

## EUROPEAN QUALIFYING EXAMINATION 2004

### PAPER B ELECTRICITY / MECHANICS

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## Description of the Application

### Liquid detector

There are many circumstances in which it is desirable to detect the presence of liquids. Liquids from leaks, pipe bursts or the like may cause a great deal of damage, for  
5 example in factories or in private homes.

Water detectors as such are known in the art. Most make use of the property of water, which generally contains small quantities of ionic impurities, being electrically conductive.

10 Water detectors typically comprise an electrical circuit with two electrodes, an electrical current source such as a battery and a current detector. When water is present between the electrodes, current flow in the circuit generates an alarm, for example using a bell, a buzzer or a lamp.

15 Document D2 discloses a detector which comprises a mat made of a layer of electrically insulating fibres. Electrical conductors are provided on the top and bottom sides of the mat. The mat can absorb water. When the mat is wet an electrical connection is made between the top and bottom conductors. It has been found that when the mat has absorbed water, the detector cannot be used again for a certain period of time. Only  
20 when the mat is dry can the detector be used again.

It is an object of the present invention to provide a liquid detector which can be more quickly used again.

25 The object is achieved by the subject matter of the independent claim.

Embodiments of the invention and various possible modifications will now be described in detail.

Fig. 1 shows a liquid detector according to a first embodiment of the invention in cross section.

Fig. 2 shows a liquid detector according to a second embodiment of the invention in cross section.

Fig. 3 shows an arrangement of liquid detectors according to a third embodiment of the invention.

Fig. 4 shows a monitoring device with the arrangement according to fig. 3.

The drawings are schematic and not to scale. In particular the vertical dimensions may be exaggerated for clarity.

Fig. 1 shows a liquid detector 100 according to a first embodiment of the invention. The detector 100 comprises a thin layer support 1 made from an electrically insulating, water impermeable material. In the support 1, a blind hole is provided which forms a receptacle 4 for receiving liquid. The depth of the blind hole is less than the thickness of the support 1. A first electrode 2 is located at the bottom of the receptacle 4 and a second electrode 3 is located on the upper part of the side wall 5 of the receptacle 4.

When there is no liquid in the receptacle 4, the first electrode 2 is electrically isolated from the second electrode 3. When the receptacle 4 is filled with an electrically conducting liquid, an electrical connection exists between the first electrode 2 and the second electrode 3. This allows current to flow between the electrodes, which can be detected. When current has been detected an alarm may be generated.

In order to bring the detector back to a state of readiness after it has detected the presence of liquid, the receptacle 4 must be emptied. The liquid receptacle 4 is shown in fig. 1 in the form of a cylindrical hole. Other forms could be used. For example, a concave form has the advantage that it is particularly easy to wipe dry.

In fig. 1, a terminal portion 6 of the first electrode 2 is located on the underside of the support 1. Alternatively the terminal portion of the first electrode 2 may be located on the topside of the support 1 (not shown in fig. 1).

5 Fig. 2 shows a liquid detector 200 according to a second embodiment of the invention. This differs from the detector 100 of the first embodiment in that the blind hole is replaced by a hole which extends through the complete thickness of the support 1, and in that the first electrode 20 is formed as a metal sheet which closes the hole to form the bottom of a receptacle 40. The receptacle 40 has a side wall 50.

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Fig. 3 shows a third embodiment of the invention in which a plurality of detectors 300 is provided in a single thin layer support 1. The detectors 300 are arranged as a matrix and each detector 300 can be of the type of the first or the second embodiment. Electrical connections are not shown in fig. 3. With this arrangement several leaks can be  
15 detected over a certain area, as will be explained subsequently. Moreover, a person can step on the arrangement without damaging it.

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In some cases it is important to know not only that liquid has been detected but also where on the surface it has been detected. This is achieved with a monitoring device  
20 400 shown in fig. 4. First electrodes 2, 20 in a given row of detectors 300, are connected to each other and linked by one of the electrical conductors  $y_1, y_2, y_3, y_4$  to the monitoring device 400. Second electrodes 3 in a given column of detectors 300, are connected to each other and linked by one of the electrical conductors  $x_1, x_2, x_3$  to the monitoring device 400. The dashed lines represent the connections on the underside of  
25 the support 1.

The monitoring device 400 detects the current flowing in each row and each column, and can thereby distinguish in which detectors current is flowing.

