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File No.: T 0130/91 - 3.2.4  
Application No.: 86 118 025.5  
Publication No.: 0 262 259  
Classification: F02D 19/02, F02M 21/04  
Title of invention: System for controlling mass flow rates of two gases

**D E C I S I O N**  
of 13 September 1993

Applicant: Air Sensors, Inc.

Proprietor of the patent:

Opponent:

Headword:

**EPC:** Art. 56

Keyword: "Inventive step (yes)"

**Headnote**  
**Catchwords**



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Boards of Appeal

Chambres de recours

Case Number: T 0130/91 - 3.2.4

**D E C I S I O N**  
of the Technical Board of Appeal 3.2.4  
of 13 September 1993

**Appellant:**

Air Sensors, Inc.  
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Seattle, Washington 98188 (US)

**Representative:**

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**Decision under appeal:**

Decision of the Examining Division 2.3.01.101 of  
the European Patent Office dispatched on  
21 August 1990 refusing European patent  
application No. 86 118 025.5 pursuant to  
Article 97(1) EPC.

**Composition of the Board:**

**Chairman:** C. Andries  
**Members:** P. Alting van Geusau  
J.-P. Seitz

### Summary of Facts and Submissions

- I. European patent application No. 86 118 025.5 was filed on 23 December 1986 and published on 6 April 1988.
- II. Following two communications, the Examining Division refused the application with its decision dispatched on 21 August 1990 on the ground of lack of inventive step of the subject-matter of Claim 1 filed with letter of 26 July 1990, in view of the teachings of US-A-4 537 172 (D1), in particular when taking into account the difference in cross-section of the air and gas conduits.
- III. An appeal was lodged against this decision on 19 October 1990 with payment of the appeal fee on the same day. The Statement of Grounds of Appeal was filed on 27 December 1990.
- IV. With its communication dated 14 April 1993 the Board expressed the provisional opinion that the difference of cross-sections of the air and gas conduits in D1 did not appear to disclose that the conduits for the respective gases had been selected such that their interior flow cross-sectional areas were sized relative to each other to correspond approximately to the predetermined ratio of mass flow rates through these conduits.

That there was no such teaching derivable from D1 would appear to follow from the fact that in the known arrangement the fuel amount control valve is positioned downstream the mass flow meter, the latter being thus in a conduit with a different pressure when compared to the pressure in the second conduit. Consequently, to allow for a predetermined ratio of the mass flow rates of the gases at the mixing point, the ratio of cross-sectional areas of the conduits at the points of mass flow

measurements did not necessarily appear to have a relation to the predetermined ratio of the mass flow rates of the gases.

However, amendments to Claim 1 underlying the contested decision appeared to be necessary in order to meet the requirements of Article 84 EPC, in particular with respect to clarity. Attention was also drawn to some necessary amendments in the description.

V. With letter of 27 May 1993 the Appellant filed amended Claims 1 to 4 and amended pages 1, 2, 6 and 9 of the description.

With letter of 13 August 1993 he filed amended pages 3 and 4 of the description.

The Appellant requested grant of a patent on the basis of these new claims, the amended pages of the description and pages 5, 7, 8 and 10 filed on 26 July 1990 together with the figure sheet 2/3 as originally filed and figure sheets 1/3 and 3/3 filed on 17 August 1988.

Claim 1 of the current set of claims reads as follows:

"1. A control system for controlling the relative mass flow rates of two gases, comprising:

a first conduit (34) for the flow of a first gas, the flow being variable over a range of mass flow rates;

a first gas mass sensor (38) positioned to sense the mass flow rate of said first gas in said first conduit (34), and to generate a first flow rate signal indicating the mass flow rate of said first gas;

a second conduit (40) for the flow of a second gas, the flow being adjustable over a range of mass flow rates;

a second gas mass sensor (42) positioned to sense the mass flow rate of said second gas in said second conduit (40), and to generate a second flow rate signal indicating the mass flow rate of said second gas;

an electronic controller (66) for comparing said first and second flow rate signals, and generating a control signal if said first and second flow rate signals vary from a predetermined ratio; and

a valve (44) adjustably controlling the flow rate of said second gas in response to said control signal to maintain said predetermined ratio, whereby the flow rate of said second gas is controlled responsive to variations in the flow rate of said first gas to maintain the mass flow rates of said first and second gases in the desired ratio,

