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D E C I S I O N
of 24 October 2002

Case Number: T 0782/98 - 3.4.1

Application Number: 92916035.6

Publication Number: 0746774

IPC: G01R 33/20

Language of the proceedings: EN

Title of invention:
Detection of explosive and narcotics by low power large sample volume nuclear quadrupole resonance (NQR)

Applicant:
THE GOVERNMENT OF THE UNITED STATES OF AMERICA, as represented by THE SECRETARY OF THE NAVY

Opponent:
-

Headword:
Detection of explosives and narcotics by low power ^{14}N nuclear quadrupole resonance

Relevant legal provisions:
EPC Art. 54(3) and (4), 56

Keyword:
"Novelty (no - main request; claimed device comprised in the content of an earlier European application)"
"Inventive step (no - auxiliary request)"

Decisions cited:
-

Catchword:

-

Case Number: T 0782/98 - 3.4.1

D E C I S I O N
of the Technical Board of Appeal 3.4.1
of 24 October 2002

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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 25 March 1998 refusing European patent application No. 92 916 035.6 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: G. Davies
Members: H. K. Wolfrum
R. Q. Bekkering

Summary of Facts and Submissions

I. European patent application 92 916 035.6 (publication No. 0 746 774) was refused by a decision of the examining division posted 25 March 1998, on the grounds of lack of novelty within the meaning of Articles 52(1) and 54(3) and (4) EPC and of lack of inventive step (Articles 52(1) and 56 EPC).

The examining division considered the teaching of the earlier International application:

D1: WO-A-92/21987

to be detrimental to the novelty of the subject-matter of the independent method claim then on file. Moreover, the examining division held that the subject-matter of all claims on file was the result of an obvious combination of the teachings of documents:

D2: JOURNAL OF MOLECULAR STRUCTURE, vol. 58, 1980, T. Hirschfeld et. al.: "Short range remote NQR measurements", pages 63 to 77;

D3: US-A-4 514 691; and

D4: JOURNAL OF MAGNETIC RESONANCE, vol. 92, No. 2, 1991, M. L. Buess et. al.: "NQR detection using a meanderline surface coil", pages 348 to 362.

II. The appellant lodged an appeal against the decision on 25 May 1998 and paid the prescribed fee. On 22 July 1998 a statement of grounds of appeal was filed.

III. Oral proceedings were held on 24 October 2002 at the request of the appellant.

IV. The appellant requested that the decision under appeal be set aside and that a patent be granted, according to a main request, on the basis of claims 1 to 9 filed on 24 September 2002 as then a third auxiliary request and, according to an auxiliary request, on the basis of claims 1 to 8 filed in the oral proceedings.

V. Independent claims 1 and 9 of the **main request** read as follows :

"*1. A method of detecting a class of explosives and narcotics containing nitrogen in a specimen by nuclear quadrupole resonance, comprising the steps of:*

(a) generating a train of radio frequency pulses having a predetermined frequency;

(b) transmitting said train of radio frequency pulses to a coil;

(c) irradiating the specimen with an rf field of predetermined strength in response to said train of radio frequency pulses to said coil at said step (b), said specimen having a local magnetic field due to dipole-dipole contributions;

(d) detecting an integrated nitrogen signal in response to irradiating the specimen at said step (c);

(e) receiving said integrated nitrogen signal detected at said step (d);

(f) comparing said integrated nitrogen signal to a predetermined threshold value; and

(g) signalling when said integrated nitrogen signal exceeds said predetermined threshold value; characterized in that the strength of said predetermined rf field and said local magnetic field is

at a ratio of 1:1 to 10:1.

9. A system for carrying out the method of claim 1 said system including:

a coil of predetermined size for irradiating the specimen with a train of radio frequency pulses of predetermined frequency and detecting an integrated nitrogen signal in response to irradiating the specimen;

pulse generating means for generating said train of frequency pulses;

coupling means for transmitting said train of radio frequency pulses to said coil and receiving said integrated nitrogen signal from said coil;

comparing means for comparing said integrated nitrogen signal to a predetermined threshold value;

characterized in that said pulse generating means is capable of causing said coil to irradiate said specimen with an rf field having a strength which is from about equal to the strength of the local magnetic field of said sample up to 10 times the strength of the local magnetic field of the specimen."

The **auxiliary request** does not contain device claims. Its claims are identical to the method claims 1 to 8 of the main request.

