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D E C I S I O N
of 14 February 2001

Case Number: T 0287/00 - 3.4.2

Application Number: 91901109.8

Publication Number: 0605409

IPC: G01N 15/00, G01N 29/02

Language of the proceedings: EN

Title of invention:
Method and apparatus for deteriming particle size distribution
and concentration in a suspension using ultrasonics

Patentee:
Malvern Instruments Limited

Opponent:
Prof. Dr. Ulrich Riebel

Headword:
-

Relevant legal provisions:
EPC Art. 54, 56

Keyword:
"Novelty - yes"
"Inventive step - yes"

Decisions cited:
-

Catchword:
-

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Beschwerdekammern   Boards of Appeal   Chambres de recours

Case Number: T 0287/00 - 3.4.2

D E C I S I O N
of the Technical Board of Appeal 3.4.2
of 14 February 2001

Appellant: Prof. Dr Ulrich Riebel
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Respondent: Malvern Instruments Limited
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Decision under appeal: Decision of the Opposition Division of the
                                  European Patent Office posted 22 December 1999
                                  rejecting the opposition filed against European
                                  patent No. 0 605 409 pursuant to Article 102(2)
                                  EPC.

Composition of the Board:

Chairman: E. Turrini
Members: M. A. Rayner
                B. J. Schachenmann

Summary of Facts and Submissions

I.   The appellant (=opponent) has appealed against the decision of the opposition division rejecting the opposition against European patent number 605 409 (application number 91 901 109.8, International Publication Number WO-A-91/07646). The appellant requested that the patent be revoked and on an auxiliary basis oral proceedings. Reference was made in the decision to, inter alia, the following documents:-

D1: DE-A-34 38 798 (=US-A-4 706 509)

D4: Dissertation of Ulrich Riebel; Die Grundlagen der Partikelgrößenanalyse mittels Ultraschallspektrometrie", 1988

The opposition division found that the subject matter of claim 1 was novel over both document D1 and D4 and involved an inventive step because the method according to the invention allows consideration of different attenuation spectra which each may relate to different physical circumstances so that various effects following from for example different degrees of concentration or chemical compositions may be taken into account. The opposition division considered that the estimate of a start value by skilled person could never amount to the confidence of actual calculations of start values.

II.   The appellant requested that the decision be set aside and the patent revoked and on an auxiliary basis oral proceedings. The appellant submitted that the mathematical part of claim 1 amounts to no more than an iteration as known to every scientist and engineer.

Attention was directed to page 78 of document D4 and reference was made to the matrix equation m=Kg on page 42 of document D4, m being submitted as nothing other than an attenuation spectrum. An estimation algorithm is described in pages 73ff and with reference to the capability of the alert observer an attenuation spectrum is calculated. It is apparent from page 73, that there are a plurality of possible distributions. Claim 1 thus amounts to a wordy generalisation of the initial step of an iterative method, about which not much fuss is made in document D4, where the experienced observer forms a set of spectra in his mind or otherwise.

III.   The respondent (=patent proprietor) requested that the appeal be dismissed and on an auxiliary basis oral proceedings. In the respondent's view, the patent requires the calculation of a library of attenuation spectra and the derivation of an approximate match to at least one of these calculated with actual measured attenuation spectra and using the corresponding particle size distribution and concentration as the starting point for deriving a better match to the measured attenuation spectra. This is simply not shown in document D4. The respondent also requested an apportionment of costs in his favour because of considerable time and effort spent responsive to frivolous attacks of the appellant.

IV.   Oral proceedings were appointed, consequent to the auxiliary requests of the parties, on the date fixed by the summons. In its preliminary opinion, the board informed the parties it had not identified any reason which might have lead to an apportionment of costs different from that mentioned in Article 104(1) EPC.

Moreover, it seemed doubtful whether the estimate of the expected result made by the alert observer according to the teaching of document D4 is the same as "calculating a set of attenuation spectra" according to claim 1.

