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## Datasheet for the decision of 1 April 2008

**Case Number:** T 0220/06 - 3.2.03

**Application Number:** 95930623.4

**Publication Number:** 0752049

**IPC:** E21B 43/12

**Language of the proceedings:** EN

**Title of invention:**
Gas lift flow control device

**Patentee:**
HALLIBURTON ENERGY SERVICES, INC.

**Opponent:**
Petroleo Brasileiro S A - Petrobas

**Headword:**
-

**Relevant legal provisions:**
EPC Art. 54, 56, 123(2)

**Keyword:**
"Novelty (yes)"
"Inventive step (no)"

**Decisions cited:**
-

**Catchword:**
-

**Case Number:** T 0220/06 - 3.2.03

# D E C I S I O N
**of the Technical Board of Appeal 3.2.03**
**of 1 April 2008**

**Appellant:** (Patent Proprietor)
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**Decision under appeal:** **Decision of the Opposition Division of the European Patent Office posted 16 December 2005 revoking European patent No. 0752049 pursuant to Article 102(1) EPC.**

**Composition of the Board:**

**Chairman:** U. Krause
**Members:** C. Donnelly
K. Garnett

## Summary of Facts and Submissions

I. The appeal lies from the decision of the opposition division, posted on 16 December 2005, revoking European patent no. EP-B-752049. Essentially the opposition division held that the subject-matter of the amended independent claims 1 and 2 filed with letter of 21 October 2005 lacked novelty with respect to Brazilian application no. PI9300292-0 A.

II. The patent proprietor (hereinafter: the appellant) filed a notice of appeal on 16 February 2006 and paid the fee the same day. The grounds of appeal were filed on 26 April 2006.

The appellant initially requested that the impugned decision be set aside, and that the case be remitted to the opposition division for consideration of the issue of inventive step on the basis of the claims according to the main request filed with the grounds of appeal.

Alternatively, it was requested that the impugned decision be set aside and remitted to the opposition division for examination of inventive step on the basis of the claims according to auxiliary requests 1 or 2 also filed with the grounds of appeal.

III. The respondent (opponent) requests that the appeal be dismissed. In support of this request the respondent referred to the following state of the art:

D1a: PI9300292-0 A (in Portuguese);
D1b: certified translation into English of D1a;

D2: "Continuous Gas-lift Instability: Diagnosis, Criteria and Solutions" by F.J.S. Alharti, Z Schmidt and D.R.Doty, SPE 26554, 1993, pp401-416;
D3: US-A-5066198
D4: US-A-3672790;
D5: GB-A-0122278;
D6: US-A-2994335;
D7: US-A-4090814;
D8: US-A-1761363;
D9: "Gas Dynamics", James E A John, 2nd Edition, Allyn & Bacon Inc, 1984, pp49-58;
D10: "Instrumentation and Control" edited by Chester L Nachtigal, John Wiley & Sons Inc, 1990, pp 479-480;
D11: ASME Standard ASME/ANSI MFC-7M-1987 relating to Venturi Nozzles;
D12: "Dual Concentric Gas-Lift Completion Design for the Thistle Field" by PC Moore and Paul Adair, SPE Production Engineering, February 1991, pp 102-112;
D13: Nieberding et al "Normalization of Nitrogen-loaded Gas-lift Valve Performance Data" SPE Production & Facilities, August 1993, pp 203-210 and 573-577;
D14: Hillbrath, H.S., Dill, W.P. and Wacker, W.A., "The Choking Pressure Ratio of a Critical Flow Venturi", Journal of Engineering for Industry, v. 97, n 4, Transactions of the ASME Journal of Engineering for Industry, series B, November 1975, pages 1251 to 1256;
D15: ASME Standard ASME MFC-3M-1989, page 37;
D16: US-A-3160113.

Additionally, the appellant has submitted an affidavit from Cynthia S. Tuckness dated 26 April 2006 and document WO2002029209 (D17).

