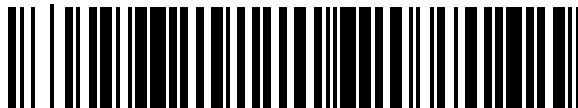


19



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INVENTION PATENT

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54 Title: **Flowmeter for determining the permeability of a material to a gas**

57 Summary:

Flowmeter (15, 25, 35) for measuring the permeability of a material to a gas, comprising an inlet (20, 33) configured to receive a gas that has previously passed through a specimen (12) of a material whose permeability to that gas is to be measured. This flowmeter comprises a mass flow detector (22) configured to convert the amount of gas flow into a certain parameter, where said gas flow can have a flow rate of the order of hundredths of a cm³/s or higher.

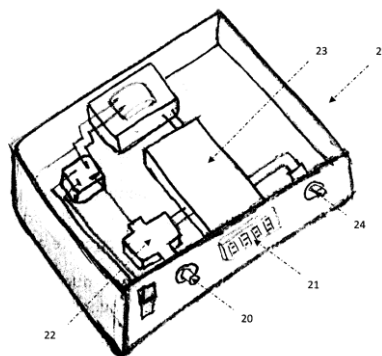


Figura 2

ES 2 400 592 B1

DESCRIPTION

**FLOWMETER FOR DETERMINING THE PERMEABILITY
OF A MATERIAL TO A GAS**

FIELD OF INVENTION

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The present invention belongs to the field of construction and, more specifically, to devices for controlling the permeability of a material.

BACKGROUND TO THE INVENTION

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There are standards that regulate the measurement of permeability of certain materials against gases. For example, the Spanish standard regulates the oxygen permeability test method through the *UNE 83966:2008 standards: Durability of concrete. Test methods. Conditioning of concrete specimens for the testing of*
15 *gas permeability and capillarity* and *UNE 83981:2008: Durability of concrete. Test methods. Determination of the oxygen permeability of hardened concrete.*

15

The basis of the test is to apply a constant pressure of gas, on a

20

of the faces of a concrete specimen (or sample) and, after a sufficient time in which the gas has passed through the entire specimen and reached its opposite face, record the gas flow at the outlet, i.e. the volume of gas passing through the specimen per unit of time. To do this, it is necessary that the side faces of the specimen are perfectly sealed, so that no gas escapes through them and

25

In this way, all the gas that is applied on one of the sides is collected on the opposite side.

The gas flow inlet is controlled by a regulator, and the flow rate at the outlet is measured, according to the referenced standard, by displacing a

30

soap bubble displaced by the outgoing gas inside one of the N pipettes

graduates who form the essay. For eHo, at the bottom of each pipette in the set of N pipettes is a rubber periHa placed. By squeezing the periHa of the selected pipette by means of a Have, a soap bubble is generated which, pushed by oxygen, travels through the pipette. It is important to close the Haves of the pipettes that are not there
5 being used.

The flow rate that the concrete specimen passes through is the result of dividing the volume that the soap bubble travels, measured as the difference in final and initial values on the graduated scale of the pipette, by the time it takes for the bubble to travel through the pipett.
10

space10.

Each of the N pipettes in the test has a different diameter. The greater the permeability of the concrete specimen, the greater the flow through the concrete specimen, and the greater the velocity of the bubble ascent within the
15 pipette, so a larger pipette diameter is required. Therefore, depending on the pressure and permeability of the concrete material, a pipette of ! set of N pipettes, in such a way that during the time that the measurement < the bubble moves upwards within said pipette and always without exiting at its upper end. If the bubble does not move, the oxygen pressure is increased
20 applied.

A time-measuring device measures the time it takes for the soap bubble to pass through the graduated volume on the surface of the pipette. If the measured bubble step time is less than 30 seconds, the pipette should be changed
25 used by another with a larger capacity, taking care to close the Haves of the pipettes that are not being used.

At the beginning of each measurement, and to avoid overpressure in the system, the Have located between the specimen and the pipette assembly is kept open. To perform the test

30 Five values of oxygen pressures are selected using the pressure regulator on the nanometer. Pressures between 0.5 bar and

3.5 bar. You can start with 0.1 bar, if the concrete is very permeable, and work up to a maximum of 5 bar, if the concrete is not very permeable.

5 To ensure a stable regime of the oxygen flow, pre-readings of the flow of this flow are made at intervals of 5 minutes until the difference between successive readings is less than 3%. This stabilization procedure must be repeated for each pressure applied, and is generally achieved in the time between 5 minutes and 30 minutes, depending on the permeability of the concrete tested. By reaching the

10 Flow stability: The value of the flow that crosses the specimen for each pressure applied is noted. The average value of the flows obtained in each of the pressures for the same specimen is considered in the test.