V.   During the oral proceedings, the appellant explained that according to the first paragraph of page 81 of document D4 in relation to equations 4.41-4-43, the location parameter of each estimated constituent particle size normal distribution is varied. The position parameter giving rise to the minimum defect is selected. A set of attenuation spectra deriving from the different positions is therefore calculated. The claim of the patent in dispute is not limited to a set of pre-existing spectra in a library nor is there in any case a limit on the order of the method steps or how these are carried out. Moreover, both a sequentially calculated and a pre-existing set are disclosed by the "selecting" according to page 81 of document D4 , any difference being trivial and making no difference in a practical computer calculation. Since, as can be seen from the last paragraph on page 66, the locations can in principle be varied in a random fashion, the calculation producing a minimum defect also does not mean that the calculation becomes locked into optimising a particular maximum of a curve to the detriment of other maxima. No underlying physics at all is present in the claim. Nor does the claim specify how an iteration based on the "new" values is to be carried out. A strict novelty analysis thus shows the subject matter of claim 1 to lack novelty.

If the board considered novelty to be provided by calculating a set of attenuation spectra, then the

problem to be addressed in relation to document D4 is the avoidance of false maxima. According to document D4 the variation of the position parameter can be random, it is thus obvious that the method is not limited to particular positions which could be false maxima. Just as in the patent in dispute, the teaching of document D4 results in a movement from a course to a fine result. In the patent in dispute there is, moreover, no specification of the "set" in terms of physical parameters, so it is not even certain that a problem of finding minima in a hyperspace is even really solved at all by the claimed features.

VI.   The respondent made four auxiliary requests for amendment of the patent and a fifth auxiliary request for referral to the first instance. The respondent argued that according to the claimed method a set of attenuation spectra was required, there was not just one starting point as in the D4 disclosure. No single matrix applies for all materials. In the invention minima in a complicated hyperspace could be found. Therefore a wide variety of physical circumstances could indeed be dealt with. The respondent submitted some graphs relating to attenuation spectra in support of his position.

VII.   The independent claims according to the main request of the respondent are worded as follows:

1.   A method of determining the size distribution and concentration of particles in a suspension (12) of particles in a suspending medium, including the steps of directing ultrasonic waves through said suspension (12) at selected discrete frequencies over a selected frequency range and measuring the attenuation of said

ultrasonic waves passing through said suspension (12)
for each of said selected discrete frequencies to
thereby obtain a measured attenuation spectrum for said
suspension (12) over said selected frequency range
(54,76) characterized by the steps of:

calculating a set of attenuation spectra for the
ultrasonic waves passing through said suspension over
said selected frequency range (50,78);
comparing said measured attenuation spectrum with said
calculated attenuation spectra to derive an approximate
match between at least one of said calculated spectra
and said measured spectrum within a selected error
range (60,80); and
selecting the particle size distribution and
concentration used to calculate said attenuation
spectra (62,86) to thereby derive a new set of values
of particle size distribution and concentration
corresponding to said measured attenuation spectrum
(64,84).

10. A method of determining the size distribution and
concentration of particles in a suspension (12) of
particles in a suspending medium, including the steps
of directing ultrasonic waves through said suspension
(12) at selected discrete frequencies over a selected
frequency range and measuring the attenuation of said
ultrasonic waves passing through said suspension (12)
for each of said selected discrete frequencies to
thereby obtain a measured attenuation spectrum for said
suspension over said selected frequency range (54,76),
characterised by the steps of:

making a preliminary approximation of the particle size
distribution based on said measured attenuation

spectrum (58,86);
calculating a set of attenuation spectra for the
ultrasonic waves passing through the suspension (12)
over the selected frequency range (50,78);
storing a plurality of algorithms and sequences of
algorithms for calculating the size distribution and
concentration from the measured attenuation spectrum,
each of said algorithms being preferred for a
predetermined set of conditions;
selecting from said plurality of stored algorithms and
sequence of algorithms at least one of the algorithms
and the sequences of algorithms for a predetermined
size distribution represented by said preliminary
approximation;
matching, according to the at least one selected
algorithms and sequences of algorithms, said calculated
attenuation spectra with said measured attenuation
spectrum (82); and
utilizing said selected algorithm to determine the size
distribution and concentration of said particles in
said medium (64,84).

