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EP 0038824

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 3: G01M 3/26	A1	(11) International Publication Number: WO 81/01333
		(43) International Publication Date: 14 May 1981 (14.05.81)

(21) International Application Number: PCT/SE80/00263

(22) International Filing Date: 29 October 1980 (29.10.80)

(31) Priority Application Number: 7908990-0

(32) Priority Date: 30 October 1979 (30.10.79)

(33) Priority Country: SE

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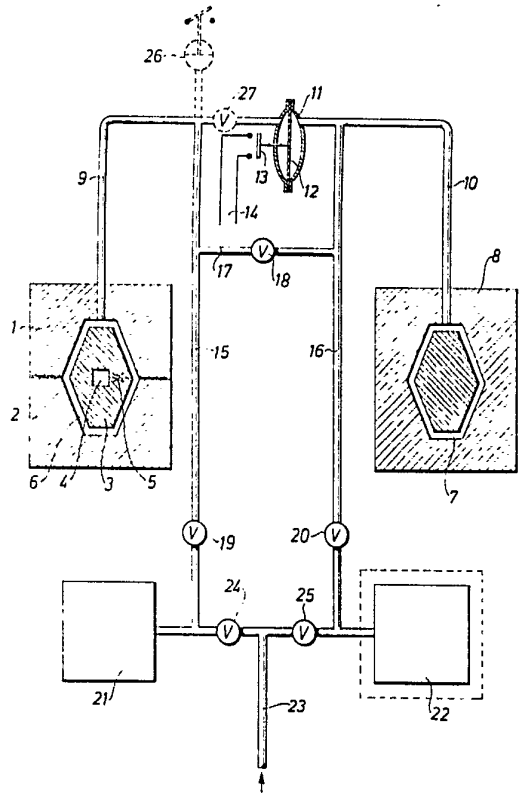
(81) Designated States: AT (European patent), CH (European patent), DE (European patent), FR (European patent), GB (European patent), JP, LU (European patent), NL (European patent), US.

Published
With international search report

(54) Title: METHOD FOR TESTING THE TIGHTNESS OF A TEST VOLUME

(57) Abstract

A method for testing the tightness of a test volume (6) constituted by the inside of a container or a closed space between a hollow test object (3) and a cover, a fixture (1, 2) or the like, which temporarily encloses the test object during the testing operation. First, a gas pressure is applied to the test volume (6) by transferring a predetermined (21) gas quantity for the detection of a possible large leakage and, thereafter, a differential pressure measurement (11) relative to a reference volume (7) is effected for the detection of a possible minor leakage.



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Method for testing the tightness of a test volume

The invention relates to a method for testing whether a test volume is tight. In this context, a test volume means either the inside of a container or the like or a closed space between a hollow test object and a cover, a fixture or similar which temporarily encloses the test object or a part thereof during the testing operation.

The method according to the invention is especially useful for testing the tightness of a test object having an internal cavity or chamber which has to be gas tight with respect to the environment. As examples hereof, ignition tubes and wrist watches can be mentioned. A method frequently used is to test the tightness of such test objects by submerging them into a liquid, whereupon a negative pressure is applied over the liquid surface and, in case of a minor leakage, gas bubbles rise to the surface. However, large leaks cannot be discovered by this method, since the chambers or cavities of the test object will be filled with liquid immediately.

According to the invention the tightness test is instead carried out as follows: A gas pressure is applied in the test volume by transferring a predetermined quantity of gas; in a first step, the gas pressure is checked momentarily for the detection of a possible large leakage and, in a second step, the test volume and a reference volume are connected for equalization of pressures and separated again, followed by measuring changes of the gas pressure of the test volume by way of differential pressure measuring for the detection of minor leaks.

