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Datasheet for the decision of 29 September 2011

Case Number: T 0635/10 - 3.4.02

Application Number: 02705935.1

Publication Number: 1356260

IPC: G01M3/32, G01L13/00

Language of the proceedings: EN

Title of invention:
PRODUCT LEAK TESTING

Applicant:
ATC, INC.

Opponent:
ATEQ

Headword:

Relevant legal provisions:
EPC 1973 Art. 100(a), 100(b), 100(c)
EPC Art. 123(3)

Keyword:
Amendments: Added subject-matter (no) - Extension of protection (no)
Sufficiency of disclosure (yes)
Novelty and inventive step (yes)

Decisions cited:
T 438/98

Catchword:

Case Number: T0635/10 - 3.4.02

D E C I S I O N
of the Technical Board of Appeal 3.4.02
of 29 September 2011

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Decision under appeal: **Interlocutory decision of the Opposition Division of the European Patent Office posted 27 January 2010 concerning maintenance of the European Patent No. 1356260 in amended form.**

Composition of the Board:

Chairman: A. G. Klein
Members: F. J. Narganes-Quijano
B. Müller

Summary of Facts and Submissions

I. The appellant (patent proprietor) lodged an appeal against the decision of the opposition division finding European patent No. 1356260 (based on the European patent application No. 02705935.1 published under the PCT with the International Publication No. WO 02/065083) as amended according to the second auxiliary request then on file to meet the requirements of the EPC.

The opposition filed by the respondent (opponent) against the patent as a whole was based on the grounds for opposition of lack of novelty and lack of inventive step (Article 100(a) EPC 1973), insufficiency of disclosure (Article 100(b) EPC 1973) and added subject-matter (Article 100(c) EPC 1973).

II. The following documents considered during the first-instance proceedings were also considered by the parties during the appeal proceedings:

D8 : US-A-5861546

D11: "Contrôle industriel de l'étanchéité par traceur hélium" J. Tallon; Société Française du Vide, Paris (1992); pages 21 to 46

D12: "Analyse industrielle II" M. Cerr; Technique & Documentation, 1997; pages 799 to 816

D15: Data sheets on leak and flow testers, ATEQ Corp. (US)

D18: "Mesure des débits et des vitesses des fluides" J. Lefebvre; Masson, 1986; pages 185 and 186

D20 to D29: Tracking sheets of devices ATEQ D (D20 to D26), order sheet (D27) and business property lease forms (D28 and D29)

D30: "Precision molecular flow measurement and control for single and multigas systems", R. A. Kiesling *et al.*; J. Vac. Sci. Technol. Vol. 15 (1978); pages 771 to 774

D31: "Selection of MKS flow elements for flow measurement and control - Application note", MKS Instruments, Inc., Massachusetts (1980); pages 1 to 4.

III. In its decision the opposition division held *inter alia* that

- the patent as amended according to the main request then on file complied with the requirements of Articles 100(b) and 100(c) EPC 1973,
- document D15 was available to the public before the filing date of the patent in suit,
- the subject-matter of claim 1 of the main request was new over the available prior art and involved an inventive step over the disclosure of document D8 as closest state of the art, but not over the disclosure of document D15 as closest state of the art and the common general knowledge, and
- the patent as amended according to the second auxiliary request met the requirements of the EPC.

IV. With the statement setting out the grounds of appeal the appellant filed, *inter alia*, a set of claims amended according to a main request and identical to the set of claims of the main request underlying the decision under appeal, and submitted the following documents:

A1: declaration of S. Werely, dated 05.22.2010

A2: "ATEQ D - User's Manual" Version 4.6, ATEQ (FR), 1998.

V. The wording of claim 1 and of dependent claims 5 and 6 of the main request reads as follows:

"1. A leak detection system (20, 200, 300, 400) for testing a product for leaks comprising a pressure system (14, 240, 340, 445) that provides a reference pressure during a test period and a flow sensor (9, 220, 320, 420), the flow sensor including an input conduit (76, 576) for receiving a first pressure, an output conduit (78, 578), a flow element defining a laminar flow path for permitting gas flow from the input conduit to the output conduit, and a pressure sensor (86, 88, 586) configured to measure a differential pressure across the laminar flow path, wherein the flow sensor (9, 220, 320, 420) is operatable in a viscous, a slip, a transition, and a molecular flow regime, characterised in that the pressure system (14, 240, 340, 440) and the flow sensor (9, 220, 320, 420) are adapted to develop a gas flow through a flow gap (60, 560) between the pressure system and the product such that the gas flow has a Knudsen number of more than 0.6 and in that the system (20, 200, 300, 400) is operable to generate a first value representative of a mass flow rate of the gas flow through the flow gap (60, 560) such that the value has a linear relationship with the differential pressure, and determine, based upon the value representative of the mass flow rate whether the product leaked an unacceptable amount during the test period."

"5. The leak detector system of any preceding claim, wherein the flow sensor comprises a body (46, 546) comprising a conical bore (44, 544) between a first end and a second end of the body, a first receiving port

(82, 582) through the body to the conical bore, and a second receiving port (84, 584) through the body to the conical bore, a center shaft (42, 52) positioned within the conical bore (46, 546) to define the flow gap (60, 560) such that a first end of the center shaft (42, 52) is within the conical bore (46, 546) and a second end of the center shaft (42, 52) is within the conical bore (46, 546), wherein the first receiving port (82, 582) is located between the first end of the body and the first end of the center shaft and the second receiving port (84, 584) is located between the second end of the body and the second end of the center shaft, the differential pressure sensor (86, 88, 586) being coupled to the conical bore (46, 546) via the first receiving port (82, 582) and the second receiving port (84, 584), the differential pressure sensor (86, 88, 586) operable to generate a differential pressure signal representative of a differential pressure developed between the first receiving port (82, 582) and the second receiving port (84, 584), and a microcontroller (96, 596) coupled to the differential pressure sensor (86, 88, 586) to receive the differential pressure signal, the microcontroller (96, 596) operable to determine whether the product leaked an unacceptable amount during the test period based upon the differential pressure signal."

"6. The leak detector system in any one of claims 1 to 4 wherein the flow sensor comprises a body (546) comprising a conical bore (544) between a first end and a second of the body, a first receiving port (582) through the body to the conical bore, and a second receiving port (584) through the body to the conical bore, a center shaft (52) positioned within the conical bore to define the flow gap (560), a manifold (610) coupled to the body (546) such that the manifold (610)

routes the first receiving port (582) of the body to a first port (612) of the manifold and the second receiving port (584) of the body to a second port (614) of the manifold, the differential pressure sensor (586) being coupled to the first receiving port (582) and the second receiving port (584) via the first port (612) and second port (614) of the manifold (610), the differential pressure sensor (586) operable to generate a differential pressure signal representative of a differential pressure developed between the first receiving port (582) and the second receiving port (584), and a microcontroller (596) coupled to the differential pressure sensor (586) to receive the differential pressure signal, the microcontroller (596) operable to determine whether the product leaked an unacceptable amount during the test period based upon the differential pressure signal."

The set of claims of the main request also includes dependent claims 2 to 4 and 7 to 12 all referring back to claim 1.

VI. Oral proceedings were held before the Board on 29 September 2011.

The appellant requested that the decision under appeal be set aside and that the patent be maintained on the basis of the set of claims of the main request filed with the statement of grounds of appeal.

The respondent requested dismissal of the appeal.