IV. On 6 December 2007 the Board issued a communication pursuant to Article 11(1) RPBA annexed to the summons to oral proceedings in which it expressed a provisional opinion. In particular, the Board indicated that, in view of the teachings of D9, it considered the subject-matter of the main request to be novel with respect to D1, but to lack an inventive step in the light of D1 in combination with either D2,D12 or D16. The Board also stated that in view of the age of the file and the fact that the arguments concerning novelty and inventive step were largely overlapping, it did not intend to remit the case to the opposition division.

V. By letter of 29 February 2008 the respondent filed further pages 39 to 48, 94 to 96 and Table 1A of D9 with a view to extending the theoretical basis shown in figure 3.15 to the analysis of gas-lift valves in practice. Reference was also made to a paper entitled "A Solution to Instability problems in Continuous Gas-Lift Wells Offshore Lake Maracaibo" Faustinelli et. al, SPE 53959 presented at the SPE conference in Caracas, Venezuela 21-23 April 1999 (D18). The respondent also, for the first time, objected that amendments to claims 1 and 7 introduced by the appellant in the opposition proceedings infringed Art. 123(2) EPC.

VI. Oral proceedings before the Board were held on 1 April 2008. At the conclusion of the debate the appellant withdrew the request for remittal to the opposition division.

VII. The set of claims according to the main request comprises two independent method claims 1 and 2 which read as follows:

"1. A method of controlling the rate of gas injected into a production string (12) positioned within a continuous-flow gas lift well drilled into the earth and lined with casing (16), said production string (12) being concentric to said casing (16), said casing (16) and said concentric production string (12) forming an annulus (14) therebetween, said method comprising the steps of: placing a gas flow control device (60) within said well at a predetermined location, said gas flow control device (60) comprising a housing including at least one inlet port (54) and at least one outlet port (64); and an orifice (34) disposed within the housing and comprising a nozzle portion (34a) and a Venturi portion (34b); said nozzle portion (34a) including a nozzle first end, a nozzle second end, and a nozzle flow path between said nozzle first end and said nozzle second end, said nozzle flow path converging from said nozzle first end to said nozzle second end; and said Venturi portion (34b) including a first end and a second end, and a Venturi flow path therebetween, said Venturi flow path diverging from said Venturi first end to said Venturi second end, said Venturi first end being disposed adjacent said nozzle second end, said Venturi flow path being aligned with said nozzle flow path to provide a continuous flow path; said gas flow control device (60) positioned for transmitting the flow of injected gas from the annulus (14) into the production string (12), whereby a pressure of said injected gas is decreased through said nozzle portion (34a) and substantially recovered through said Venturi portion (34b) during an operation of said gas flow control device (60); forcing compressed gas into the annulus (14); constraining the compressed gas to flow through said gas flow control device (60) to mix said gas with reservoir fluids within the production string (12), thereby reducing the density of said reservoir fluids; and controlling the pressure of the gas forced into the annulus (14) with a pressure control device (9) to achieve critical flow through the gas flow control device (60), thereby increasing the gas injection rate through the gas flow control device (60) by increasing the pressure of the gas in the annulus (14), and decreasing the gas injection rate through the gas flow control device (60) by decreasing the pressure of the gas in the annulus (14)."