In this connection, "transferring" a predetermined quantity of gas means "delivering to" or "exhausting from", i.e. it is possible to operate with either a positive or a negative

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pressure relative to the atmospheric pressure. The simplest way to obtain a "predetermined" quantity of gas is to enclose gas (e.g. air) under a certain pressure in a container having a well-defined volume and then connect the container to the test volume, so that the pressures are equalized. Provided that the container and the test volume have volumes of the same order, the resulting gas pressure will constitute a certain positive or negative pressure, the size of which indicates whether or not the test volume leaks. In case of a large leakage, the test volume appears larger and, consequently, the positive pressure will be lower or the negative pressure higher, respectively. The predetermined quantity of gas may alternatively be obtained by means of a piston-cylinder unit having a well-defined piston stroke.

During the first step, the check of the gas pressure in the test volume can be made by means of a pressure sensor, which indicates the absolute pressure in the test volume after the transfer of the predetermined gas quantity. If, in this case, the measured pressure is below a minimum value (when operating with positive pressure) or above a maximum value (in case of negative pressure), a large leakage can be detected, in which case the testing operation can be concluded for the particular test object.

An alternative method to check the gas pressure in the test volume is to transfer a predetermined gas quantity simultaneously to the test volume as well as the reference volume and to perform, immediately thereafter, a momentary differential pressure measuring. In case of leakage in the test volume, there will be different pressures in the test volume and the reference volume, causing a differential pressure sensor to react accordingly.

The invention will be described further below with reference to the attached drawing showing schematically a device for tightness testing in accordance with the inventive method.

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On the left hand side of the drawing, an object 3 is placed in a two-part fixture 1, 2, said object having an internal cavity 4. Normally, this cavity must be gas tight towards the environment, but in practice, e.g. in case of serial production, small or large leaks will appear at some objects, indicated schematically by a throttling 5 on the drawing.

Between the outside of the object 3 and the internal walls of the fixture 1,2, a space having a rather well-defined volume is defined, in the following being referred to as the test volume 6. Of course, the test volume depends on the outer size tolerances of the particular object, but these tolerances are supposed to have no influence on the test results.

To enable comparative measurements, a reference chamber 7 is formed in a body 8 (to the right hand side of the drawing), and the geometrical configuration as well as the volume of the chamber 7 correspond substantially to those of the test volume 6. In the following, the chamber 7 is referred to as the reference volume.

Via couplings (not shown) and conduits 9 and 10, respectively, or hoses, the test and reference volumes 6,7 are each connected to an associated chamber of a differential pressure sensor 11 provided with a diaphragm, e.g. an inductive pressure sensor of the type described in the Swedish patent specification 7507483-1. The drawing shows, however, a contact 13 mechanically connected to the diaphragm 12 and adapted to close an electric circuit, indicated at 14, when the diaphragm is deflected towards the left.

The conduits 9 and 10 are each connected to a conduit 15 and 16, respectively, between which a shunt 17 with a cut-off valve 18 is inserted. Each conduit 15,16 is also provided with a cut-off valve 19 and 20, respectively, and is connected to an associated vessel 21 and 22, respectively, to which pressurized air can be supplied via a feeding conduit 23

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and a cut-off valve 24 and 25, respectively.

The device operates in the following way:

An object 3 to be tightness tested with respect to a possible leakage in an internal cavity 4 is placed into the fixture 1,2. The valves 18, 19 and 20 are closed, whereas the valves 24 and 25 are opened so that the two vessels 21 and 22 are charged with pressurized air. Thereafter, the valves 24 and 25 are closed and the valves 19, 20 are opened. The pressurized air in the vessels 21,22 will then be distributed, on the one hand, in the closed circuit constituted by the test volume 6, the conduits 9,15 and the vessel 21 and, on the other hand, in the closed circuit constituted by the reference volume 7, the conduits 10,16 and the vessel 22. In case these closed circuits are of equal size (or if the volume of the vessel 21 is related to the test volume 6 in the same way as the volume of the vessel 22 is related to the reference volume 7) the equalized positive pressures will be equal in the test volume and in the reference volume, provided that no large leak 5 exists. Since the pressures on both sides of the diaphragm 12 of the differential pressure sensor 11 are equal, no signal from the differential pressure sensor will be obtained. Thus, it can be established that no large leak exists between the outside of the object 3 and its cavity 4. If, on the other hand, such a leakage really exists, the differential pressure sensor will give a signal indicating leakage.