At the end of the oral proceedings the Board gave its decision as set out in the Order below.

VII. The arguments submitted by the appellant in support of its requests are essentially the following:

In claim 1 the expression "linear flow path" has been replaced by "laminar flow path". The skilled person would have immediately understood that, to be consistent, the replaced expression corresponded to the earlier reference in the claim to "a laminar flow path".

Dependent claim 6 is supported by the disclosure of Figure 17, the flow paths of the first and the second embodiments being structurally identical. Paragraphs [0093] and [0094] of the patent specification contain a general description of the functionality of the manifold, without however requiring a specific arrangement of the ports.

In the embodiment defined in dependent claim 5 the receiving ports are outside the flow gap, but at locations at which the flow is very small and the Reynolds number is also very small. Therefore, there is no contradiction with claim 1 and there is no problem in carrying out the measurements as disclosed in paragraphs [0093] to [0097] of the patent specification with reference to the second embodiment, the operational principle being the same as that of the first embodiment.

The evidence on file, and in particular documents D20 to D29, is insufficient to support the conclusion that the content of document D15 was rendered available to the public before the filing date of the patent.

In a viscous and in a molecular flow regime different physical phenomena dominate, with the consequence that

the pressure drop across a laminar flow path is linear with the volume flow in a viscous flow regime and linear with the mass flow in a molecular flow regime. The leak detection system of the invention exploits the flow behaviour with a Knudsen number greater than 0.6 to provide a direct measure of mass flow rate; this has proven useful in measuring small leaks. Measuring mass flow is not equivalent to measuring volume flow as a given mass flow corresponds to different volume flows at different temperatures and pressures.

The tester ATEQ D is described in document D15 as operable in a linear region of the laminar flow tube (figure on page 35, see also the manual A2), and it is clear that this corresponds to operation in a viscous flow regime. There is no disclosure in document D15 of reliable operation of the apparatus outside the linear region - for example in a molecular or transition flow regime - or of the linear region being changed, and this constitutes a clear indication not to operate outside the viscous regime. Further indications that the tester is designed to specifically operate in the viscous flow regime is the fact that all units used in the document to describe flow are volume flow units and the output of the apparatus ATEQ D is a measure of volume flow, that the pressure drop in the tube is described as being due to friction, and that there is no suggestion of the determination of mass flow. Thus, there is no information in the document, both in terms of pressure and in relation to the dimensions of the laminar flow tubes, in support of the contention that the tester is adapted to operate in the molecular flow regime. While in the molecular flow regime what is measured is the mass flow, in the viscous flow regime it is the volume flow; it is therefore important to know in which regime the apparatus operates because

that determines the calibration to be used. Document D15 can only operate in one flow regime in which the disclosed relationship "FLOW = Lc P" is valid. There is no evidence that the tester could reach a pressure of 68 Pa as contended by the respondent or could operate with the appropriate electronics and/or with the pressure sensors having the appropriate accuracy and resolution for operating at such low pressures. The pressure value -15 psi given in document D15 is not to be understood as the accurate value of the actual operational pressure limit of the tester, but as a rounded figure merely indicating that the apparatus can be used with low pressures. The pressures indicated in the patent are considered very low pressures in this context and document D15 does not point towards such pressures; in particular, the lowest pressure in the jet calibration disclosed in document D15 is of 20 mbar, i.e. a value much higher than those required to reach the molecular flow regime. The manual of the tester ATEQ D shown in document A2 and the declaration shown in document A1 further corroborate all these submissions.

The problem solved by the claimed apparatus is not simply a matter of better detecting small leaks as assumed by the opposition division, but of determining the mass flow of a leak and improving the capability of the system to detect small leaks, and when compared with the apparatus ATEQ D the claimed apparatus operates on a different principle, employs a different model to address a different physical phenomenon, and gives a different type of output.

Document D15 relies on a viscous flow for reliable measurement and the figure on page 35 of the document specifically cautions against measuring outside the

linear region of the laminar flow tube. In addition, no reason was given by the opposition division as to why the skilled person would choose to operate outside the region where the Poiseuille's equation is valid, i.e. outside the linear response region of the laminar flow element or at very low reference pressures at which the linearity between the pressure drop and the volume flow is lost. Based on document D15 the skilled person would use a particular one of the range of capillary tubes available for the tester for a particular flow rate range, and the idea of changing the static pressure in order to change the linear range of flow rates for a particular tube appears to run contrary to what is taught in the document. In addition, it is not always true that a lower test pressure allows the detection of a lower flow or of a smaller leak; in the molecular flow regime, for instance, the mass flow is independent of the static pressure, and lowering the static pressure does not help the sensitivity of the measurement and, in addition, complicates the measurement and the operation of the device. There are also other problems when simply operating with the tester ATEQ D at very low pressures, such as the phenomenon of "choked flow" (paragraph [0113] of the patent specification), the inability of the differential pressure transducer to make accurate pressure measurements at such pressures, and the need to reconfigure the processing architecture of the device. The skilled person, faced with the problem of detecting smaller leaks, rather than attempting to completely alter the principle of operation of the tester ATEQ D, would have looked for other solutions, such as the use of other techniques (spectrometers, etc.) or the provision of smaller laminar flow tubes operating in the same manner as described in document D15, without however leaving the viscous regime because

he is aware of the technical obstacles in moving to the molecular flow regime and in redesigning the apparatus to operate in both regimes due to the difficulties in determining the switching point between the regimes and in operating and recalibrating the apparatus in the different regimes.

The leak detection system of document D8 measures fluid flow from a pressurized reference chamber to a product in a chamber initially pressurized to the reference pressure. In this context, the pressure or vacuum controller in the document is not set up to apply a vacuum to the product under test, but to reduce fluctuations and to maintain a steady reference pressure during measurement. Thus, the system of document D8 measures the mass flow to the unit under test, and the mass flow is calculated as a third order polynomial of the differential pressure on the basis of viscous flow equations. There is no suggestion in document D8 towards measuring the mass flow from the unit under test, and certainly no suggestion towards operating the system in a molecular flow regime.

Documents D30 and D31 were filed about one month before the first-instance oral proceedings and should not be admitted into the proceedings. These documents do not relate to leak detection, but to a quite different technical field, i.e. to gas flow control systems for use in semiconductor manufacturing technology, and in particular in sputtering techniques requiring very low pressures. In addition, document D30 discloses a gas flow control system in which gas flow is measured in terms of the pressure drop across a flow element and compares the measured gas flow with a desired gas flow, and there is no suggestion in the document towards using the system for leak detection; the components of

the system, and in particular the 26500 capillary passages, are set up to measure and control significant flow rates of the order of litres per second, which is at least one order of magnitude greater than what is considered as a leak. Document D31 mentions flow measurement and control, but no leak testing of a product and no pressure system for providing a reference pressure, and the document also relies on a multi-capillary device as that disclosed in document D30. There is no motivation for the skilled person to combine document D15 with documents D30 and D31.

VIII. The arguments submitted by the respondent in support of its request are essentially the following:

In a laminar flow there is no turbulence, and in a linear flow the flow is proportional to the differential pressure, so that a laminar flow can be linear or not. Therefore, the replacement in claim 1 as granted of the expression "linear flow path" by "laminar flow path" extends the scope of protection of the claim (Article 123(3) EPC).