"2. A method of eliminating instability in a production string (12) positioned within a continuous-flow gas lift well drilled into the earth and lined with casing (16) said production string (12) being concentric to said casing (16), said casing (16) and said concentric production string (12) forming an annulus (14) therebetween, said method comprising the steps of: placing a gas flow control device (60) within said well at a predetermined location, said gas flow control device (60) comprising a housing including at least one inlet port *(54)* and at least one outlet port (64); and an orifice (34) disposed within the housing and comprising a nozzle portion (34a) and a Venturi portion (34b); said nozzle portion (34a) including a nozzle first end, nozzle second end, and a nozzle flow path between said nozzle first end and said nozzle second end, said nozzle flow path converging from said nozzle first end to said nozzle second end; and said Venturi portion (34b) including a first and a second end, and a Venturi flow path therebetween, said Venturi flow path diverging from said Venturi first end to said Venturi second end, said Venturi first end being disposed adjacent said nozzle second end, said Venturi flow path being aligned with said nozzle flow path to provide a continuous flow path; said gas flow control device (60) positioned for transmitting the flow of injected gas from the annulus (14) into the production string (12), whereby a pressure of said injected gas is decreased through said nozzle portion (34a) and substantially recovered through said Venturi portion (34b) during an operation of said gas flow control device (60); forcing compressed gas into the annulus (14); constraining the compressed gas to flow through said gas flow control device (60) to mix said gas with reservoir fluids within the production string (12), thereby reducing the density of said reservoir fluids; and controlling the pressure of the gas forced into the annulus (14) with a pressure control device (9) to achieve critical flow through the gas flow control device (60), thereby maintaining a constant gas injection rate across said gas flow control device (60) that is independent of the pressure within the production string (12)."

VIII. Auxiliary requests

Independent claims 1 and 2 of auxiliary request 1 are identical to the main request except that additional features have been introduced essentially as follows:

(i) a throat (36) interposed between said nozzle second end and said Venturi first end;
(ii) said nozzle portion (34a) including a nozzle first end adjacent the housing
(iii) wherein the nozzle portion includes curvilinear sidewalls extending from the housing to the throat, the

radius of curvature of the curvilinear sidewalls being greater than the diameter of the nozzle second end;
(iv) said Venturi portion (34b) including a second end adjacent the housing;
(v) wherein the Venturi portion is defined by venturi walls extending from the throat to the housing, which form a constant angle from $4^{o}$ to $15^{o}$ to the longitudinal axis of the venturi flow path.

Auxiliary request 2 is identical to auxiliary request 1 except that it additionally specifies that:

"wherein said gas constrained to flow through said gas flow control device achieves critical flow across the gas flow control device at a differential pressure across the gas flow control device of between 4 and 10% of the gas injection pressure"

IX. The arguments of the parties with respect to the issues relevant to the final decision are summarised below.

1. *Main Request*

*(a) Article 123(2) EPC*

*Respondent*

There is no basis in the application documents as originally filed to support the feature in claims 1 and 2 of the main request that the pressure of the injected gas is "substantially recovered through said Venturi portion" since in the original disclosure it is only stated that the pressure is "recovered". By specifying that the pressure is "substantially recovered", pressure differentials other than those explicitly specified in the application in connection with the requirement for critical flow are also covered.

Claims 1 and 2 of the main request have also been amended to specify that the pressure of the gas forced into the annulus is controlled to achieve critical flow through the gas flow control device. The basis for this amendment is claim 21 of the application as originally filed. However, this specification was made only in combination with the requirement for a differential pressure of less than 46% of the pressure within the annulus. Since claim 1 effectively covers the attainment of critical flow at all differential pressures Article 123(2)EPC is contravened. Further, the statement in claims 1 and 7 that the pressure of gas forced into the annulus is "controlled" to achieve critical flow links the achievement of critical flow with the controlling of the gas injection rate. However, this is in contradiction to the description on page 34 of the application as filed which states that the obtaining of critical flow leads to a stable flow though the gas lift valve and hence there is no need to have a finite control of the injection gas on the surface.

*Appellant*

It is difficult to see how specifying that the pressure is "substantially recovered" - which is a tighter requirement than merely stating that the pressure is "recovered" - can contravene Art. 123(2) EPC.

Since claims 1 and 2 now specify that the pressure is substantially recovered it must be clear that not all pressure differentials are covered but only those meeting this requirement and which therefore must be less than 46%.

The controlling of the gas injection pressure into the annulus to control flow rate through the gas flow control device is disclosed in original claim 19; the application to critical flow rate is disclosed in claim 21.

(b) *Novelty*

*Appellant*

D1 does not show the following features specified in claims 1 and 2:
(a) said Venturi flow path being aligned with said nozzle flow path to provide a continuous flow path; and
(b) controlling the pressure of the gas forced into the annulus with a pressure control device to achieve critical flow.

