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(54) Abstract Title: **Explosion-protected gas sensor**

(57) An explosion-protected gas sensor has a measuring element 2, which generates a measurement signal dependent on the concentration of the measuring gas and is bounded off from the surroundings by means of a porous, gas-permeable and sintered metal body 7. The sintered metal body has a high degree of mechanical stability, so that additional components, which hinder the diffusion of the measuring gas into the sensor and therefore increase the response time of the gas sensor can be dispensed with for impact protection of the gas sensor.

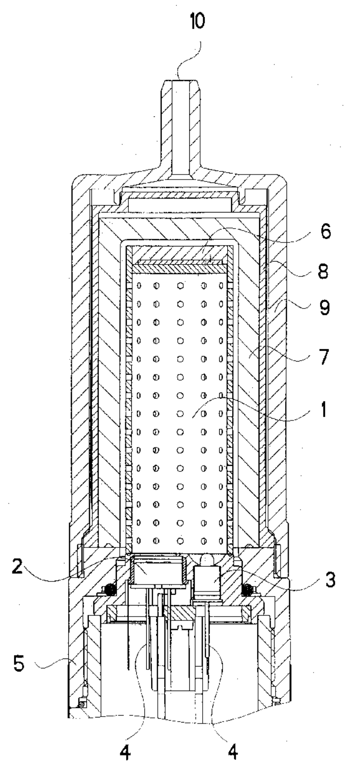

Fig. 1

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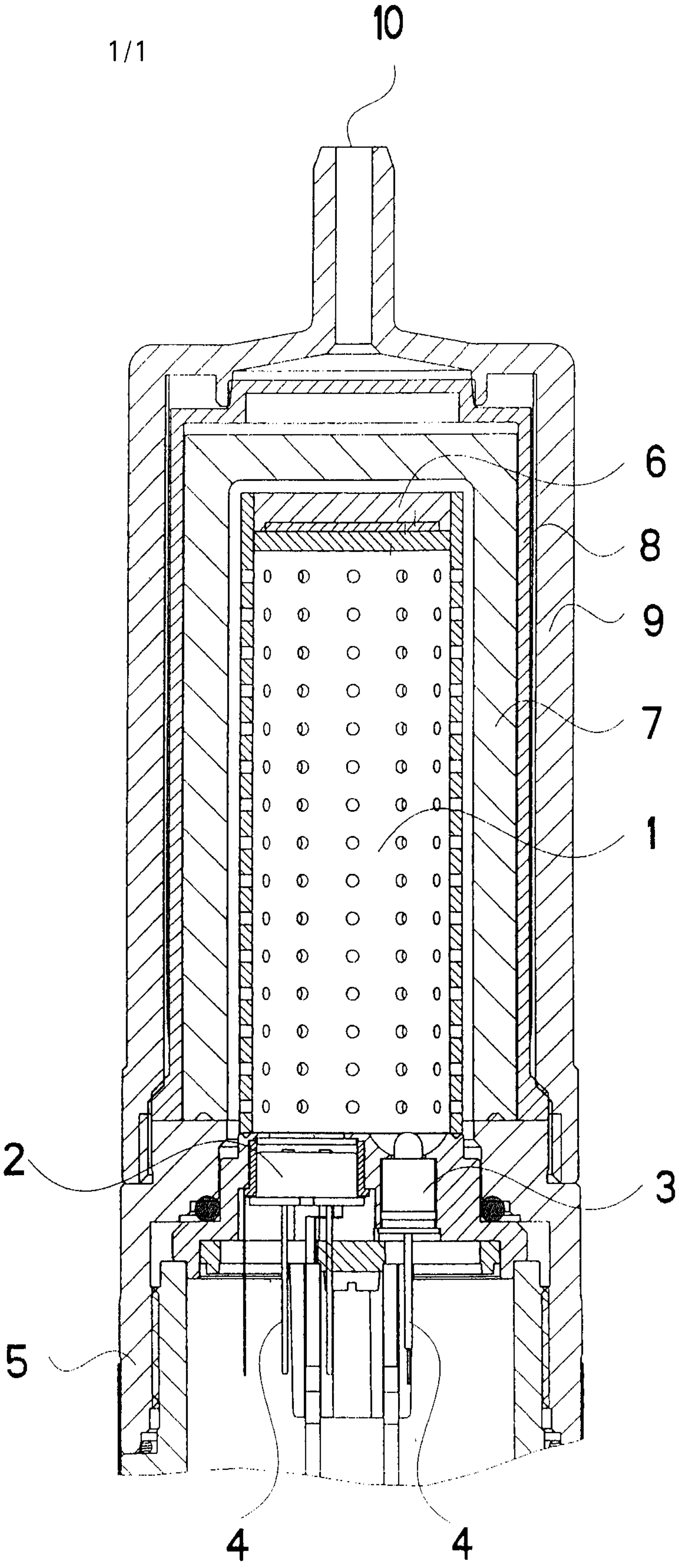