Dependent claim 6 is directed to a system with a flow sensor comprising the laminar flow path defined in claim 1 and a manifold disclosed in the second embodiment of the description (paragraph [0084] *et seq*.). The description, however, specifies that the flow path in the second embodiment is uniform and adjustable (paragraph [0090]), but not that the flow path is laminar. Moreover, original claims 55 to 58 defining the laminar flow path are independent of original claims 27 and 44 defining the provision of the manifold. In addition, the disclosure of the manifold in the second embodiment contains a precise disclosure of the position of the different ports, and the

corresponding features are absent from dependent claim 6. Therefore, there is no support in the original application for the combination of features of claim 6 and, in addition, the subject-matter of the claim constitutes an unallowable generalization (Article 100(c) EPC 1973).

According to the arrangement defined in dependent claim 5 the receiving ports coupled to the differential pressure sensor are positioned outside the cylindrical portion of the centre shaft and therefore outside the flow gap, i.e. at locations in which the flow is turbulent and not molecular, in contradiction with claim 1 which requires carrying out the measurement of the differential pressure across a laminar flow path. In addition, the second embodiment is not disclosed in the description with reference to the first embodiment. In these circumstances, the skilled person cannot implement the invention as defined in dependent claim 5 (Article 100(b) EPC 1973).

Documents A1 and A2 do not appear to be relevant and should not be admitted into the proceedings.

Documents D20 to D29 constitute evidence that document D15 disclosing the tester ATEQ D was rendered available to the public before the priority date of the patent. Document D15 discloses two ranges of test pressures, namely the range 0-(-15) psi ("vacuum") and the range 0 to 60 psi, where the values are relative pressures. Since the first of these ranges is sufficiently large to include extremely low pressures up to the vacuum in the so called "vacuum option" referred to in the documentation and to include specifically the pressures disclosed in the patent, and the molecular flow regime is reached for a pressure value sufficiently low that

depends on the geometry of the flow channel, a value of the Knudsen number above 0.6 is necessarily reached with the tester ATEQ D operating with the range of pressures specified in document D15. In particular, one of the laminar flow tubes for use with the tester had a diameter of 0.56 mm, and with this tube a value of the Knudsen number of 0.6 could be reached with a pressure below 68 Pa. In addition, the transducers of the tester have a resolution of 0.000015 psi (document D15, page 26), i.e. of about 0.10 Pa, a value that is consistent with a pressure of 68 Pa, and the pricing list shown in document D15 refers to laminar flow tubes "from 0-1 l/ hr to <4m3/hr". Document D15 also refers to test pressures of 20 mbar (page 33) and it was possible to operate the tester with this pressure and with capillary tubes having a diameter such that the tester operated in the molecular flow regime.

Document D15 refers to friction, and friction takes place not only in the viscous regime but also in the molecular flow regime in the form of friction between the fluid and the walls of the tubes. Document D15 specifies that the flow is given by Lc P, where Lc is a characteristic value of the laminar flow tube being used. The document does not specify whether the flow is the mass flow or the volume flow, but these two flows are equivalent since it is known that they are proportional under specific test conditions, i.e. at a constant and known value of the test pressure. The dependency of the flow on the inlet pressure is not important because the apparatus operates at a constant pressure (document A2, page 3/50); thus, it is not relevant whether or not Lc depends on pressure, it being noted that, in any case, in the molecular flow regime the coefficient of proportionality depends on the temperature (document D11). It is generally known

that in the molecular flow regime the mass flow is proportional to the differential pressure, and from the above considerations it follows that at a predetermined test pressure both the mass flow and the volume flow are proportional to the differential pressure in both regimes. Consequently, the value measured in the tester ATEQ D is representative of the mass flow rate in the molecular flow regime.

The figure on page 35 of document D15 shows only that the linear proportionality between the flow and the differential pressure for a predetermined test pressure is not valid for flows that are too low or too high, and a test pressure beyond the pressure range for which the proportional relationship is valid does not imply that the linearity is lost; document D15 therefore does not teach away from operating in the molecular flow regime or at lower test pressures. Also document A2 does not exclude or discourage operating in the molecular flow regime.

Document D15 refers to the use of the tester ATEQ D in all industrial applications which cover the electronics industry in which high vacuum is used. A leak is just a small flow and the skilled person, confronted with the measurement of small leaks with the tester ATEQ D, would consider carrying out the measurements in the molecular flow regime as disclosed in documents D30 and D31 pertaining to a neighbouring or close technical field, without however using the multi-capillary device disclosed in these documents. In the viscous flow regime the differential pressure is proportional to the quotient between the flow rate and the pressure, and the skilled person would then understand that a lower pressure allows for a better resolution and would consider working in the molecular flow regime, without

however being compelled to continuously lower the value of the pressure and to consider the intermediate flow regimes. The microprocessor of document D15 being programmed to calculate and display a value proportional to the differential pressure which, in the molecular flow regime, is proportional to the mass flow, the displayed value would necessarily be representative of the mass flow in the molecular flow regime. In any case, the skilled person knows when the apparatus requires recalibration, and it is obvious to program the microprocessor of the tester ATEQ D to give account of the known fact that in the molecular flow regime the mass flow is linearly related to the differential pressure. Therefore, document D15 anticipates or at least renders obvious the claimed apparatus.

For similar reasons, the claimed invention was also anticipated by the tester ATEQ G disclosed in document D15, or anticipated or at least rendered obvious by the prior use of the testers ATEQ D and ATEQ G as evidenced by documents D15 and D20 to D29.

Document D8 discloses a gas flow measurement and leak detection apparatus relying on the measurement of the mass flow and comprising a vacuum controller and a gas leak sensor. The gas leak sensor (Figure 1) is identical to that disclosed in the patent in suit and comprises the same adjustable conical structure (column 7, lines 2 to 5) and the same differential pressure sensor (column 7, lines 48 to 54) as the patent (paragraph [0079]). The document does not exclude operating under vacuum, and the apparatus is adapted to develop a gas flow having a Knudsen number above 0.6 by adjusting the conical structure of the gas leak sensor or, as explained in paragraph [0116] of the patent

specification, by applying an extremely low pressure. In addition, the apparatus comprises a microcontroller card with a computer software (column 8, lines 8 to 10, and column 11, lines 46 to 14) which implements the equation in column 11, line 44 expressing the mass flow in terms of the differential pressure, and it is a simple matter to program the microcontroller card to calculate the mass flow with a linear relationship with the differential pressure by simply setting predetermined coefficients equal to zero. Since the indication of a different use of a device does not render the device novel, the claimed apparatus is anticipated by document D8, and in any case rendered obvious because it is well known in the art that in the molecular flow regime the mass flow has a linear relationship with the differential pressure (documents D11, D12, D18, D30 and D31).

Document D30 discloses an apparatus comprising a pressure system, a flow element and a differential pressure transducer and the apparatus is arranged to develop a molecular flow and to detect the pressure drop across the flow element and to provide a voltage signal proportional to the mass flow (page 772, section "Experimental"). In addition, the value of the mass flow constitutes information about the leak rate through a leak valve. The valve is a controlled valve, but the apparatus is also adapted to detect leaks in a product since it would be sufficient to place the test product at the entry of the leak valve and to let open the leak valve, or to replace the valve by the object. Therefore, by only changing the utilisation of the device, the skilled person would arrive at claim 1. In any case, the skilled person knows that a leak is nothing else than a low flow and that a system for measuring low flows can be used for the detection of

leaks. Therefore, document 30 anticipates or at least renders obvious the claimed invention.