If it is unimportant to know precisely where a leak has occurred, all the first electrodes 2, 20 may be connected together, and all the second electrodes 3 may be connected together. In this case only a single connection between the first electrodes 2, 20 and the monitoring device 400 and a single connection between the second electrodes 3 and the monitoring device 400 are necessary.

Conductors  $y_1, y_2, y_3, y_4; x_1, x_2, x_3$  and the electrodes 2, 20, 3 may be placed on the support 1 by any suitable process, for example by printing, etching or gluing.

10 In all the embodiments of the invention the material of the support 1 can be either rigid or flexible. Arrangements of liquid detectors having a flexible thin layer support 1 can be rolled up.

**Claims:**

1. Liquid detector (100, 200, 300) comprising a first electrode (2, 20), a second electrode (3) and an electrically insulating material on which the first electrode (2, 20) and the second electrode (3) are arranged, characterised in that the insulating material is liquid impermeable, that the liquid detector comprises a receptacle (4, 40) for receiving liquid, and that the first and second electrodes are arranged such that when sufficient electrically conductive liquid is in the receptacle (4, 40) an electrical connection is established between them.
2. Liquid detector (100, 200, 300) according to claim 1 wherein, in use, the first electrode (2, 20) is at least partially located below the second electrode (3) and wherein the second electrode (3) is at least partially located on a side wall (5, 50) of the receptacle (4, 40).
3. Liquid detector (100, 300) according to claim 2 wherein the receptacle (4) is a blind hole in the insulating material.
4. Liquid detector (200, 300) according to claim 2 wherein the receptacle (40) is formed as a hole passing completely through the insulating material and wherein the first electrode (20) closes one end of the hole.
5. Arrangement comprising a plurality of liquid detectors (100, 200, 300) according to any preceding claim.
6. Arrangement according to claim 5 wherein the current flowing in each liquid detector (100, 200, 300) is individually detectable.

Drawings of the Application

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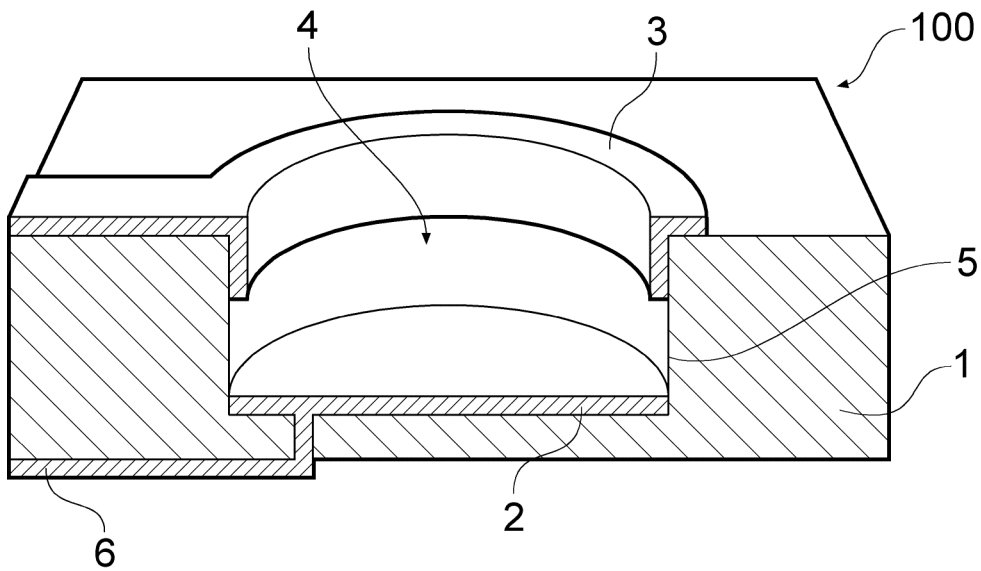


