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(71) Applicant(s)
INFICON GmbH

(72) Inventor(s)
Wetzig, Daniel;Decker, Silvio;Puchalla-König, Jochen

(74) Agent / Attorney
FPA Patent Attorneys Pty Ltd, ANZ Tower 161 Castlereagh Street, Sydney, NSW, 2000, AU

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(71) Anmelder: **INFICON GMBH** [DE/DE]; Bonner Straße 498, 50968 Köln (DE).

(72) Erfinder: **WETZIG, Daniel**; c/o Inficon GmbH, Bonner Straße 498, 50968 Köln (DE). **DECKER, Silvio**; c/o Inficon GmbH, Bonner Straße 498, 50968 Köln (DE). **PUCHALLA-KÖNIG, Jochen**; c/o Inficon GmbH, Bonner Straße 498, 50968 Köln (DE).

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[Fortsetzung auf der nächsten Seite]

(54) **Title**: LEAKAGE DETECTION ON A FLEXIBLE TEST PIECE IN A FILM CHAMBER

(54) **Bezeichnung** : LECKSUCHE AN EINEM FLEXIBLEN PRÜFLING IN EINER FOLIENKAMMER

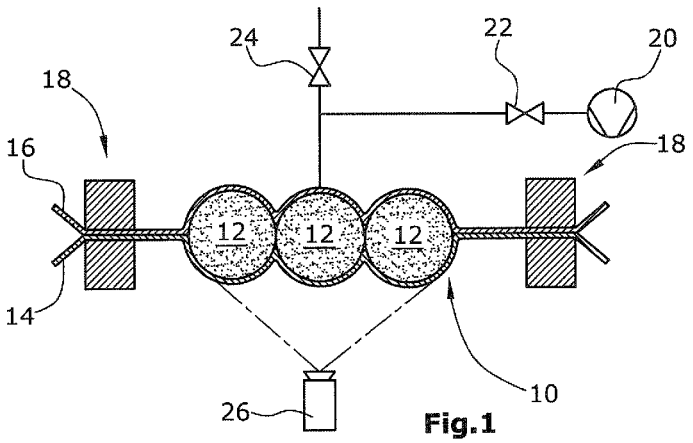

Fig.1

(57) **Abstract**: The invention relates to a method for leakage detection on at least one flexible test object (12) in a film chamber (10), comprising the following steps: inserting the at least one test object (12) into a film chamber (10), lowering the pressure in the film chamber (10) outside the at least one test object (12), and detecting a leakage in the at least one test object (12) by observing the spatial change of the film (14, 16) of the film chamber (10), characterised in that the outer contour of the at least one test object is transmitted to at least one section of the film (14, 16) by the lowering of the pressure in the film chamber (10), said contour of the film is recorded with an image recording system (26), and the recorded images of the contour are compared with reference images of said contour in the event of a tight test object.

(57) **Zusammenfassung**:

[Fortsetzung auf der nächsten Seite]

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— *mit internationalem Recherchenbericht (Artikel 21 Absatz 3)*

Verfahren zur Lecksuche an mindestens einem flexiblen Prüfling (12) in einer Folienkammer (10), mit den Schritten: Einbringen des mindestens einen Prüflings (12) in eine Folienkammer (10), Absenken des Drucks in der Folienkammer (10) außerhalb des mindestens einen Prüflings (12) und Detektion eines Lecks in dem mindestens einen Prüfling (12) durch Beobachtung der räumlichen Veränderung der Folie (14, 16) der Folienkammer (10), dadurch gekennzeichnet, dass die äußere Kontur des mindestens einen Prüflings durch das Absenken des Drucks in der Folienkammer (10) auf zumindest einen Abschnitt der Folie (14, 16) übertragen wird und dass diese Kontur der Folie mit einem Bilderfassungssystem (26) erfasst wird und dass die erfassten Bilder der Kontur mit Referenzbildern dieser Kontur im Falle eines dichten Prüflings verglichen werden.

Leakage detection on a flexible test piece in a film chamber

The present disclosure relates to a method for leak detection on a flexible, non-rigid test piece.

Non-rigid test pieces have a flexible structure yielding with pressure change. Such test pieces are, e.g., food packages. When the differential pressures between the inner pressure of the test piece and the ambient pressure thereof is too large, there is a risk that the test piece bursts or is damaged at least.

Conventionally non-rigid test pieces are filled with a test gas and the test gas is measured in the exhaust gas flow of the pump system used to create the necessary differential pressures. As an alternative, the use of a specific test gas may be omitted, if the sensor is adapted to the filler gas inside the test piece. In this measuring method, influences by the ambient gas may compromise the measuring result.