As regards feature (a) the device according to D1 is provided with an intermediate straight vertical portion (9) of length ($h_2$), defining the second part (13) of the device. Thus, in figure 4, there is no continuous flow path between Venturi flow path (12) and the nozzle flow path (14) since it is interrupted by the second part (13).

Regarding feature (b), D1 makes no explicit reference to critical flow. It is also not inevitable that the critical flow will occur when the device is used since it is of a very inefficient design. With reference to figure 4 it can be seen that gas flowing through the device will have to pass over a series of steps which will inevitably lead to energy losses. Consequently, in a large number of situations, the differential pressure required to achieve critical flow will be greater than the standard industry pressure drops of 100 to 200psi currently practised.

*Respondent*

As regards feature (a): the Venturi and nozzle portions of the device according to D1 are aligned and provide a continuous flow path, otherwise the gas would not be able to pass through. Further, the intermediate portion could be deemed to be either part of the Venturi or of the nozzle; this is just a matter of definition and anyway the wording of the claim does not preclude the presence of such an intermediate portion.

As regards feature (b): when using the device of D1 with standard industry pressure drops, i.e. between 100 to 200psi, critical flow is inevitable. Table A1 of D9 gives the values for various parameters, notably the throat/outlet area ratio of the device and the pressure ratio, which essentially govern flow through a converging-diverging nozzle under isentropic conditions. Applying this to the device according to D1 which, by measurement of the relevant diameters on figure 4, can be deduced to have a throat/outlet area ratio of between 3 and 4, it can be seen that the differential pressure required to produce critical flow is in the order of 1.5% to 2.5%. This would mean that even in deep wells, with tubing pressures of around 1800 to 2000psi (see for example Table 3 of D2), a pressure differential of as low as 50psi, i.e. comfortably within industry standards, would ensure critical flow.

Hence, when using the nozzle of D1 in a practical gas-lift situation, critical flow must occur and consequently the subject-matter of claims 1 and 2 is not new.

Further, according to T 26/85 and T 666/89, if the skilled person reading D1 would have seriously contemplated using the device with flow parameters which would induce critical flow then D1 is a novelty destroying disclosure. Since the skilled person could hardly avoid operating with flow parameters which would lead to critical flow such is the case here.

(c) *Inventive step*

*Respondent*

The subject-matter of claims 1 and 2 is not inventive with respect to a combination of D1 and any of D2, D12, D13 together with the skilled person's general knowledge as exemplified in D11.

The subject-matter of claims 1 and 2 only differs from the method disclosed in D1 by the step of:

- controlling the pressure of the gas forced into the annulus with a pressure control device to achieve critical flow.

However, the advantages of operating gas-lift valves in the critical flow regime are well known and are reported for example in D2, page 404, left-hand column, final paragraph i.e. Region B in Figure 5, D12 page 102, left-hand column, final paragraph and D16, (see column 1, lines 38 to 42).

Faced with the problem of minimising sensitivity to changes in bottomhole flowing pressure, it would be obvious for the skilled person to operate the device of D1 in the critical flow regime.

*Appellant*

The literature cited by the respondent does not necessarily teach that operating the gas control valve in the critical flow regime is a good option for eliminating instability in a production string. In fact, D2 lists several ways of stabilising wells and concludes by making a recommendation to operate in Region A of Figure 5, i.e. in the throttling close region of a valve's throttling flow performance (see page 404, right-hand column, third paragraph). Thus, D2 teaches away from using the gas control valve in critical flow mode.

D12 concludes that the gas-lift/liquid ratio must be increased and that problems were encountered with the critical flow regime. Further, figure 2 of D12 shows that the gas-lift process under consideration is of a different type since flow is from a tubing string outwards rather than from the annulus into the tubing as in the claims. Thus, the two systems are not compatible. D16 dates from 1964 and is directed to a device and method intended to prevent critical flow (see column 1, lines 56 to 62).