Fig. 1

Explosion-protected gas sensor

The invention relates to a gas sensor with a measuring element which generates a measurement signal dependent on the concentration of a gas of interest ("measuring gas").

Examples of such gas sensors are infrared-optical gas sensors and catalytic heat-tone sensors which, especially in the stationary operation, are also used as so-called explosion-protected gas sensors in order to determine combustible gases and their concentration in the ambient air or atmosphere. Inside the housing, these gas sensors have a measuring cell, in which the gases to be measured are detected by physical processes such as infrared absorption or heat tone. The measuring gas passes through openings in the housing or in the measuring cell of the gas sensor into the latter, whereby the response time of a gas sensor to the given measuring gas is dependent on the number and arrangement of these openings. The more openings there are in the housing or the measuring cell, the more rapidly the measuring gas can diffuse into the gas sensor. In the case of gas sensors for combustible measuring gases such as methane, however, there is the risk of the measuring gas becoming ignited inside the measuring cell due to heated and electrically operated sensor elements or measuring elements. In order that the occurring spark cannot spread into the sensor surroundings, there have to be so-called flame arresters at the housing openings. These are generally produced from individual metal sintered elements, such as known for example, from EP 0 182 064 A1, by means of which the measuring gas ignited inside the measuring cell in the gas sensor is cooled down as it flows out, to such an extent that the measuring gas located outside the gas sensor cannot be ignited.

The overall housing construction of the gas sensor must be constituted in such a way that the explosion or flame-penetration protection is still present even after severe mechanical external influences. The gas sensor housing itself must be produced from mechanically resistant material and, in particular, measures must be taken to prevent damage to the sintered elements. One possibility of embodiment is protection by means of an externally fitted stable component, which is permanently fixed over the sintered element. A drawback with this solution is the increased production cost for the gas sensor due to the additional component. On the other hand, the diffusion of the measuring gas into the measuring cell is impaired by the covering of a part of the surface of the sintered element, as a result of which an undesirable increased response time of the gas sensor results.

An alternative solution for the protection of the sintered element consists in the structural integration in the housing, so that the complete impact protection of the housing is offered and the sintered element itself cannot be damaged. Here too, however, the drawback lies in the more difficult measuring gas diffusion into the measuring cell, associated with the increased response time of the gas sensor, and in additional components and assembly steps that are required.

The present invention is as claimed in the claims.

The invention makes available an explosion-protected gas sensor which, without additional components, offers a large surface for the diffusion of the measuring gas into the gas sensor and at the same time has a high degree of mechanical stability.

An essential advantage of the invention consists in the fact that the measuring cell with the measuring element is completely bounded off from the ambient atmosphere by a porous, gas-permeable, sintered metal body, whereby the impact protection against external mechanical influences is taken over completely by the metal body itself rigidly connected to the base region, without additional components having to be used for stabilisation. Apart from being able to provide the desired explosion protection, the sintered metal body also provides the desired mechanical protection and offers a large effective surface for a high diffusion rate of the measuring gas into the sensor, said surface not being reduced by further components and housing parts.

The sub-claims specify advantageous developments and configurations of the gas sensor according to the present invention.

An example of embodiment of the invention is explained below with the aid of the single Figure 1, which shows a cross-section through an infrared-optical gas sensor.

The gas sensor shown is an infrared-optical gas sensor with a radiation source 3 and with a measuring element 2 designed as an infrared detector, which are fitted in base region 5 of the gas sensor, said base region being metallic or produced from a plastics material. Electrical contacts 4 are connected to evaluation electronics of the gas sensor secured to base region 5.

