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Case Number: T 0955/09 - 3.4.02

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Title of invention:
Detecting natural gas pipeline failures

Patent Proprietor:
ITT Manufacturing Enterprises, Inc.

Opponent:
E.ON Ruhrgas AG

Headword:

Relevant legal provisions:
EPC Art. 100(c)

Keyword:
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Catchword:

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Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T0955/09 - 3.4.02

D E C I S I O N
of the Technical Board of Appeal 3.4.02
of 9 November 2011

Appellant: (Patent Proprietor)	ITT Manufacturing Enterprises, Inc. 1105 North Market Street, Suite 1217 Wilmington, Delaware 19801 (ETATS-UNIS D'AMERIQUE)
Representative:	Dreiss Patentanwälte Postfach 10 37 62 70032 Stuttgart (ALLEMAGNE)
Respondent: (Opponent)	E.ON Ruhrgas AG Huttropstr. 60 45138 Essen (ALLEMAGNE)
Representative:	Schmidt, Frank-Michael ZENZ Patent- und Rechtsanwälte Rüttenscheider Strasse 2 45128 Essen (ALLEMAGNE)
Decision under appeal:	**Decision of the Opposition Division of the European Patent Office posted 6 March 2009 revoking European patent No. 1416258 pursuant to Article 101(3)(b) EPC.**

Composition of the Board:

Chairman: A. Klein
Members: M. Rayner
B. Müller

Summary of Facts and Submissions

I. The patent proprietor has appealed against the decision of the opposition division revoking European Patent No. 1 416 258 (application number 03078345.0). The patent concerns detecting failures in a natural gas pipeline. During the opposition and appeal proceedings, reference has been made to documents including US-A-5 481 476 hereinafter referred to as document D1.

II. The application as filed included the following passages {bold typeface added by the board to simplify identification of pertinent parts in context}:-

(a) Page 1, line 25 to page 2, line 18

"When electromagnetic radiation from either a natural or man-made source interacts with matter a number of phenomena may occur including scattering, absorption, transmission and reflection. When the interactions of electromagnetic radiation and matter are carefully examined, analyzed, and represented in an ordered fashion as a function of wavelength, frequency, or time this is referred to as a spectral or spectroscopic analysis. During spectroscopic analyses different materials exhibit different scattering, absorption, reflection and transmission characteristics. These characteristics are determined by the chemical and physical structure of the materials. When a set of these characteristics are determined to a given level of certainty, as with the use of known test subjects, these spectroscopic results may be referred to as reference spectral signatures or reference spectra. **Natural gas characteristically contains a mixture of methane, ethane, and small amounts of other gases. Gas generated by the decomposition of organic matter**

henceforth referred to as swamp gas, only contains methane. It is highly desirable for a method of detection to be able to distinguish between gases released as a result of a failure in a pipeline or holding container versus swamp gases in this manner avoiding false alarms. It is possible to use methods involving illuminants and their corresponding interaction with the probed areas to detect the presence of various chemical compositions and mixtures as described in document D1. This patent describes the chemometric analysis of data. **This patent provides for a quantitative method of determining remotely the nature of chemicals detected by the probe.** In many cases this provides the required certainty for avoiding false alarms and potentially the capability of identifying the source(s) of the detected species. This same methodology can be applied to species other than natural gas."

(b) Full paragraph on page 3 and paragraph bridging pages 3 and 4

"...It is an advantage of the present invention to provide a more effective way of determining failures in natural gas pipelines by automatically processing images captured from a remote platform. This automatic processing can include comparing with previously detected images. This automatic processing can also include algorithms and expert systems that act in a predictive manner.

A feature of the present invention is that **an emission plume created by natural gas escaping from a pipeline whether on the surface or below interacts with laser light to provide a detectable spectral signature. This spectral signature is then used in accordance with the**

present invention to determine if there is a failure. Furthermore when natural gas is under pressure and it escapes, as in the case of a failure, from a pressurized container like pipeline or cylinder the natural gas undergoes thermal changes characteristic of the natural gas and based on the corresponding Joule-Thompson coefficient. These thermal changes can also be detected remotely in accordance with the present invention."