The gas flow rates to be measured in the oxygen permeability test on specimens
15 of concrete, they are remarkably small, in the order of 0.1 to 0.5 cm³ls. Because of this, it is not possible to use conventional flow meters and the device that applies the soap pump method is usually used. However, this device has a series of limitations and shortcomings, such as:

20 - The measurement of permeability with the device that applies the soap bubble method is a slow and laborious procedure because for each pressure measurement, it is necessary to find the appropriate pipette for the corresponding flow rate, being necessary to carry out a significant test of measurements with different pipettes until the appropriate pipette is found. In addition, once the pipette is located, the

25 Complete flow stabilization is achieved after a time of 5 to 30 minutes, it being understood that this is achieved when the measurements made in intervals of 5 minutes do not differ by more than 3% from the value of the measured flow. That is, in a test in which the stabilization time is 30 minutes, after locating the most suitable pipette, 6 flow measurements will have to be made every 5 minutes to confirm the

30 stabilization at the corresponding pressure.

- There is no possibility to electronically record permeability values continuously. Discrete measurements can only be made both in the stabilization process and in the measurements after stabilization.

5 - The device that applies the soap bubble method requires increasing the inlet pressure when the bubble does not move as a result of a low flow rate and low permeability of the concrete. The use of high pressures can lead to modifications in the viscosity of oxygen, thus altering the permeability values obtained. In addition, the use of high pressures can lead to the rupture of the
10 structure of the cement paste of young concretes, creating new capillaries and voids through which oxygen would pass. This also alters the permeability value obtained.

SUMMARY OF THE INVENTION

15 The present invention seeks to solve the aforementioned drawbacks by means of a flowmeter for the measurement of the permeability of a material to a gas that allows the measurement of flows of the order of hundredths of a cm^3/s , preferably from 0.02 cm^3/s .

20 Specifically, in a first aspect of the present invention, a flowmeter is provided for the measurement of the permeability of a material to a gas, which includes an inlet configured to receive a gas that has previously passed through a specimen of a material whose permeability to said gas is to be measured. The
25 Flowmeter comprises a mass flow detector configured to convert the amount of gas flow into a certain parameter, where said gas flow can have a flow rate of the order of hundredths of a cm^3/s or higher.

In a possible realization, the flowmeter includes in addition to a means of
30 conversion of data configured to measure that parameter and convert it into a value of flow expressed in cm^3/s .

In one possible embodiment, the flowmeter also comprises an output interface configured to connect the output of the flowmeter's mass flow detector to external data conversion media connected to a computer, with these external data conversion media configured to measure the output parameter

5 of the mass flow detector and convert it into a flow value expressed in cm³/s.

In a possible realization, the parameter is a continuous electrical voltage. Alternatively, this parameter is an electric current.

10 In one possible embodiment, the mass flow detector is a membrane mass flow detector . Alternatively, the mass flow detector is a laser mass flow detector .

In a possible realization, the material whose permeability is to be measured is
15 concrete.

BRIEF DESCRIPTION OF THE FIGURES

In order to aid a better understanding of the characteristics of the invention,
20 according to a preferential example of practical realization of the same, and to complement this description, a set of drawings is accompanied as an integral part of it, whose character is illustrative and not limiting. In these drawings:

Figure 1 shows a schematic of a system comprising the flow meter of the
25 invention.

Figure 2 shows a diagram of the interior of a flowmeter according to a realization of the invention.

30 Figure 3 shows a schematic of the front view of the flowmeter according to

a realization of the invention.

Figure 4 shows a graph of the evolution of the flow rate leaving the specimen as a function of time, and which is measured by the flow meter, for five pressures of
5 Different input.

DETAILED DESCRIPTION OF THE INVENTION

10 In this text, the term "comprises" and its variants must not be understood in an exclusive sense, that is to say, those terms are not intended to exclude other technical characteristics, additives, components or steps.

In addition, the terms "approximately", "substantially", "around", "some",
15 etc. should be understood as indicating values close to those that these terms accompany, since due to errors of calculation or measurement, it is impossible to obtain these values with total accuracy.

In addition, a specimen is a sample of a material on which to measure its
20 permeability.

The characteristics of the device of the invention, as well as the advantages derived from them, can be better understood by the following description, made with reference to the drawings listed above.

25 The following preferred embodiments are provided by way of illustration and are not intended to be limiting to the present invention. In addition, the present invention covers all possible combinations of particular and preferred embodiments herein indicated. For experts in the field, other objects, advantages and characteristics of the
30 invention will be derived in part from the description and in part from the practice of the invention.

The following is a description of a minimum configuration of the system comprising the flow meter of the invention for the measurement of the gas permeability of a material, according to the schematic of the material in Figure 1. The material under measurement must be permeable. Non-limiting examples of materials whose permeability can be measured by the system described are: concretes, cenyumics or natural stones.

