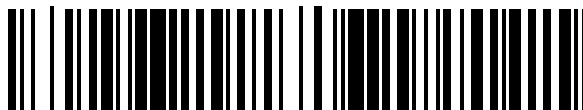


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INVENTION PATENT

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

57 Summary:

A system for measuring the permeability of a material to a gas, comprising at least one gas storage medium (11), attached by at least one transport medium (13) configured to circulate the gas within it, to one end of a specimen (12) of a material whose permeability to that gas is to be measured; located inside a device (17) configured to keep the side faces of the specimen sealed

(12) ensuring its tightness and allowing gas to enter through one end of the specimen (12) and exit at the opposite end. The opposite end of this specimen (12) is connected by means of a transport medium (16) configured to circulate the gas inside it, to a flow meter (15, 25, 35) comprising a mass flow detector (22) responsible for converting the amount of gas flow at the exit of the specimen (12) into a certain parameter.

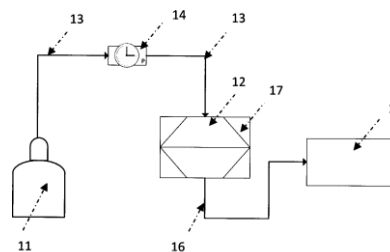


Figura 1

ES 2 406 386 B1

Notice Consultation may be carried out as provided for in art. 37.3.8 LP.

DESCRIPTION**SYSTEM FOR DETERMINING THE PERMEABILITY
OF A MATERIAL TO A GAS****FIELD OF INVENTION**

5

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

BACKGROUND TO THE INVENTION

10

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 oxygen permeability of hardened concrete.*

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, a rubber periHa is placed at the bottom of each pipette in the N pipette set. 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 through the concrete specimen is the result of dividing the volume that the soap bubble travels, measured as the initial final difference in values on the pipette's graduated scale, by the time it takes for the bubble to travel through the pipett.

10 space.

Each of the N pipettes in the test has a different diameter. The higher the permeability of the concrete specimen, the greater the flow through the concrete specimen, and the greater the rate of ascent of the bubble within the
15 pipette, so a larger pipette diameter is required. Therefore, depending on the pressure and permeability of the concrete material, a pipette is selected from the set of pipettes, in such a way that during the time that the measurement lasts, the bubble moves upwards within the pipette and always without coming out of 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 end of each measurement, and to avoid overpressure in the system, the Have located between the specimen and the pipette set 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 oxygen flow regime, pre-readings of the flow of this flow are made at 5-minute intervals 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, are remarkably small, in the order of 0.1 to 0.5 cm³/s; because of this, it is not possible to use conventional flowmeters 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, being necessary to make a significant number 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 low flow and low permeability of the concrete. The use of high pressures can lead to modifications in the viscosity of oxygen, thereby altering the permeability values obtained. In addition, the use of high pressures can lead to the rupture of the
10 structure of the concrete cement paste of young concrete, 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 tries to solve the aforementioned drawbacks by means of a system for measuring the permeability of a material to a gas that allows to measure flow rates of the order of hundredths of a cm^3/s , preferably from $0.02 \text{ cm}^3/\text{s}$, and to obtain in real time graphs of evolution
20 of the flow over time.

Specifically, in a first aspect of the present invention, a system for measuring the permeability of a material to a gas is provided, comprising at least one gas storage medium, bonded by at least one gas storage medium.

25 A transport configured to circulate the gas inside it, to one of the ends of a specimen of a material whose permeability to said gas is to be measured, located inside a device configured to keep the lateral faces of the specimen sealed, ensuring its tightness and allowing the entry of gas through one of the ends of said specimen and the exit through the opposite end. The opposite extreme of
30 This specimen is attached by means of a means of transport configured to circulate the gas inside, to a flowmeter that includes a flow detector

A mass responsible for converting the amount of gas flow at the exit of the specimen into a certain parameter.

5 In a possible realization, the flowmeter includes means of conversion of data responsible for measuring the parameter that comes out of the mass flow detector and converting it into a flow value expressed in cm^3/s .

10 In one possible embodiment, the flowmeter comprises an output interface configured to connect the mass flow detector output of the flowmeter to some external data conversion media connected to a computer, with these external data conversion media configured to measure the parameter coming out of the mass flow detector and convert it to a flow value expressed in cm^3/s .

