BESCHWERDEKAMMERN DES EUROPÄISCHEN PATENTAMTS

BOARDS OF APPEAL OF THE EUROPEAN PATENT OFFICE

CHAMBRES DE RECOURS DE L'OFFICE EUROPEEN DES BREVETS

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File Number: T 255/92 - 3.5.2

Application No.: 87 110 754.6

Publication No.: 0 256 356

Title of invention: A method of measuring the flying height of a slider in a moving magnetic storage apparatus

Classification: G11B 5/60

D E C I S I O N
of 9 September 1992

Applicant: International Business Machines Corporation

Headword:

EPC Articles 56, 111(1) and (2)

Keyword: "Inventive step - (yes)"
"Remittal to Examining Division for further prosecution"

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Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number : T 255/92 - 3.5.2

D E C I S I O N
of the Technical Board of Appeal 3.5.2
of 9 September 1992

Appellant : International Business Machines Corporation
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Decision under appeal : **Decision of Examining Division 067 of the European Patent Office dated 15 November 1991 refusing European patent application No. 87 110 754 pursuant to Article 97(1) EPC.**

Composition of the Board :

Chairman : E. Persson
Members : W.J.L. Wheeler
M. Villemin

Summary of Facts and Submissions

I. The appeal contests the decision of the Examining Division to refuse the Appellant's European patent application No. 87 110 754.6 on the ground that the subject-matter of Claim 1 (as amended during oral proceedings on 15 October 1991) did not involve an inventive step.

II. Claim 1 reads as follows:

"A method of measuring the absolute flying height of a slider (26) supporting a magnetic transducer (27) relative to a magnetic recording medium (10) in a moving magnetic storage system comprising the steps of:

producing relative motion between said magnetic transducer and said magnetic recording medium at a first velocity v so that the resulting air bearing positions a magnetic transducer slider at a first flying height from the recording medium;

writing a signal of constant periodicity T_1 over a predetermined area of said recording medium with said magnetic transducer;

sensing a readback signal at said first flying height and at a wavelength $W_1 = vT_1$ from said predetermined area of said recording medium with said magnetic transducer to produce a first readback signal;

sensing a readback signal at a substantially constant known flying height at said wavelength W_1 from said predetermined area of said recording medium to produce a second readback signal; and

calculating on the basis of the Wallace formula said first flying height relative to said known flying height from said first and second readback signals and a quantity representative of the wavelength W_1, said method being characterised by the further step of, prior to sensing said second readback signal, lowering the flying height of said magnetic transducer slider until it is substantially in contact with the recording medium by reducing said first velocity v to a second velocity v_2, so that said known flying height is zero and that said calculated first flying height is directly the absolute flying height of the slider."

III. The following prior art documents were considered in the proceedings before the Examining Division:

D1: R.L. Wallace, Jr.: "The Reproduction of Magnetically Recorded Signals", THE BELL SYSTEM TECHNICAL JOURNAL, October 1951, pages 1145 to 1173;

D2: US-A-4 146 911;

D3: F. Morris et al.: "Effect of flying height variation on offtrack data handling", IEEE TRANSACTIONS ON MAGNETICS, Vol. MAG-17, No. 4, July 1981, pages 1372 to 1375;

D4: W-K. Shi et al.: "Use of Readback Signal Modulation to Measure Head/Disk Spacing Variations in Magnetic Disk Files", The Center for Magnetic Recording Research, University of California, Contract UCB ENG-5730, Technical Report No. 11, December 1985.

IV. According to the reasons for the decision under appeal, Claim 1 was delimited in accordance with Rule 29(1) EPC with respect to document D1, which was considered to be the closest prior art. In the Examining Division's opinion, the claimed method solved the problem of measuring the spacing between the flying magnetic

transducer and the recording medium. D1 taught that with the head in contact with the recording medium the spacing loss was zero. It was trivial to calculate directly any head spacing from the recording medium on the basis of the Wallace formula, taking the in-contact amplitude as a reference. It was a matter of course to lower the flying height prior to sensing the signal. There was no technical prejudice against making in-contact measurements, since, although D2 said it was not usually practical to determine the in-contact amplitude and disclosed a method in which it was not necessary to do so, it did not exclude making in-contact measurements. Claim 1 did not recite any features for overcoming difficulties in reading at reduced speed. It was therefore assumed to be obvious to the skilled person how to do this, otherwise the claim would not contain all the technical features essential to the invention. Furthermore, it appears from the first paragraph on page 5 of the decision under appeal, that the Examining Division interpreted the phrase "substantially in contact with the recording medium" as covering cases in which no actual contact occurred.