The claimed invention is also anticipated by the disclosure of document D31 which relates to a system comprising a differential pressure transducer operating in the molecular flow regime and that can be used for obtaining a value of the mass flow proportional to the differential pressure, the document specifying that in the molecular flow regime the conductance is independent of the pressure (page 1, fifth paragraph). The document discloses flows of the order of a leak flow, and the system can measure very low flows and therefore can detect leaks.

Documents D18 and D31 show that flowmeters adapted to develop a molecular flow regime and comprising means for generating a value of the mass flow proportional to the differential pressure were implemented and rendered public before the priority date of the patent. These flowmeters were adapted for very low flows and could therefore be used for the detection of leaks, so that the prior use of these flowmeters also anticipates the claimed invention.

Reasons for the Decision

1. The appeal is admissible.

2. *Claim 1 - Amendments*

The set of claims amended according to the main and sole request of the appellant differs from the set of claims as granted only in that the expression "across

the *linear* flow path" in claim 1 as granted has been replaced by "across the *laminar* flow path" in present claim 1 [emphasis added].

During the appeal proceedings the respondent has objected that a laminar flow can be linear or not, with the consequence that the replacement in claim 1 of the term "linear" by "laminar" contravenes the requirements of Article 123(3) EPC, and the appellant has submitted that, as found by the opposition division, this amendment constitutes the correction of a clear error and is consistent with the earlier reference in the claim to a "laminar flow path".

In the communication annexed to the summons to oral proceedings the Board noted that

- the expression "across the *linear* flow path" in claim 1 as granted was replaced by "across the *laminar* flow path" in reply to the objections raised by the respondent under Articles 100(b) and 100(c) EPC 1973 in respect of the replaced expression and consequently the amendment appeared to be admissible pursuant to Rule 80 EPC, and that
- the opposition division had held that the resulting amended claim 1 overcame the aforementioned objections under Articles 100(b) and 100(c) EPC 1973, and this finding of the opposition division had not been disputed during the written appeal proceedings.

The Board also noted in the aforementioned communication that according to the established case law amending a claim to remove or clarify an inconsistency did not contravene Article 123(3) EPC if the amended claim had the same meaning as the unamended claim when construed in its context (see for instance T

438/98, point 3.1.2 of the reasons, and the decisions cited therein), and during the oral proceedings the respondent did not contest the application of this case law to the present case.

It follows from the above considerations that the skilled person reading claim 1 as granted would have understood the expression "across the linear flow path" in the technical context of the claimed subject-matter as referring to the "laminar flow path" previously defined in the claim, and that the amendment to the claim clarifies an inconsistency without changing the meaning of the claim when construed in its technical context. Consequently, in accordance with the case law referred to above, the replacement of the expression "across the linear flow path" by "across the laminar flow path" in claim 1 does not extend the scope of protection of the claim within the meaning of Article 123(3) EPC.

3. *Article 100(c) EPC 1973 - Dependent claim 6*

In the decision under appeal the opposition division found that the remaining grounds for opposition raised under Article 100(c) EPC 1973 with regard to claim 1 and dependent claim 6 as granted were not convincing, and in the appeal proceedings the respondent has maintained the corresponding grounds with respect to dependent claim 6.

Dependent claim 6 is directed to the system defined in claim 1, i.e. to a system comprising a flow sensor with a flow element defining a laminar flow path as primarily disclosed in the description of the patent with reference to the first embodiment and arranged to operate in the claimed molecular flow regime as

disclosed in the description in paragraph [0115] *et seq*.. Dependent claim 6 further requires a manifold coupled to the body of the flow sensor, the features relating to the manifold being disclosed in the second embodiment of the description with reference to Figure 17 (patent specification, paragraph [0084] *et seq*. and the corresponding paragraphs of the application as published). According to the disclosure of this embodiment the flow path is uniform and adjustable (paragraph [0090] of the patent specification), but - as submitted by the respondent - there is no explicit reference in the corresponding disclosure of the application as published to the flow path being laminar as required in dependent claim 6 by reference to claim 1 and, in addition, the original claims defining the features of the laminar flow path (claims 55 to 58 of the application as published) do not refer back to the original claims defining the provision of the manifold according to present dependent claim 6 (claims 27 and 44 of the application as published).

However, as pointed out by the opposition division in its decision, the second embodiment is disclosed in the context of the establishment of a non-turbulent flow within the flow gap (paragraph [0097] of the patent specification and the corresponding paragraph of the description of the application as published) and, in addition, the structural arrangement defining the flow gap in the flow sensor of the second embodiment is identical to that of the first embodiment, the latter forming an adjustable and uniform flow gap capable of generating a laminar flow path (paragraph [0068] of the patent specification). Furthermore, in agreement with the finding of the opposition division in its decision, there is no reason to presume that the provision of the manifold coupled to the flow sensor would affect the

kind of flow within the body of the flow sensor. In these circumstances, the skilled person would understand in the technical context of the disclosure of the invention that, although there is no express disclosure of the second embodiment operating with a laminar flow path, the "uniform and adjustable gap" of the flow sensor of the arrangement described in connection with the second embodiment and represented in Figure 7 is also arranged - as is the case in the first embodiment - to generate a laminar flow path as required by the subject-matter defined in dependent claim 6 by reference to claim 1.

As regards the submission of the respondent that the second embodiment is disclosed in the description with reference to a specific positional arrangement of the different ports connecting the body of the flow sensor, the manifold and the pressure and temperature sensors (Figure 17 and paragraphs [0093] and [0094] of the patent specification and the corresponding paragraphs of the application as published) and that the corresponding features are omitted in dependent claim 6, the Board notes that, as long as the claim defines the essential technical features of the system including the manifold - as it was the case in claims 27 and 44 of the application as published each defining the same features as present dependent claim 6 -, there is no need for the claim to define the specific arrangement of ports detailed in the description. In addition, the respondent has not identified any essential functional correlation between the specific arrangement of ports referred to above and the features of the manifold and/or the flow element required by the claimed subject-matter, and in these circumstances no unallowable generalization can be seen in the fact that dependent claim 6 does not define the specific

positional arrangement of ports disclosed in the description.

In view of the above considerations, the ground for opposition raised under Article 100(c) EPC 1973 with regard to dependent claim 6 is not found persuasive by the Board.

4. *Article 100(b) EPC 1973 - Dependent claim 5*

In the decision under appeal the opposition division found that the grounds for opposition raised under Article 100(b) EPC 1973 with regard to claim 1 and dependent claims 3 and 5 as granted were not convincing, and during the appeal proceedings the respondent has maintained the corresponding grounds with regard to the invention defined in dependent claim 5.

According to the submissions of the respondent dependent claim 5 defines an arrangement in which a sensor measures the differential pressure between two receiving ports respectively located outside the cylindrical portion of the centre shaft defining the laminar flow path, i.e. outside the laminar flow gap and therefore at locations in which the flow may be turbulent and not molecular, in contradiction with claim 1 which requires carrying out the measurement of the differential pressure across a laminar flow path.

However, as submitted by the appellant, the patent specification discloses in the second embodiment an arrangement in which the two receiving ports coupled to the differential pressure sensor are respectively located downstream and upstream of the flow gap (*cf.* paragraph [0097]) and this arrangement is not excluded

by the subject-matter defined in claim 1. In addition, under the operating conditions required by the claimed invention and involving a gas flow having a Knudsen number above 0.6 in the flow gap, no turbulent flow would be expected in the regions immediately outside the flow gap and adjacent the receiving ports, and in any case no evidence or technical argument has been provided by the respondent that would support the view that, under the operating conditions mentioned above, the characteristics of the flow in the regions adjacent the receiving ports would interfere with a measurement of the differential pressure across the laminar flow path as required by the reference in dependent claim 5 to claim 1.