The system in Figure 1 comprises at least one gas storage medium **11**, in charge of storing the gas inside. Said at least one means of

Gas Storage **11** must contain the gas at a pressure greater than the pressure needed to perform the measurement. In one particular embodiment, this storage medium **11** is a gas bottle.

The gas storage medium **11** is attached to one of the ends of the a specimen **12** whose permeability to a gas is to be measured, by means of a transport medium **13** configured so that the gas circulates inside it from the storage medium **11** to the corresponding end of the specimen **12**. Preferably, the pressure at which the gas circulates inside the means of transport **13** is regulated and controlled by means of a control meter **14**.

Alternatively, the man6meter-regulator device **14** is implemented by means of two different devices: a manometer and a regulator.

The medium of transport **13** can be made of any material capable of withstanding pressures of approximately 10 bar, and with a diameter not greater than approximately 20

mm. Non-limiting examples of materials are steel, rubber or latex tubes, rigid or flexible. Preferably, and for safety reasons, the means of transport **13** connected to the storage medium **11** It is a rigid steel tube.

In a possible realization, in the event that the regulator meter **14** is a single device, it is placed between the storage medium **11** and the 12th test tube. In this case, the means of transport **13** can be made up of two different elements,

consecutive, joined by the manometer-regulator 14. Alternatively, the controller-control 14 is located in the storage medium itself **11**.

In another possible realization, in the event that the controller and regulator are two
5 differentiated devices, both are located between the storage medium **11** and the 12th
test tube. In this case, the means of transport 13 can be made up of three different,
consecutive elements. Alternatively, the pressure gauge and the regulator are located
on the storage medium itself **11**. Alternatively, one of the devices (manometer or
regulator) is located on the storage medium **11**, and the

10 Another device (regulator or manometer, respectively) is located between storage medium **11**
and specimen 12. In this case, the means of transport 13 can be made up of two
different, consecutive elements.

Specimen 12 is located inside a device 17 configured to hold
15 sealed the side faces of specimen 12, ensuring its tightness and allowing gas to enter through
one end of specimen 12 and exit through the opposite end. The materials from which
device 17 is made are sealing materials, such as rubber or latex.

20 Thus, during the use of the system, the gas from the storage medium 11 circulates inside the
transport medium 13 with a certain pressure, selected in the controller 14 (or in the
regulator if two independent devices are used). The gas enters through one end of the
specimen 12 and passes through it until it reaches its opposite end.

25
The gas outlet at the opposite end of specimen 12 is measured by the flow meter of
invention 15 connected to that end of specimen 12 by means of a means of transport
16. The means of transport 16 may be of any material such as to guarantee internal
pressure and safety. Non-limiting examples of materials
30 They are steel, rubber or latex tubes, rigid or flexible.

The inventors have observed that a conventional turbine gas or variable diameter flowmeter is not capable of measuring gas flows in the order of $0.02\text{cm}^3/\text{s}$ due to the extreme sensitivity required. To overcome this problem, they have designed a new flowmeter whose schematic is shown in Figure 2.

5

The new flowmeter 25 comprises a mass flow detector 22 responsible for converting the amount of gas flow that passes through the specimen into direct electrical voltage (or current indistinctly).

The mechanism by which mass flow is converted into an electric voltage or current depends on the type of detector. A membrane detector quantifies the flow based on the deformation of the membrane. A laser detector is capable of detecting a mass flow from the number of particles that come between a laser emitter and a detector. A temperature detector has an electrical resistance that is cooled

15 by flow. Preferably the mass flow detector 22 is a membrane or laser mass flow detector.

The mass flow detector 22 must be accurate enough to detect and convert quantities of gas flow in the range of approximately

20 $0.02\text{ cm}^3/\text{s}$ and $5\text{ cm}^3/\text{s}$, at a voltage of $\pm 5\text{ V}$. Examples of mass flow detectors with these characteristics are: Honeywell AWM3000 Series, Omron's manifold or Mass flow from SENSORTECHNICS.

Data conversion media 23 measures direct electrical voltage (or current

25 indistinctly) that comes out of the mass flow detector 22 and converts it into a flow value expressed in cm^3/s . To do this, it is necessary to perform a pre-calibration of the data conversion media 23, comparing at least five flow values measured by the soap pump method with the voltage measured by the data conversion means 23, thus obtaining a calibration equation. Happiness

30 equation is valid for the measurement of the permeability of any material that

require inlet pressure ranges between the minimum and maximum calibration values.