(c) Paragraph bridging pages 7 and 8 and following paragraph

"FIG. 4 illustrates a somewhat different embodiment of the present invention. An aerial platform 32 is depicted with a sensor system 42 and an onboard illuminant 8. The onboard illuminant 8 is shown being directed at a natural gas plume 34 leaking from a failure 36 in a buried natural gas pipeline 38. The buried natural gas pipeline 38 is located beneath the surface of the ground 40. For example, the illuminant 8 may include a pulsed laser system directed at the 30 natural gas plume 34. In this case **the sensor system 42 is optimized to detect the returning radiation as backscattered Raman light from the natural gas plume 34, through the appropriate choice of optical filter 3 (described in FIG. 1). For Raman analyses it is appropriate to consider the use of spectrometers or spectrographs for use as the optical filter 3. Raman spectroscopy is based upon the inelastic scattering of light; chemical components scatter light at frequencies different from the exciting light frequency. The differences are indicative of the various energy levels of the molecular or chemical components. The preferred embodiment of the detection system includes an optical system optimized to detect the vibrations of methane**

(at 2920 cm^{-1}) and ethane (at either 2957 or 996 cm^{-1}). Natural gas samples typically consist of approximately 85% methane and smaller concentrations (10 to 15%) of ethane. As discussed previously, ethane is found in natural gas, but not swamp gas samples. Hence the presence of spectral features unique to ethane, for example, the 2957cm^{-1} band, concurrent with the presence of the strong 2920 cm^{-1} methane Raman band is strongly indicative of a natural gas leak at a position identified as proximate to a natural gas pipeline, buried or otherwise. Alternatively, the sensor system may sense infrared returning radiation at wavelengths appropriate for the detection of ethane and methane. For ethane the absorption band at 2977 cm^{-1} is typically used, while for methane there is an absorption at 3044 cm^{-1}. In this manner the presence of the leaking hydrocarbon natural gas is directly detected."

(d) Paragraph bridging pages 8 and 9

"FIG. 5 depicts both a reference spectral signature 44 and a spectral signature 46 and their comparison, and illustrates the method of analysis to determine mixture composition. As noted previously the interactions of electromagnetic radiation and matter are carefully examined, analyzed, and represented in an ordered fashion as a function of wavelength, frequency, or time and this is referred to as a spectral or spectroscopic analysis. **During spectroscopic analyses different materials exhibit different scattering, absorption, reflection or transmission characteristics.** These characteristics are determined by the chemical and physical structure of the materials. When a set of these characteristics are determined to a given level of certainty, as with the use of known test subjects, these spectroscopic results may be referred to as

reference 10 spectral signatures 44 or reference spectra. **The spectral signature 46 of a test subject is the spectrum of an unknown, in this case, a section of natural gas that is being evaluated for a failure.** FIG. 5 depicts both the reference spectral signature 46 and a spectral signature 46 of a test subject and thus facilitates their comparison. Those skilled in the spectroscopic art would perform such a comparison by attempting to identify characteristic spectral peaks 48 in both spectra in order to identify a match condition. In FIG. 5., such a match is readily accomplished. Typically, reference spectral signatures 44 are obtained under somewhat idealized laboratory conditions, whereas the spectral signature 46 of the test subject is compromised due to additional noise sources, contaminants, and so forth. In these circumstances **the apparatus described in document D1 provides additional capability for the spectral analysis of complex mixtures.** This patent describes the chemometric analysis of data."

(e) Claims 1 and 4 as are as follows:-

"1. A method for detecting failures in a natural gas pipeline comprising the steps of:

(a) illuminating portions of the pipeline from a remote platform;

(b) detecting returning radiation from the pipeline;

(c) determining that there is a failure in the pipeline when the spectral signature indicates that there is a plume of escaping natural gas from the pipeline escaping from a failure; and

(d) indicating to a customer that a failure in the pipeline has been detected at a predetermined coordinate position.

4. The method of claim 1 where the analysis of the spectral data includes **the determination of whether there is ethane and methane present;".**

III. In the decision under appeal, the reasoning of the opposition division, in relation to the claims as granted, included the following.

