Intellectual Property Office

BL O/436/19

26 July 2019

**PATENTS ACT 1977**

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| APPLICANT | Schlumberger Holdings Limited |
| ISSUE | Whether patent application GB 1515488.3 complies with section 1(1)(b) |
| HEARING OFFICER | Dr C L Davies |

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**DECISION**

**Introduction**

1 Patent application GB 1515488.3 ("the application") entitled "Systems and methods for analyzing fluid from a separator " was filed on 1 September 2015, with an earliest declared priority date of 29 September 2014. It was published as GB 2531641 A on 27 April 2016.

2 Following a number of rounds of correspondence between the examiner and the applicant's attorneys, the examiner remains of the view that the claimed invention does not involve an inventive step.

3 With the position unresolved the applicant asked to be heard and the matter came before me at a hearing conducted in person at the UK IPO on 19 June 2019. The issue of inventive step before me was set out in the examiner's pre-hearing report of 22 May 2019. The applicant was represented at the hearing by attorney Mr Martin Hyden of Wynne-Jones IP Limited. I was assisted by Mr Marc Collins.

**The invention**

4 The invention relates to a method for analyzing the reliability of a measured volumetric flow rate of a fluid in a gas line of a gas-liquid separator, the method includes measuring a gas volume fraction of the fluid in the gas line, comparing the measured gas volume fraction of the fluid to a threshold gas volume fraction level, and determining whether the measured volumetric flow rate is reliable based on the comparison.

5 The invention is concerned with measuring the flow from a gas-liquid separator which may be used in the oil industry as oil wells produce oil, water and gas mixed together in various proportions. Typically, the water is not wanted but the oil or gas or both is e.g. a gas well might produce predominantly gas with some oil and water which is not of interest, so it is separated out and vice versa in an oil well. When separating out the gas, oil and water from one another it is desirable to understand

how much of each is being produced. The invention is primarily concerned with gas coming out of a separator and determining how much gas is being obtained from the separator. Typically, this would be done by measuring a volumetric flow of gas from the separator. However as explained by Mr Hyden at the hearing the crux of the invention lies in determining the reliability of the measured volumetric flow.

6 An apparatus 10 for separating multiphase fluid and measuring flow rates of separated fluids is generally depicted in FIG. 1 of the application below. The apparatus 10 includes a separator 12 having a separation tank or vessel 14. Fluid produced from the well 30 can be routed through the wellhead equipment 28 and the inlet line 16 into the separation vessel 14. The produced fluid can be separated within the vessel 14 and routed into the outlet lines. The separator 12 uses gravity to separate gas and liquid components of the multiphase fluid within the vessel 14. Gas separated from the multiphase fluid can be routed away from the vessel 14 through a gas outlet line 18, while the remaining fluid can be routed away from the vessel 14 through one or more liquid outlet lines 20. Various sensors 34 and 36 can be used with an analysis system 38 to determine parameters of the fluids passing through the outlet lines 18 and 20. For example, in some embodiments, the sensors 34 and 36 are provided in the form of Coriolis flow meters. Data collected by the sensors 34 and 36 can be processed by the analysis system 38 to determine one or more fluid parameters, such as mass flow rate, density, and volumetric flow rate.