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

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

25 In one possible realization, the system comprises a pressure gauge configured to measure the pressure of the gas circulating from at least one gas storage medium to one end of the specimen. In another possible realization, the system It comprises a regulator configured to regulate the pressure of the gas circulating from at least one gas storage medium to one end of the specimen. Alternatively, the system comprises a regulator-gauge configured to measure and regulate the pressure of the gas circulating from at least one gas storage medium to one end of the specimen.

30 In a possible realization, each of the means of transport is implemented

by means of one or more sections of pipe, where each of these sections can be made of both rigid and flexible materials such as steel, gas rubber or latex. Preferably, the means of transport that connects the gas outlet end of the specimen with the flowmeter is a latex tube. Preferably, the means of

5 Transport connected to the storage medium is a rigid steel tube.

In a possible realization, at least one gas storage medium holds the gas at a pressure greater than the pressure needed to perform the measurement.

10 In a possible realization, the material < which is going to be measured for permeability is concrete.

BRIEF DESCRIPTION OF THE FIGURES

In order to aid a better understanding of the characteristics of the invention,

15 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:

20 Figure 1 shows a schematic of a system according to a realization of the invention.

Figure 2 shows a diagram of the interior of a flowmeter included in the system of the invention

25 Figure 3 shows a diagram of the front view of the flowmeter, included in the system of the invention

30 Figure 4 shows a graph of the evolution Q flow rate that comes out of the specimen as a function of time, and which is measured by the flow meter, for five pressures of Different input.

DETAILED DESCRIPTION OF THE INVENTION

5 In this text, the term "comprises" and its variants should not be understood in an exclusive sense, i.e., these terms are not intended to exclude other characteristics techniques, additives, components or steps.

10 In addition, the terms "approximately", "substantially", "around", "we", etc., must 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 understood to be a sample of a material on which its permeability can be measured.

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

20 The following preferred embodiments are provided for illustration only, and are not seeks to limit 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 invention will follow partly from the description and partly from the practice of the invention.

25 A minimum configuration of the invention system for measuring the gas permeability of a material is described below, according to the scheme of the rism in Figure 1. The material under measurement must be permeable. Non-litlit examples of materials whose permeability can be measured by the system being used to described are: concrete, ceramics or natural stones.

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

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

5 The Gas Storage Medium **11** It is attached to one end of 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 storage medium 11 to the corresponding end of specimen 12. Preferably, the pressure at which the gas circulates inside the
10 transport 13, it is regulated and controlled by a control meter 14. Alternatively, the man6meter-regulator device 14 is implemented by means of two different devices: a manometer and a regulator.

The means of transport 13 can be made of any material capable of withstanding pressures
15 of approximately 10 bar, and with a diameter of no more than approximately 20
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 is a rigid steel tube.

20 In a possible realization, if the control meter 14 is a single device, it is located between the storage medium 11 and the specimen 12. In this case, the means of transport 13 may be made up of two different, consecutive elements, joined by the regulator 14. Alternatively, the regulator 14 is located in the storage medium 11 itself.

25
In another possible embodiment, if the controller and the regulator are two different devices, they are located between storage medium 11 and specimen 12. 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
30 located in the storage medium itself 11. Alternatively, one of the devices (controller or regulator) is located on the storage medium 11, and the

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.

5 Specimen 12 is located inside a device 17 configured to keep the side faces of specimen 12 sealed, 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.

10 Therefore, 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 in the case of two independent devices). The gas enters at one end of the

15 test tube 12 and crosses it until it reaches its opposite end.

The gas outlet at the opposite end of specimen 12 is measured by a flow meter 15 connected to that end of specimen 12 by a means of transport 16. The means of transport 16 may be of any material such that
20 ensure internal pressure and safety. Examples of materials that are not limited to 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 of the order of cm^3/s per the
25 extreme sensitivity that is required. To overcome this problem, they have designed a flowmeter whose schematic is shown in Figure 2.

The flow meter 25 of the system of the invention comprises a mass flow detector 22 responsible for converting the amount of gas flow that passes through the specimen into
30 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 are interposed between a laser emitter and a detector. A temperature detector has an electrical resistance that is cooled by the 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 gas flow quantities in the range of approximately 0.02 cm³/s and 5 cm³/s, at a voltage of ± 5 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 measure the direct electrical voltage (or current indistinctly) coming out of the mass flow detector 22 and convert it into a flow value expressed in cm³/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 bubble method with the voltage measured by the means of data conversion 23, thus obtaining a calibration equation. This equation is valid for the measurement of the permeability of any material that requires inlet pressure ranges between the minimum and maximum calibration values.