23 data conversion media are connected through an output interface
5 to a computer. Thanks to this connection, it is possible to obtain real-time graphs of
the evolution of the flow over time and to observe when the system stabilizes without
the need to take measurements to check it. In addition, the data conversion media 23
can comprise a display 21 showing the gas flow rate in cm^3/s that passes through the
specimen.

10

In a possible realization, the means of data conversion 23 are external and are not
included in the flow meter 25. Preferably, the flow meter 25 has an output interface
24, preferably an analog output type BNC, which allows the output of the mass flow
detector 22 of the flow meter 25 to be connected to the

15 data conversion media 23 extrem. In another possible realization, the means of data conversion
23 are included in the flow meter 25. In another possible realization, data conversion
means 23 are implemented both inside the flowmeter 25 and outside it.

20 An example of the front of flowmeter 35 is shown in Figure 3, showing the on-off switch 31
connected to the main voltage input, the display of the data conversion media 32
within flowmeter 35, the input of flowmeter 33, and the output interface 34 providing
an analog electrical output of $\pm 5\text{V}$ corresponding to the measured flow rate
25 by the flow meter 35.

To measure the permeability of a specimen 12 to a gas, at least three inlet pressure
values are selected on the pressure gauge 14 (or on the regulator if two independent
devices are used).

30 Preferably the number of selected inlet pressure values is five.

For each of the selected inlet pressure values, at least one measurement of the flow through specimen 12, expressed in cm³/s, is made with the flow meter 15, 25, 35. Preferably the number of flow measurements that are made for each selected inlet pressure is three. Then, and in the event that

5 If this number of flow measurements is different from one, an average flow value is obtained for each pressure.

The measured flow value for each selected input value (or the average value in the case of a different number of flow measurements than one) is substituted in the
10 Darcy's equation, thus obtaining the permeability coefficient K :

$$K = \frac{2\mu R L T J}{A(P_1 - P_2)}$$

Where

15

K = Permeability coefficient [m²]

μ = Viscosity of the gas used [N*s/m²] L

= Length of the specimen [m]

R = Gas flow rate at the outlet of the specimen [m³/s]

20

A = Area of the cross-section of the specimen [m²] P_1

= Absolute pressure at specimen outlet [N/m²] P_2 =

Absolute pressure at specimen inlet [N/m²]

Finally, the permeability coefficient of specimen 12 is obtained from the value
25 average of the permeability coefficients obtained with Darcy's equation, corresponding to each selected input pressure value.

The flow meter of the invention 15, 25, 35 allows the measurement of flow rates in the order of hundredths of a cm³/s, preferably from 0.02 cm³/s, thanks to its larger

sensitivity, avoiding having to use pressures as high as those necessary to obtain measurable flow rates in the device that applies the soap pump method.

Example

5

Below is a concrete example of the realization of the invention and the results obtained.

The gas storage medium used is a gas bottle, which contains the gas
10 to a pressure greater than the minimum necessary in the course of the tests, which is regulated and controlled by means of a regulator meter. This gas cylinder is connected to the upper end of a cylinder whose permeability to a gas is to be measured, by means of a rigid steel tube that connects the gas cylinder with the regulator lever and by means of a flexible gas rubber tube that connects the gas cylinder to the regulator.
15 manometer-regulator with said top of the specimen.

The specimen is cylindrical made of 20% recycled concrete, measuring 96 mm in height and 150 mm in diameter, and is located inside a rubber side covering device, configured to keep the side faces sealed
20 of the specimen, in such a way that the constant pressure of gas that is applied at its upper end, passes through the entire specimen and reaches its opposite end.

Therefore, during the use of the system, the gas from the gas cylinder circulates inside the rigid steel pipe at a pressure of 5 bar. Once said gas
25 It reaches the regulator meter, passes through the gas rubber hose, at the pressure selected in the regulator meter, until it reaches the upper end of the specimen. The gas enters through this upper end and passes through the entire specimen until it reaches its lower end.

30 The gas outlet at the opposite end of the specimen is measured thanks to a flowmeter connected to the lower end of the specimen by a latex tube.

The flowmeter includes an on-off switch, which must be connected to the main voltage input, a membrane mass flow detector responsible for converting the amount of gas flow that passes through the specimen into direct electrical voltage (or current indistinctly) and a BNC output that allows connection

5 the output of the mass flow detector from the flowmeter to external data conversion media that measures the voltage or electrical current coming out of the mass flow detector and converts it to a flow value expressed in cm^3/s . The conversion media are in turn connected to a computer, and thanks to this connection it is possible to obtain real-time graphs of the evolution of the flow over time.

10

Figure 4 shows a graph obtained with the flow meter of the invention, which represents the stabilization curve of the concrete specimen described above for five different pressure values. The ordinate axis represents the flow rate in cm^3/s and the abscissa axis represents the time in seconds.

