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Bezeichnung der Erfindung: Magnetic recording method and apparatus
Title of invention:
Titre de l'invention :

Klassifikation / Classification / Classement : G11B 5/02

ENTSCHEIDUNG / DECISION

vom / of / du 13 February 1989

Anmelder / Applicant / Demandeur : EASTMAN KODAK COMPANY

Patentinhaber / Proprietor of the patent /
Titulaire du brevet :

Einsprechender / Opponent / Opposant :

Stichwort / Headword / Référence : Magnetic recording/KODAK

EPÜ / EPC / CBE Art. 56

Schlagwort / Keyword / Mot clé : "Inventive step (yes)"

Leitsatz / Headnote / Sommaire

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Case Number : T 194/83 - 3.5.1

D E C I S I O N
of the Technical Board of Appeal 3.5.1
of 13 February 1989

Appellant : EASTMAN KODAK COMPANY
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Decision under appeal : Decision of Examining Division 067 of the European Patent Office dated 13 June 1983 refusing European patent application No. 80 400 464.6 pursuant to Article 97(1) EPC

Composition of the Board :

Chairman : P.K.J. van den Berg
Members : J.A.H. van Voorthuizen
G.D. Paterson

Summary of Facts and Submissions

I. European patent application 80 400 464.6 filed on 09.04.80 (publication No. 0 018 267) claiming a priority of 11.04.79 (US) was refused by decision of Examining Division 067 dated 13.06.83. That decision was based on Claims 1-2 filed on 27.01.83.

II. The reason given for the refusal was that the subject-matter of the application lacked inventive step having regard to the article by Kobayashi in "Digests of the Intermag Conference", 1978, IEEE, page 7-4 (document 1) and the article by Mallinson in "Proceedings IEEE", Vol. 64, No. 2, February 1976, p. 196-208 (document 2).

III. In arriving at this conclusion the Examining Division considered essentially that there exists a general trend to increase recording density and thereby extend playing time for which purpose a reproduction head having a sufficiently small gap length is essential because of the well known condition $g \leq \frac{\lambda}{2}$ (g = gaplength, λ = the recorded wavelength). In documents 1 and 2 the use of a gaplength of 0,3μm resp. 1/3μm was already mentioned to achieve operation at very short wavelengths. Although the length of the recording gap is not bound to this condition and relatively large gaps are often used, in view of the fact that combination heads are used in most video recorders a method of recording with a gap length less than 0,38μm would be the consequence when increasing the recording density.

IV. The Appellant lodged an appeal against this decision on 10.08.83. The appeal fee was paid on the same date. A Statement of Grounds was received on 14.10.83.

V. In the course of the procedure several communications were issued by the Board and replied to by the Appellant. Oral proceedings were held on 12.10.87. Subsequently the proceedings were continued in writing. The Board and the Appellant cited several further documents which will be referred to later in this decision as appropriate.

VI. The Appellant's arguments can be summarised as follows: By proposing a magnetic (or effective) gap length of less than 0,38μm for recording the Appellant has confronted the well established prejudice of utilizing as wide a gap as possible (typically a gap about as long as the coating thickness of the magnetic medium, if recording was the only consideration). The Appellant has shown that by using such a recording gap smaller than others would have contemplated, a completely unexpected improved performance at short wavelengths would be provided. With regard to documents 1 and 2 it was strongly contested that these documents disclosed the use of a magnetic gap length smaller than 0,38μ for recording purposes, it being well known that large discrepancies exist in practice between the magnetic and the physical gaplength (as measured e.g. optically) particularly for very small gaplengths. Therefore the classical formula $g_m = 1{,}12g_p$ (cf. Fan, "IBM Journal", October 1961, pp 321-325) cannot be applied. In practice g_m is always greater than $1{,}12g_p$ due to erosion and diffusion effects at the walls of the gap.