VI. The appellant's submission in support of its requests may be summarized as follows:

The invention was based on the recognition that nuclear quadrupole resonance (NQR) experiments for the detection of explosives and narcotics could be successfully performed with rf magnetic fields which were much lower, ie by one or two orders of magnitude, than the fields previously required and were in fact comparable to the strength of local magnetic fields. Very surprisingly, the strength of the detectable NQR signal did not drop linearly with decreasing strength of the rf field. The invention allowed to use larger coils with lower power consumption and thus to detect small quantities of nitrogenous explosives or narcotics in a large volume of material, as required for instance for luggage inspection.

Document D1 did not teach to perform an NQR experiment with an rf field which was so low that the ratio of its strength to that of the local magnetic field was in a range of 1 : 1 to 10 : 1, as specified in claims 1 and 9 of the main request as well as claim 1 of the auxiliary request. Hence the claimed method was novel with respect to the content of the earlier International application according to D1.

To perform an NQR experiment within the claimed range was not known from documents D2 and D4 either:

As far as document D2 specified values of the strength of the rf field actually employed, it could be inferred from the reference to the excitation by "ð/2" pulses of 50 µs length at the top of page 68 that an rf field of approximately 11 Gauss (G) was used, which, in the case of the explosive RDX (having a local field of 0.13 G), provided a ratio of about 85 : 1. Insofar as D2 showed in Figure 4 the contour lines of a field pattern obtained with a remote coil shown in Figure 3, it was stated that the coil was not optimum and that it did not produce an optimum rf field intensity. Thus, D2 actually taught away from the invention. But even if the skilled person contemplated performing an experiment with an rf field indicated in Figure 4, it was clear from the cross-hatched region shown in this figure that the field values would vary between 2.1 and 2.7 G, providing a range of ratios of 16 : 1 to 21 : 1, in case of RDX, and 66 : 1 to 84 : 1, in case of TNT (having a local field of 0.032 G).

Document D4 mentioned a field strength of 1.7 G. However, it was indicated that, in the region containing the sample, the average field strength was nearly twice as large. Moreover, the measurement was done on sodium nitrite ($NaNO_2$, having a local field of 0.31 G), which was neither an explosive nor a narcotic, and the ratio for this chemical was 11 : 1, ie outside the claimed range. If an actual explosive such as RDX were used, the ratio would be significantly higher (26 : 1). Furthermore, the method known from D4 was suitable only for probing a sizeable surface area to a very limited depth, whereas the invention was concerned with searching large volumes.

In summary, the cited prior art did not teach the average skilled person, who was a chemist or physicist familiar with nuclear magnetic resonance as an analytical tool, to detect explosives or narcotics by NQR at the extremely low rf fields claimed (document D3 did not refer to NQR measurements at all), notwithstanding the fact that he would have wished, for obvious reasons, to save power. On the contrary, the prior art led the skilled person to think that substantially higher rf fields were required in order to observe the relatively weak NQR signals. Thus, in the present case, although the skilled person knew the art of reference and probably was aware of the problem to be solved, he did not know nor learn the claimed solution.

Reasons for the Decision

1. The appeal complies with the requirements of Articles 106 to 108 and Rule 64 EPC and is, therefore, admissible.

2. *Amendments*

Independent claims 1 of the main and auxiliary requests correspond in substance to original claim 5. Dependent claims 2 to 8 of both requests correspond to original claims 7 to 12 and 6, respectively.

Claim 9 of the main request is based on original claim 18, from which an apparently insignificant feature concerning the provision of an alarm for signalling the detection of an explosive or narcotic has been deleted.

The Board is thus satisfied that the amendments comply with the requirements of Article 123(2) EPC.

A. Main request

3. *Novelty*

3.1 Claim 1

Document D1 has a publication date of 10 December 1992 and claims a priority date of 23 May 1991 which lies before the priority date 16 July 1991 of the present application. The same states (ie AT, DE, FR, GB and IT) as for the present application were designated in the international application. Furthermore, the application according to D1 satisfies the requirements of Article 158(2) EPC. According to Article 158(1) EPC, D1, therefore, constitutes prior art within the meaning of Articles 54(3) and (4) EPC.

D1 (see in particular claims 1 and 21; and Figures 1 to 3 and 5 with the corresponding description) discloses a method of detecting a class of explosives and narcotics by NQR according to the preamble of claim 1 and discusses some of the relevant parameters of the NQR measurement. However, although reference is repeatedly made to the desire to minimize rf power deposition into the body under examination (see page 2, line 39 to page 3, line 5; page 3, lines 38 to 40; and page 7, lines 34-40), D1 does not provide any explicit data concerning the strength of the rf field.