The 23 data conversion media is connected through a digital output interface, 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, 23 data conversion media can comprise a 21 screen that shows the gas flow rate in cm³/s that passes through the specimen.

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

5 means of data conversion 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.

10 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 a $\pm 5V$ analog electrical output corresponding to the measured flow rate
15 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).

20 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 $\text{cm}^3 \text{ Is}$, is made with the flow meter 15, 25, 35. Preferably the number of flow measurements that are carried out

25 For each selected input pressure is three. Then, and in the event that 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
30 in the event that the number of flow measurements is different from one) is substituted in Darcy's equation, thus obtaining the permeability coefficient K:

$$K = \frac{2\pi RLQ}{A(P_1 - P_2)}$$

Where

- 5 K = Permeability coefficient [mD]
- 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]
- A = Area of the cross-section of the specimen [m²]
- 10 P₁ = Absolute pressure at specimen outlet [N/m²] P₂ =
- Absolute pressure at specimen inlet [N/m²]

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

20 The system of the invention solves the drawbacks detected in the current state of the art, since it allows the continuous measurement of the flow in real time. In this way, it is possible to obtain the stabilization curve of the system, specifying the at which time data can be recorded without the need to make time-spaced measurements to confirm stabilization. This reduces the test time and the number of measurements required to stabilize the system, optimizing the duration of the test. Flow values are obtained more quickly than with the systems described in the state of the art.

25 The system allows the evolution of the permeability of a material to a gas to be analyzed, over wide intervals of time. In addition, the greater sensitivity of the flow meter 15, 25, 35 included in the system of the invention allows the measurement of flow rates in the order of hundredths of a cm³/s, preferably from 0.02 cm³/s,

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 at 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 which 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 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 by a flow meter 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 invention's system, 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 pressure gauge-regulator, 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 input 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 expected, 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 duration of approximately 300 seconds. Each stabilization asympto, and therefore the flow at the outlet, is greater the higher the power at the inlet

5

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, being in this case 9.17×10^{-16} m².

DEMANDS

1. A system for measuring the permeability of a material to a gas, comprising at least one gas storage medium (11), bonded by at least one gas storage medium.

5 transport (13) configured to circulate the gas inside it, to one of the ends of a specimen (12) of a material whose permeability to that gas is to be measured, located inside a device (17) configured to keep the lateral faces of the specimen (12) sealed, ensuring its tightness and allowing gas to enter through one of the ends of said specimen (12) and exit through the end

10 opposite;

the system being characterized by

the opposite end of this specimen (12) is connected by a means of transport
15 (16) configured to circulate the gas inside it, to a flow meter (15, 25, 35) comprising a mass flow detector (22) responsible for converting the amount of gas flow at the outlet of the specimen (12) into a certain parameter.

2. The system of claim 1, where said flow meter (15, 25, 35) includes
20 data conversion means (23) are responsible for measuring the parameter coming out of the mass flow detector (22) and converting it into a flow value expressed in cm^3/s .

3. The system of any of the foregoing claims, wherein said flowmeter (15, 25, 35)
25 comprises an output interface (24, 34) configured to connect the Mass flow detector output (22) from the flow meter (15, 25, 35) to external data conversion media (23) connected to a computer, with such data conversion media (23) being configured to measure the parameter coming out of the mass flow detector (22) and convert it to a flow value expressed in cm^3/s .

30 4. The system of any of the above claims, where that parameter is

a continuous electrical voltage.

5. The system of any of claims 1 through 3, where that parameter is an electric current.

5

6. The system of any of the foregoing claims, wherein said mass flow detector (22) is a membrane mass flow detector.

7. The system of any of claims 1 to 5, where said flow detector Masico (22) is a laser mass flow detector.

10

8. The system of any of the foregoing claims, which further comprises a manometer configured to measure the pressure of the gas circulating from at least one gas storage medium (11) to one end of the specimen (12).

15

9. The system of any of the foregoing claims, which further includes a regulator configured to regulate the pressure of gas circulating from at least one gas storage medium (11) to one end of the specimen (12).

20

10. The system of any of claims 1 to 7, which further comprises a regulator (14) configured to measure and regulate the pressure of the gas flowing from at least one gas storage medium (11) to one end of the specimen (12).

25

11. The system of any of the foregoing claims, wherein the means of transport (16) connecting the gas outlet end of the specimen (12) to the flow meter (15, 25, 35) is a latex tube.