V. The Appellant argued that the prior art documents D1, D2, D3 and D4 demonstrated that the skilled person was aware that the Wallace equation could be used to measure relative head-disk spacing and that the advantages of being able to make in situ measurements during the operational lifetime of the disk drive were appreciated. The prior art did not provide or suggest a practical method of calibrating the Wallace equation to obtain absolute flying heights without recourse to complicated optical equipment which could not be used in situ. Claim 1 was delimited against D3, not D1. Due to the age of D1, the technology was very different: there was no slider supporting a magnetic transducer and the head did not fly. The head-disk clearance was not measured, but was already

known from the thickness of paper shims introduced between the head and the medium. The characterising part of Claim 1 reflected the distinction between D3 and the present invention: the former calibrated using a glass disk whereas the latter obtained absolute values by measuring a reference signal at zero flying height. The phrase "in contact" was qualified by "substantially" only so as to cover any temporary separations between the head and the disk due for example to the head hitting a bump on the disk. Because flying height was often measured in order to allow head-disk contact to be avoided, the skilled person would be surprised that such contact was used in the measurement itself. In the invention, the head was lowered onto the disk surface by reducing the rotational velocity of the disk, thus greatly reducing the possibility of damage to the head or disk surface. The fact that Claim 1 did not recite special features for reading a signal at reduced velocity did not mean that the skilled person would not be surprised at the idea of obtaining an in-contact signal at reduced velocity. The conventional wisdom was that the number of extraneous variables in measurement systems should be reduced rather than increased and that disk drives could only be successfully operated at normal speed and flying height. Once the approach had been tried and found to be workable, the lack of special measures became an advantage, since it allowed implementation on a standard disk drive.

VI. The Appellant requested that the decision under appeal be set aside and the application allowed to proceed to grant. The Appellant also submitted a conditional request for oral proceedings if the Board was considering upholding the decision under appeal.

VII. In its present form, the application consists of:

Claims 1 to 12 as submitted and amended during the oral proceedings on 15 October 1991;

Description: pages 3 and 7 as filed with a letter dated 21 March 1991 (received 26 March 1991), and pages 1, 2, 4 to 6 and 8 to 14 as originally filed, pages 2 and 12 being amended as requested in the letter of 21 March 1991;

Drawings: sheets 1/4 to 4/4 as originally filed.

Reasons for the Decision

1. The appeal is admissible.

2. The Appellant and the Examining Division have expressed different interpretations of the phrase "substantially in contact with the recording medium" which appears in the characterising part of Claim 1. According to the Examining Division, the phrase covers cases where no actual contact occurs. According to the Appellant on the other hand, "in contact" is qualified by "substantially" only so as to cover any temporary separations between the head and the disk due for example to the head hitting a bump on the disk.

2.1 Although the Examining Division's interpretation might be possible if the phrase is considered in isolation, the phrase must, in the opinion of the Board, be construed in the context of Claim 1 read as a whole. When this is done, it is clear from the explanatory phrase at the end of the claim, namely "so that said known flying height is zero and that said calculated first flying height is directly the absolute flying height of the slider" that the second readback signal is meant to be obtained at zero flying

height, i.e. with the head in contact with the recording medium. This interpretation is fully consistent with the description, see the paragraph bridging pages 7 and 8 of the application as filed (lines 31 to 50 on page 4 as printed in EP-A2-0 256 356).

3. The Appellant and the Examining Division have expressed different opinions concerning the prior art. The Board has studied the documents D1, D2, D3 and D4. Their disclosure, insofar as relevant to the present case, is summarised below.

3.1 Document D1, cited by the Examining Division as the closest prior art, describes an experimental study of the effect of head/disk spacing in a magnetic disk drive. As described on page 1146, a single frequency recording was made with the head in contact with the disk and the level of the readback signal was measured, first with the head in contact, and then after introducing paper shims of various thickness between the head and the disk. The effect of spacing was measured at a particular frequency and recording speed and the process was repeated for other recorded frequencies and several record-reproduce speeds. D1 discloses a formula (referred to in the present application as the Wallace formula), according to which the spacing loss in decibels is proportional to the spacing and inversely proportional to the recorded wavelength. The spacing loss is zero at zero spacing (by definition).