Fig. 1

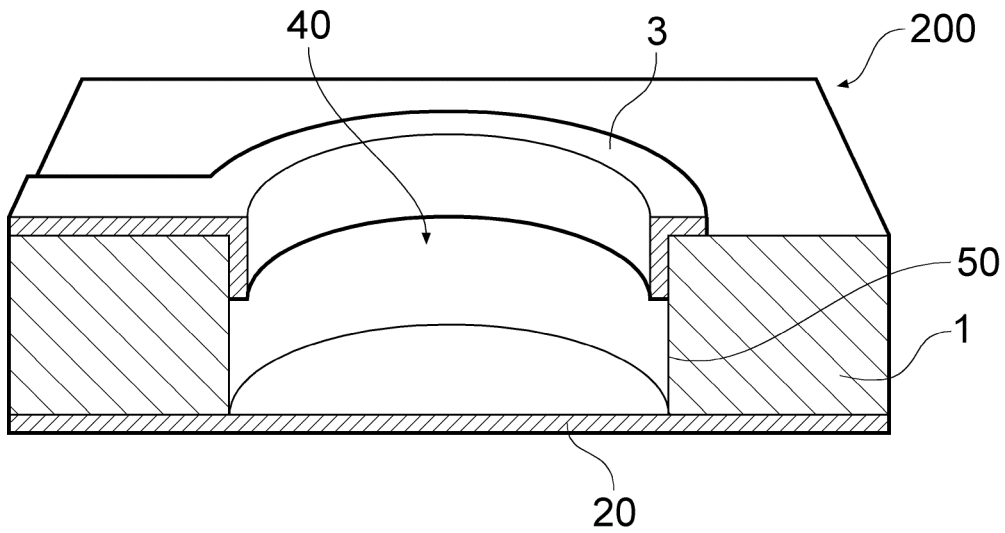


Fig. 2

Drawings of the Application

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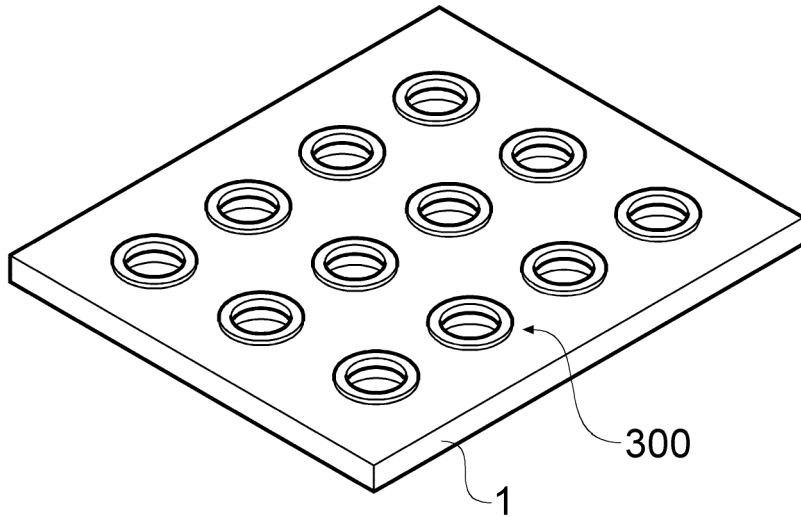


Fig. 3

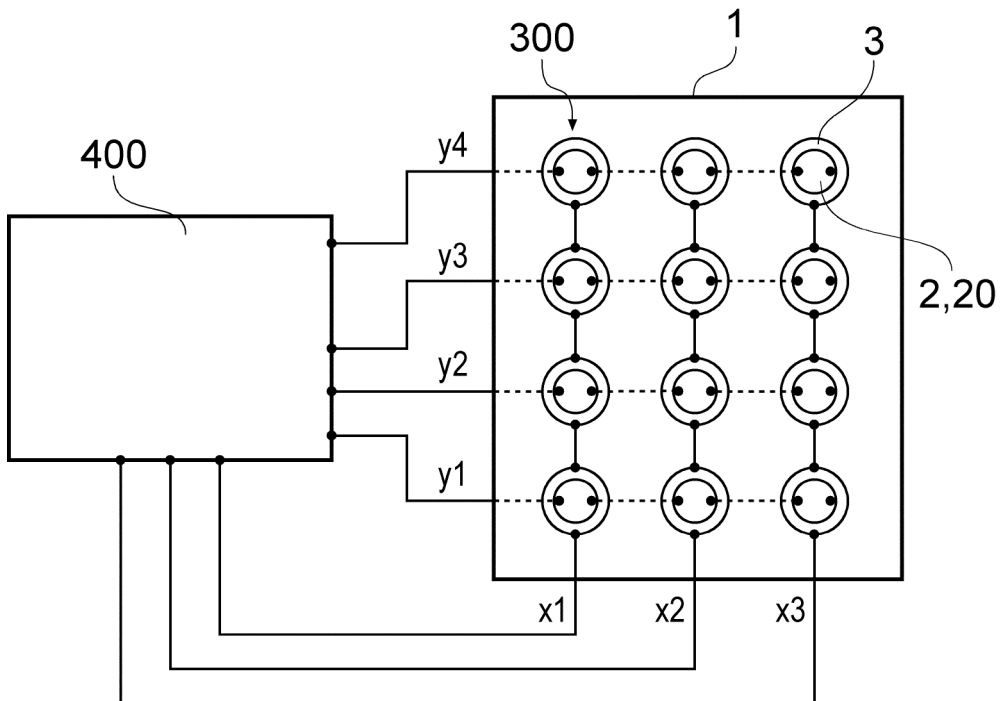


Fig. 4



**Communication under Art. 96(2) EPC**

The examination is being carried out on the application documents as originally filed.