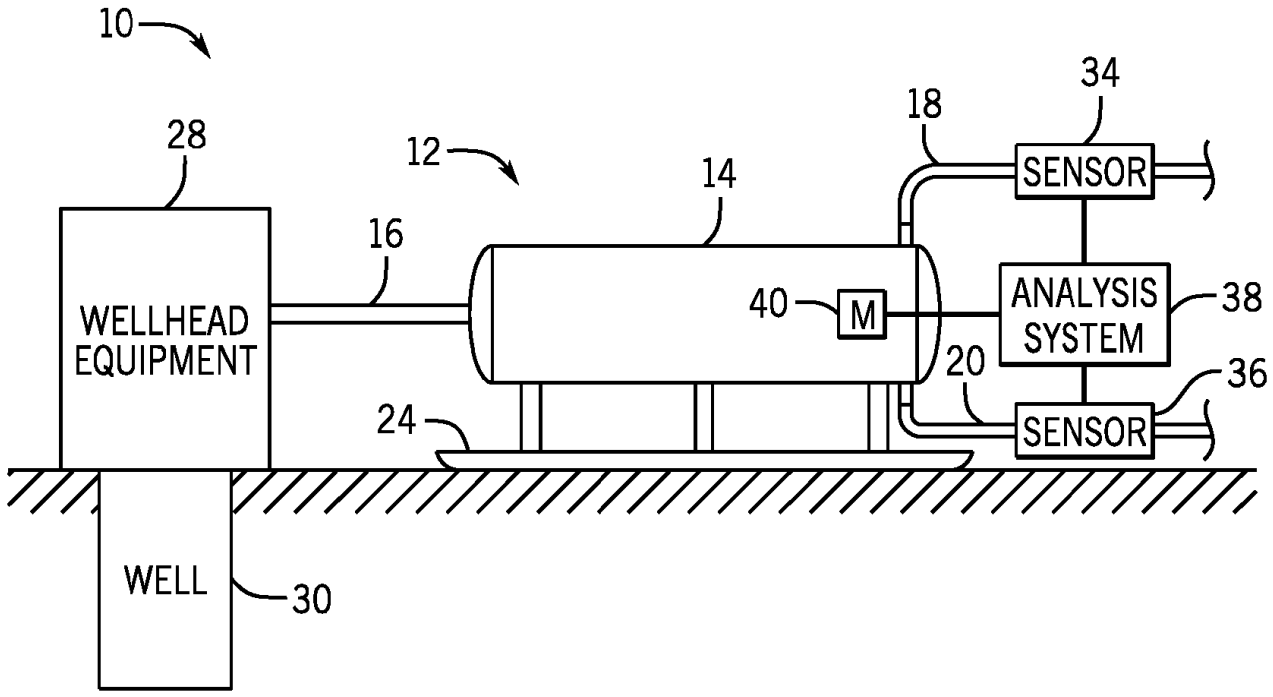



FIG. 1

7 In the invention the gas volume fraction (GVF) of the separated fluid is used to verify the accuracy of the determined volumetric flow rate of the fluid. An example of such a process for using a GVF measurement to verify the accuracy of a determined volumetric flow rate of a separated fluid is generally represented by flow chart 74 in FIG. 4. The flow rate of a separated fluid (e.g. fluid flowing from the separation vessel 14 through the gas outlet line 18) and its GVF are measured (blocks 76 and 78). The reliability of the measured volumetric flow rate can be determined by

comparing (block 80) the measured GVF to a threshold GVF level (block 82). The threshold GVF may be selected based on a desired level of accuracy for the determined volumetric flow rate.