In view of the above considerations, the Board sees no reason to doubt that the skilled person would be able to carry out the invention defined in claim 1 together with dependent claim 5 on the basis of the information in the patent in suit within the meaning of Article 100(b) EPC 1973.

5. *Documents and alleged prior uses - Formal issues*

5.1 Document D15 shows an information folder containing different sets of data sheets disclosing the technical specifications of a series of different leak and flow testers, and in particular of the testers ATEQ D and ATEQ G. The respondent submitted during the first-instance proceedings documents D20 to D29 as evidence in support of the public availability of document D15 before the priority date of the patent in suit.

During the appeal proceedings the appellant has contested the view of the opposition division that, irrespective of documents D20 to D29, document D15 was

available to the public before the priority date of the patent, and the respondent has referred to the testers ATEQ D and ATEQ G disclosed in document D15 and also alleged as further evidence the prior use of the testers as evidenced by documents D20 to D29 together with document D15.

As will become apparent from the following (points 6.2, 6.3 and 7.1 below), however, neither the disclosure of document D15 nor the subject-matter of the alleged prior use of the testers ATEQ D and ATEQ G are sufficient to challenge the substantive patentability of the claimed invention. Consequently, there is no need to address in the present decision either the question of whether document D15 was made available to the public before the relevant date or the question of whether the alleged prior use of the testers ATEQ D and ATEQ G has been sufficiently substantiated and proven by the respondent.

5.2 During the appeal proceedings the appellant submitted that documents D30 and D31 should not be admitted into the proceedings before the Board because they were filed late during the first-instance proceedings.

However, as already noted by the Board in its communication annexed to the summons to oral proceedings, document D30 was *de facto* admitted by the opposition division into the proceedings and no reason can be identified for concluding that the opposition division would have exercised its discretion under Article 114(2) EPC 1973 in a wrong manner.

As regards document D31, on the one hand, the Board noted in the aforementioned communication that the pertinent content of the document did not appear to go

beyond that of document D30 or D18 but, on the other hand, during the oral proceedings the parties discussed extensively the content of the document.

In these circumstances, the Board sees no reason for refusing to consider the disclosure of documents D30 and D31 in the appeal proceedings.

5.3 During the appeal proceedings the respondent alleged the public prior uses of flowmeters implemented according to the disclosure of each of documents D18 and D31, and in the communication annexed to the summons to oral proceedings the Board noted that the only support offered by the respondent for the subject-matter of the alleged prior uses was the technical disclosure of documents D18 and D31 themselves, with the consequence that the subject-matter of the alleged prior uses could not go beyond the proper disclosure of each of documents D18 and D31.

In addition, as will be apparent from the following (points 6.5.2 and 6.5.3 below), neither document D18 nor document D31 are sufficient to challenge the substantive patentability of the claimed invention and, in view of the above considerations, nor does the alleged prior use of devices implemented according to the disclosure of these documents. In these circumstances, there is no need to address the admissibility, let alone the substantiation of the public prior uses alleged by the respondent in connection with documents D18 and D31.

5.4 During the appeal proceedings the appellant filed documents A1 and A2 in support of its case on appeal and the respondent contested the admissibility of these documents into the proceedings.

Document A2 is a copy of the user's manual of the tester ATEQ D described in document D15 and document A1 is a declaration by an expert on the features of the tester ATEQ D disclosed in documents D15 and A2. However, during the proceedings it became apparent that the pertinence of the disclosure of document A2 referred to by the appellant does not go beyond that of document D15, and the relevant statements in the declaration shown in document A1 were recited by the appellant itself during the proceedings and incorporated into its own submissions. In these circumstances, the Board sees no reason for addressing the content of documents A1 and A2 in the present decision, and consequently there is no need for the Board to address the issue of the formal admissibility of these two documents into the proceedings.

6. *Claim 1 - Novelty*

6.1 Claim 1 is directed to a system for detecting leaks in a product. The claimed system comprises a pressure system and a flow element defining a laminar flow path, these components being arranged so as to develop a gas flow through a flow gap between the pressure system and the product. A measure of the differential pressure across the laminar flow path by means of a pressure sensor allows the determination of the flow rate through the flow gap and the subsequent determination of whether or not the product leaks a predetermined amount.

In addition, according to the subject-matter of claim 1

a) the pressure system and the flow sensor are adapted to develop a gas flow through the flow gap having a Knudsen number of more than 0.6 and

b) the system is operable to generate a value representative of the mass flow rate of the gas flow through the flow gap such that the value has a linear relationship with the differential pressure, the determination of whether the product leaks an unacceptable amount being carried out on the basis of this value.

6.2 Document D15

It is undisputed by the parties that the leak and flow tester ATEQ D disclosed in document D15 comprises all the features mentioned in the first paragraph of point 6.1 above. In particular, the tester ATEQ D comprises a transducer arranged to measure the differential pressure $P = P_1-P_2$ across a laminar flow tube connected to the product under test (document D15, page 26), and means for determining the flow rate in terms of the flow through the tube which according to the document is given by Lc P, i.e. is linearly proportional to the measured value of the differential pressure P (page 27).

During the proceedings the issue of novelty focused on the question of whether the disclosure of document D15 also anticipates the claimed features a) and b) mentioned in point 6.1 above.

6.2.1 It is common ground that the Knudsen number (Kn) characterizes the flow of a fluid through a conduit and is defined as /L, where is the mean free path length of the molecules in the fluid and L is a characteristic linear length of the conduit. Thus, depending on whether the Knudsen number is lower than about 0.01, between about 0.01 and about 0.1, between about 0.1 and about 3.0, or greater than about 3.0, the fluid flow

can be described respectively as a viscous flow, as a slip flow, as a transition flow, and as a molecular flow in which the fluid behaves as a gas of free molecules. Accordingly, the claimed feature a) requiring a flow having a Knudsen number of more than 0.6 requires operation of the claimed system in the molecular flow regime, or at least in a transition flow regime close to the molecular flow regime. In addition, since the lower the pressure of a fluid, the longer the mean free path () of the molecules of the fluid, the claimed feature a) requires operation at a sufficiently low pressure and with sufficiently small conduits so that the Knudsen number Kn is above 0.6.

However, there is not sufficient information in document D15 that would allow the conclusion that the different means of the tester ATEQ D, and in particular the pressure system and the laminar flow tubes referred to in the document, were such that the fluid would flow in the molecular flow regime or in a transition flow regime close to the molecular flow regime. In particular, the document discloses in the context of the calibration of the tester ATEQ D a series of values of the test pressure running from 20 to 4000 mbar (document D15, page 33), and while all these values would allow the conclusion that the tester ATEQ D can at least be operated in the viscous flow regime, even the lowest of these pressure values, i.e. 20 mbar or about 2 kPa, appears insufficient to reach the molecular flow regime or at least a transition flow regime close to it. As a matter of fact, the highest of the maximum pressure values considered in the patent for developing a flow in the claimed flow regime is of 1.33 kPa (paragraph [0116] of the patent specification), and according to the submissions of the respondent the tester ATEQ D would reach a flow regime

with a Knudsen number of 0.6 when operating at pressures below 0.068 kPa and with a laminar flow tube having a diameter of 0.56 mm, and all these values of the pressure are below the lowest of the test pressure values disclosed in document D15.