11.   An apparatus for determining the size distribution
and concentration of particles in a suspension (12) of
particles in a suspending medium, including means
(10,14) for directing ultrasonic waves through said
suspension (12) at selected discrete frequencies over a
selected frequency range and means (28) for measuring
the attenuation of said ultrasonic waves passing
through said suspension (12) for each of said selected
discrete frequencies to thereby obtain a measured
attenuation spectrum for said suspension over said
selected frequency range, characterized by
means (34) for calculating a set of attenuation spectra
for ultrasonic waves passing through said suspension

(12) over said selected frequency range, for
numerically comparing said measured attenuation
spectrum with said calculated spectra to derive an
approximate match between at least one of said
calculated spectra and said measured spectrum within a
selected error range and for selecting the values of
particle size distribution and concentration used to
calculate said attenuation spectra to thereby derive a
new set of values of particle size distribution and
concentration corresponding to said measured
attenuation spectrum.

VIII.   At the end of the oral proceedings, the board gave its
        decision.

Reasons for the Decision

1.   The appeal complies with the provisions mentioned in
        Rule 65(1) EPC and is therefore admissible.

2.   *Amendments - main request*

        Since the patent, including the granted claims, has not
        been amended, no question in relation to Article 123(3)
        arises. With respect to Article 123(2), admissibility
        of amendments made during examination proceedings have
        not been part of the opposition or appeal proceedings.

3.   *Novelty - main request*

3.1   Document D1 discloses a method of ultrasonic measuring
        of solid concentration and particle size distribution
        in a suspension. The suspension is excited by a
        plurality of ultrasonic waves of different respective

frequencies f_j and the absorption of the wave is measured for each frequency. As particles of each dimensional interval contribute in the absorption in correspondence with the coefficient of absorption for this frequency and interval, the overall absorption measured A_j represents the sum across all particle size intervals. If the overall dimensional spectrum of the solid particles is divided into n intervals, n unknown concentrations c_j of solid particles each for a dimensional interval Δx_j are determined. A plurality n of frequencies f_j are used for radiation producing a linear system of equations for an unambiguous solution, whereby under favourable or unfavourable boundary condition a smaller or greater number, respectively, is used. The absorption measured is expressed as follows:

$$A_j = \sum_{i=1}^{n} a_{ij} c_i$$

The linear equation system is solved in a known manner for c_i.

3.2   The subject matter of claim 1 differs from this disclosure by virtue of the step relating to calculating a set of attenuation spectra and consequentially their comparing in the comparing step.

3.3   Document D4 is a document of over 150 pages which addresses the fundamentals of particle size analysis by means of ultrasonics. Several aspects of this field are discussed, such as the basic physics and experimental setup. Linear methods of mathematical analysis, similar to the disclosure of document D1, are also discussed.

The disclosure concentrated upon by the appellant in the present appeal case is however that relating to non linear methods for determining the solution vector g. The scene is set in this respect on page 65, where it is explained that several non linear methods for solution are available, these being characterised by the solution being produced from a given start value by stepwise modification. At the sth step, the original measured values vector and the sth measured values vector deriving from the solution of the sth step are compared. The way the comparison is carried out and the result used in the subsequent step differentiates the various iteration algorithms.

3.4   A relaxation method is discussed on page 66 et seq. The start data is specified as the same as that shown in Figure 4.1. The method involves determination of an error function deriving from a step involving a solution for a small change. This error function is compared with that of the previous step and if smaller the solution is taken over, otherwise that of the previous step is retained. The only criterion for continuing or breaking off the iteration is that the error becomes smaller, there are no restrictions on the small change, which can be completely random and selected on the basis of success. A multiplication or division of the vector components is suggested for example. The second method discussed is based on the Chahine algorithm (see page 71 et seq.), where beginning from a freely assumed start value the comparison of step results leads to a calculation of the next change to be made, the direct allocation of vector components not however checking whether an error reduction really occurs. Viable results are only produced if the components of principle diagonal of the