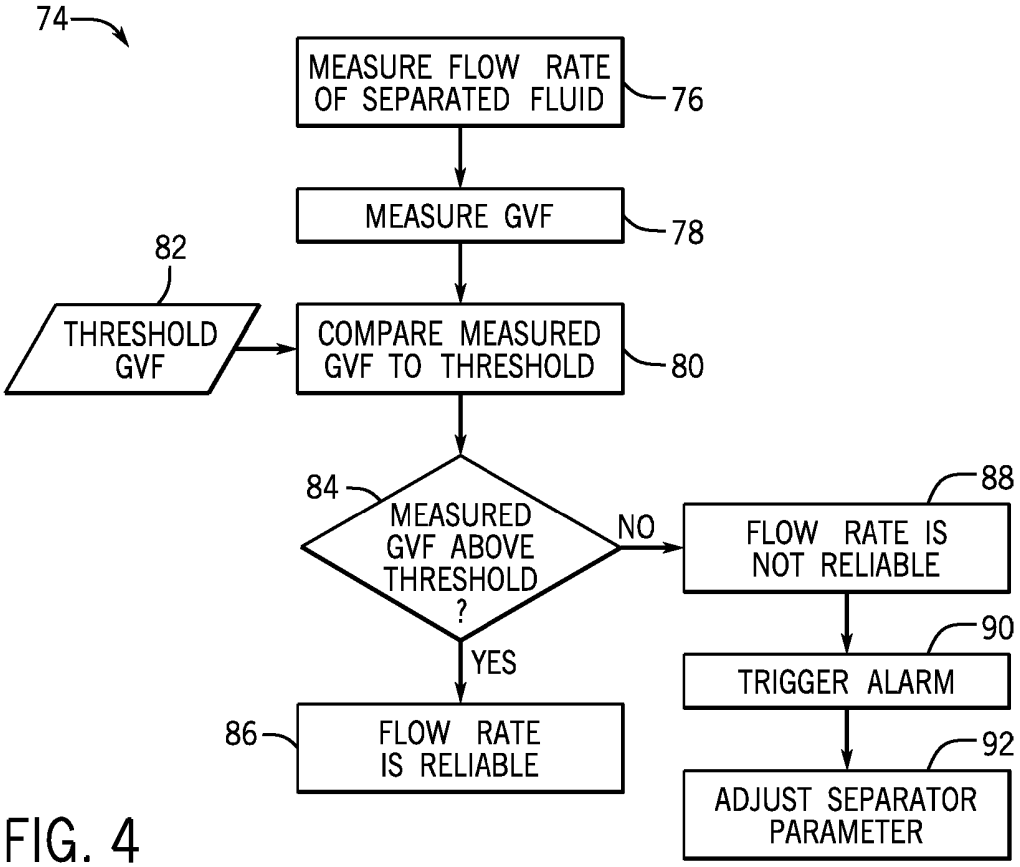



FIG. 4

8 Fig.6 shows that for a measurement of volumetric flow that according to the GVF there is a spread of measurement which is an indication of reliability i.e. the lower the GVF, namely the higher the liquid content, the more spread in the volumetric flow measurement. In Fig.6 it can be seen at 98% GVF there is high vertical spread whereas at 100% GVF there is low spread. Mr Hyden explained that this is the basis of the understanding of the invention – the recognition that the GVF percentage indicates the reliability of the measured volumetric flow. With reference to Fig.6 below, the margin of error in the gas rate measurement at standard conditions can be used in combination with the margin of error in the GVF measurement for verifying gas rate accuracy. For example, in the case of Separators A and B, if a gas flow rate that is accurate to within ± 5% is desired (a level indicated by the horizontal dashed line in FIG. 6), the flow rate should not be trusted if the actual GVF is below 98.5%. If the margin of error in the measured GVF is ± 1%, the flow rate at standard conditions should not be trusted if the measured GVF is below 99.5% (as accuracy would be below the 5% acceptable margin of error requested for the gas flow rate).