The respondent has referred to the disclosure of document D15 according to which the tester ATEQ D operates with a range of high test relative pressures from 0 to 60 psi or, alternatively, under the option "Vacuum testing" (pricing list on page 32) with a range of test relative pressures specified as "0-(-15) PSI (Vacuum)" (page 26), and submitted that the lowest of these relative pressure values, i.e. -15 psi, indicates that the tester could operate in perfect vacuum and/or at low pressures including the range of pressures envisaged in the patent. However, the disclosed value range from 0 to -15 psi of the relative pressure appears to constitute in the context of the document only a generic indication that the tester can operate at low pressures, i.e. with absolute pressures below the atmospheric pressure, but in the absence of any other supporting disclosure or evidence the mere fact of specifying a generic value range going from 0 to -15 psi is not in itself sufficient to conclude that the tester actually comprised means for reaching any arbitrarily low pressure below the atmospheric pressure or any arbitrarily high level of vacuum, let alone the perfect vacuum. As a matter of fact, reaching any arbitrarily low pressure, and in particular a value of the absolute pressure arbitrarily close to 0 corresponding to the perfect vacuum, would require complex, non-standard, high-performance vacuum technology and, in the absence of any evidence or indication to the contrary, the Board considers highly implausible that a tester having the characteristics

disclosed in document D15 would have included such technology. Accordingly, in the absence of any clear and unambiguous evidence, the Board is of the opinion that the disclosure of the generic range 0 to -15 psi of the values of the relative pressure does not constitute sufficient evidence to conclude that the tester ATEQ D was actually arranged to operate at arbitrarily low pressures, or at least at pressures sufficiently low to reach in the laminar flow tubes disclosed in the document a molecular flow regime or a transition flow regime close to it.

The further submission of the respondent that it would have been possible to operate the tester ATEQ D disclosed in document D15 with thinner laminar flow tubes and with pressures lower than those exemplified in the document so that the molecular flow regime would have been reached is not persuasive because for the issue of novelty the relevant question is whether the actual disclosure of the document, and in particular the different means of the tester disclosed in document D15, would have allowed the actual operation of the tester in such a flow regime, and not whether such a flow regime could have been reached when some of the means disclosed in the document were modified or replaced by some other means not actually disclosed in the document, the latter question belonging, by its very nature, to the assessment of inventive step.

The respondent has also referred to the specifications in document D15 relating to the value of the resolution of the transducers and to the flow values of the laminar flow tubes. However, the fact that the transducers of the tester ATEQ D have a resolution of 0.000015 psi (document D15, page 26) and the fact that the laminar flow tubes are characterized in the pricing

list of the document by the specification "from 0-1l/hr to <4m3/hr" (page 32) are also insufficient to conclude that the tester was adapted to reach a flow regime as claimed with the laminar flow tubes made available according to the disclosure of the document. In particular, the mere fact that the resolution value of the transducers mentioned above might be consistent with a test pressure of 0.068 kPa and with operation of the tester in a molecular flow regime is insufficient by itself to conclude that the tester was actually arranged to operate at pressures sufficiently low to reach a flow regime as claimed, and the lower value "0-1l/hr" of the flow range of the laminar flow tubes disclosed in document D15 includes values of the flow arbitrarily close to zero, but - as reasoned above with respect to the disclosure of the generic range 0 to -15 psi - the value appears to be disclosed as a generic lower value of the flow and, in any case, does not constitute evidence that the tester was actually arranged to operate with any arbitrarily low value of the flow through the laminar flow tubes, let alone in a flow regime as claimed.

In addition, as already noted by the opposition division in its decision, while the patent specification specifies that systems according to the claimed invention measure mass flow rates below 50 g/min (paragraph [0116]) and this value corresponds to a volume flow rate of about 3 cm^3/min for air at a pressure of 1.33 kPa, in document D15 flow is defined as "any leak greater than 50 cc/min" (page 27). The disparity between a flow range having a lower flow value of 50 cm^3/min and a flow range having an upper flow value of about 3 cm^3/min constitutes a further indication that the tester disclosed in document D15

was not conceived to reach flow conditions comparable to those required by the claimed invention.

It follows from the above considerations that, while document D15 contains several indications that the tester ATEQ D is adapted to operate at least in the viscous flow regime, the document contains no clear and unambiguous indication that would allow the conclusion that the different means of the tester ATEQ D, and in particular the laminar flow tubes and the pressure system, are adapted to develop a gas flow having a Knudsen number of more than 0.6 as claimed, i.e. to operate in a molecular flow regime or in a transition flow regime close to it.

6.2.2 This finding is not affected by the submissions of the parties relating to the claimed feature b) listed in point 6.1 above. In particular, contrary to the respondent's submissions, the disclosure of document D15 relating to the flow being given by Lc P (page 27), i.e. being linearly proportional to the differential pressure, does not constitute evidence that the molecular flow regime is inherently contemplated in the document. Indeed, it is common ground that the differential pressure of a fluid flow across a conduit constitutes a measure of the flow rate across the conduit, and that in particular

- in the viscous flow regime the volume flow is proportional to the differential pressure or, equivalently, the mass flow is proportional to the product of the static pressure and the differential pressure P, as expressed by the Poiseuille's law when the differential pressure P is much smaller than the pressure (document D11, paragraph 5.22 and equation 5.3),

- in the molecular flow regime the mass flow is proportional to the differential pressure P (document D11, paragraph 5.3 and equation 5.8), and
- when the fluid flows in an intermediate flow regime, i.e. in the slip or in the transition flow regime, the flow rate is an interpolation given by a linear combination of the two flow rates mentioned above (document D11, equation 5.14; see also document D12, page 814, equation 13.4.1-22, the Knudsen number being defined according to the criteria used in this document as the inverse of the value /L).

Accordingly, although the disclosure of document D15 that the flow is linearly proportional to the differential pressure would in principle - as submitted by the respondent - be consistent with operation of the tester ATEQ D in a molecular flow regime, the mentioned disclosure is also consistent with operation of the tester in a viscous flow regime in which P is much smaller than the operation pressure, as actually appears to be the case in document D15 where for testing pressures of the order of 20 inch water (about 5 kPa) the differential pressure P is of the order of 1 inch water (about 0.25 kPa) (page 29 of document D15). Consequently, the mere fact of mentioning that the flow is given by Lc P does not allow the conclusion that the tester was inherently arranged to operate in the molecular flow regime.

In addition, as noted above, the linear dependency of the flow on the differential pressure is different in the different flow regimes, i.e. involves different coefficients of proportionality, and for a proper determination of either one of the volume or the mass flow rates according to a measurement of the

differential pressure it is necessary to identify the flow regime of operation and to recalibrate or modify the corresponding processing means. In this context, if it were assumed that the tester ATEQ D was not only adapted to operate in the viscous flow regime, but also in the molecular flow regime, then it would have to be expected that the determination of the flow is described in document D15 by different relationships in the different flow regimes or at least that some information (possibly on recalibration, or on changes of operation mode or of data processing mode, etc.) is given in the document to this effect. However, document D15 specifies for all ranges of operating pressures a common relationship with one single coefficient relating the flow with the differential pressure and, in addition, the document is silent as to any consideration relating to any change in the flow regime, and these findings constitute a further indication that the tester ATEQ D was arranged to operate in the viscous flow regime, but not arranged to switch to operate in other flow regimes, let alone in a flow regime associated with a Knudsen number above 0.6.