With regard to an existing trend to high density recording the Appellant argued that great improvements in this respect had been realized in the past but much more by decreasing the track width than by decreasing the recorded wavelength. An important advantage of the present invention is the higher output at short wavelengths which permits the use of smaller track widths.

VII. The Appellant requested by his main request the grant of a European patent on the basis of Claims 1-7 filed on 13.10.88 which Claims read as follows:

1. A method for short wavelength recording of information signals onto a magnetic medium composed of magnetic particles, comprising applying the signals to a gapped magnetic recording head and providing relative motion between the head and the medium, the length of the magnetic recording gap extending in the direction of relative motion, characterized in that the magnetic length of the recording gap is less than 0.38μm as related to the permeability of the magnetic medium.

2. The method according to Claim 1, wherein said information signals have a bandwidth in excess of one full octave.

3. The method according to Claim 1, further comprising the step of pre-emphasizing the high frequency components of said information signals prior to the recording thereof on said magnetic medium.

4. The method according to Claim 1, wherein said magnetic medium is comprised of magnetic particles having both cubic crystalline and acicular shape anisotropies.

5. Apparatus for short wavelength recording of information signals onto a magnetic medium composed of magnetic particles, comprising means for applying the signals to a gapped magnetic recording head and means for providing relative motion between the head and the medium, in which the magnetic length of the recording gap which extends in the direction of relative motion is characterized in that said magnetic length of the recording gap is less than

0.38μm as related to the permeability of the magnetic medium.

6. The apparatus according to Claim 5, characterized in that said head comprises a plurality of gapped magnetic cores adapted to record information signals in respective tracks of a multitrack magnetic medium and in that the magnetic gap length of each of said plurality of cores is less than about 0.38μmeters.

7. The apparatus according to Claim 5, characterized in that said means for applying information signals to said head is adapted to pre-emphasize the high frequency components of information signals.

The Appellant also filed an auxiliary request, but in view of what follows there is no need to refer to this further.

Reasons for the Decision

1. The appeal complies with Articles 106-108 and Rule 64 EPC and is therefore admissible.

2. In so far as the length of the recording gap is concerned it has been a long standing practice to choose one which is relatively large, mainly in order to provide a sufficient magnetization of the magnetic medium. Cf. in this respect Athey, "Magnetic Tape Recording", 1966, p. 68: "It is generally accepted that the factor which determines the recording resolution of the record gap is not the gap length but the sharpness of the trailing edge. ... The gap length has a secondary effect on the recording phenomenon ... In any case, the record gap is always considerably longer than the reproduce gap". When

discussing in more detail the influence of the gaplength on the recording process (p. 71-72) he states that the use of a narrow gap might even worsen short wavelength response and that a compromise between long and short wavelength response has to be found (considering also the bias signal level). Lowman in his book "Magnetic Recording" (1972) makes the same point where he states (p. 33): "Thus it is that the record gap width is a compromise between a wide gap, for strong recorded signals, and a narrow one, for definition of small increments of change." Furthermore Mee in his book "The Physics of Magnetic Recording", 1964, p. 245, states: "Hence no advantage is gained by the use of extremely narrow gaps for wideband recording". Equally Mallinson in doc. 2 (p. 197): "the gap length in the WRITE head is relatively large ..."

3. However, for reasons of costs and simplicity combined recording and reproducing heads have extensively been used. In determining the gaplength in such a head the well known condition for reproduction $g \leq \frac{\lambda}{2}$ has to be taken into account. Cf. Smaller, "IEEE Transactions on Magnetics", Vol. Mag-1, No. 4, December 1965 p. 361 who states that an optimal SNR is obtained when $g = \frac{\lambda}{2}$. Mallinson l.c. states: "READ head gap lengths are invariably smaller than one-half the minimum recorded wavelength in order to obtain satisfactory output spectra".

Kostyshyn, "IEEE Transactions on magnetics", Vol. Mag-7, No. 4, December 1971, p. 882 addresses the problem of designing a combination head and says: "A reasonable compromise is to choose the largest gap possible to maintain resolution of the fundamental defined by the shortest flux reversal the system will see".