US 6,955,076 describes the detection of a leak in a test piece in a film chamber with the use of a test gas. It is described to improve the closability and the tightness of the film chamber by evacuating a volume in the edge zone of the film chamber, the volume being independent of the test chamber. Thereby, it is achieved that no gas from the environment of the film chamber gets into the test chamber volume through leaks in the closure region of the chamber and compromises the measuring result.

DE 10 2012 200 063 A1 describes a method for leak detection on a non-rigid test piece contained in a film chamber. After the test piece has been positioned in the film chamber, the pressure in the film chamber is reduced in the region outside the test piece. A leak in the test piece is detected based on a spatial change of the film of the film chamber. Here, the change in film position or a change in the volume of the film chamber is measured. This method offers the advantage that the tightness of the film chamber has only a negligible influence on the measuring result. It is merely necessary to achieve a tightness of the film chamber that allows the reduction of the pressure inside the film chamber. The measuring of the

positional change may be performed by a laser-optical measuring of the position of the film surface, by measuring the change in capacitance of a metalized film surface, or by measuring a contact with the film surface. The subject matter of DE 10 2012 200 063 A1 is incorporated into the present application by reference.

When measuring the positional change of the film it is not possible, in particular with a plurality of test pieces contained in the film chamber at the same time, to determine which of the test pieces is leaking. The measuring accuracy depends on the variance of the volume from test piece to test piece.

At least preferred embodiments provide an improved method for leak detection on a flexible test piece in a film chamber.

Reference to any prior art in the specification is not an acknowledgement or suggestion that this prior art forms part of the common general knowledge in any jurisdiction or that this prior art could reasonably be expected to be combined with any other piece of prior art by a skilled person in the art.

According to an aspect of the invention, there is provided a method for leak detection on at least one flexible test piece in a film chamber having at least one film provided with a grid, the method comprising the following steps: introducing the at least one flexible test piece into the film chamber; transferring an outer contour of the at least one flexible test piece to the at least one film provided with the grid by lowering the pressure in the film chamber outside of the at least one flexible test piece such that the at least one film clings to the outer surface of the at least one flexible test piece; capturing an image of the at least one film and its grid by means of an image capturing system that is adapted to capture images of the film chamber; comparing the captured image of the at least one film and its grid to a reference image of the at least one film and its grid previously contour captured in the case of a tight test piece; and detecting a leak in the at least one test piece by monitoring a spatial change of the at least one film of the film chamber based on an evaluation of this comparison between the grid in the captured image and the grid in the reference image.

According to embodiments of the invention, the pressure in the film chamber is reduced outside the test piece such that at least a portion of the film clings to the outer contour of the test piece contained in the film chamber or the test pieces contained in the film chamber. The outer contour of the test piece or the test pieces is thus transferred to the film. This contour of the film is sensed using an image capturing system. The images of the film contour captured are compared to previously captured stored reference images captured for a tight test piece with otherwise identical marginal conditions of the measuring arrangement. The image captured by the image capturing system is thus subjected to a variance comparison to detect leaking test pieces. In particular, with a plurality of test pieces in the film chamber, it is possible to detect which test piece is leaking. This is possible because the contour only changes in the region of the leaking test piece, whereas with tight test pieces no change occurs or the extent of change is at least not the same.

The contour of the film surface may be sensed in different ways. Advantageously, the film surface is provided with a grid which is formed e.g. by dots arranged in a raster (grid structure) or by intersecting lines. In the case of dots, these are arranged at the intersections of an imaginary grid.

The grid may be projected on the film surface, e.g. by means of a laser or another optical system which images the grid on the film surface using light. Preferably, grid lines are projected on the film surface by means of a laser.

As an alternative, the grid is fixedly applied on the film surface, e.g. by printing, embossing, painting etc.

Using a known image processing and image recognition system, the images captured are analyzed and evaluated. The contours and grids of the respective images captured are compared to the corresponding contours and grids of the previously captured reference images.

Here, the temporal course of the contour change is a measure of the leakage rate used to determine the leakage rate of a detected leak. In particular, in case of a

gross leak, a test piece pumped empty can be detected based on the changed contour. When a plurality of test pieces is tested at the same time, a detected leakage can be attributed to one of the test pieces.

By way of clarification and for avoidance of doubt, as used herein and except where the context requires otherwise, the term "comprise" and variations of the term, such as "comprising", "comprises" and "comprised", are not intended to exclude further additions, components, integers or steps.