**characterised in that**

said first and second conduits (34, 40) have interior flow cross-sectional areas sized relative to each other to correspond approximately to said predetermined ratio of the mass flow rates of said first and second gases, and

that said first and second gas mass sensors (38, 42) have a substantially identical non-linear output response relative to the mass flow being sensed,

whereby said first and second conduits (34, 40) have - at the points of flow mass measurement - interior flow cross-sectional areas sized to provide approximately equal output responses of said first and second gas mass

sensors (38, 42) when the mass flow rates of said first and second gases are in said predetermined ratio so that said first and second flow rate signals will remain comparable during operation over a wide range of flow rates without introducing unacceptable error."

### Reasons for the Decision

1. The appeal complies with the requirements of Articles 106 to 108 and Rule 64 EPC. It is admissible.
2. *Amendments*
  - 2.1 The current Claim 1 is based on a combination of the originally filed Claims 1 to 3 and further contains the clarification that the first and second conduits have, at the point of flow mass measurement, interior flow cross-sectional areas sized to provide approximately equal output responses of the gas mass sensors. These clarifications follow immediately from the description of the preferred embodiment of the invention.

The features of Claim 2 are disclosed on page 9, lines 24 to 30 of the originally filed description.

The features of Claims 3 and 4 follow immediately from page 2, second paragraph of the originally filed description and the original Claim 7.

In view of the above conclusions no objections under Article 123(2) EPC arise against the present claims.
  - 2.2 The description was amended to take account of the relevant prior art disclosed in D1, EP-A-0 071 588 (D2) and US-A-4 335 697 (D3) and thus meets the requirements

of Rule 27(1)(b) EPC. Some corrections for reason of clarity and consistency were carried out.

The single independent Claim 1 is related in its precharacterising part to the closest prior art disclosed in D1. Thus in this respect no objections arise under Rule 29(1) EPC either.

3. *Novelty*

Novelty of the subject-matter of Claim 1 follows from the fact that none of the cited documents discloses that first and second conduits for first and second gases to be mixed and maintained at a predetermined ratio have interior flow cross-sectional areas which are sized to provide approximately equal output responses of gas mass sensors having substantially identical non-linear output responses.

Since novelty of the subject-matter of the application was also not contested by the first instance, further elucidations are not considered necessary in this respect.

4. *Inventive Step*

4.1 Considering the cited documents, the closest prior art is disclosed in US-A-4 537 172 (D1), as was also established by the Examining Division.

4.2 The Appellant submitted that the flow meter disclosed in D1 is not a "gas flow anemometer".

However, Claim 1 only specifies gas mass sensors and in this respect clearly the air flow meters used in D1 fall within this term because they are indicated as gas mass flow meters (see column 9, line 24 of D1). No further

details which would suggest a different nature of the gas mass sensors are derivable from the application under consideration.

D1 thus discloses a control system comprising the combination of precharacterising features of Claim 1.

- 4.3 Because, in accordance with the characterising features of Claim 1, the flow meters are positioned in conduits with interior flow cross-sectional areas sized relatively to each other to correspond approximately to the predetermined ratio of the mass flow rates of the gases, it can be ensured that the flow velocities at the measuring points, which to a high degree determine the characteristics of the mass flow meters, are substantially equal over the whole range of measurement.

This leads to the technical effect that even with the output responses of both gas mass sensors being non-linear, the first and second flow rate signals will remain comparable during operation over a wide range of flow rates without introducing unacceptable errors (see page 2, third paragraph of the present description).

- 4.4 The problem to be solved by the features of Claim 1 can therefore be seen in the provision of a control system for controlling mass flow rates of two gases which in a simple manner allow relatively accurate and reliable regulation of the mass ratio and yet be inexpensive to manufacture (see page 2, first paragraph of the description) because no processing of the mass meter signals to provide comparable signals for the ratio control is necessary.

- 4.5 The Examining Division considered that D1 contained a direct lead to the solution of this problem in exactly the same manner as defined in Claim 1 because of the

different sizes of the conduits shown in the diagrammatic representation in Figures 1, 14 and 16 of D1, which would suggest to the skilled person a choice of the cross-sections to correspond to the relative flow rates.