The patent as granted comprises subject-matter which extends beyond the content of the application as filed (Articles 100 (c) and 123(2) EPC). Extension of subject matter of the European Patent exists in relation to claim 1 concerning the following subject matter:
(a) "... wherein concentrations of methane and ethane are indicated independently from another" (last part of the first feature of the characterising portion of claim 1),
(b) "... Raman signatures indicate a predefined concentration of methane concurrent with a predefined concentration of ethane and wherein the predefined concentration of methane and the predefined concentration of ethane correspond to the typical concentrations of ethane and methane in the natural gas to be detected" (last feature of the characterising portion of claims 1).

The feature (a) "wherein concentrations of methane and ethane are indicated independently from another" is not directly and unambiguously derivable from the application as filed, because the application as filed only discloses the detection of the presence of ethane and concurrent methane Raman peaks at 2957 cm^{-1} and 2920 cm^{-1}, respectively, (page 8, first paragraph) and does not disclose an indication of methane and ethane concentration. The term "concentration" implies a quantitative indication, whereas the application as

filed only discloses a qualitative evaluation of the measurement results. A passage on page 8, line 30 to page 9, line 1 in combination with Figure 5 only depicts a reference spectral signature and a spectral signature in a very general manner and does not refer to ethane and methane detection and, therefore, cannot be used "for a basis of" feature (a). In addition the feature "determination of a mixture composition" is not a basis for the feature (a). The application as filed only discloses the statement that natural gas consists of 85% methane and 10-15% ethane (page 8, first paragraph) and that the Raman spectra are analysed by comparison of measured Raman spectra and reference spectra (page 8, last paragraph). There is no direct link in the application as filed between the Raman reference signatures and the typical concentrations of ethane and methane in the natural gas to be detected.

IV. The appellant requested that the decision under appeal be set aside and the opposition be rejected or the patent be maintained in amended form on the basis of its auxiliary requests 1 to 5 as filed with the statement of grounds for appeal.

So far as feature (a) as referred to by the opposition division is concerned, the second part simply defines further how Raman spectral signatures are detected. If signatures not indicating presence or concentration of methane separately from each other were analysed, the method could not be carried out. Furthermore, an inherent feature of spectral signals is to indicate concentration because a small peak indicates a small concentration and a stronger peak a higher concentration. Thus differentiating between quantitative indication and qualitative evaluation does not reflect how Raman measurements are carried out

technically. So far as feature (b) as referred to by the opposition division is concerned, the claimed wording does not require a quantitative value of concentration, it only requires determination if the detected signature indicates concentrations that are typical for natural gas. Moreover, in referring to document D1, the application discloses a quantitative measure of concentration. Concerning the first auxiliary request, the claim defines the spectral range. The spectral range includes wavelengths of 2920 cm^{-1} and either 2957 or 996 cm^{-1}. These wavelengths guarantee that the vibrations in the detected signatures will indicate concentrations of methane and ethane independently from another, if natural gas escapes from the pipeline. The vibrations in the Raman signature indicate concentrations and thus allow a quantitative evaluation. Claim 1 according to the second auxiliary request emphasizes that concentrations of ethane and methane are indicated by the wavelength characteristics of the returned radiation, namely by presence of a strong 2920 cm^{-1} methane Raman band and the presence of spectral features unique to ethane. It is therefore clear that the claimed method is not directed to a measurement of accurate concentration values, but to an indication of concentrations provided by the spectral features of the signatures. The features concerned are disclosed on page 8, lines 5-15. In the third auxiliary request the characterising part of claim 1 defines the typical concentrations of ethane and methane in natural gas which form predefined concentrations to carry out the invention. In the fourth auxiliary request the characterising part of claim 1 includes the additional feature that Raman spectral signatures of both methane and ethane are detected and reference spectral signatures of intensity versus wave number are compared

to the detected Raman signatures of intensity versus wave number in order to identify a match condition. The concentrations of methane and ethane are indicated by the presence of a strong 2920 cm^{-1} methane Raman band concurrent with the presence of spectral features unique to ethane. The added features are disclosed on page 8, line 30, to page 9, line 22.