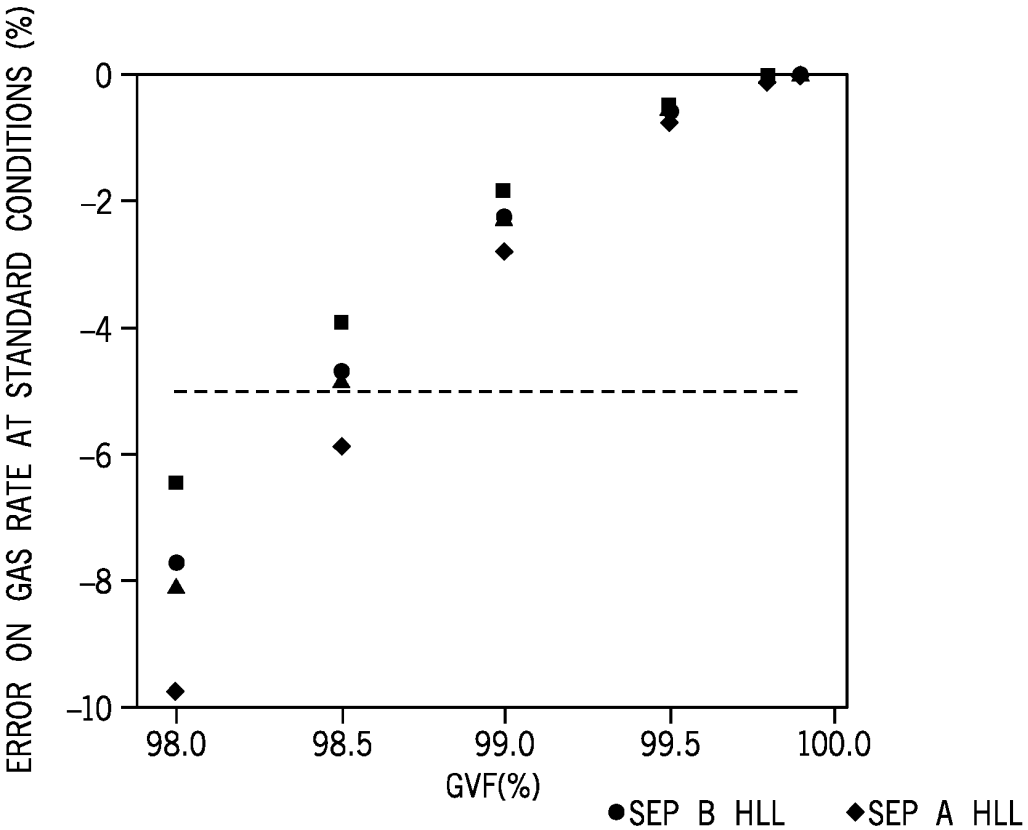



FIG. 6

9 The latest set of claims filed with attorney's letter dated 12 April 2019 has fourteen claims including independent method claim 1 and apparatus claim 10 which are set out below:

*1. A method comprising:*
*measuring volumetric flow rate of a fluid in a gas outlet line of a gas-liquid separator; and*
*analyzing reliability of the measured volumetric flow rate of the fluid, wherein analyzing reliability of the measured volumetric flow rate of the fluid includes:*
*measuring with a sensor a gas volume fraction of the fluid in the gas outlet line of the gas-liquid separator;*
*comparing the measured gas volume fraction of the fluid in the gas outlet line of the gas-liquid separator to a threshold gas volume fraction level; and*
*determining whether the measured volumetric flow rate of the fluid is reliable based on the comparison of the measured gas volume fraction of the fluid to the threshold gas volume fraction level.*

*10. An apparatus comprising:*
*a separator including a gas-liquid separation vessel;*
*a gas outlet line coupled to receive a gas-containing fluid from the gas-liquid separation vessel;*
*a Coriolis meter coupled to the gas outlet line to enable measurement of mass flow rate of the gas-containing fluid; and*

*an analysis system operable to: (i) calculate a volumetric flow rate of the gas-containing fluid using the measured mass flow rate measured using the Coriolis meter; (ii) determine from the mass flow rate, a gas volume fraction of the gas-containing fluid; and (iii) execute the method according to any of the preceding claims using the calculated volumetric flow rate and the determined gas volume fraction.*

**The issues to be decided**

The issue for me to decide is inventive step i.e. whether the invention involves an inventive step as required by section 1(1)(b) of the Patents Act 1977.

**The law**

*10* The examiner has raised an objection under section 1(1)(b) of the Patents Act 1977 that the invention does not involve an inventive step. The relevant provisions of the Act are shown below:

***Section 1(1)***

*A patent may be granted only for an invention in respect of which the following conditions are satisfied, that is to say –*

*(a) the invention is new;*

***(b) it involves an inventive step;***

*(c) it is capable of industrial application;*

*(d) the grant of a patent for it is not excluded by subsections (2) and (3) or section 4A below;*

*and references in this Act to a patentable invention shall be construed accordingly.*

and

***Section 3***

*An invention shall be taken to involve an inventive step if it is not obvious to a person skilled in the art, having regard to any matter which forms part of the state of the art by virtue only of section 2(2) above (and disregarding section 2(3) above).*

11 The examiner and the applicant agree that the structured approach first set out in *Windsurfing*[1] and reformulated as the Windsurfing/Pozzoli test in *Pozzoli*[2] should be