An embodiment of the invention will be explained in more detail hereunder, by way of example, only with reference to the Figures. In the Figures:

Figure 1 shows a measuring arrangement for the application of the method according to the invention,

Figure 2 shows the contour of the film surface in the case of a leaking test piece, and

Figure 3 shows the contour of the film surface of a tight test piece (reference image).

The measuring arrangement consists of a film chamber 10, into which a plurality of flexible, i.e. non-rigid test pieces 12 in the form of food packages have been placed. After having placed the test pieces 12 into the film chamber 10, the same is closed by laying the two films 14, 16 forming the film chamber onto each other with the test pieces 12 therebetween and pressing the films 14, 16 against each other in an air-tight manner at the edge zones by means of a clamping device 18.

Thereafter, the film chamber is evacuated by means of a vacuum pump 20 connected with the interior of the film chamber via a valve 22. Here, the valve 22 is opened and a vent valve 24 that is also connected with the interior of the film chamber 10 is closed to atmosphere. While atmospheric pressure still prevails in the test pieces 12, the pressure in the volume surrounding the test pieces 12 is lowered inside the film chamber 10 by at least 100 mbar with respect to the

ambient pressure of the film chamber 10. After the pressure in the film chamber has been lowered, the valve 22 is also closed and the pump 20 is deactivated.

Using a laser system not illustrated in the Figures, a grid 28 of intersecting lines is projected on the surface of the film 14. Using the optical camera of an image capturing system 26, the surface of the film 14 provided with the grid 28 is filmed. The pressure inside the film chamber 10 in the region outside the test pieces 12 is lowered such that the films 14, 16 cling to the outer contour of the test pieces 12. The outer contour 12 is impressed into the films 14, 16 and is thereby transferred to the films 14, 16. In case of a leaky test piece 12 the contour of the film surfaces of the films 14, 16 changes, since gas escapes from the leaking test piece 12 and its contour is changed thereby. The change of the contour of the films 14, 16 changes the shape of the grid 28 projected on the films 14, 16. This change of the shape of the grid 28 can be detected in the images 30, 32 captured by the image capturing system 26.

The images 30 captured are compared to previously captured reference images 32 for the case of a tight test piece 12 or the case of a plurality of tight test pieces 12. It is decisive that the reference images 32 were captured for the same number and arrangement of the test pieces 12 as in the case of the leakage measurement. By a comparison of the shape of the grid 28 in the captured images 28 and the shape of the grids 28 in the reference images 32, a variance comparison can be performed and, e.g. when a predetermined deviation from the contours in the reference images 32 is exceeded, the presence of a leak can be concluded therefrom.

For this purpose, the image capturing system 26 is provided with an image processing and image recognition software. The captured images are evaluated based on known image recognition algorithms. In particular, it is possible to thereby determine which of a plurality of test pieces 12 contained in the film chamber is leaky.

Figure 2 shows the image 30 of the grid 28 in the case of one leaky test piece 12 of a plurality of test pieces 12.

Figure 3 shows the previously captured reference picture 32 of the grid 28 for the same number and arrangement of the test pieces 12 as in Figure 2 in the case of tight test pieces 12. The situation illustrated in Figure 3 serves as a reference for tight test pieces 12, i.e. for capturing a reference image 32 for a later comparison with the images 30 captured during leak detection. By comparing the contours and grids 28 in Figures 2 and 3, it is readily detectable which of the test pieces 12 is leaky, namely the central test piece 12.

Claims

1. A method for leak detection on at least one flexible test piece in a film chamber having at least one film provided with a grid, the method comprising the following steps:

introducing the at least one flexible test piece into the film chamber;

transferring an outer contour of the at least one flexible test piece to the at least one film provided with the grid by lowering the pressure in the film chamber outside of the at least one flexible test piece such that the at least one film clings to the outer surface of the at least one flexible test piece;

capturing an image of the at least one film and its grid by means of an image capturing system that is adapted to capture images of the film chamber;

comparing the captured image of the at least one film and its grid to a reference image of the at least one film and its grid previously captured in the case of a tight test piece; and

detecting a leak in the at least one test piece by monitoring a spatial change of the at least one film of the film chamber based on an evaluation of this comparison between the grid in the captured image and the grid in the reference image.

2. The method of claim 1, wherein the grid is formed of intersecting lines or dots on a surface of the at least one film.

3. The method of claim 1 or 2, wherein the grid is projected on the at least one film.

4. The method of claim 1 or 2, wherein the grid is fixedly applied onto the at least one film.

5. The method of one of the preceding claims, wherein a temporal course of a change of the contour of the at least one film is evaluated as a measure of a leakage rate.