3.2 Although it may be obvious that the Wallace formula disclosed in D1 can be used for calculating the head/disk spacing from measurements of the readback signal level, D1 does not disclose a method of measuring the absolute flying height of a slider supporting a magnetic transducer relative to a magnetic recording medium, as recited at the beginning of Claim 1.

3.3 Document D3 discloses a method for measuring the flying height of a slider supporting a magnetic transducer in a disk drive, involving the following steps:

producing relative motion between the transducer and the disk so that the slider flies on an air bearing over the disk;

writing a signal of constant wavelength over a predetermined area of the disk with said magnetic transducer;

sensing a readback signal at said constant wavelength from the predetermined area of the disk with the transducer to produce a first readback signal; and

calculating on the basis of the Wallace formula the flying height relative to a known steady state flying height (d0).

3.4 D3 does not disclose making any measurements with the head in contact with the disk. In the first paragraph on page 1374, it is stated: "The steady state flying height can be obtained either by measurement from glass disc or from theoretical calculation." According to the Appellant, the standard approach has been to perform calibration by replacing the normal disk by a glass disk and using optical instruments to measure the flying height, which is assumed to be the same for the glass disk and the magnetic disk. The pre-characterising part of Claim 1 is based on D3 (as read by a skilled person supplementing its rather general disclosure with his knowledge of the standard procedures).

3.5 Document D4 recognises the disadvantages of the optical calibration techniques (which require the disk drive to be disassembled so that such techniques cannot be used in product disk drives) and discusses the advantages of measuring relative flying height using the readback signal and the Wallace formula. There is no disclosure of making any measurements with the head in contact with the disk or of how to perform the calibration into absolute values.

3.6 Document D2 discloses a flying height control system incorporated in a product disk drive in which the head is maintained at a predetermined flying height based on the relative readback strengths of two signals of different wavelength. There is no disclosure of how the predetermined reference point is calibrated and no disclosure of making any measurements with the head in contact with the disk. In fact, when using the method disclosed in D2, there is no need to determine the in-contact amplitude (see column 4, lines 40 to 46).

3.7 Thus the skilled person was aware that the Wallace formula can be used to measure relative head/disk spacing in situ during the lifetime of a disk drive. However, there is no disclosure (explicit or implicit) in the cited documents of the idea of calibrating the Wallace formula by reducing the velocity of the relative motion between a flying transducer and the magnetic recording medium so as to lower the slider until it makes contact with the recording medium and sensing a readback signal at zero flying height for use as a reference.

4. Starting from prior art known from D3, the present invention solves the problem of directly measuring the absolute flying height between a magnetic transducer and the recording medium in situ in an operational magnetic storage system. This problem is more specific, and more

difficult to solve, than the one assumed by the Examining Division.

5. As noted in paragraph 3.7 above, there is no mention in any of the cited prior art documents of the basic idea behind the solution proposed by the present invention. The prior methods disclosed in D2, D3 and D4 avoid making in-contact measurements in situ, even though a theoretical basis for obtaining absolute flying heights using in-contact measurements as a reference has been known for a long time from D1 (published 1951). It therefore appears to the Board that Appellant is correct in arguing that persons skilled in the art have not considered making in situ in-contact readback measurements to be a practical option. Indeed, the purpose of measuring flying height is normally to allow it to be controlled to avoid head/disk contact. The Board is aware that it is conventional practice, when a disk drive is powered down, to park the heads in contact with the disk, usually in a specially designated landing area, but this is not done for the purpose of obtaining a reference point for measuring flying height. No readback is performed while the heads are in contact with the disk.

6. In the opinion of the Board, given these facts, it cannot have been obvious to obtain absolute flying height values by measuring a reference signal at zero flying height and reduced speed (cf. the characterising part of Claim 1).

7. The Board concludes that the subject-matter of Claim 1 involves an inventive step within the meaning of Article 56 EPC. Consequently, the decision under appeal must be set aside.

8. The Board has not examined the other claims (apart from checking that they are dependent on Claim 1) or the

description (apart from reading it to obtain an understanding of the invention) to see if they meet the requirements of the EPC, but makes use of its powers under Article 111(1) EPC to remit the case to the Examining Division for further prosecution.

9. For avoidance of doubt, it is pointed out that according to Article 111(2) EPC the Examining Division is bound by the present decision only to the extent that it has been decided that the subject-matter of Claim 1 as amended during the oral proceedings held before the Examining Division on 15 October 1991 involves an inventive step over the prior art considered in the present decision.

Order

For these reasons, it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the Examining Division for further prosecution.

The Registrar: The Chairman:

M. Beer E. Persson