[1] Windsurfing International Inc. v Tabur Marine (Great Britain) Ltd, [1985] RPC 59
[2] Pozzoli SPA v BDMO SA [2007] EWCA Civ 588

followed in assessing inventive step. The Windsurfing/Pozzoli approach reads as follows:

> *(1)(a) Identify the notional "person skilled in the art"*
>
> *(1)(b) Identify the relevant common general knowledge of that person;*
>
> *(2) Identify the inventive concept of the claim in question or if that cannot readily be done, construe it;*
>
> *(3) Identify what, if any, differences exist between the matter cited as forming part of the "state of the art" and the inventive concept of the claim or the claim as construed;*
>
> *(4) Viewed without any knowledge of the alleged invention as claimed, do those differences constitute steps which would have been obvious to the person skilled in the art or do they require any degree of invention?*

12 In terms of construing the claims, section 125(1) applies:

> *For the purposes of this Act an invention for a patent for which an application has been made or for which a patent has been granted shall, unless the context otherwise requires, be taken to be that specified in a claim of the specification of the application or patent, as the case may be, as interpreted by the description and any drawings contained in that specification, and the extent of the protection conferred by a patent or application for a patent shall be determined accordingly.*

13 I must interpret the claims in the light of the description and drawings. It is well established that this is done through the eyes of the person skilled in the art, thus determining what the skilled person would understand the patentee to be using the language of the claim to mean.

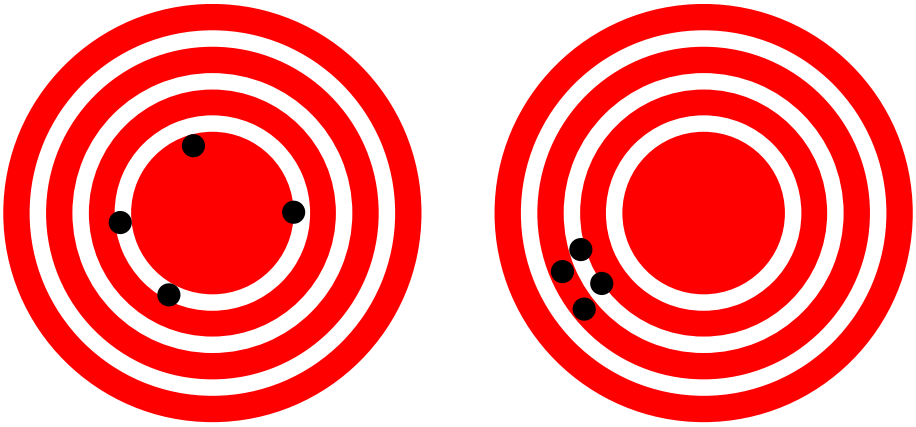
**Argument and analysis**

14 Independent claim 1 has not been amended since filing and the construction of the claim has not been the subject of any disagreement between the examiner and attorney throughout processing of the application to date. In my opinion the language of claim 1 is clear and the skilled person would have no issue construing the scope of the claim in light of the description and drawings.

15 The examiner maintains that the claims do not define an invention which includes an inventive step. His position is set out most recently in his pre-hearing report. Detailed arguments against the examiner's position are contained in the applicant's responses to the examination reports, through their attorney. Mr Hyden highlighted his letter of 12 April 2019 as setting out the applicant's position in detail. These arguments were elaborated clearly and helpfully at the hearing by Mr Hyden. Taking all these arguments into account, I must determine whether the claimed invention includes an inventive step under sections 1(1)(b) and 3.