In view of the absence from D1 of any specific disclosure concerning the strength of the rf magnetic field, the Board does not concur with the examining division in its finding of lack of novelty for the subject-matter of the independent method claim 1 of the main request. In fact, the Board is not convinced that it can be argued that the skilled person using the method according to D1 would inevitably choose an rf field strength corresponding to a ratio within the claimed range.

Since, moreover, none of the other documents of the available prior art discloses a method comprising all the features of claim 1 under consideration, the claim has to be regarded as defining novel subject-matter.

3.2 Claim 9

D1 (see in particular Figure 1) discloses also a system for carrying out a method of detecting a class of explosives and narcotics containing nitrogen including a coil, pulse generating means, coupling means and comparing means within the meaning of the preamble of claim 9 under consideration.

Moreover, the pulse generating means of the NQR detecting system according to D1 are perfectly capable of causing, in accordance with the characterising clause of claim 9, the coil to irradiate the specimen with an rf field having a strength which is from about equal to the strength of the local magnetic field of said sample up to 10 times the strength of the local magnetic field of the specimen, since it is an inherent feature of such pulse generating means that the pulse amplitude can be set to any desired level within a range from zero to a maximum value determined by the capabilities of the rf power amplifier.

It follows that, as far as the technical elements and their functional capabilities are concerned, the claimed system does not differ from that described in D1. This finding was indeed acknowledged by the appellant.

Finally, the phrase "a system for carrying out the method of claim 1" cannot be considered to render the claimed system as such new because novel details of a method of operating a device cannot be considered to constitute novel device features as long as the corresponding structural elements of the known device are capable, without any technical modification, of being operated in the novel manner.

Consequently, the subject-matter of claim 9 under consideration lacks novelty within the meaning of Articles 52(1) and 54(3) and (4) EPC in conjunction with Articles 158(1) and (2) EPC.

3.3 The main request is therefore not allowable.

B. Auxiliary request

4. *Inventive step*

4.1 From document D2 (see in particular pages 64 to 68 and the chapter "Experimental Results" at pages 74 to 77) a method of detecting explosives and narcotics by NQR is known which employs features (a) to (e) of claim 1 under consideration. Specific explosives under examination are TNT and RDX. In fact, the results of two experiments are presented, which mainly differ in the type of the coil used for irradiating the specimen and detecting the NQR signals: a spectrometer with a solenoid coil, which is capable of producing an rf magnetic field of about 20 G in a cylindrical sample (see page 66, last paragraph), or a remote system, in which the solenoid coil is replaced by a remote coil in the form of a ribbon pancake coil (see page 68, third paragraph and Figure 3). With respect to the latter system, it is indicated in Figure 4 that the strength of the rf magnetic field generated by the remote sampling geometry drops over a sample region extending away from the coil from a value of 3.3 Oe closer to the coil to 0.9 Oe further away from the coil (corresponding to a variation of the magnetic flux density between 3.3 G and 0.9 G). Figures 9 and 10 show experimental results obtained with the remote sampling geometry for the explosive RDX.

4.2 The field range disclosed in Figure 4 of D2 corresponds to a calculated range of 6.9 : 1 to 25.4 : 1 for the ratio to the strength of the local field in RDX, ie a range, the lower end of which overlaps the claimed range.

Even if, for the sake of the argument, the skilled person took into consideration only the field range of 2.1 to 2.7 Oe, accentuated in Figure 4 by crosshatching, the resulting ratio would vary between 16.1 and 20.8 and thus be still close to the range specified in claim 1 under consideration. Thus, contrary to the appellant's submission that the prior art used rf fields which were one or two orders of magnitude higher than those applied in the invention, D2 provides evidence as to the technical feasibility of detecting explosives by NQR of ^{14}N nuclei at much smaller rf fields. Apart from that, Figure 4 of D2 shows that a substantial part of the sample (indicated as "1st sample") is placed in much lower rf fields outside said crosshatched region.