It is not agreed that Figure 5 does not relate to Raman measurements. Figure 5 explains in general how spectra may be analyzed. On page 9, line 5,the application teaches that during spectroscopic analyses different materials exhibit different scattering, absorption, reflection or transmission characteristics, and that these characteristics can be evaluated. On page 8, lines 3-5, the application states that Raman spectroscopy is based on inelastic scattering of light. As such, Figures 5 and the explanations on page 8 are linked, and a person skilled in the art understands that a comparison of detected signatures and reference signatures as shown in Figure 5 may also be used for Raman light. Lines 7-16 on page 9 disclose the features which have been incorporated into the claim. In the fifth auxiliary request, claim 1 defines the concentrations of ethane and methane in natural gas as disclosed on page 8, lines 9-10. Again, the claim wording does not call for an explicit measurement of concentration values. It is sufficient that there is an indication of 85% methane and 10-15% ethane by the presence of a strong 2920 cm^{-1} methane Raman band concurrent with the presence of spectral features unique to ethane.

V. The respondent (=opponent) requests that the appeal be dismissed. Arguments including the following were advanced by the respondent.

In deciding whether an infringement of Article 123(2) has occurred, solely the understanding of the original application by the skilled person is relevant, a subsequent interpretation by the patent proprietor cannot be taken into account. In the present case, the skilled person has no reason for any interpretation other than that of the opposition division. Document D1 simply illustrates the state of the art and the skilled person had no reason to consider it essential to the invention. The auxiliary requests concern features to change the determination to a qualitative spectral comparison and thus concern a different method to that of the granted claim.

VI. The board appointed oral proceedings, and, in a communication accompanying the summons made comments including the following.

The board had doubts about whether "concentrations" should be understood as presence and whether "predefined concentration" should be understood as spectral signature. Why should the same word have these different meanings, especially as "concentrations" in line 10 on page 8 is in a sentence with numerical (=quantitative) values of 85% and ~10-15%.

VII. During the oral proceedings, the parties presented the following arguments.

Appellant

The patent in dispute concerns detecting natural gas using Raman measurement. A skilled person in this field reads the patent and takes document D1 into consideration as per pages 2 and 9 of the application

as filed. Natural gas contains ethane and methane and its detection derives from both. Should only methane be detected, then swamp gas is detected as can be seen from page 8, line 11. Different vibrations in the spectral signature are detected separately and registered quantitatively. Two different vibrations are detected at the same time according to page 8, line 11 meaning not only that natural gas is present but also its quantitative measurement. Claim 1 is supported by the specific values in the documents as filed, the relationship in the percentages is the support for the second feature having regard to usual natural gas values. The claim calls for indication, the system evaluates the values and determines whether there is natural gas. Methane and ethane are determined as present but not their relative concentrations, yet if they are strongly indicated, quantitative presence is indicated, as per the intensity peaks, as is known to the skilled person. Spectra are, as such, known independently of reference to document D1, yet should more information be needed, reference can be made to document D1. The word "indicated" refers to Raman signatures explicit to natural gas.

In reply to the chairman, the appellant confirmed that concentration of methane and ethane is determined according to claim 1. The appellant did not identify where disclosure of say 20% as opposed to 15% ethane was present in the documents as filed. However, should a natural gas non-typical concentration, say 50% ethane and 50% methane, be detected, this simply indicates the system is incorrectly calibrated. With reference to the second paragraph on page 4 of the letter dated 19 December 2005 during the examination proceedings - "A failure is determined only if a predetermined ratio between the concentrations of methane and ethane is

measured" -, the appellant explained the concentration results from analysis of the peaks, the signatures permit quantitative interpretation.

The claims according to the auxiliary requests are more precise, in particular, the first auxiliary request specifies indication by Raman scattering with high peaks indicating high concentration. The second auxiliary request specifies spectral features unique to ethane and an exact teaching of concentration is given in the third auxiliary request. The fourth auxiliary request specifically includes wave number as disclosed on page 8 as originally filed.