If no large leakage is found, the testing is continued by closing the valves 19 and 20 and momentarily opening the valve 18, so that exactly the same pressure prevails on both sides of the diaphragm 12 of the differential pressure sensor 11. The closing of the valve 18 is followed by a test with respect to a minor leak 5 in the object 3. During a predetermined measuring time (e.g. 5 seconds; however, the time period depends on the particular tightness requirements) the separated air circuits of the test and reference volumes 6 and 7 are left alone.

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Even a very small leakage 5 will now be detected by means of the differential pressure sensor 11, the diaphragm 12 of which is deflected (to the left on the drawing) as soon as the air pressure in the test volume 6 is reduced , the reduction being caused by a leakage flow into the internal cavity 4. When this testing step has been carried out as well, the object 3 can be regarded as tight, and a new object is placed in the fixture 1,2.

As an alternative to the above-described operation during the first testing step (for detecting a large leakage), the vessel 22 can possible be excluded (on the drawing this corresponds to the valves 20 and 25 being permanently closed) and a pressure sensor 26 (dashed) can be connected to the conduit so as to indicate whether the air pressure, upon feeding air from the vessel 21, falls below a predetermined threshold value. At this stage, the differential pressure sensor 11 is separated from the measuring circuit by means of a valve 27, which is likewise dashed on the drawing.

Instead of measuring a positive pressure, it is possible to use a negative pressure, in which case the vessels 21,22(or the vessel 21 in the modified dashed embodiment) are initially connected to a vacuum pump via the conduit 23, so that a certain negative pressure is obtained in each vessel. The following operation may, however, be effected correspondingly as described above.

Furthermore, the vessels 21,22 or the vessel 21, respectively, can be replaced by a piston-cylinder unit (not shown) having a well-defined piston stroke. During the coarse leakage detection it is, in fact, sufficient to supply a well-defined air or gas quantity to the test volume 6 and the reference volume 7.

Even in other respects, those skilled in the art can apply the inventive idea in many different ways within the scope of the following claims.

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C L A I M S

1. A method for testing the tightness of a test volume (6) by applying a certain gas pressure, the timely variations of which are measured by differential pressure measurement (11) relative to a reference volume (7), c h a r a c t e r i z e d in that the gas pressure in said test volume (6) is applied by transferring a predetermined (21) gas quantity, wherein in a first step the gas pressure in the test volume is checked (11,26) momentarily for the detection of a possible large leakage, and in a second step said differential pressure measurement is effected for the detection of a minor leakage.

2. A method as set forth in claim 1, c h a r a c t e r i z e d in that the predetermined gas quantity is transferred between a vessel (21) having a well-defined volume and said test volume (6).

3. A method as set forth in claim 1 or 2, c h a r a c t e - r i z e d in that during the first step the gas pressure in the test volume (6) is checked by means of a pressure sensor (26) indicating leakage if the gas pressure falls below a minimum value or rises above a maximum value.

4. A method as set forth in claim 1 or 2, c h a r a c t e- r i z e d in that during the first step predetermined gas quantities are transferred to or from the test volume (6) as well as to or from the reference volume (7), wherein even the detection of a possible large leakage is effected by differential pressure measurement (11).