Further, it must be asked, when both the effects of critical flow and the venturi valves themselves have been known for a considerable period of time, why the two have never been put together in the context of a gas-lift operation. Surely, this must be an indication in support of inventive step.

Thus, it would not be obvious for the skilled person to operate the valve of D1 in the critical flow regime.

2. *Auxiliary requests 1 and 2.*

*(a) Article 123(2) EPC, Article 84 EPC*

*Respondent*

The expression "adjacent the housing", used to qualify the positions of both the nozzle first end and the Venturi second end, has been introduced into the claims. However, the only "housing" mentioned in the application as filed is "housing (234)" which, according to figure 7A and 7B, is not in contact with the nozzle first end.

*Appellant*

It is evident that the expression "housing" means all the components going to make up the outer envelope of the device as depicted in figure 6A. Both the nozzle first end and the Venturi second end are adjacent this envelope.

*(b) Inventive step*

*Respondent*

The additional features introduced into auxiliary request 1 (AR1) merely appertain to constructional features which are standard in the field of Venturi valves and which, for example, are detailed in D11. Faced with the problem of optimising the efficiency of the device according to D1, it would be routine procedure to eliminate any abrupt changes in the internal surface profile so as to minimise turbulence. These constructional modifications are also described in the ASME standard D11, which are also consulted as a matter of normal design routine by those skilled in the art.

The further functional feature introduced into the independent claims of AR2 is merely a consequence of the constructional features defined in AR1. The gas flow control device must be understood as being composed of the elements defined in the claim. Therefore any arguments referring to pressure losses caused by components not defined in the independent claims are irrelevant.

*Appellant*

The nozzle of D1 does not have curvilinear sidewalls extending from the housing to the throat since this specification excludes the presence of any steps or other like discontinuities. D11 refers to a Venturi device for pressure measurement and would not be consulted by the skilled person seeking to improve the performance of a gas-lift valve.

The additional functional feature specified in AR2 is not a mere consequence of the constructional features introduced in AR1 since it refers to the pressure drop across the whole gas flow control device. Hence, it must be understood as an instruction to modify the whole tool to ensure minimal pressure drop. The device of D1 is fitted with a sprung nose section which would cause considerable turbulence and pressure losses.

## Reasons for the Decision

1. *Main request*

1.1 *Article 123(2) EPC*

The Board concurs with the appellant that the expression "substantially recovered through said Venturi portion" is narrower in scope than specifying that the pressure is just "recovered". There is no doubt that the recovery of the pressure through said Venturi portion disclosed in the application as originally in figure 9, as well as in claim 30, which specifies a differential pressure of between 5 and 10%, is "substantial". On the other hand, originally filed claim 28 specifies a differential pressure value of "less than 46%" and the point at which a differential pressure within this range can be defined as "substantial" may be a moot point. However, this is a question of clarity and since any unclarity does not arise out of any amendments to the granted claims (see granted claim 1, line 16), it is not a valid objection. Since all values of pressure differential less than 46% were originally disclosed and there is no doubt that examples of substantial pressure recovery were also disclosed, the Board is of the view that the incorporation of such a definition in the independent claims is justified and that the skilled person is in a position to interpret its meaning.

The controlling of the gas injection pressure into the annulus to control flow rate through the gas flow control device is disclosed in original claim 19; the application to critical flow rate is disclosed in claim 21.

In conclusion claims 1 and 2 according to the main request do not infringe Article 123(2)

1.2 *Novelty*

It is not disputed that document D1 discloses a method as defined in claims 1 and 2 with the exception of the following features:

(a) said Venturi flow path being aligned with said nozzle flow path to provide a continuous flow path; and
(b) controlling the pressure of the gas forced into the annulus with a pressure control device to achieve critical flow.

As regards feature a), D1b states at page 3, at line 14 that "the second part 13 may in theory be reduced to a single section". Hence, the Board considers that D1 discloses feature (a) wherein "said Venturi flow path being aligned with said nozzle flow path to provide a continuous flow path".