15

Each of the five peaks observed in the figure correspond to the five pressure values selected in the regulator-meter, these inlet pressures being 1 bar, 1.1 bar, 1.2 bar, 1.3 bar and 1.4 bar respectively.

20 The first ascent corresponds to the connection of the system (start of the test) with an inlet pressure of 1 bar. The graph then descends gently until it reaches the stabilization zone. As can be seen, this stabilization process lasts approximately 300 seconds (5 minutes).

25 Next, a new rise in the flow corresponding to the disconnection and connection of the pressure gauge-reducer can be observed, with the aim of modifying the inlet pressure in the system. In this case, the inlet pressure is increased to 1.1 bar, which is why this second peak is higher than the first. The stabilization curve is very similar to that of the first peak and its duration is also

30 approximately 300 seconds. As you might expect, the stabilization asymptote and, therefore, the flow at the outlet is higher in the second case.

The third, fourth and fifth ascent correspond to the disconnection and connection of the pressure gauge-reducer, with the aim of increasing the input pressure of the system to

1.2 bars, 1.3 bars and 1.4 bars respectively, which is why each peak is greater than the previous one. The stabilization curve is very similar in all cases, being its

5 duration of approximately 300 seconds. Each stabilization asymptote, and therefore the flow at the outlet, is greater the greater the power at the inlet.

For each inlet pressure, three measurements of the flow are made once it has stabilized and its average is made. This average flow value as a function of pressure shown in Table 1.

10

Press O2 [kg/cm ²]	Flow rate [m ³ /s]
1.00	1.25E-06
1.10	1.43E-06
1.20	1.61E-06
1.30	1.79E-06
1.40	1.98E-06

Table 1. Average value of flow that crosses the specimen depending on the inlet pressure.

The mean flow value is substituted in Darcy's equation, thus obtaining the permeability coefficient K shown in Table 2:

15

Press O2 [kg/cm ²]	Flow rate [m ³ /s]	Coef. Permeability [m ²]
1.00	1.25E-06	9.14E-16
1.10	1.43E-06	9.20E-16
1.20	1.61E-06	9.20E-16
1.30	1.79E-06	9.16E-16
1.40	1.98E-06	9.13E-16

Table 2. Average value of flow through the specimen and permeability coefficient as a function of the inlet pressure.

Finally, the permeability coefficient of the specimen is the average value of the permeability coefficients obtained with each pressure, in this case being 9.17×10^{-16} m².

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DEMANDS

1. Flowmeter (15, 25, 35) for measuring the permeability of a material to a gas, comprising an inlet (20, 33) configured to receive a gas that

5 It has previously passed through a specimen (12) of a material whose permeability to said gas is to be measured, characterized by the fact that it comprises a mass flow detector (22) configured to convert the amount of gas flow into a certain parameter, where said gas flow can have a flow rate of the order of hundredths of a $\text{cm}^{3/\text{s}}$ or superior.

10 2. The flow meter (15, 25, 35) of claim 1, which also comprises data conversion means (23) configured to measure that parameter and convert it into a flow value expressed in $\text{cm}^{3/\text{s}}$.

15 3. The flow meter (15, 25, 35) of any of the above claims, which further comprises an output interface (24.34) configured to connect the mass flow detector output (22) of the flow meter (15, 25, 35) to external data conversion media (23) connected to a computer, such data conversion media (23) being configured to measure the parameter output from the
20 mass flow detector (22) and convert it into a flow value expressed in cm^3/s .

4. The flow meter (15, 25, 35) of any of the above claims, where said parameter is a continuous electrical voltage.

25 5. The flow meter (15, 25, 35) of any of the claims 1 to 3, where that parameter is an electric current.

6. The flowmeter (15, 25, 35) of any of the above claims, where said mass flow detector (22) is a membrane mass flow detector.

30 7. The flow meter (15, 25, 35) of any of claims 1 to 5, where said

Mass Flow Detector (22) is a laser mass flow detector.

8. The flowmeter (**15**, 25, 35) of any of the above claims, where the material to be measured for permeability is concrete.