1. D1 and D2, which were both published before the priority date of the present application, are referred to in this communication.
2. In the following the claims will be analysed with respect to the requirements of Art. 52(1) EPC.
- 2.1 The subject matter of claim 1 is not new (Art. 54(1), (2) EPC). Document D1 discloses the following features:

A liquid detector (water level detector, line 1) comprising a first electrode 11, a second electrode 12a, 12b, 12c and an electrically insulating material (glass or plastic) on which the first electrode 11 and the second electrode 12a, 12b, 12c are arranged, [wherein] the insulating material is liquid impermeable, the liquid detector comprises a receptacle (cup 10) for receiving liquid (see fig. 1), and the first and second electrodes are arranged such that when sufficient electrically conductive liquid is in the receptacle an electrical connection is established between them (D1, paragraph 6).

Therefore there is no difference between the subject matter of claim 1 and the liquid detector of D1.

It is noted that the subject matter of claim 1 also lacks novelty with respect to the document D2. D2 discloses a liquid detector comprising a mat 3 having a first electrode 5a, 5b, 5c and a second electrode 4a, 4b, 4c, 4d. The conductors are arranged on an electrically insulating, liquid impermeable material (waterproof element 1). The waterproof element 1 of D2 forms a series of receptacles (depressions 2) for receiving liquid. All the features of claim 1 are therefore also known from D2.

2.2 The subject matter of claims 2 and 3 is likewise not new. D1 also discloses the electrode arrangement of claim 2 (see D1, electrodes 11 and 12). From fig. 1 it is clear that the cup 10 is formed as a single piece of material. Therefore the cup can be seen as a blind hole in the insulating material (glass or plastic).

2.3 The subject matter of claim 4 would appear not to be known from the available prior art. Furthermore, in view of the available prior art, the subject matter of claim 4 appears to involve an inventive step.

2.4 The subject matter of claim 5 is not new. D2 also discloses a plurality of liquid detectors, formed by the crossover points of the first electrodes 5a, 5b, 5c and second electrodes 4a, 4b, 4c, 4d.

The subject matter of claim 5 also lacks an inventive step in view of D1 in combination with common general knowledge. If the skilled person wished to detect rainfall at different points in a certain area, he/she would provide an arrangement with a plurality of liquid detectors according to D1 without having made an inventive step.

2.5 The subject matter of claim 6 is not new. Document D2 discloses that current flowing in each liquid detector is individually detectable (see D2, 5<sup>th</sup> and 6<sup>th</sup> paragraphs and figures).

3. If the applicant wishes to pursue the application, a new set of claims in accordance with Rule 29 EPC should be filed, taking into consideration the above objections.

In the letter of reply, the applicant should identify clearly all the amendments made in the claims and their basis in the application as filed and provide additional explanation, where necessary. Further he/she should set out his/her arguments in support of the patentability of the independent claim(s).

**Document D1 (Prior Art)**

This document discloses a new kind of water level detector as schematically shown in fig. 1. In the field of meteorology it is necessary to record how much rain has fallen in a given period of time.

5 In the past this has been done by collecting rainwater in a cylindrical cup which is provided with a volume scale. A disadvantage of this is that in order to provide a time profile of rainfall, a person must frequently go to the device to read the volume scale.

10 This document discloses a device which overcomes this problem. It works on the principle that rainwater is a conductor of electricity.

The detector comprises a cylindrical cup 10 made from glass or plastic. The cup 10 has a flat bottom 13 and a side wall 14. On the inner surface of the bottom 13 of the cup, a bottom electrode 11 is provided. Side wall electrodes 12a, 12b, 12c extend from the top of the cup on the inner side of the side wall 14 to end at different heights above the bottom 13.