**Accuracy and reliability**

16 At the hearing Mr Hyden took time to explain what is meant by the terminology "accuracy" and "precision" (reliability) in the context of the invention as opposed to trueness. The term "accuracy" in metrology has two components: "precision" (reliability), being the closeness of agreement among a set of results; and "trueness", being the closeness of the mean of a set of measurement results to the actual (true) value. The term "accuracy" is sometimes used to mean "trueness" or "precision" depending on circumstances. Looking at the two figures reproduced below, Mr Hyden explained that the figure on the right illustrates low accuracy due to poor trueness i.e. there's an offset. Such an offset can be managed by use of a correction factor which would bring the offset back into line. By contrast, the figure on the left shows low accuracy due to poor precision resulting in poor reliability. In this situation offsets don't help as there is scatter on the measurement and the location of the correct point is not known. It is this problem shown in the left-hand figure and illustrated in Fig.6 above with which the invention is concerned i.e. the problem with the variability in the measurements. The precision/reliability of single measurement cannot be determined in this situation as it is not known if it is correct or even how far from being correct it is. Therefore, in the context of the invention as described in the application the term "accuracy" is meant as "precision/reliability". The skilled person when faced with the reliability of a measurement would look at repeatability i.e. if I do the same thing again will I get the same result.



17 From my understanding of the specification I agree with Mr Hyden's explanation that in the context of the invention the term "accuracy" means "precision/reliability" which maps to the situations shown in the left-hand figure and Fig.6 above.

**Inventive step**

18 The examiner maintains that claims 1-14 are obvious in light of:

D1: US 2006/096388 A1 (GYSLING et al.) in view of common general knowledge in the art; and

D2: US 2008/028822 A1 (MATTAR) in view of common general knowledge in the art

19 I will now consider whether independent claim 1 involves an inventive step using the Windsurfing/Pozzoli approach.

Step 1(a) and 1(b): Identify the notional "person skilled in the art" and their relevant common general knowledge

20 The first step is to identify the notional skilled person and their common general knowledge. The examiner has defined the skilled person as a "fluid engineer". I consider this definition to be too broad and it's not entirely clear what the full breadth of skills and knowledge such a "fluid engineer" would have. Mr Hyden has defined the skilled person as an engineer involved in the measurement and analysis of multiphase flows from hydrocarbon wells. They are well-versed in the construction and operation of separators, flow measurement techniques that can be applied to the output from such separators, and routine operational changes that can be made during the use of such separators. I have no difficulty accepting Mr Hyden's definition of the skilled person.

21 The examiner considers the common general knowledge of the skilled person to encompass the dynamics of multiphase flow and measurement techniques therefor. Mr Hyden has gone a little further in detailing what he considers to be the common general knowledge of the skilled person. He considers it to include:

• The gas flowing from the gas outlet of a separator can include liquid, i.e. "wet gas" (and that liquid flowing from the liquid output can include gas)

• Carry-over meters exist for measuring the amount of liquid in a gas flow (Gas Volume Fraction (GVF) = the volumetric ratio of gas and liquid)

• Volumetric flow is the common way to measure production output from gas wells

• A single phase measurement is common for gas flows with high GVF (> 95%)

• Coriolis mass flow measurements are affected by wet gases or aerated liquids, and may need further testing to establish desired flow measurements

The examiner has not raised any issue with this assessment of the common general knowledge and I am happy to accept what Mr Hyden has put forward in this respect.

22 At the hearing Mr Hyden explained that he disagrees with the examiner with regard to some statements made in the pre-hearing report on common general knowledge. Mr Hyden raised the question of whether it was common general knowledge in the skilled person to flip between liquid and gas phase measurement and move measurement technologies across? Mr Hyden explained that it is a very context specific question and is not as simple as saying it works with liquid with gas in it therefore it will work with gas with liquid in it. Even though one may be using a measurement technique which rely on a fundamental similarity in physics it is not a simple case of porting one measurement technique from one to the other and say the issues will be the same. I have no evidence before me to suggest that this is not the case and therefore I am again willing to accept what Mr Hyden has put forward in this respect.

Step 2: Identify the inventive concept of the claim in question or if that cannot readily be done, construe it

23 There would appear to be little disagreement on the inventive concept of claim 1. In his exam report of 14 August 2017, the examiner has defined the inventive concept as an explicit method of determining whether a measured fluid flow rate in a gas outlet line of a gas-liquid separator is reliable/accurate based on a measured gas volume fraction (GVF) of the fluid.