coefficient matrix are greater than the sum of the contributions of all the other components on the corresponding line. As a rule however, ultrasonic components are far removed form this situation. The third method (see page 73 et seq.) is an iterative estimation algorithm. This algorithm relies on the ability of an alert observer to estimate the expected result directly from the measured values. Starting with the estimated values, the algorithm allocates a normal distribution in the measured values vector to a normal distribution in the size distribution. A linear superposition of a finite number of normal distributions is used to reproduce distributions of any type. The iteration terminates when changes in the particle concentration and size distribution become small. Finally, a combination of the various algorithms (see page 80 et seq.) leads to a modified estimation algorithm. In this case the position parameter of each estimated grain size normal distribution is varied enabling use of the relaxation method with a significantly reduced number of matrix operations.

3.5 The subject matter of present claim 1 differs from the disclosure of document D4 relating to the non linear methods by virtue of the feature relating to calculating a **set** of attenuation spectra (see also for example block 50 in figure 3 or block 72 in Figure 6 and the reference to a set in the associated description) and consequentially their comparing in the comparing step. Accordingly, the kickoff point of the method according to claim 1 of the patent in dispute is different. This is because a set is not just a **single** (assumed or estimated) spectrum which is sequentially iterated according to the non linear methods as is disclosed in document D4.

3.6   The board cannot, therefore, concur with the submission
        of the appellant that the individual steps in the
        sequential iteration steps of document D4 amount to
        calculating a set of attenuation spectra. The very
        nature of an iteration is sequentially to move ever
        closer to the solution meeting the termination
        condition and then stop. Therefore, according to
        document D4, a step result, dependent on the error
        function, either displaces the single "best yet" step,
        is rejected before the next step (see the five lines
        under equation 4.26) or meets the termination condition
        and is then the result (see for example the nine lines
        under equation 4.26 or the five lines under
        Figure 4.12). Therefore, according to the disclosure of
        document D4 no set of attenuation spectra within the
        meaning of claim 1 is calculated.

3.7   The board considers the submission of the appellant
        that both a setwise and sequential calculation are
        disclosed in document D4 to be in error as it is, as
        can be seen from the foregoing, of the view that only
        the latter alternative is disclosed. Moreover, the
        submission that it makes no difference in a computer
        which way the calculation is effected does not expand
        the disclosure of document D4 to include a setwise
        calculation because no details of such a computer are
        given. Furthermore, calculating a set of attenuation
        spectra is in itself a "step" in the method of claim 1,
        it does not read onto interleaving the calculation of
        an individual spectrum with an individual comparing and
        matching step. A strict analysis of novelty in this
        respect as requested by the appellant thus indicates
        that novelty is present.

3.8   Finally, the board concurs with the assessment of the

opposition division that the capability of the alert
observer to estimate an attenuation spectrum is not the
same as calculating a set of attenuation spectra. The
same comment applies to an assumed spectrum.

3.9   Independent claims 10 and 11 also contain a novel
        feature relating to calculating a set of attenuation
        spectra. Accordingly, the subject matter of claims 1,
        10 and 11 (and that of the remaining claims, which
        depend from these claims) satisfies the novelty
        requirement of Article 54 EPC.

4.   *Inventive step - main request*

4.1   Only documents D1 and D4 were relied on by the
        appellant in the appeal proceedings. Document D1 had
        been taken to represent the closest prior art in the
        proceedings before the first instance, but this
        document was only mentioned in the appeal proceedings
        in the context of it being an extract out of the
        scientific presentation of document D4. Having regard
        to both documents D1 and D4, the board reached the view
        that calculating a set of attenuation spectra and
        comparing the measured spectrum with the calculated
        spectra enables a wider range of starting points to be
        taken into consideration because each spectrum in the
        set represents a different starting point. Therefore,
        the problem solved by this novel feature can be
        considered to be that of providing a method capable of
        dealing with a wider variety of initial conditions (for
        example 100 to 500 monosize increments are mentioned in
        line 18 on page 13 of the patent).