As regards feature b), it is not disputed that D1 makes no explicit reference to critical flow. The Board is also of the view that it is not inevitable that critical flow will occur when the device of D1 is used with standard industry pressure drops.

The gas flow control device of D1 is defined in the description of D1b at page 1, lines 18 to 20 as a "compact venturi" which is "almost as efficient as traditional venturi". For this reason the respondent's argument based on Table A1 of D9 cannot be accepted since the values cited relate to perfect isentropic conditions which even traditional Venturi devices cannot achieve in practice.

Further, it can be seen that in the exemplary embodiment of the device shown in figure 4 of D1, that gas passing through the device will have to pass over a series of steps in the flow channel. This will inevitably lead to energy losses and consequent increase in differential pressure required to achieve critical flow. The presence of such sharp edges in the flow channel is also indicative of the fact that the inventor of D1 was not primarily concerned with approaching isentropic conditions to ensure that critical flow would inevitably occur but rather with designing a valve which would be easy and cheap to manufacture (see page 1, line 21) as well as offering some improvement in flow efficiency (see page 1, lines 22 to 26) and easing design analysis (see page 2, line 29 to page 3, line 3).

As regards the respondent's arguments based on T 26/85 and T 666/89, the Board is of the opinion that these decisions relate to cases where the prior art explicitly claims a large range of parameters whereas the specific teaching, in terms of examples, discussion and embodiments etc, is clearly limited to a much narrower field. Therefore, the question may arise as to whether such a disclosure is sufficient to enable the skilled person to seriously contemplate using the parameters over the entire range or indeed, is even in a position to do so. Thus, prior art which is prima facie of a novelty destroying character by virtue of an unduly large and unsupported parameter range specification may not in fact be so. However, in the present case the question of whether the skilled person would seriously contemplate operating in the critical flow regime is rather one of inventive step since there is no parameter range explicitly disclosed.

In conclusion the Board considers that it is not inevitable that flow through the gas control valve of D1 would be in the critical flow regime when it is used in a gas-lift operation with standard industry pressure drops.

Hence, the subject-matter of claims 1 and 2 according to the main request is new.

1.3 *Inventive step*

As discussed above, the subject-matter of claims 1 and 2 only differs from the method disclosed in D1 by the step of:

- controlling the pressure of the gas forced into the annulus with a pressure control device to achieve critical flow.

This feature has the technical effect of minimising sensitivity to changes in bottomhole flowing pressure, and thus solves the objective technical problem of stabilising a gas-lift well.

The advantages of operating gas-lift valves in the critical flow regime to minimise instabilities or well heading are well known. D2, page 404, left-hand column, final paragraph indicates that setting the gas-lift valve to the critical flow regime i.e. Region B in Figure 5, is one possible way of stabilising a gas-lift well.

The appellant's argument that the skilled person would disregard this option because D2 explicitly remarks that operating within the throttling close region A of figure 5 "should be very effective", is not convincing. As remarked by the respondent, D2 effectively dissuades the reader from trying all the options listed at the bottom of the left-hand column on page 404 except for the critical flow and throttling close solutions (see paragraph 2, right hand column, page 404). The author of D2 only chooses to make a particular note of the throttling close procedure because it "has not been recognised by former investigators" and is thus worthy of special mention. However, this is not to say that critical flow is not a viable solution, indeed it is an indication that previously it was the solution of choice.

In D12, page 102, left-hand column, final paragraph the skilled person is also given a direct indication as to the value of operating in the critical flow regime in that it is stated: "This valve ideally is sized to operate in critical flow so that the gas-injection rate is relatively insensitive to changes in bottomhole flowing pressure (BHFP)". The appellant's argument, that since D12 at page 108, left-hand column, final paragraph, comments that "The only long-term solution to the heading in Well A32 is to increase the gas/liquid ratio still further" it in fact teaches away from applying critical flow, is not convincing. This comment refers only to Well A32 (e.g. Well A34 mentioned in the next sentence "does not pose the same problem") and consequently does not detract from the general indication given at page 102, concerning the use of critical flow.