6.2.3 As regards feature b) of the claimed invention, the Board notes that - as stated in point 6.2.2 above - in the claimed flow regime, i.e. in the molecular flow regime and also in the transition flow regime close to it, it is the mass flow which is linearly proportional to the differential pressure P with a coefficient of proportionality independent of the pressure (document D11, paragraph 5.3 and equation 5.8). Consequently, the operation of the claimed system in the claimed flow regime implies that the value of the differential pressure measured by the system constitutes itself, up to a coefficient of proportionality, a direct

measurement of the mass flow, and the Board adheres to the appellant's view that it is in these terms that the skilled person would understand the claimed feature b) requiring the generation of a value representative of the mass flow rate such that the value has a linear relationship with the differential pressure, the determination of whether the product leaks an unacceptable amount then being carried out on the basis of this value.

In addition, since, as concluded above, the tester ATEQ D operates in the viscous regime and no indication can be found in document D15 that the tester is also adapted to operate in the molecular flow regime, the measurement of the value of the differential pressure with the tester ATEQ D constitutes directly a measure of the volume flow rate and not of the mass flow rate within the meaning of the claimed invention. The Board agrees with the respondent that the volume and the mass flow rates of a fluid through a passage are equivalent, however only in the sense that the respective values are correlated to each other by the density of the fluid, which in turn depends on the temperature and the pressure. As noted in point 6.2.2 above, the relationship between the differential pressure and the mass and the volume flow rates is different in the different flow regimes with the consequence that while the determination of the mass flow rate in the viscous flow regime requires the determination of the test conditions, and in particular the measurement of the pressure, in the molecular flow regime the mass flow rate is directly given by the differential pressure and there is no need to determine or measure the pressure. In addition, the mass flow is technically more significant than the volume flow in the evaluation of the leak amount from a product with a flowmeter of the

type under consideration. Therefore, although the mass and the volume flow rates are physically equivalent in the sense noted above, their determination in the different flow regimes cannot be considered to be technically equivalent to the extent of considering the determination of the flow in the tester ATEQ D as inherently anticipating the determination of the mass flow as defined in the claimed feature b).

6.2.4 In view of the above considerations, the Board concludes that, as already held by the opposition division in its decision - and irrespective of whether document D15 was rendered available to the public before the relevant date, *cf.* point 5.1 above -, there is no clear and unambiguous disclosure in document D15 that the tester ATEQ D is arranged to operate so as to satisfy features a) and b) referred to above and required by the claimed invention.

6.2.5 The same conclusion in point 6.2.4 above applies to the submissions of the respondent with regard to the tester ATEQ G disclosed in document D15 since no submission has been made with regard to this tester in addition to those made with regard to the tester ATEQ D and already considered above.

6.3 Prior use of the testers ATEQ D and ATEQ G

During the appeal proceedings the respondent has also alleged prior use of the testers ATEQ D and ATEQ G disclosed in document D15. However, as already noted by the Board in the communication annexed to the summons to oral proceedings, the subject-matter of the alleged prior uses does not go beyond the technical features of the testers ATEQ D and ATEQ G disclosed in document D15. Accordingly, the alleged prior use of the testers

is insufficient to question novelty of the claimed subject-matter for the same reasons as those given in point 6.2 above.

6.4 Document D8

Document D8 discloses a gas flow measurement and leak detection apparatus (abstract) comprising, among others, a flow sensor unit (Figure 1 and the corresponding description). However, as held by the opposition division in its decision, the apparatus operates in a pressurized mode (column 4, lines 39 to 41, column 8, lines 41 to 43, and column 13, lines 13 to 15), and not in a low-pressure or vacuum mode as inherently required by the claimed subject-matter, so that the apparatus measures "the amount of make-up mass flow to the unit under test" (document D8, column 13, lines 35 to 39), and not the amount of fluid leaking from the product under test as in the claimed invention. In addition, the apparatus comprises a "pressure/vacuum controller", but the vacuum functionality of the controller is disclosed in the document only in the context of reducing pressure fluctuations (column 4, lines 29 to 51, and column 13, lines 7 to 63), and there is no disclosure of the use of the controller for operating the apparatus in a low-pressure or vacuum mode.

The respondent's submission that the flow sensor unit disclosed in document D1 with reference to Figure 1 is similar or even identical to that disclosed in the patent specification (Figure 10 and the corresponding disclosure) and could therefore be used with a flow regime having a Knudsen number as claimed is not relevant for the issue of novelty of the claimed subject-matter because there is no disclosure in the

document that would allow the conclusion that the remaining means of the apparatus are adapted to operate as claimed. In particular, there is no evidence that the components of the pressure system are arranged to reach a sufficiently low pressure to allow the apparatus to operate in a flow regime associated with a Knudsen number greater than 0.6 as claimed or that the pressure sensors are adapted to measure values of the differential pressure at such low pressures, and, in addition, the measurement data processing means of the apparatus are arranged to determine the mass flow rate according to a polynomial of third order with the differential pressure (column 11, line 34 *et seq*.), i.e. according to an approach relying on a flow in the viscous regime, and not to generate a value having a linear relationship with the differential pressure as required by the claimed subject-matter.

Consequently, the subject-matter of claim 1 is novel over the disclosure of document D8.

6.5 Documents D18, D30 and D31 - Prior uses

6.5.1 Document D30 discloses a high precision flow measurement system operating in the molecular flow regime and discloses the determination of the mass flow through a servo leak valve in terms of the pressure drop across a flow element sensed by a differential pressure transducer (abstract, Figures 1 and 2, and page 771, first column, penultimate paragraph). However, the system is disclosed in the context of processing techniques such as reactive sputtering, reactive ion etching and plasma reactor deposition operating at low pressure and requiring the measurement and the control of backfill gases in the pressure range above 0.0133 Pa (page 771, section "Introduction"), and

the document describes the generation of an error signal when the signal representative of the mass flow of the gases deviates from a reference signal corresponding to a desired value of the flow rate (page 771, first column, penultimate paragraph), and consequently the system is not arranged to detect leaks in a product as claimed.

As regards the submissions of the respondent relating to the possibility of placing a product at the entry of the valve and keeping the valve in its open state or, alternatively, replacing the valve by the product, the Board notes that these submissions involve modifications of the disclosed system and therefore pertain, by their very nature, to the assessment of inventive step, and that in any case the flow element disclosed in document D30 is constituted by a matrix of about 26500 capillary passages (Figure 3 and the corresponding description) allowing for flows significantly above those associated with the detection of a leak in a product according to the claimed system, so that the system resulting from the modifications proposed by the respondent would not allow the measurement of a leak in the product as claimed.

6.5.2 Document D31 discloses the measurement and control of flows in the molecular flow regime, and document D18 discloses a flowmeter operating in the molecular flow regime, both documents relying on the proportionality between the mass flow rate and the differential pressure to measure the mass flow. However, the documents are silent as to the provision of means for the detection of leaks in a product and, in addition, both documents disclose a multichannel flow element of the same type as that disclosed in document D30 (document D31, Figure 1, and document D18, Figure

522-1), so that, as mentioned above with regard to document D30, the element is not suitable for the detection of leaks in a product as claimed.