4. The foregoing review of the prior art permits the conclusion that the person skilled in the art would not expect any advantage to accrue from the use of an extremely narrow recording gap.

5. In document 1, which is concerned with a video (= combination) head, a gaplength is mentioned of 0,3 ± 0,03μm. In document 2, p. 200, it is stated that "by using very small (1/3μm) gaplengths, satisfactory operation of REPRODUCE heads at very short (1/2μm) wavelengths is achievable..." It is to be noted that these gaplengths have to be understood as the physical gaplengths in the absence of any indication to the contrary.

6. The Appellant has cited a number of publications which all point out that in ferrite heads with glass filled gaps such as described in document 1 erosion and diffusion effects occur, which cause the real physical gap length to be greater than the one optically measured, due to the formation of transition layers in the gap. Consequently, the magnetic gap length would be greater than the one calculated according to the well known formula $g_m=1,12g_p$. Of these references three were published earlier than document 1: "Bulletin Jap. Soc. of Precision Eng." Vol 5/1971/No.4, p. 113/114, "Annals New York Academy of Sciences", Jan. 1972, pp. 171-191 and a paper by Kobayashi in a Japanese Journal, "Television Society Recording Conference Report", dated 23.3.1978, the latter containing a large number of references to further publications dealing with the same problem. This literature provides ample evidence that at the time of publication of document 1, it belonged to the normal knowledge of the person skilled in the art that in ferrite heads during their fabrication transition layers will develop leading to a wider gap than is optically measured and that great care has to be taken to avoid this as much as possible.

7. From document 1 it appears that its author was aware of the problem and did all he could to approximate a gap having a real physical length of 0,3μm, and he specifically claims to have removed the Beilby layer on the gap walls, and the residual stresses due to the machining process. However, the frequency characteristic which he presents does not enable the magnetic gap length that he obtained in reality to be ascertained, because he does not give the null frequency for the output signal.

8. In the light of the literature cited above the person skilled in the art would still expect a transitional layer, however thin, to exist at the ferrite-glass boundary as some mutual diffusion must necessarily occur. Document 1 does not mention any specific measure to avoid this. Even if the thickness of such a layer were estimated to be only 0.05μm on each side of the gap (cf. the article in "TV Society Recording Conference Report", figure 10, where a minimum value of 0.05μm is indicated) the actual magnetic gap length would be 0.41μm at least i.e. departing from a minimum physical gaplength g_p in accordance with D_1 of 0,3μm - 0,03μm = 0,27μm which has to be increased by the two said layers of 0,05μm on each side of the gap resulting in a physical gaplength g_p = 0,37μm which after application of the classical formula $g_m = 1,12 g_p$ gives a magnetic gaplength g_m = 1,12 x 037μm ~ 41,44μm. The Board has come to the conclusion, therefore, on the evidence at present available, that document 1 would not necessarily and unequivocally disclose to a person skilled in the art a head having a magnetic gap length less than 0.38μm.

9. The statement in document 2 quoted in paragraph 5 above does not refer to a possible use of such a gap length for

recording purposes. Moreover the considerations set out in paragraphs 6-8 apply also for this publication.

10. It follows that in the Board's judgement the use of a magnetic gap length of less than 0,38μm for recording purposes does not form part of the state of the art and is novel.

11. From the description and drawings of the present application it appears that the claimed invention was made in the context of short wavelength recording, and the surprising effect of recording with a magnetic gap length smaller than 0.38μm is present to an appreciable extent only at short recorded wavelengths, in particular wavelengths less than 1μm. From the explanations given by the Appellant at the oral proceedings it seems to follow that an optimum magnetic gap length of 0.38μm applies at the wavelength of 1μm, where the optimum recording gap length would be 0.25μm and the optimum read gap length 0.5μm.