30

12. The system of any of the above claims, where the means of Transport (13) connected to the storage medium (11) is a rigid steel tube.

13. The system of any of claims 1 to 10, where each of the means of transport (13,16) is implemented by means of one or more sections of tube, where each of these sections may be made up of both rigid and flexible materials such as steel, gas rubber or latex.

5

14. The system of any of the foregoing claims, wherein at least one gas storage medium (11) contains the gas at a pressure greater than the pressure necessary to perform the measurement.

10

15. The system of any of the above claims, where the material to be measured for permeability is concrete.

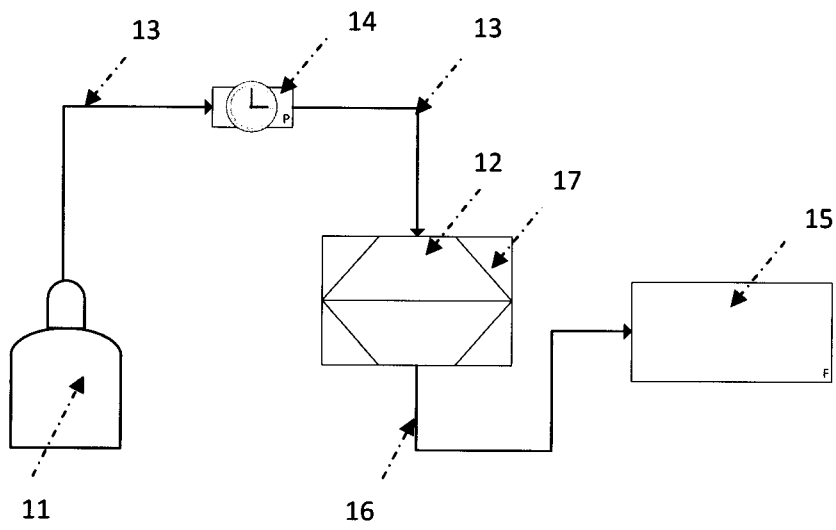


Figura 1

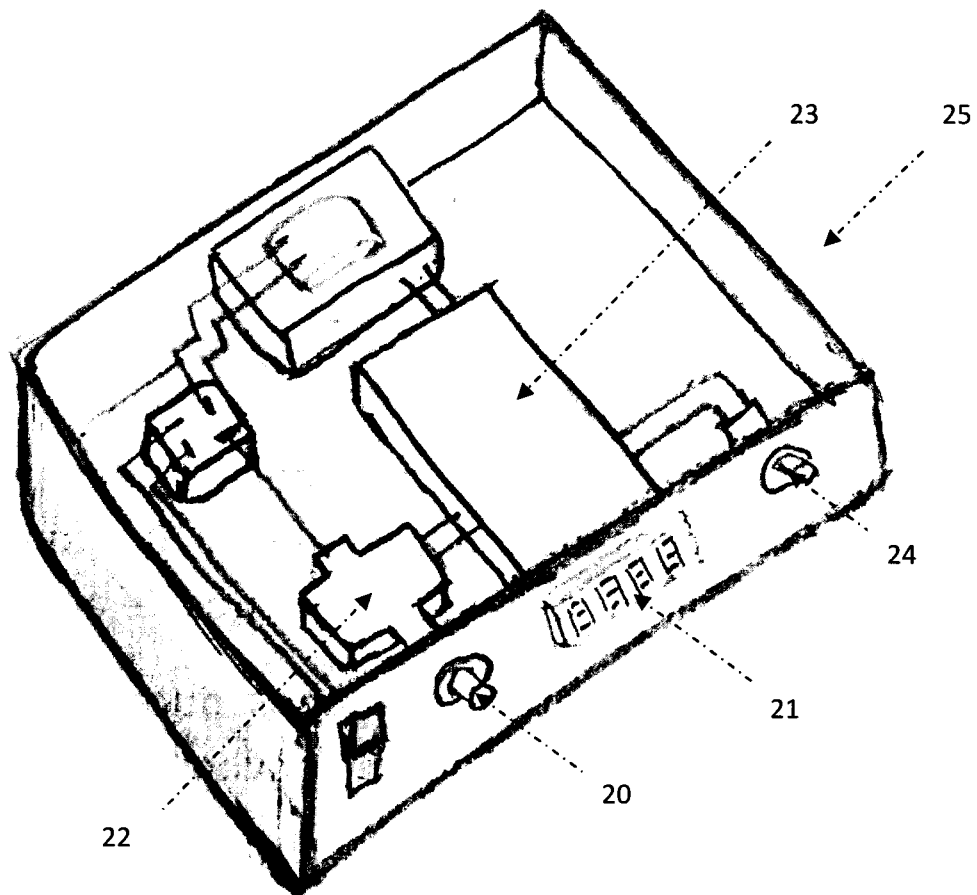


Figura 2

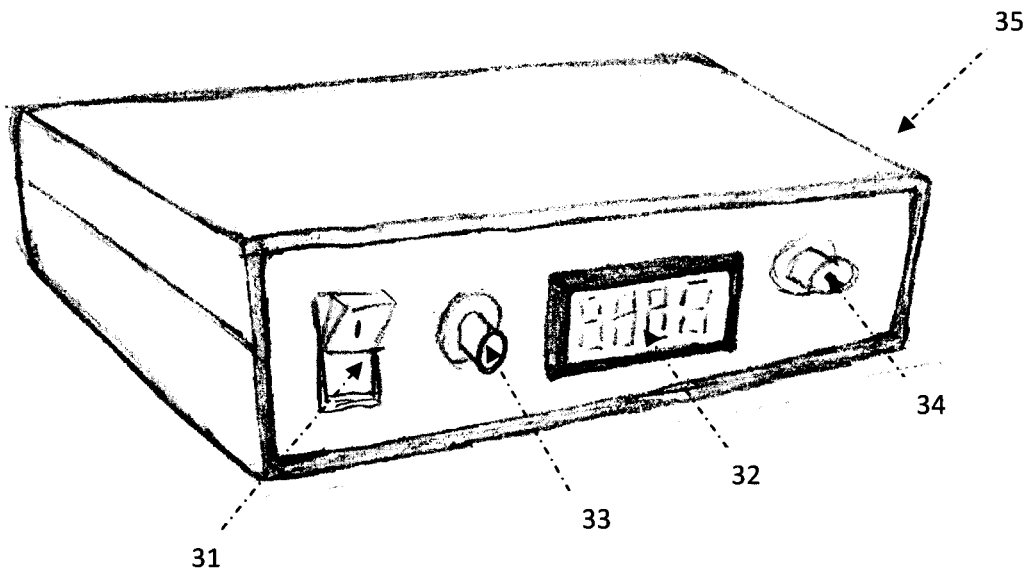


Figura 3

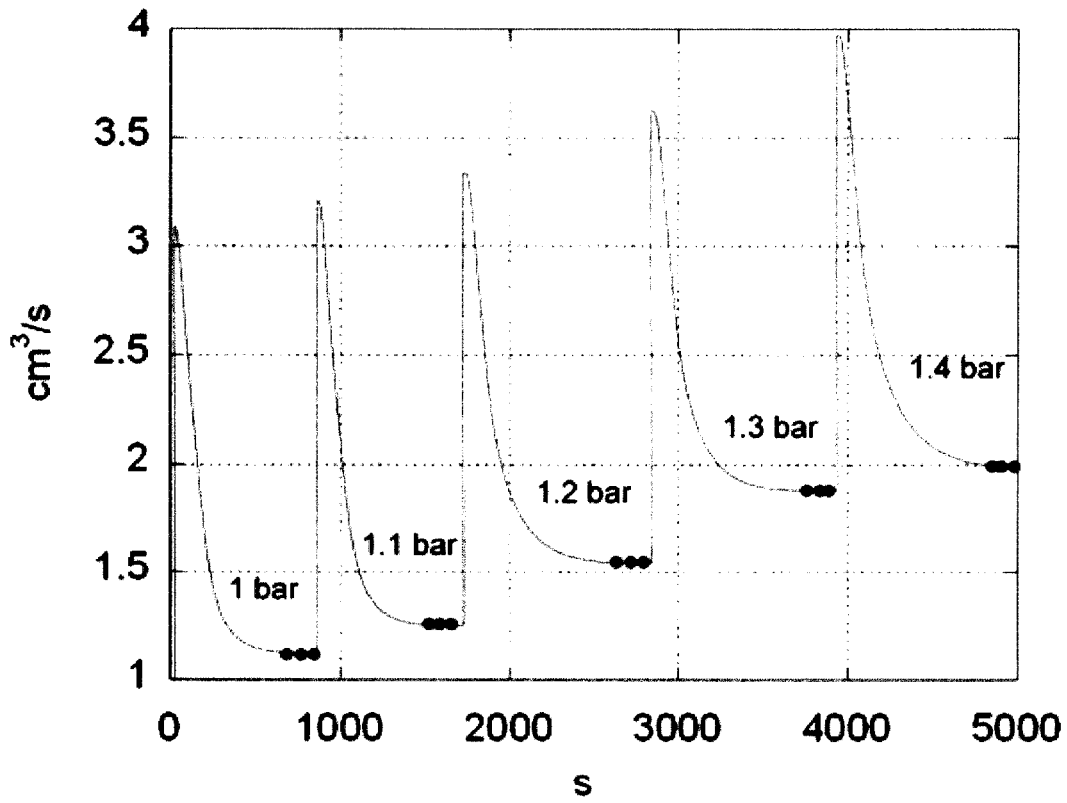


Figura 4



- ②① Application number: 201300196
- ②② Date of submission of application: 19.02.2013 Priority
- ③② date:

REPORT ON THE STATE OF THE ART

⑤① Int. Cl. : **G01N15/08** (2006.01)

RELEVANT DOCUMENTS

Category	⑤⑥ Documents cited	Affected claims
X	CN 1815174 A (UNIV TONGJI) 09.08.2006, the entire document.	1-15
A	(HONEYWELL) Data Sheet. "Mass flow sensor for gases: AWM3000 Series". June 2006.	1-7
X	US 2010206050 A1 (BIALLAS) 19.08.2010, paragraphs [15,19,20,31-33,44,45]; Figure 1.	1,3,8,14,15
A	US 4979390 A (SCHUPACK et al.) 25.12.1990, Figures 1,3.	1-15

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
24.05.2013

Examiner
F. J. Olalde Sánchez