Respondent

In considering added subject matter, what matters is not what the description might have meant but the actual disclosure. Concentration is recited as being indicated in the claim, yet the appellant in some arguments understands only presence. Figure 5 is not covered by claims because it does not relate to Raman spectra. The skilled person would have understood from this Figure that marsh gas is differentiated from natural gas and at most to associate the peaks in a spectrum. A given concentration as generally known for natural gas is not a determined ratio for which latter there is no support in the documents as filed. Moreover, determination of concentration does not depend solely from detected peaks. Furthermore, in the documents as filed, wave numbers were not associated with Raman peaks.

VIII. Claim 1 according to the main and five auxiliary requests is worded as follows.

N.B. To increase intelligibility, the board has marked parts of claim 1 according to the auxiliary requests and differing from the main request in bold typeface.

Main Request

"1. A method for detecting failures in a natural gas pipeline (38) comprising the steps of:
(a) illuminating portions of the pipeline (38) from a remote platform (1, 42);
(b) detecting returning radiation from the pipeline (38);
(c) determining that there is a failure in the pipeline (38) if the returning radiation indicates that there is a plume (34) of escaping natural gas from the pipeline;
characterized in that
-Raman spectral signatures of both methane and ethane are detected wherein concentrations of methane and ethane are indicated independently from another;
-wherein it is determined that there is a failure in the pipeline if the Raman signatures indicate a predefined concentration of methane concurrent with a predefined concentration of ethane; and
-wherein the predefined concentration of methane and the predefined concentration of ethane correspond to the typical concentrations of ethane and methane in the natural gas to be detected."

First Auxiliary Request

"1. A method for detecting failures in a natural gas pipeline (38) comprising the steps of:
(a) illuminating portions of the pipeline (38) from a remote platform (1, 42);
(b) detecting returning radiation from the pipeline (38);

(c) determining that there is a failure in the pipeline (38) if the returning radiation indicates that there is a plume (34) of escaping natural gas from the pipeline; characterized in that

- Raman spectral signatures of both methane and ethane are detected wherein **in the detected Raman signatures** concentrations of methane and ethane are indicated **by vibrations at 2920 cm^{-1} for methane and at either 2957 or 996 cm^{-1} for ethane, i.e.** independently from another; **and**
- wherein it is determined that there is a failure in the pipeline if the Raman signatures, **namely the vibrations at 2920 cm^{-1} for methane and at either 2957 or 996 cm^{-1} for ethane in the detected Raman signatures**, indicate a predefined concentration of methane concurrent with a predefined concentration of ethane; and
- wherein the predefined concentration of methane and the predefined concentration of ethane correspond to the typical concentrations of ethane and methane in the natural gas to be detected."

Second auxiliary request

"1. A method for detecting failures in a natural gas pipeline (38) comprising the steps of:
(a) illuminating portions of the pipeline (38) from a remote platform (1, 42);
(b) detecting returning radiation from the pipeline (38);
(c) determining that there is a failure in the pipeline (38) if the returning radiation indicates that there is a plume (34) of escaping natural gas from the pipeline; characterized in that

- Raman spectral signatures of both methane and ethane are detected wherein **in the detected Raman signatures**

concentrations of methane and ethane are indicated **by vibrations at 2920 cm^{-1} for methane and at either 2957 or 996 cm^{-1} for ethane, i.e.** independently from another; **and**

- wherein it is determined that there is a failure in the pipeline if the Raman signatures, **namely the vibrations at 2920 cm^{-1} for methane and at either 2957 or 996 cm^{-1} for ethane in the detected Raman signatures**, indicate a predefined concentration of methane **by the presence of a strong 2920 cm^{-1} methane Raman band** concurrent with a predefined concentration of ethane by the presence of spectral features unique to ethane; and
- wherein the predefined concentration of methane and the predefined concentration of ethane correspond to the typical concentrations of ethane and methane in the natural gas to be detected."