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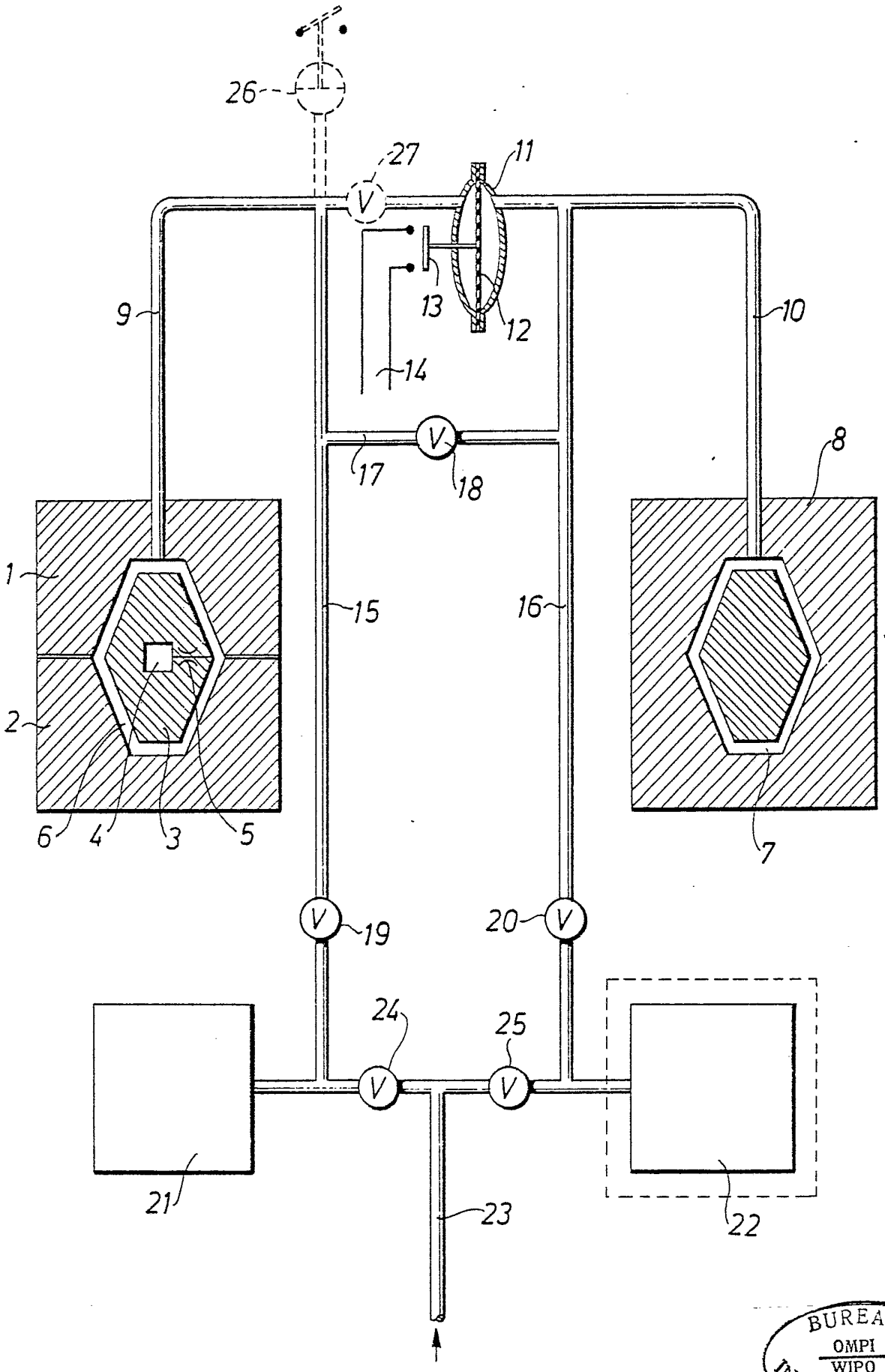

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INTERNATIONAL SEARCH REPORT

International Application No PCT/SE80/00263

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC 3

G 01 M 3/26

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
IPC 3	G 01 M 3/00, 02, 04, 06, 20, 26, 32, 34
National Cl	42k:30/01, 04
US Cl	73/40, 40.7, 45.1, 49.2, 49.3, 52

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

SE, NO, DK, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
A	SE, B, 386 271 published 1976, August 2, Bergstrand G M	1
A	DE, A, 1 750 362 published 1971, January 28, Torre J	1, 2
X	US, A, 3 504 528 published 1970, April 7, Weinberg M H et al	1, 2
X	US, A, 3 791 197 published 1974, February 12, Akira Fukuda	1, 4
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IV. CERTIFICATION

Date of the Actual Completion of the International Search [3]	Date of Mailing of this International Search Report [3]
1981-02-04	11 FEB 1981
International Searching Authority [1]	**Signature of Authorized Officer [20]**
Swedish Patent Office	Per H Cederholm