24 Similarly, Mr Hyden defines the inventive concept as residing in the recognition that the reliability/precision of a volumetric flow measurement of a gas outlet from a separator correlates with the GVF of that flow, and specifically that the lower the GVF, the lower the reliability/precision. With this knowledge, it is possible to establish a minimum measured GVF (i.e. a threshold) for which the desired "accuracy" (margin of error = precision/reliability) of the volumetric flow measurement will be obtained, and consequently to determine whether or not an obtained volumetric flow measurement can be considered to be precise/reliable at the desired level of accuracy.

25 I am content that the inventive concept of claim 1 lies in the recognition that the reliability/precision of a volumetric flow measurement of a gas outlet from a gas-liquid separator correlates with the GVF of that flow.

Step 3: Identify what, if any, differences exist between the matter cited as forming part of the "state of the art" and the inventive concept of the claim or the claim as construed

26 Mr Hyden identified four differences between D1 and D2 and his definition of the inventive concept:

• Measuring volumetric flow in a gas outlet line of a gas-liquid separator

• Measuring the GVF in the gas outlet line

• Establishing a threshold GVF for the gas flow

• Comparing the measured GVF with the threshold to determine whether or not the measured volumetric flow has a desired level of accuracy (reliability)

27 Mr Hyden explained that D1 sets out to obtain a mass flow in a liquid line and not a volumetric flow in a gas outlet and whilst they are related they are not the same. Mr Hyden argues that D1 does not disclose any measurements in the gas outlet line (106). All measurements and calculation are in respect of the liquid outlet flow line (108). A processing device 124 processes signals from the flow meter (120) in the liquid outlet line to determine GVF and volumetric flow of the liquid outlet flow (amongst other properties, see para [0031]). GVF is compared to a predetermined threshold GVF (para [0036]). If the measured GVF is less than the predetermined threshold GVF, mass flow rate is measured using the Coriolis meter (122). If the measured GVF is above the predetermined GVF threshold, mass flow rate is calculated from volumetric flow and density for the flowing mixture. At no point does

the processing establish the accuracy (reliability) of the volumetric flow using the GVF measurement and threshold.

28 The examiner agrees that the differences between D1 and the inventive concept lie in the measurements occurring in the liquid outlet line rather than the gas outlet line, and further that there is no explicit method of determining that the flow measurement is reliable/accurate.

29 Turning now to D2, Mr Hyden considers it to disclose making volumetric flow measurement in a wet gas as part of a method for obtaining density measurements from a Coriolis meter. A vortex meter is specifically mentioned for making the volumetric flow measurement. The Coriolis meter does not provide a volumetric flow measurement. While void fraction (equivalent to GVF) is mentioned, there is no detail as to how or where this might be measured. The accuracy of the volumetric flow above a specific void fraction is mentioned ("reasonable accuracy" para [0054]). There is no indication as to whether or not this "accuracy" is precision (reliability), trueness, or both. There is also no discussion of when the accuracy ceases to be "reasonable" or what might be done in such a case.

30 With regard to D2, the examiner highlights paragraphs [0054] and [0031]-[0033] as teaching the skilled reader that a measured volumetric flow rate is reliable if the GVF is above a particular threshold in the gas outlet line. The difference between this piece of prior art and the inventive concept that there is no *explicit* method of determining that the flow measurement is reliable/accurate on the basis of the comparison.

Step 4: Viewed without any knowledge of the alleged invention as claimed, do those differences constitute steps which would have been obvious to the person skilled in the art or do they require any degree of invention?

31 As discussed by Mr Hyden at the hearing, the prior art does not recognise the correlation between GVF and the reliability of the volumetric flow rate measurement. The invention is a thresholding technique for discriminating between reliable and unreliable measurements.