6. The method of one of the preceding claims, wherein a plurality of flexible test pieces is contained in the film chamber at the same time.

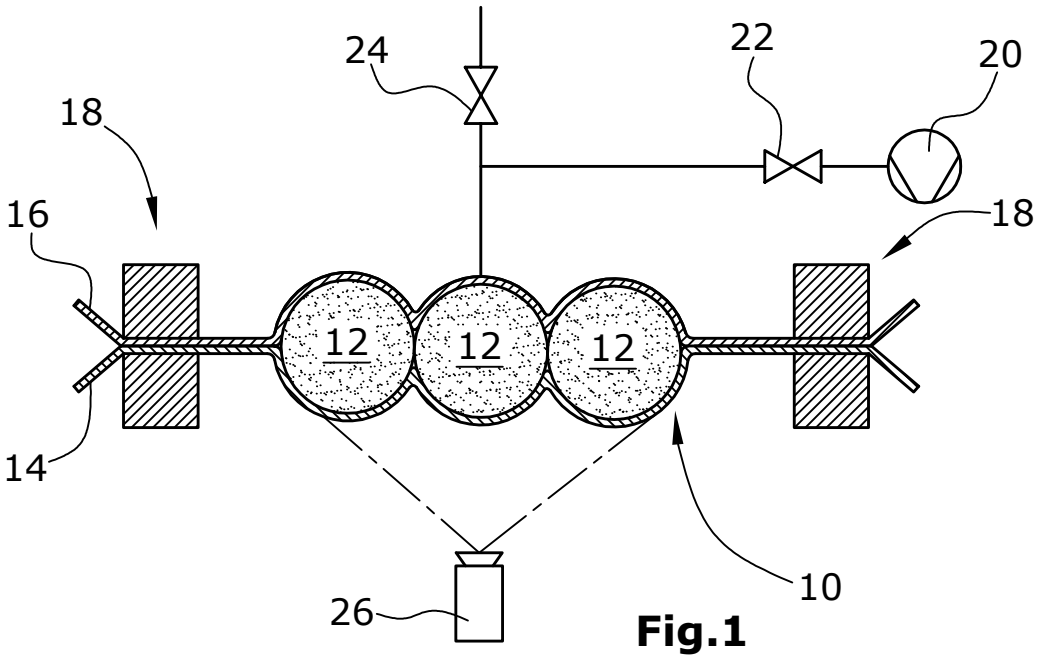

Fig.1

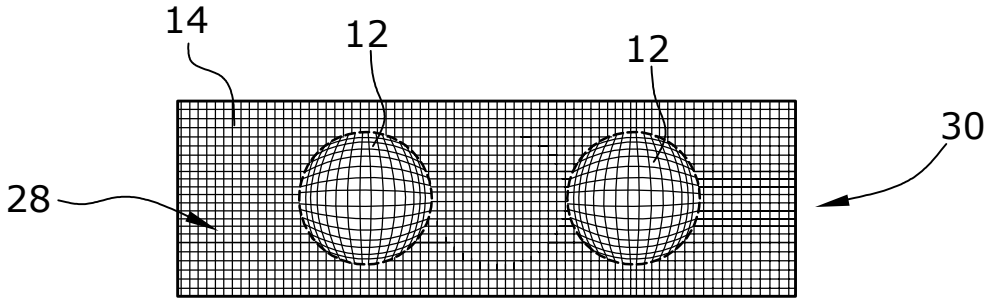

Fig.2

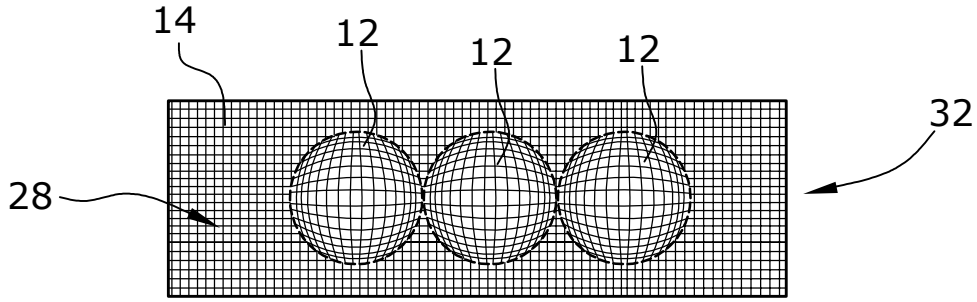

Fig.3