Page
1/4

Minimum documentation sought (classification system followed by classification symbols) G01N15/08

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

EPODOC

Date of Written Opinion: 24.05.2013

Statement

Novelty (Art. 6.1 LP 11/1986)	Claims 2-12	YES
	Claims 1:13-15	NO
Inventive step (Art. 8.1 LP11/1986)	Demands	YES
	Claims 1:13-15	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	CN 1815174 A (UNIV TONGJI)	09.08.2006
D02	"Mass flow sensor for gases: AWM3000 Series". June 2006	June 2006

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 1-15 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,

Document D01 disclosed a system for measuring the permeability of a material (concrete) to a gas comprising a gas storage medium (7), a means of transport (9) configured to circulate the gas inside it to one of the ends of a specimen (3) located inside a device (1,2) configured to keep the lateral faces (4) of the specimen sealed, ensuring its tightness. The opposite end of the specimen is joined by a transport medium (10,9) configured to circulate the gas towards a flowmeter (8) that converts the flow quantity into a certain parameter.

Therefore, D01 disclosed all the technical characteristics of the object of protection defined by claim 1, so it appears to be devoid of novelty.

DEPENDENT CLAIMS:

The technical characteristics present in claims 13 (rubber pipes as means of transport), 14 (gas at a higher pressure than that necessary to carry out the measurement) and 15 (concrete specimen) are explicitly disclosed in D01, so they also appear to lack novelty.

From the flowmeter disclosed in D01, flow values expressed in L3/T (volume/time) are obtained from which the permeability is calculated (selecting three pressure values, making three to five flow measurements for each pressure and obtaining the average permeability values using an equation according to Darcy's Law).

Therefore, the additional technical characteristics contained in claims 2 and 3 (means of converting data from the output parameter to flow values internal/external to the flow meter) and 8-10 (pressure gauge, pressure regulator or regulator-pressure gauge assembly) can either be considered implicit in the teachings of D01, or are obvious solutions to the technical problems raised (calculation and pressure measurement/regulation), commonly used in the technique.

The additional technical characteristics contained in claims 4 and 5 (direct voltage / electric current output parameters) are commonly used in the art (e.g. D02)

The additional technical characteristics contained in claims 6, 7, result in the use of known means (flowmeters) equivalent to the flowmeter used in D01.

The additional technical characteristics contained in claims 11 and 12 (latex tube between specimen and flowmeter and rigid steel tube between gas storage medium and specimen) respond to design choices devoid of inventive step compared to the rubber pipes disclosed in D01.

Consequently, it appears that the objects of protection defined by claims 2-12 lack inventive step vis-à-vis D01, considering the common knowledge of the art.