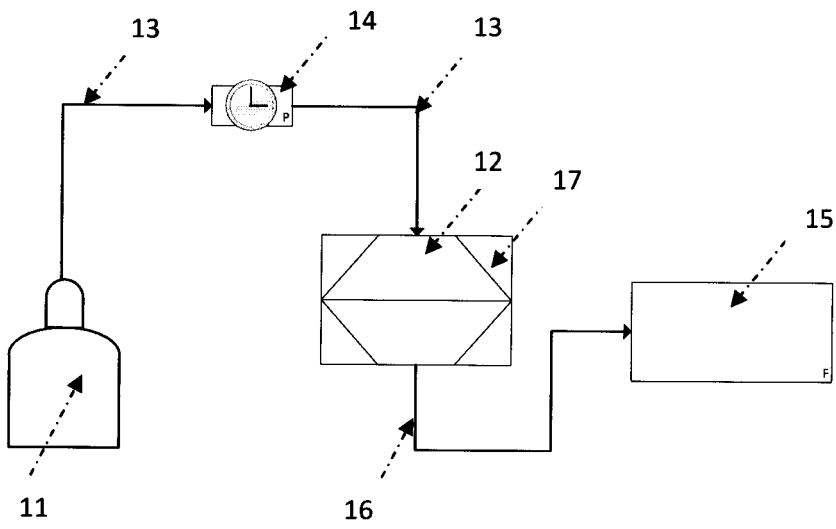


Figura 1

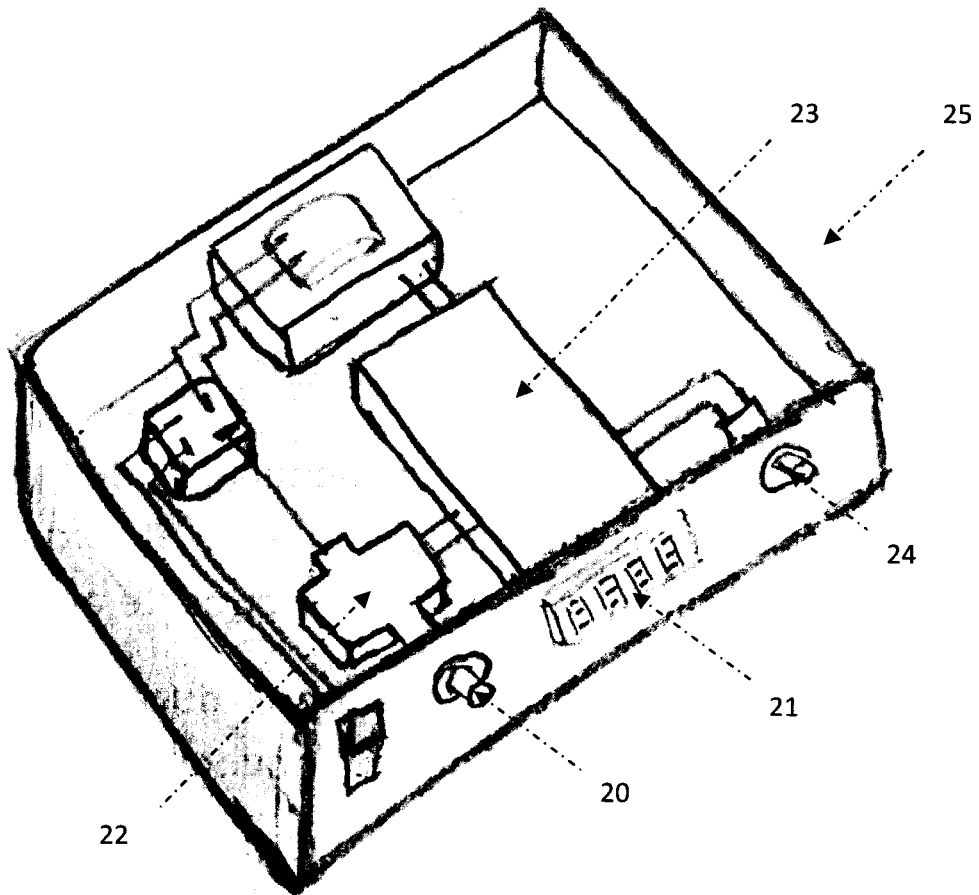


Figura 2

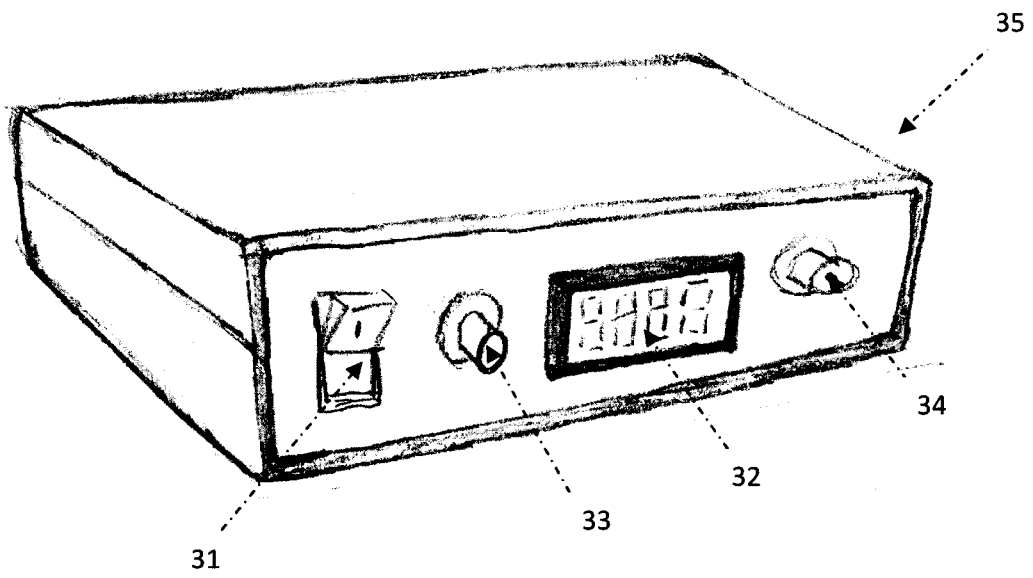


Figura 3

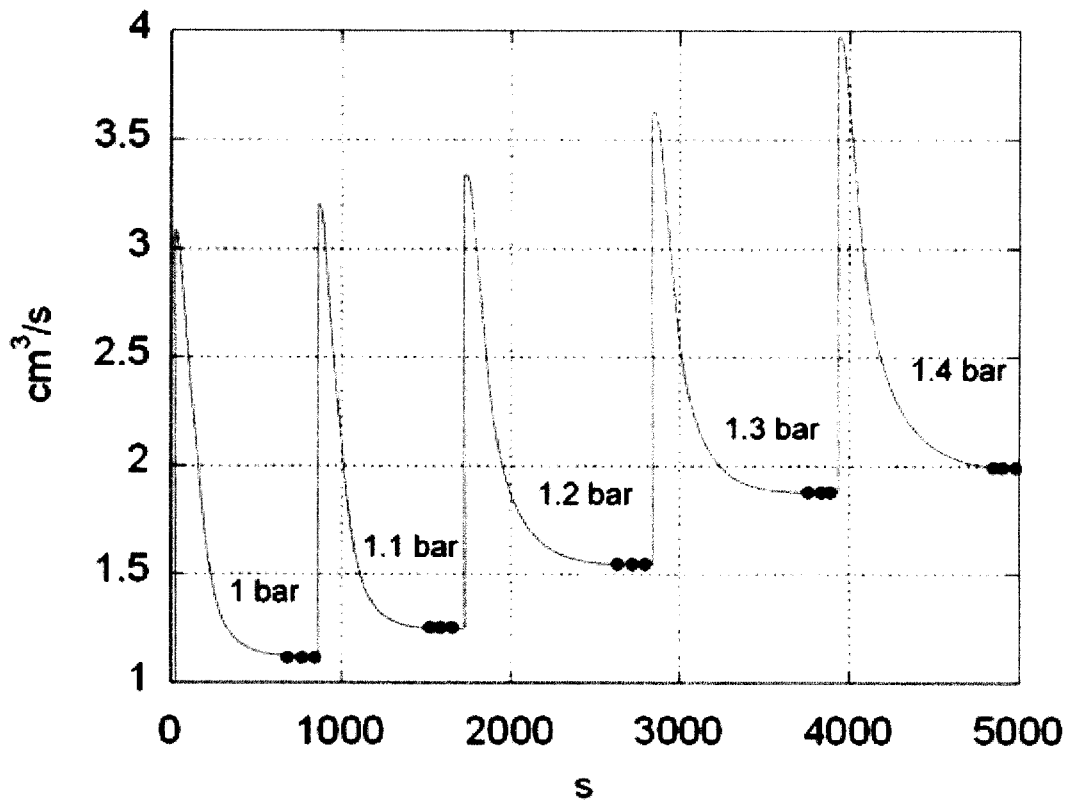


Figura 4



- ②① Application number: 201300197
- ②② Date of submission of application: 19.02.2013 Priority
- ②③ date:

REPORT ON THE STATE OF THE ART

⑤① Int. Cl. : **G01F1/00** (2006.01)
G01N11/02 (2006.01)

RELEVANT DOCUMENTS

Category	⑤⑥ Documents cited	Affected claims
X	EP 2177883 A1 (HONEYWELL) 21.04.2010, paragraphs [8,11,13,34,38,39,40,41,50,52,55,66,82]; Figure 3.	1-8
X	US 7280927 B1 (DMYTRIW) 09.10.2007, column 2, lines 22-60; column 3, line 42 – column 4, line 41; column 6, lines 17-38; Figures 2.3.	1-8
X	US 2011146398 A1 (BECK et al.) 23.06.2011, paragraphs [3,4,23,24,25,28]; Figures 2A,2B.	1-8
X	HONEYWELL. Data Sheet. "Mass flow sensor for gases: AWM3000 Series". June/2006.	1-8
A	HONEYWELL. Technical Note 008043-2-EN: "Mass Flow Sensors: Mass Flow versus Volumetric Flow and Flow Rate Unit Conversions". November/2012.	1-8