Third auxiliary request

"1. A method for detecting failures in a natural gas pipeline (38) comprising the steps of:
(a) illuminating portions of the pipeline (38) from a remote platform (1, 42);
(b) detecting returning radiation from the pipeline (38);
(c) determining that there is a failure in the pipeline (38) if the returning radiation indicates that there is a plume (34) of escaping natural gas from the pipeline;
characterized in that

- Raman spectral signatures of both methane and ethane are detected wherein **in the detected Raman signatures** concentrations of methane and ethane are indicated **by vibrations at 2920 cm^{-1} for methane and at either 2957 or 996 cm^{-1} for ethane, i.e.** independently from another; **and**

- wherein it is determined that there is a failure in the pipeline if the Raman signatures, **namely the vibrations at 2920 cm^{-1} for methane and at either 2957 or 996 cm^{-1} for ethane in the detected Raman signatures**, indicate a predefined concentration of 85% for methane by the presence of a strong 2920 cm^{-1} methane Raman band concurrent with a predefined concentration of **10—15% for** ethane **by the presence of spectral features unique to ethane**; and
- wherein the predefined concentration of **85% for** methane and the predefined concentration of **10-15% for** ethane correspond to the typical concentrations of ethane and methane in the natural gas to be detected."

Fourth auxiliary request

"1. A method for detecting failures in a natural gas pipeline (38) comprising the steps of:
(a) illuminating portions of the pipeline (38) from a remote platform (1, 42);
(b) detecting returning radiation from the pipeline (38);
(c) determining that there is a failure in the pipeline (38) if the returning radiation indicates that there is a plume (34) of escaping natural gas from the pipeline;
characterized in that
- Raman spectral signatures of both methane and ethane are detected **and reference spectral signatures of intensity versus wave number for methane and ethane are compared to the detected Raman signatures of intensity versus wave number in order, to identify a match condition,** wherein **in the detected Raman signatures** concentrations of methane and ethane are indicated **by vibrations at 2920 cm^{-1} for methane and at either 2957 or 996 cm^{-1} for ethane, i.e.** independently from another; and

- wherein it is determined that there is a failure in the pipeline if the Raman signatures, **namely the vibrations at 2920 cm^{-1} for methane and at either 2957 or 996 cm^{-1} for ethane in the detected Raman signatures**, indicate a predefined concentration of methane **by the presence of a strong 2920 cm^{-1} methane Raman band** concurrent with a predefined concentration of ethane **by the presence of spectral features unique to ethane**; and
- wherein the predefined concentration of methane and the predefined concentration of ethane correspond to the typical concentrations of ethane and methane in the natural gas to be detected."

Fifth Auxiliary Request

"1. A method for detecting failures in a natural gas pipeline (38) comprising the steps of:
(a) illuminating portions of the pipeline (38) from a remote platform (1, 42);
(b) detecting returning radiation from the pipeline (38);
(c) determining that there is a failure in the pipeline (38) if the returning radiation indicates that there is a plume (34) of escaping natural gas from the pipeline;
characterized in that
- Raman spectral signatures of both methane and ethane are detected **and reference spectral signatures of intensity versus wave number for methane and ethane are compared to the detected Raman signatures of intensity versus wave number in order to identify a match condition**, wherein in the detected Raman signatures concentrations of methane and ethane are indicated **by vibrations at 2920 cm^{-1} for methane and at either 2957 or 996 cm^{-1} for ethane, i.e.** independently from another; **and**

– wherein it is determined that there is a failure in the pipeline if the Raman signatures, **namely the vibrations at 2920 cm^{-1} for methane and at either 2957 or 996 cm^{-1} for ethane in the detected Raman signatures**, indicate a predefined concentration of **85% for** methane **by the presence of a strong 2920 cm^{-1}** methane Raman band concurrent with a predefined concentration of **10-15% for** ethane **by the presence of spectral features unique to ethane**; and

– wherein the predefined concentration of **85% for** methane and the predefined concentration of **10-15%** for ethane correspond to the typical concentrations of ethane and methane in the natural gas to be detected."

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

Reasons for the Decision

1. The appeal is admissible.

2. Amendments - Main request

2.1 As can be seen from section II(a) and (b) of the Facts and Submissions above, the application addresses failure of natural gas pipelines and mentions, for example, image comparison, interactions of electromagnetic radiation and matter and thermal changes characteristic of the natural gas and based on the corresponding Joule-Thompson coefficient. In the context of interaction with laser light, Raman analysis is mentioned (see section II(c) of the Facts and Submissions above).