12. Sugaya in "IEEE Transactions in Magnetics", September 1978, p. 632-637, discusses video tape recording and points out (p. 632-634) that increased recording density in the past has not only been obtained by the use of shorter recorded wavelengths but to a large measure also by the use of reduced track widths. While the track width in early machines around 1955 was about 400μm the modern VHS System in 1979 uses a track width of 30μm (NTSC) to 50μm (PAL). It follows from this that the use of shorter wavelengths cannot be considered the exclusive way of increasing recording density with the ensuing lower tape consumption per unit of time.

13. In the section "Conclusions" (p. 637) of the same article it is stated that "The minimum recording wavelength on

tape will be further reduced", which implies the use of smaller recording/playback gaps. The author adds, however, that "from a cost-performance point we are already approaching a good compromise point, unless there is a sudden breakthrough". There can be found no suggestion, either in this article or in any other of the numerous documents cited, that with a magnetic recording gap length less than 0,38μm a surprisingly good recording result is obtained, however arbitrary this value may appear at first sight.

14. As will be apparent from the reasoning developed in the foregoing paragraphs, the Board on its interpretation of documents 1 and 2 and taking into account also the teachings of a number of prior art documents which had not been introduced into the proceedings before the Examining Division, had to come to an assessment of the prior art and the inventive step involved in the claimed subject-matter which is different from that arrived at by the Examining Division.

15. The present claims seek protection for a magnetic recording method and apparatus in which a recording gap is used having a magnetic length lying between 0 and 0,38μm which constitutes a fairly broad range of values for the gap length. In contrast thereto the examples given in the description, which show the surprisingly good results being obtained, refer solely to a magnetic gap length of 0,3μm. The explanation given in the description on the basis of Fig. 2, however, indicates that the said effect is not bound to any particular gap length but is due to the use of a very small recording gap generally and prima vista there appears to be no reason to doubt that the asserted effect can be obtained throughout the whole claimed range. Therefore the Board considers that there is

sufficient support for the present claims in the application as filed.

16. The value of the magnetic gaplength for any particular magnetic head has to be assessed by a measuring method in which the null frequency of a reproduced signal is determined (cf. Athey p. 65-66). In this measurement the permeability of the magnetic medium enters (cf. Fan, p. 324). Therefore the magnetic medium which is used in the measurement has to be specified, which the Appellant has effected by stating in Claims 1 and 5 that "the magnetic length of the recording gap is less than 0,38μm as related to the permeability of the magnetic medium", i.e. the medium used in the claimed method and apparatus for the actual information signal recording/reproducing process. The Board considers this as a necessary and sufficient specification for the purpose of assessing the magnetic gaplength. The Board also considers that this addition with respect to the originally filed claims is allowable under Art. 123(2), because in the originally filed description it is stated that "the magnetic gap length equals the wavelength" (p. 2, lines 22-23) which in turn is defined as "the distance along the recording on the recording medium between successive similarly magnetized portions of the medium" (p. 1, lines 32-34).

17. For the foregoing reasons the Board is of the opinion that the independent Claims 1 and 5 are allowable. The same holds for the dependent Claims 2-4 and 6, 7 which describe further embodiments of the invention.

18. The amendments to the description filed on 31.01.83, 12.10,87 and 13.10.88 serve to put the invention in proper perspective with respect to the prior art. They are not open to objections.

19. However, a few small amendments are still required as follows:

p. 1, l. 21, insert after "No. SP-5038": (January 1966)
p. 5, l. 21 delete: "about"
p. 5, l. 25 delete: "about"
p. 7, l. 13 replace "on the order of 0,38μm or less" by : "less than 0,38μm"
Claim 6, last line, delete: "about"

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 grant a European patent on the basis of the following documents:

(a) Claims 1-7 filed on 13.10.88
(b) Description as amended on 31-01.83, 12.10.87 and 13.10.88, under the proviso that the amendments indicated in paragraph 19 above are introduced.
(c) Drawings as originally filed.

The Registrar: The Chairman:

S. Fabiani P.K.J. van den Berg