Category of documents cited

X: of particular relevance

And: of particular relevance combined with others of the same category

A: reflects the state of the art

Or: referred to unwritten disclosure

P: published between the priority date and the filing date

E: previous document, but published after the date of submission of the application

This report has been prepared

☐ for all claims

■ for claims no:

Date of preparation of the report 25.03.2013	Examiner Javier Olalde	Page 1/4
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Minimum documentation searched (classification system followed by classification symbols) G01F1,
G01N11

Electronic databases queried during the search (name of the database and, if possible, search terms used)

INVENES, EPODOC

Date of Written Opinion: 25.03.2013

Statement

Novelty (Art. 6.1 LP 11/1986)	Claims 3, 8	YES
	Claims 1,2,4-7	NO
Inventive step (Art. 8.1 LP11/1986)	Demands	YES
	Claims 3,8	NO

The application is considered to meet the requirement of industrial application. This requirement was assessed during the formal and technical examination phase of the application (Article 31.2 of Law 11/1986).

Basis of the Opinion.-

This opinion has been made on the basis of the patent application as published.

1. Documents considered.-

The following is a list of the documents pertaining to the state of the art taken into consideration for the realization of this opinion.

Document	Publication or Identification Number	Publication Date
D01	EP 2177883 A1	21.04.2010
D02	US 7280927 B1	09.10.2007
D03	US 2011146398 A1	23.06.2011
D04	Mass flow sensor for gases: AWM3000 Series".	June/2006
D05	Mass Flow Sensors: Mass Flow versus Volumetric Flow and Flow Rate Unit Conversions	November/2012

2. Reasoned declaration in accordance with Articles 29.6 and 29.7 of the Implementing Regulations of Law 11/1986 of 20 March 1986 on Patents on novelty and inventive step; Quotes and explanations in support of this statement

In accordance with Article 29.6 of the Implementing Regulations of Law 11/86 on Patents, it is considered, preliminarily and without obligation, that the objects defined by claims 1-8 do not apparently meet the requirements of novelty within the meaning of Article 6.1 of Law 11/86 on Patents (LP), and/or of inventive step within the meaning of Article 8.1 LP, in relation to the state of the art established by Article 6.2 of said Law. Specifically

OBJECTIONS OF NOVELTY.

All D01-D04 documents reported flowmeters with an input configured to receive a gas comprising a mass flow detector configured to convert the amount of gas flow into a parameter. That is, they disclosed all the technical characteristics present in claim 1, so it lacks novelty compared to all of them taken separately. The rest of the text of the main claim defines a use of the flowmeter for which all those disclosed in D01-D04 are suitable (measurement of the flow rate of a gas that has previously passed through a specimen of a material whose permeability to that gas is to be measured, with flow values in the order of hundredths of a cm³ or higher).

In addition, document D01 explicitly disclosed a flowmeter equipped with a laser mass flow detector (R7) and data conversion means configured to measure this parameter and convert it into a volumetric flow value (R2), where said parameter is an electrical current output of a photodiode (R5), so claims 2, 5 and 7 seem to lack novelty compared to D01 taken alone.

The additional technical characteristics of claim 4 (electric voltage parameter) were explicitly disclosed in documents D02-D04, so that the subject matter of claim 4 is not new compared to all of them taken alone. Additionally, the D04 flowmeter also reported an electric current as a parameter.

The use of a membrane mass flow detector was disclosed in D03, so the subject matter of claim 6 is not new compared to D03 taken alone.

OBJECTIONS OF INVENTIVE STEP.

Document D01 disclosed a flowmeter with an output interface for the possible transmission to an external computer of the volumetric flow data obtained by the data conversion means, but did not explicitly disclose the alternative of making such conversion means available externally. Although a provision commonly used in technology and lacking inventive step, both provisions, internal and/or external means of conversion, were explicitly disclosed in D02. The expert in the art would clearly use the teachings of D02 in the flow meter of D01, having the means of conversion externally available to obtain the object of claim 3, so that he would also lack inventive step against the combination of D01 and D02.

In addition, taking documents D02-D03 alone, although they did not explicitly disclose the arrangement of means of conversion of the output parameter of the mass flow detector to volumetric flow units, this conversion is also commonly used in the art (e.g. D05) and lacks inventive step.

In addition, they are also of known use, constituting equivalent means of mass/volumetric flow measurement to be obtained by means of current or voltage parameters and/or by laser and/or membrane flowmeters.

In addition, the use of a flow meter for a specific flow measurement (gas passing through a concrete specimen) would not present an inventive step compared to any other flow measurement use.