Although, admittedly, the known conduits in these schematic diagrams have different diameters no teaching is, in the Board's opinion, derivable from this fact that the cross-sectional areas of the conduits should be sized approximately to the predetermined ratio of the mass gas flow.

Not only can the Board follow the Appellant's argument that the drawings referred to by the Examining Division are schematic representations of the fuel supply control which do not allow plain conclusions as to the actual sizes of the conduits, but, moreover, the fuel amount control system disclosed in D1 functions substantially different in comparison with the system disclosed in the present application and also for this reason would not suggest this characterising feature.

In this respect it is noted that in the arrangement of D1 the fuel amount control valve (12) is positioned **downstream** the fuel mass flow meter (11) whereas in the system disclosed in the present application the fuel amount control valve (44) is situated **upstream** the gas mass sensor (42).

In such an arrangement, because of the different pressures involved at the points of mass measurement, there is no reason to suppose that for a predetermined gas **mass** mixing ratio the gas flow **velocities** at the measuring points are substantially equal - which, as follows from the above conclusions, is the basic principle of the present application - even if the

relation of the cross-sectional areas of the conduits at the gas mass measuring positions would comply with the predetermined gas mass mixing ratio.

Therefore, when placed in the technical context of the disclosures of D1, the difference between the diameters of the gas conduits in this prior art document does not give the skilled person any teaching or incentive to select the ratio of the cross-sectional areas of the conduits so that it intentionally corresponds with the predetermined mass flow ratio.

- 4.6 Whether the feature that the first and second gas mass sensors have a substantially identical non-linear output response relative to the mass flow being sensed would be obvious in itself from the teachings of D1 is not considered decisive for the question of inventive step of the subject-matter of Claim 1 since in the present case it is the combination of such a relatively simple mass flow sensor with a non-linear output response and the selected ratio of cross-sectional areas of the conduits which leads to the effect that the gas mass sensors can be used essentially in the same part of their characteristic so that, even when such simple sensors are used, an accurate control can be ensured (see section 4.3 above).

Such a particular application of sensors with a non-linear characteristic cannot, in the Board's opinion, be derived from the disclosures of D1 even when it is stated that "both of the meters have same output characteristics and the same response characteristics" (see column 9, lines 18) as referred to by the Examining Division, because, as is shown above, no link whatsoever with the cross-sectional areas of the conduits at the measuring points is hinted to in D1.

- 4.7 In comparison with D1 the other cited documents clearly lie further away from the subject-matter of Claim 1 of the present application. Since none of these documents discloses particularities of the cross-sectional areas of the gas supply conduits or contain a lead to a selection of the cross-sectional areas of the conduits for the gases to be mixed in accordance with a predetermined mixing ratio, no further discussion of these documents is considered to be necessary. In this respect it is also noted that in the examination procedure no reference to these further documents was made by the Examining Division in respect of the subject-matter of the independent Claim 1.
5. Summarising, in the Board's judgment, the proposed solution to the technical problem underlying the present application defined in the independent claim is inventive and therefore this claim as well as its dependent Claims 2 to 4 relating to particular embodiments of the invention in accordance with Rule 29(3) EPC, can form the basis for grant of a patent (Article 52(1) EPC).
6. The description and drawings are in agreement with the actual wording and scope of the current claims. Hence these documents are also suitable for grant of a patent.

**Order**

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

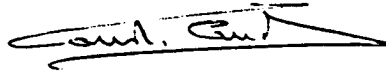
1. The impugned decision is set aside.
2. The case is remitted to the first instance with the order that the further prosecution, i.e. the grant of a patent, be based on Claims 1 to 4 and the description pages 1, 2, 6 and 9 filed with letter of 28 May 1993, the description pages 3 and 4 filed with letter of 13 August 1993, description pages 5, 7, 8 and 10 filed on 27 July 1990, figure sheet 2/3 as originally filed and figure sheets 1/3 and 3/3 filed on 17 August 1988.

The Registrar:



N. Maslin

The Chairman:



C. Andries

*Handwritten initials*  
TAS