The measuring cell, designed here as a cylindrical measuring-gas vessel 1, is designed internally radiation-reflecting in the case of the infrared-optical gas sensor and has, distributed over the lateral surface area, perforations which enable the diffusion into the vessel of the gas to be measured in respect of the concentration. Such a gas sensor is for example a stationary gas sensor installed at a specific, possibly difficultly accessible measuring point, such as is used for example in industrial and process installations in chemistry or in the petroleum/natural gas industry.

The represented gas sensor is connected rigidly by a pulse-welding method to base region 5 by, in particular, a cylindrical, porous, gas-permeable, sintered metal body 7 as explosion protection 5, so that an explosion of any explosive ambient gas cannot be triggered by any electrical sparks in the gas sensor Metal body 7 is made from a sintered, porous and gas-permeable special steel with a wall thickness of 3 to 4 millimetres and an average pore size of 10 to 80 and in particular 30 to 60 microns. It has emerged in tests that the explosion protection, the mechanical stability and the diffusion properties are particularly favourable if sintered metal body 7 is resintered in a vacuum at a temperature of over 1200 degrees Celsius. Moisture effects and measurement errors due to condensation in the gas sensor should be prevented with electric heating 6.

A replaceable, also cylindrical, cap 8 made from a porous, gas-permeable and water-impermeable material is placed or screwed onto porous, sintered metal body 7. Cap 8 is preferably produced from bright to white, porous, sintered PTFE or sintered hydrophobised PE (polyethylene) with a pore volume of approx. 30 to 70% and with a layer thickness of, for example, approx. one millimetre. The brightness of the material of cap 8 results in good visibility of the consumption state for a possible replacement after corresponding dust or environmental pollution. The porous hydrophobic material of cap 8, in particular PTFE or

PE, ensures that no moisture penetrates into the gas sensor or metal body 7 and the latter are not therefore damaged or impaired in the measuring function.

A calibration adapter 9, screwed onto the gas sensor is located over metal body 7 with cap 8, said calibration adapter being produced for example from a glass-fibre reinforced plastic such as polyacryl. Calibration adapter 9 is produced interrupted, in order to hinder the gas diffusion from the surroundings as little as possible, and it has at the upper end a gas-supply connection piece 10 for the connection of a gas supply line of a calibration gas from a compressed gas supply, for example from a calibration compressed-gas bottle. Calibration adapter 9 preferably remains on the gas sensor both during the measurement and also during the calibration, so that, when a calibration gas supply is connected to gas-supply connection piece 10, a remote calibration can, if need be, readily be carried out by opening the calibration gas supply, but without assembly expenditure on retrofitting being required as previously for each calibration. This is advantageous especially in the case of difficultly accessible measuring points.

The flow resistance of the porous material of cap 8 is selected by means of the layer thickness and/or porosity in such a way that the pressure in the measuring cell during the calibration using calibration gas supplied via gas-supply connection piece 10 exceeds the dynamic pressure of the wind on the external side of cap 8 with calibration adapter 9 placed thereon, so that the calibration is not influenced by wind.

In the region of gas-supply connection piece 10, cap 8 is preferably provided with a smaller layer thickness and/or a higher porosity than in the remaining region, in order to enable as unhindered a calibration gas admission as possible into the interior of cap 8 with the gas sensor, so that as small a calibration gas pressure as possible is required. Calibration adapter 9 is designed, for example, in the form of a base section in the region of gas-supply connection piece 10 in the upper section of cap 8, in such a way that a good seal of the inflow region of the calibration gas into cap 8 is provided. The remaining region of cap 8 is selected in such a way that, when there is a calibration gas flow of, for example, 1 litre/minute, an overpressure arises in the measuring cell that at least corresponds to the dynamic pressure of the maximum tolerable external wind speed during the calibration process, so that the calibration is not influenced in an unacceptable way. On the other hand, the inflow of the measuring gas through cap 8 should be as unhindered as possible during the remaining measurement time with screwed-on calibration adapter 9. The pressure build-up on the material of cap 8 through which the flow passes is proportional to the calibration gas flow, but inversely proportional to the air conductance and the magnitude of the area through which the flow passes. It has been ascertained that, with acceptable calibration gas flows of, for example, one litre/minute with a remaining surface outside the inflow area of the calibration gas of approx. 45 square centimetres in total, air conductance L amounts with a desired pressure build-up of 4 hPa to approx. 100 *ml/(s·cm2·bar)*.