2.2 The application discloses to the skilled person that natural gas differs from marsh gas in that it contains

85% methane and 10 to 15% ethane (see sections II(a) and (c), bold portions of the Facts and Submissions above). It is disclosed to the skilled person that the presence of spectral features unique to ethane, for example, the 2957cm^{-1} band, concurrent with the presence of the strong 2920 cm^{-1} methane Raman band is strongly indicative of a natural gas leak at a position identified as proximate to a natural gas pipeline, buried or otherwise.

2.3 However, the description is more general in relation to Figure 5 (see section II(d) of the Facts and Submissions above), which does not show Raman scattering and where it is explained that the interactions of electromagnetic radiation and matter are carefully examined, analyzed, and represented in an ordered fashion as a function of wavelength, frequency, or time and this is referred to as a spectral or spectroscopic analysis. During spectroscopic analyses different materials exhibit different scattering, absorption, reflection or transmission characteristics. These characteristics are determined by the chemical and physical structure of the materials.

3. The disclosure specified in points 3.1 therefore tallies with the understanding of the opposition division and of the respondent that a qualitative, but not a quantitative determination was disclosed in the documents as filed.

4. There are three strands to the arguments in the appellant's case in relation to added subject matter, namely

4.1 concentration as recited in claim 1 would have been taken by the skilled person to signify presence,

4.2 concentration is a function of the presence of ethane and methane because the skilled person knows that if both are detected, natural gas is present so that the concentration is determined as that known for natural gas, i.e. approximately 85% methane and smaller concentrations (10 to 15%) of ethane, and

4.3 concentration does mean a quantitative measurement and does not extend beyond the documents as filed, with or without reference to document D1.

4.3.1 The first strand is not unlike the position of the opposition division and the respondent because it requires no more than detection of presence of ethane and methane in determining a leak. It is also consistent with originally filed claim 4 (see section II(e) of the Facts and Submissions above). However, the first strand also requires that concentration in the claim as granted be understood to amount to no more than presence and predetermined concentration as a spectral signature. No reason has been given to the board responsive to its doubts in the communication attached to the summons concerning why "concentrations" should be understood as presence and "predefined concentration" should be understood as spectral signature, i.e. the same word should have different meanings, especially as "concentrations" in line 10 on page 8 is in a sentence with numerical (=quantitative) values of 85% and ~10-15%. The doubts of the board were thus not resolved and the board reached the conclusion that concentration as used in granted claim 1 does not mean presence but indeed means a quantitative measure. Thus the first strand of the appellant's argument failed to convince the board that the subject matter of

amended claim 1 did not extend beyond the content of the documents as filed.

4.3.2 Moreover, quantitative determination is not effected automatically according to the second strand of the appellant's case because it is only presence that is detected consequent to the Raman signatures and actually indicated. No concentration derives from the detection as such because only a separate assumption about 10 to 15% and 85% independent of the detection occurs. In making this assumption, the whole argument about peak sizes indicating concentration is also defeated as the assumed values are taken whatever the peak size. Whether or not there is some kind of calibration error is neither relevant nor discussed in the documents as filed. Accordingly, the second strand of the appellant's argument failed to convince the board that the subject matter of amended claim 1 did not extend beyond the content of the documents as filed.

4.3.3 The board thus reached the view that concentration means a quantitative measure and sees its view confirmed by the specific affirmation of the appellant during the oral proceedings. Moreover, this view is also consistent with the argument advanced during the examination proceedings that a failure is determined only if a predetermined ratio between the concentrations of methane and ethane is measured (see section VI of the Facts and Submissions above, second paragraph of appellant's submissions).

4.4 The board therefore concluded that the case turns on whether the third strand of the appellant's case, concentration means a quantitative measurement (point 4.3 above), is persuasive or not.

