the contested patent.

According to column 2, lines 35 to 42, this objective is achieved by providing an initial high-gain, low-noise amplifier, the output of which is applied to the interstage amplifier. As is apparent from the drawings, the total amplification of the signal applied to the interstage amplifier (2) is determined not only by the gain of the first-stage amplifier (1), but also by the attenuation of the immediately following first attenuator (4). It follows that in order to maximise the total initial amplification the attenuation of the attenuator (4) should be as low as possible.

- 4.1 Three features in claim 1 appear essential for the solution of the noise problem. Employing the above numbering, they are b1), b2) and c).
- 4.2 According to feature b1), the compressor and expander are continuously variable. In the context, "continuously variable" evidently means that no discrete steps are present, i.e. the amount of compression/expansion may take on any value between a minimum and a maximum.
- 4.3 According to feature b2), the amount of compression/expansion is proportional to the amount by which the level of the signal detected exceeds a preset level.
- This feature must be interpreted in the light of the description, where it is made clear that the output of the first attenuator in fact never exceeds a certain maximum value (column 4, lines 43 to 46).
- 4.4 Feature c) specifies that the preset signal level is set in correspondence to a saturation signal level of an interstage amplifier means.

Taken in connection with feature b2) as interpreted above, the feature implies not only that the saturation value is never exceeded, but also that the signal, when at all compressed, always assumes a value at (or just below) the saturation level. This situation is described in column 4, lines 32 to 47, of the contested patent.

4.5 It appears that features b1), b2) and c) provide an optimum solution to the double problem of preventing saturation while maintaining a high signal-to-noise ratio. The input level of the signal applied to the intermediate stage is fixed at (or slightly below) saturation level, which implies that for any input signal level, the compressor attenuates the signal as little as possible.

4.6 None of these features is disclosed in D14.

As to feature b1), Figures 1 and 3 of D14 show that there are four discrete levels of attenuation and amplification. The amount of gain is determined by the resistor chain (311 to 314, Fig. 3). As explained on page 8, line 14, to page 9, line 13, the transistors (331 to 333) function merely as switches to short out one or more of the resistors but do not otherwise influence the amount of attenuation/amplification. Gain values between those set by the resistor chain are not obtainable.

Feature b2) is not disclosed since the gain cannot be continuously variable.

Feature c) as interpreted above is also not disclosed in D14. Because the attenuation is fixed at each discrete level the signal from the attenuator is not constant but evidently varies in a saw-tooth manner as the input signal increases.

4.7 In D14, the noise is not particularly considered. This is not surprising since the described amplifier is intended for DC - or low-frequency signals, where noise is usually less critical. It is noted that in D14 in fact not even a first-stage amplifier - feature a) in Claim 1 - is regarded as necessary. Moreover, there is no hint in D14 that, for any other reason, the compression/expansion should be continuously variable or that the number of discrete gain levels should be increased.

It follows that the problem underlying features b1), b2) and c) cannot be deduced from D14, let alone the features themselves. Thus the Appellant's contention that these features were obvious alternatives cannot be accepted by the Board.

4.8 The Board also notes that there is no reason for doubting the existence of the advantage associated with the claimed amplifier put forward by the Respondent, namely that the generation of spikes in the output signal is prevented.

4.9 Features d) and e) of requested Claim 1 include clarifications related to features identified earlier in the claim, thereby giving the principal design conditions of the multistage amplifier.

Observing finally that feature f) is neither disclosed in D14, nor rendered obvious by it, the Board is satisfied that the subject matter of Claim 1 involves an inventive step (Articles 52(1) and 56 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 with the order to maintain the patent on the basis of Respondent's request (see point IX above).

The Registrar:

The Chairman:

M. Beer

P.K.J. van den Berg