6.5.3 Finally, there is no evidence that the features of the flowmeters implemented on the basis of the disclosures of documents D18 and D31 and allegedly used according to the submissions of the respondent before the priority date of the patent would go beyond the features of the respective flowmeters disclosed in the documents themselves. Accordingly, the prior uses alleged by the respondent are also insufficient to challenge novelty of the claimed subject-matter for the same reasons as those given in point 6.5.2 above.

6.6 In view of the considerations in points 6.2 to 6.5 above, the Board concludes that the evidence submitted by the respondent is not sufficient to conclude that the system defined in claim 1 lacks novelty in the light of the prior art.

7. *Claim 1 - Inventive step*

7.1 The issue of inventive step was primarily addressed during the proceedings relying on the tester ATEQ D disclosed in document D15 as the closest state of the art. As concluded in point 6.2.4 above, the claimed apparatus differs from the tester ATEQ D in features a) and b) listed in point 6.1 above.

7.1.1 In its decision the opposition division referred to the common general knowledge of the person skilled in the art and held that the claimed invention improved the capability of the tester ATEQ D to detect small leaks, that the detection of smaller leaks required reduction of the reference pressure, that the skilled person was

aware that lowering the pressure ended up in a molecular flow regime, that the tester would automatically generate a value representative of the flow rate in this flow regime, and that only a recalibration would be necessary to obtain a correct value of the mass flow rate.

However, in the absence of any precise hint or clear suggestion in the prior art that would support the chain of considerations presented by the opposition division, the Board is reluctant to accept the opposition division's finding of lack of inventive step. In particular, document D15 relies on a predetermined approach for the determination of the flow as the product Lc P in a predetermined flow range associated with the region of linear response of the laminar flow element being used (the "laminar flow region" represented in the figure on page 28 of the document) and, assuming that the skilled person would consider lowering the reference pressure in the system in order to detect small leaks instead of other possible alternatives (such as using improved pressure sensors or other alternative measures known in the art), he would then reduce the pressure only within the range of operating pressures of the tester compatible with the approach referred to above. In the Board's opinion the skilled person would not consider, without a clear motivation, lowering the pressure in the tester beyond the point at which the approach on which document D15 relies ceases to be valid, because the skilled person would be concerned that, as the pressure is gradually lowered beyond that point, the flow regime ceases to be viscous to become a slip flow, then a transition flow and finally a molecular flow regime (point 6.2.1, first paragraph), and that the determination of the volume and/or the mass flow on the

basis of the measured value of the differential pressure is different in these flow regimes (point 6.2.2, first paragraph) and would require a complex modification of the data processing architecture of the tester. For these reasons, the Board is of the opinion that, when considering the disclosure of document D15 alone together with the common general knowledge in this field, only hindsight knowledge of the claimed invention would lead the skilled person to operate the tester ATEQ D with values of the reference pressure well below the operating pressures considered in document D15 to specifically end up in a flow regime having the claimed value of the Knudsen number and possibly to readapt or at least adjust the characteristics of the tester, and in particular of the sensors, to carry out reliable measurements under such conditions, and subsequently undertake a recalibration of the tester in order to obtain a technically meaningful value of the flow.

7.1.2 In addition, none of the documents considered during the proceedings suggests modifying the tester ATEQ D disclosed in document D15 so as to result in a system as claimed. In particular, as already noted in point 6.4 above, document D8 teaches the detection of leaks by means of a flow sensor operating in a pressurized mode and is silent as to the detection of leaks by means of a flow sensor operating under low pressure, let alone operating in the molecular flow regime.

As regards documents D18, D30 and D31, these documents relate to the measurement of mass flows in the molecular flow regime. However, as noted in point 6.5 above, all these documents pertain to a quite different technical field in which low-pressure gas flows in the molecular flow regime are required for a particular

technical purpose and the documents address the problem of the measurement and control of such molecular flows, and none of them discloses or suggests generating a flow in the molecular flow regime for the purpose of detecting leaks in a product as claimed. In addition, as already noted in points 6.5.1 and 6.5.2 above, the flow elements used in documents D18, D30 and D31 are multichannel flow elements that allow flows significantly above those associated with the detection of a leak according to the claimed invention (compare in particular the flows in paragraph [0116] of the patent specification with those in Table I of document D31) and of the order of magnitude of the flows already achievable by the tester ATEQ D disclosed in document D15. Therefore, there appears to be no motivation for the skilled person to combine the disclosure of document D15 with the teaching of any of documents D18, D30 and D31.

7.2 Document D8 has been considered by the parties as an alternative starting point for the assessment of inventive step. As concluded in point 6.4 above, however, the apparatus disclosed in document D8 has been arranged to operate in a pressurized mode for the purposes of determining the amount of fluid leaking to the product under test, and there is no suggestion in the prior art that would incite the skilled person to modify the apparatus disclosed in document D8 so as to operate in a low-pressure or vacuum mode and to determine the fluid leaking from the product, let alone to go one step further and to operate the apparatus in the molecular flow regime or to combine the apparatus with partial aspects of the systems disclosed in document D30, D31 or D18, this step further requiring a modification of the measurement data processing means

of the apparatus (*cf.* point 6.4 above, penultimate paragraph).

The respondent has emphasized the similarities between the flow sensor unit of the apparatus of document D8 (Figure 1 and the corresponding disclosure) and that disclosed in the patent specification with reference to Figure 10. However, irrespective of whether the two flow sensor units are identical or whether the unit of document D8 is adjustable so that under a sufficiently low pressure the unit would operate in the molecular flow regime, the remaining components of the apparatus of document D8, and in particular the pressure system and the measurement data processing means, are different from those required by the claimed subject-matter (*cf.* point 6.4 above), and the similarities pointed out by the respondent are not sufficient to suggest the modification of the remaining components of the apparatus so as to result in a system as claimed.

7.3 The respondent has also referred to document D30 as the closest state of the art and submitted that it would be obvious to arrive at the claimed subject-matter by placing a product at the entry of the valve and keeping the valve in its open state or, alternatively, replacing the valve by the product. However, it is apparent from the analysis of document D30 in point 6.5.1 above that this document pertains to a different technical field and that, notwithstanding the technical similarities, the system is not even suitable for the detection of leaks in a product, and in this context only hindsight knowledge of the present invention would suggest the skilled person to start from the system disclosed in document D30, to consider the use of the system for the detection of leaks in a product, to modify the system as suggested by the respondent by

replacing the valve by the product or by coupling the product to the valve, and to change the signal processing architecture of the system in order to obtain a signal representative of the leak in the product.

Document D31 does not go beyond the disclosure of document D30 (see point 6.5.2 above), and consequently similar considerations apply if document D31 were to be adopted as the closest state of the art.

7.4 The Board concludes that the subject-matter of claim 1 is not rendered obvious by the prior art considered by the respondent within the meaning of Article 56 EPC 1973.

8. The same conclusions as those drawn in points 6.6 and 7.4 above with regard to claim 1 also apply to dependent claims 2 to 12 by virtue of their dependency on Claim 1.

9. For the reasons given above, the Board concluded during the oral proceedings that none of the submissions of the respondent prejudiced the maintenance of the patent amended according to the main and sole request of the appellant (Article 101 (3) (a) EPC).

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the department of first instance with the order to maintain the patent as amended in the following version:
   - description and drawings of the patent specification and
   - claims 1 to 12 of the main request filed with the statement of grounds of appeal dated 26 May 2010.

The Registrar: The Chairman:

M. Kiehl A. G. Klein

Decision electronically authenticated