32 The examiner argues that whilst the method of D1 does not include an explicit step of determining that the flow measurement is reliable, such a step is considered to have been implicitly disclosed by virtue of the decision being made to change the measurement technique on the basis of a GVF threshold being exceeded. I do not agree. In D1 the GVF threshold is used to decide whether or not to use the volumetric flow measurement to derive mass flow rate. If the GVF is less than the threshold the Coriolis meter is used to measure mass flow rate. However, if the GVF is above the threshold, the skilled person is instructed to use the volumetric flow rate (from the flow meter) and a corrected density measurement obtained from speed of sound, pressure and GVF (measured by the flow meter), and density (measured by the Coriolis meter) to derive the mass flow rate. Whilst the GVF threshold is used to decide which measurement technique to use in deriving mass flow rate, it is not, in my opinion, implicit that the reliability of the volumetric flow rate has been considered – based on GVF or otherwise.

33 I agree with Mr Hyden that nowhere in D1 is the reliability of the volumetric flow discussed. Further I agree with both the examiner and Mr Hyden that the additional required feature of claim 1 that measurements occur in the gas outlet line is absent with the measurements occurring in the liquid outlet line. Therefore, I consider claim 1 to involve an inventive step beyond the disclosure of D1.

34 With regard to D2, the examiner argues there is no explicit method of determining that the flow measurement is reliable on the basis of the comparison. However, the skilled person would not require inventive thought to arrive at the inventive concept of an explicit method of determining whether a measured fluid flow rate in a gas outlet line of a gas-liquid separator is reliable/accurate based on a measured gas volume fraction (GVF) of the fluid given that the relationship between these two variables has been established.

35 Mr Hyden counters by explaining that D2 does not describe comparing the measured GVF with the threshold to determine whether or not the measured volumetric flow has a desired level of accuracy (reliability). D2 describes a system that makes a volumetric flowrate measurement, and a mass flowrate measurement using a Coriolis meter (see para [0035]). A vortex meter is disclosed for making the volumetric flowrate measurement. Such a meter is stated to give a “reasonably accurate” indication of volumetric flowrate at 0.8 void fraction (80% GVF) and above. There is also a statement that “The actual bounds depend on the accuracy required.” (see para [0054]).

36 Mr Hyden further explains that whilst D2 refers to the accuracy of measurements at several places, this is not presented in any way that allows the skilled person to know whether this is referring to precision or trueness. None of the figures show data plots that would allow this to be inferred. There is no discussion of the effect of error in measurements, either of precision or accuracy, and none of the equations show factors that the skilled person could understand as being related to either error or accuracy. All that D2 tells the skilled person is that GVF may affect the volumetric flow measurement and that they may need to do something about it to use the disclosed analysis method. There is nothing to tell the skilled person whether this effect is a trueness effect such as this shown in Fig. 14 of D2, or a reliability effect such as shown in Fig. 6 of the application. Mr Hyden argues that common general knowledge does not answer this question nor is there any indication whether one or other effect might be present.

37 Again I find myself in agreement with Mr Hyden. Whilst D2 discusses that the vortex meter is “reasonably accurate” at 0.8 void fraction (80% GVF) and above, I do not agree that it is obvious that the reliability of a volumetric flow rate in a gas outlet line of a gas-liquid separator can be determined from a measured GVF. Following on from the discussion in paragraphs 16 and 17 above I also agree with Mr Hyden that the skilled person is not taught whether the “accuracy” in D2 is precision/reliability as addressed by the invention or trueness. Therefore, I consider claim 1 to involve an inventive step beyond the disclosure of D2.

38 The inventive concept identified as residing in the recognition that the reliability/precision of a volumetric flow measurement of a gas outlet from a gas-liquid separator correlates with the GVF of that flow has not been disclosed in the prior art. Furthermore, I have no evidence before me to suggest that such a

correlation between GVF and the reliability of a volumetric flow measurement would form part of the common general knowledge of a person skilled in the art.

**Outstanding issues**

39 Other than inventive step, I note there are no further issues outstanding on this application.

**Conclusion**

40 I find that the claimed invention involves an inventive step under sections 1(1)(b). I therefore remit the application to the examiner for grant.

**Appeal**

41 Any appeal must be lodged within 28 days after the date of this decision.

**C. L. Davies**

Deputy Director, acting for the Comptroller