4.2   The linear method of document D1 offers no hint in this
        direction and indeed the appellant has not made

submissions in this direction during the appeal
proceedings. The board therefore reached the conclusion
that an inventive step is present over the disclosure
of document D1.

4.3   According to document D4 in relation to the modified
        estimation algorithm a starting point is taken based on
        an estimate of the skilled observer (for other
        algorithms it is assumed). The iterations, whatever
        their basis of selection (including varying position
        parameter), result from adapting this starting point
        stepwise towards the solution and do not involve a
        setwise procedure. The D4 procedure is much more like
        that explained in lines 28 et seq. on page 13 of the
        patent. Subject matter as disclosed in lines 9 to 23 on
        page 13 (set of spectra) on the other hand is simply
        missing from the disclosure of document D4. Therefore,
        a variety of start points, like the monosize
        increments, represented by spectra outside the
        framework defined by the estimate (or assumption) is
        not used, i.e. a variety of **initial** conditions is not
        dealt with. The remark that difference is trivial does
        not bear on the issue of inventive step, which turns on
        whether the claimed subject matter can be reached in an
        obvious way from document D4. The board also agrees
        with the opposition division that the estimate of a
        skilled person could never amount to the confidence of
        actual calculations of start values. In the view of the
        board, it is not just that no fuss is made about the
        set of attenuation spectra in document D4, the reality
        is that this is not there.

4.4   The submission that a computer can process the
        iterations in parallel does not persuade the board as
        to lack of inventive step. General computer techniques

for efficient processing such as parallel or pre-
emptive calculation can be used in any computer based
process, but this is for carrying out the process
concerned. In the present case, the process is the
method explained in document D4, where a step
involving parallel processing of a set iteration step
candidates, would run counter to the disclosure
concerned by vitiating the stepwise sequence required
in proceeding towards the result. This is because in
the context of document D4 irrelevant open ended
calculations would be necessary, which would delay
termination of the iteration. Finally, the submission
that the patent in dispute and the teaching of document
D4 (and many other things) involve going from the
general to the specific may be true, but it does not
bear on the novelty or inventive step of the claimed
subject matter.

4.5   The questions of whether physical parameters should be
        recited in the claim and how the subject matter claimed
        should interface to the iteration relate to subject
        matter falling within the ambit of Article 84 EPC. In
        opposition (and appeal proceeding therefrom), the
        granted claims are not open to opposition on the
        grounds of non compliance with Article 84 EPC.
        Therefore, whatever the doubts of the board on this
        issue might be, the submissions of the appellant in
        this direction are not relevant in the present
        proceedings, it having been shown that the case of the
        appellant on the substantive issues of novelty and
        inventive step fails.

4.6   In view of the foregoing, the subject matter of claim 1
        is considered to involve an inventive step within the
        meaning of Article 56 EPC. Since claims 10 and 11 also

contain corresponding subject matter (the feature
relating to calculating a set of attenuation spectra),
the same applies to these claims as well as to
dependent claims 2 to 9, 12 to 13 by virtue of their
dependence.

5.   *Apportionment of costs*

Article 104(1) EPC provides for each party to the
proceedings meeting the costs it has incurred. Any
departure from this principle for reasons of equity
requires special circumstances, such as costs being
culpably incurred owing to improper behaviour or abuse
of the proceedings. Contrary to the argument of the
respondent, an abuse cannot be based on the fact that
the attacks of the other party cause time and effort
for the respondent. A party of the opinion that a
decision of the opposition division is wrong is
entitled to file an appeal according to the first
sentence of Article 107 EPC and to submit arguments
which it believes to be helpful for its case and also
to request oral proceedings according to Article 116(1)
EPC with a view to trying to convince the board that
its appeal has to be allowed. The appellant has not
moved outside this framework. Consequently, no improper
behaviour or abuse justifying a different apportionment
of costs has taken place in the present case.

6.   Since the board is positive in respect of the main
request of the respondents, consideration of the
auxiliary requests is not necessary.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

P. Martorana   E. Turrini