5. While Figure 5 is recited as depicting both a reference spectral signature 44 and a spectral signature 46, there is no explanation of exactly what spectrum is concerned. However as remarked by the respondent during the oral proceedings, the spectrum is not a Raman spectrum. The board concurs with the view of the opposition division that Figure 5 relates to a reference spectral signature and a spectral signature in a very general manner and does not refer to ethane and methane detection. In this situation, the board cannot consider Raman signatures as directly and unambiguously disclosed to the skilled person by Figure 5 and its related description. As the respondent suggested during the oral proceedings, there could, at most, be a hint to the skilled person to modify and apply the teaching to comparing Raman peaks at certain frequencies. Even were this disclosed in the documents as filed, it would hardly go beyond the disclosure of detecting spectral features as set out in the disclosure of section II(c) of the Facts and Submissions above, i.e. a qualitative comparison. The board did not therefore find the appellant's submissions persuasive and had to conclude that there is no disclosure of "concentration" in a quantitative sense in the documents as filed.

6. The appellant also argued that document D1 makes good the defect in disclosure of quantitative determination. However, the appellant did not explain what teaching in the thirty one figures and twenty seven columns of description in document D1 is concerned, nor explain just why the skilled person would have considered this important to the invention. In fact the appellant did not even show that natural gas, ethane or methane was mentioned at all in document D1. In the board's view,

in the documents as filed, document D1 is mentioned generally as prior art (see section II(a) of the Facts and Submissions above - various chemical compounds) or in the context of error reduction in general analysis methods for reducing noise in spectral analysis (see section II(e) of the Facts and Submissions above - ...signature compromised due to additional noise sources, contaminants, and so forth. In these circumstances...). The board does not therefore consider that it has been shown to disclose directly and unambiguously to the skilled person that the disclosure of the application as filed should be turned to move away from the qualitative determination actually disclosed to quantitative determination as claimed in claim 1.

7. In view of the foregoing, the board reached the conclusion that the subject matter of claim 1 as granted extends beyond the content of the application as filed.

8. Amendments - Auxiliary requests

The amendments made to claim 1 according to the auxiliary requests amount to attempts to step back to the claim being directed only to qualitative evaluation. These attempts cannot succeed because the reference to "concentration" and consequently the additional matter is not removed thereby. In more detail, the auxiliary requests concern the following.

8.1 First auxiliary request

The recitations concerning vibrations at 2920 cm^{-1} for methane and at either 2957 or 996 cm^{-1} for ethane are present in the documents as filed. These recitations

are present in the documents as filed (c) and concern the spectral values indicating that natural gas is present. In doing this they do not change the quantitative meaning of concentration and go no further than the description. The claimed subject matter therefore extends beyond the content of the application as filed.

8.2 Second auxiliary request

The further recitations concerning a strong 2920 cm^{-1} methane Raman band are present in the documents as filed but are just a known feature of a methane spectrum and do not change the quantitative meaning of concentration. The claimed subject matter therefore extends beyond the content of the application as filed.

8.3 Third auxiliary request

The further recitations concerning the values of 85% methane and 10-15% ethane and features unique to ethane are present in the documents as filed but are just the known values for natural gas, not an indicated concentration (see also section 4.3.2 above) and thus do not change the quantitative meaning of concentration. The claimed subject matter therefore extends beyond the content of the application as filed.

8.4 Fourth auxiliary request

The further recitations concern reference spectral signatures of intensity versus wave number for methane and ethane being compared to the detected Raman signatures of intensity versus wave number in order, to identify a match condition. The board shares the doubt of the respondent that wave numbers were associated

with Raman peaks in the documents as filed. However, leaving aside this doubt, the features concerned relate to presence of natural gas as such (see also point 5 above) and do not change the quantitative meaning of concentration. The claimed subject matter therefore extends beyond the content of the application as filed.

8.5 Fifth auxiliary request

This claim contains features directed to subject matter already dealt with in relation to the higher order requests, which therefore, for corresponding reasons, extends beyond the content of the application as filed

9. In view of the foregoing, the appeal did not succeed.

Order

For these reasons it is decided that:

The appeal is dismissed

The Registrar: The Chairman:

M. Kiehl A. Klein

Decision electronically authenticated