CLAIMS

1. A gas sensor with a measuring element, which generates a measurement signal dependent on the concentration of a measuring gas, in which the gas sensor with the measuring element is bounded off from the surroundings by means of a porous, gas-permeable and sintered metal body.

2. The gas sensor according to claim 1, in which the metal body is a hollow cylinder closed at an end side.

3. The gas sensor according to claim 1 or 2, in which the metal body is made from high-grade steel and has a wall thickness of 3 to 5 millimetres and an average pore size of 10 to 80 and in particular 30 to 60 microns.

4. The gas sensor according to any one of the preceding claims, in which the metal body is resintered in a vacuum at a temperature above 1200 degrees Celsius.

5. The gas sensor according to any one of the preceding claims, in which the metal body is connected to the base region of the gas sensor by means of a pulse-welding method.

6. The gas sensor according to any one of the preceding claims, in which a replaceable cap made from a porous, gas-permeable and water-impermeable material is placed or screwed onto the metal body.

7. The gas sensor according to claim 6, in which the cap is made from PTFE (polytetrafluoroethylene) or hydrophobised PE (polyethylene), in particular from a sintered PTFE or PE with a pore volume of approx. 30 to 70%.

8. The gas sensor according to claim 6 or 7, in which a calibration adapter is placed or screwed onto the cap, said calibration adapter having a gas-supply connection piece for the calibration gas supply to the cap of the gas sensor.

9. The gas sensor according to claim 8, in which the cap and the calibration adapter are designed individually or jointly as a one-piece component.

10. The gas sensor according to any one of the preceding claims, in which the gas sensor is an infrared-optical gas sensor and the measuring element is an infrared detector.

11. The gas sensor according to any one of claims 1 to 9, in which the gas sensor is a catalytic heat-tone sensor and the measuring element is a pellistor.

12. The gas sensor according to any one of claims 8 to 11, in which the cap has, in the region of the gas-supply connection piece, a smaller layer thickness and/or a higher porosity than in the remaining region.

13 The gas sensor according to any one of claims 8 to 12, in which the gas sensor is equipped with vessel heating in the region of the gas-supply connection piece of the calibration adapter.

14. The gas sensor according to any one of claims 8 to 13, in which the cap and the calibration adapter are connected to the gas sensor both during use for measurement and during calibration.

15. The gas sensor according to any one of claims 8 to 14, in which the flow resistance of the material of the cap is selected in such a way that the pressure in the region of the gas sensor during calibration using supplied calibration gas exceeds the dynamic pressure of the wind on the external side of the cap with calibration adapter.

16 The gas sensor according to any one of claims 8 to 15, in which, by means of the geometry of the calibration adapter and the flow resistance of the material of the cap, the diffusion of measuring gas to the measuring element is hindered only to an extent such that the response time of the gas sensor in the gas measurement is lengthened by less than 30% compared with the operation without calibration adapter and cap.

17. The gas sensor according to any one of claims 8 to 16, in which the flow resistance of the material of the cap is selected in such a way that the over-pressure in the measuring cell generated by the calibration gas flow through the gas-supply connection piece does not exceed 50 hPa.

18. A gas sensor substantially as hereinbefore described with reference to, and/or as shown in, the accompanying drawing.

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Claims searched: 1 to 18
Examiner: Mr Tony Oldershaw
Date of search: 27 April 2006

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1 to 18	GB2262338 A (GOOM) - see figure 3; page 2 paragraph 2
X	"	GB1338870 A (VYSOKA) - see page 1 lines 68 to 71
X	"	EP0094863 A1 (BENDIX) - see figure 1; page 4 lines 33 to 36
X	"	US4709150 A (BUROUGH) - see figure 1; column 2 lines 50 to 65
X	"	US4596975 A (REDDY) - see figure 2; column 3 lines 36 to 38
X	"	US4489590 A (HADDEN) - see figure 2; column 5 lines 46 to 53
X	"	US4466880 A (TORII) - see figure 3; column 3 lines 35 to 38
X	"	US4305724 A (MICKO) - see figure 1A; column 3 lines 48 to 56
X	"	US4255960 A (BOUTONNAT) - see figure 1; column 2 lines 44 to 50
X	"	JP2003227794 A (NAKAMURA) - see figure 1

Categories:

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G1A

Worldwide search of patent documents classified in the following areas of the IPC

G01N

The following online and other databases have been used in the preparation of this search report

Online: WPI, EPODOC, TXTE