4.3 Confirmation for the fact that NQR detection of ^{14}N nuclei can indeed be performed at relatively low rf fields is given by document D4. D4 (see in particular pages 348, 349, 353, 356 to 359) reports the results of NQR experiments performed on sodium nitrite ($NaNO_2$) with a meanderline surface coil and compares these results with those obtained by means of a conventional solenoid coil. In the experiments summarized in Figure 6, an rf magnetic field of 1.7 G is calculated in the case of irradiating the sample by the solenoid coil with a SORC pulse sequence at various spin-flip angles. From the observed data it is concluded that the strength of the corresponding rf field of the meanderline surface coil is nearly twice as large (ie 3.4 G) in a sample located in the immediate vicinity of the coil. Moreover, D4 summarises in Figure 5 data concerning the intensity of the observed signal as a function of the distance between the sample and the surface of the meanderline surface coil. Signals from remote locations are observed, the intensity of which drops by approximately an order of magnitude with respect to the intensity measured for the closest possible distance. Since, as indicated by the authors of D4, a linear relationship between the signal amplitude and the strength of the irradiating rf field can be assumed, the data presented in Figure 5 imply the teaching that it is in principle feasible to detect ^{14}N NQR signals for rf magnetic fields having an estimated strength as low as 0.3 to 0.4 G.

4.4 For $NaNO_2$, the field strength of 1,7 G applied in D4 in the experiment with the solenoid coil corresponds to a ratio to the strength of the local field of approximately 5.5 : 1. From the combined information derivable from Figures 5 and 6 of D4 a range of approximately 1 : 1 to 11: 1 is calculated for the experiments made with the meanderline surface coil. In this context, it is noted that, if RDX instead of $NaNO_2$ were studied with the experimental setup of D4, the ratio would lie in a range of 2 to 3 : 1 to 26 : 1.

A comparison with the only specific experimental data concerning the strength of the rf field disclosed in the present application as given at page 5, lines 30 to 32 of the description ("*for RDX-based explosives,* *the present invention has successfully utilized rf fields as low as 0.7 G*") reveals that the experiments reported in D4 operate at the same low rf fields as envisaged by the present application. In any case, the skilled person, applying the teaching of D4 to the detection of explosives or narcotics, is led to consider operation under experimental conditions, for which the range of field ratios would at least partially overlap with the range defined in claim 1 under consideration. Performing the NQR experiments at a low rf field strength means less consumption of rf power so that the problem addressed by the present application is already solved in the experiments according to D4 (and D2).

In view of the above observations, the Board cannot agree with the appellant's perception of the teaching of D4 since this perception does not take into account the fact that the estimated value of 3.4 G is actually an upper limit value for the strength of the rf field applied in the experiments performed with the surface coil and that D4 shows experimental results obtained for significantly lower rf fields, the strength of which complies with the requirement set out in the characterising feature of claim 1. In this respect, it is immaterial for the relevance of the teaching of D4 that the specimen $NaNO_2$ is neither an explosive nor a narcotic, because the skilled reader of D4 would be aware of the fact that sodium nitrite constitutes a widely used reference material for the detection of ^{14}N NQR, the experimental handling of which is far less dangerous and/or restricted than the handling of explosives or narcotics. Finally, in view of the fact that dependent claim 4 is directed to the use of the same type of meanderline coil used in D4, the Board finds the appellant's argument unconvincing that the method known from D4 was suitable only for probing samples to a very limited depth, whereas the invention was concerned with searching large volumes.

4.5 It follows from the above considerations that the skilled practitioner in the field of NQR detection methods learns from documents D2 and D4 about the technical feasibility of performing ^{14}N NQR experiments at low excitation levels which correspond to a strength of the rf field being as low as the strength of local magnetic fields.

Hence the subject-matter of claim 1 under consideration is mainly distinguished from the teaching of document D2 by the provision of steps (f) and (g), ie the steps of comparing the detected nitrogen signal to a predetermined threshold value and of signalling when the detected signal exceeds this threshold value.

The Board concurs with the examining division's finding that these features constitute measures conventionally applied to indicate a positive detection of dangerous substances. Evidence for the fact that such measures are indeed conventional (eg in baggage inspection) in the context of detecting explosives by nuclear resonance methods is provided by document D3 (see in particular the abstract and column 8, lines 26 to 37).

4.6 Consequently, in view of the teachings of documents D2 and D4, the skilled person would have devised a method as defined in claim 1 without the exercise of inventive skill. Therefore, in the Board's judgment, the subject-matter of claim 1 of the auxiliary request does not involve an inventive step within the meaning of Article 56 EPC. Claim 1 is therefore not allowable.

4.7 Dependent claims 2 to 8 are also not allowable because of their dependency on an unallowable claim 1. Moreover, the additional features according to these claims are in principle known from D2 and/or D4.

Order

For these reasons it is decided:

The appeal is dismissed.

The Registrar	The Chairman
R. Schumacher	G. Davies