The appellant has also argued that an inventive step must be recognised since although both the effects of critical flow and venturi valves themselves have been known for a considerable period of time, the two have never been put together in the context of a gas-lift operation. However, this reasoning cannot be accepted by the Board since D1 was published 16 August 1994 (i.e. three weeks before the priority date of the contested patent) and is the only and therefore earliest document showing the decisive step of using a venturi type gas flow control valve in a gas-lift operation.

In conclusion, the Board is of the view that faced with the problem of stabilising a gas-lift well it would be obvious for the skilled person to operate the device of

D1 in the critical flow regime. Thus, the subject-matter of claims 1 and 2 according the main request does not involve an inventive step.

2. *Auxiliary request 1*

2.1 *Article 123(2) EPC, Article 84 EPC*

In the Board's view the term "housing" refers to the assembly of components going to make up the outer envelope containing the gas flow control device.

The expression "adjacent the housing", used to qualify the positions of both the nozzle first end and the Venturi second end, is directly derivable from figure 6A of the application as filed.

Thus, the requirements of Articles 84 and 123(2) EPC are met.

2.2 *Novelty*

The additional features introduced into the independent claims are essentially as follows:

(i) a throat (36) interposed between said nozzle second end and said Venturi first end;
(ii) said nozzle portion (34a) including a nozzle first end adjacent the housing
(iii) wherein the nozzle portion includes curvilinear sidewalls extending from the housing to the throat, the radius of curvature of the curvilinear sidewalls being greater than the diameter of the nozzle second end;

(iv) said Venturi portion (34b) including a second end adjacent the housing;
(v) wherein the Venturi portion is defined by venturi walls extending from the throat to the housing, which form a constant angle from $4^o$ to $15^o$ to the longitudinal axis of the venturi flow path.

D1 clearly shows a throat section (9,13), thus feature (i) is known. D1 also states that "the diameter $d_1$ may coincide with $d_2$" (see page 3, line 13), thus feature (iv) is known.

The method according to claims 1 and 2 is thus distinguished from that of claim 1 by features (ii),(iii) and (v) together with the requirement for critical flow previously identified in connection with the main request.

2.3 *Inventive step*

Features (ii),(iii) and (v) have the technical effect of minimising turbulence and energy losses in the gas flow control device such that critical flow and, hence, well stabilisation can be achieved at lower pressure differentials.

The objective technical problem is therefore to be seen as one of optimising well stabilisation using the critical flow technique.

In the Board's opinion features (ii), (iii) and (v) specify constructional features which are standard in the field of Venturi valves and would form part of the skilled person's general knowledge. This is supported by the fact that these features are detailed in D11 which is an industry standard.

Faced with the above objective technical problem, it would be routine procedure for the skilled person to eliminate any abrupt changes in the internal surface profile of the flow channel so as to minimise turbulence and energy losses. These constructional modifications are also described in the ASME standard D11 which is typical of industry standards that would be consulted as a matter of normal design routine by those skilled in the art. Further, the Board notes that the "Conclusion" paragraph of D15 (which is also an industry standard) gives the skilled person direct indications as to the use of venturi devices and the effect of different diffuser lengths and divergence angles.

3. *Auxiliary request 2*

This request is identical to auxiliary request 1 except that it additionally specifies that:

"wherein said gas constrained to flow through said gas flow control device achieves critical flow across the gas flow control device at a differential pressure across the gas flow control device of between 4 and 10% of the gas injection pressure"

In the Board's view, this feature defining the performance of a rather efficient Venturi device is merely a consequence of the additional constructional features defined in AR1 for optimising the venturi device. The gas flow control device must be understood as being composed of the elements defined in the claim. Therefore any arguments referring to pressure losses caused by components not defined in the independent claims are irrelevant.

Hence, the subject matter of claims 1 and 2 according to both auxiliary requests 1 and 2 does not involve an inventive step.

## Order

**For these reasons it is decided that:**

The appeal is dismissed.

Registrar: Chairman:

A. Counillon U. Krause