20 A voltage is applied between the bottom electrode 11 and the side wall electrodes 12a, 12b, 12c.

When the rainwater in the cup 10 has reached the lower end of a side wall electrode 12a, 12b, 12c, current flows between that electrode and the bottom electrode 11. This current can be monitored using a monitoring device 15. Thus different water levels in the cup 10 can be detected and recorded by means of a computer.

25 It is noted that this detector could also be used outside the field of meteorology, for example in an industrial environment to monitor the leakage of an electrically conductive liquid. In this case the computer may also generate an alarm.

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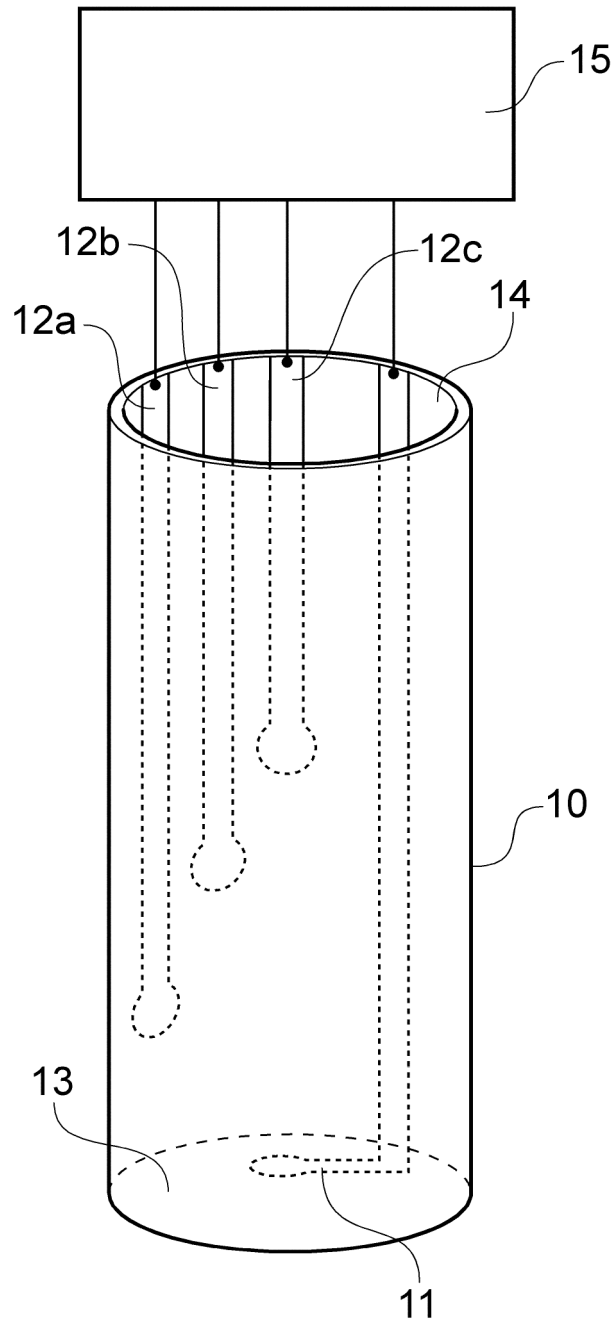


Fig. 1

**Document D2 (Prior Art)**

This invention concerns a detector for detecting the position of water leaks.

Fig. 1 is a schematic representation of a detector according to the invention.

5 Fig. 2 shows a detail of the detector in cross section.

As shown in fig. 1, the detector comprises a rigid, electrically insulating, waterproof element 1 which is provided with a series of depressions 2. A flexible mat 3 of electrically insulating fibres is provided on the element 1 and follows the contours of the element 1. However in fig. 1, for clearer presentation, the mat 3 is shown slightly spaced  
10 from the element 1. A first set of parallel electrical conductors 4a, 4b, 4c, 4d is provided on the top side of the mat 3. A second set of electrical conductors 5a, 5b, 5c is provided on the bottom side of the mat 3. The conductors 5a, 5b, 5c of the second set are oriented perpendicularly to those 4a, 4b, 4c, 4d on the top side. Viewed from above, the crossover points of the conductors of the first and second sets coincide with the centres  
15 of the depressions 2.

Fig. 2 shows a cross section through the centre of the depression 2 at the crossover point of the conductors 4c and 5b. The crossover points are typically spaced at 1 metre  
20 intervals. A monitoring unit 6 is connected to the conductors 4a, 4b, 4c, 4d; 5a, 5b, 5c.

The detector is placed in a leak-endangered area such that water from a leak can fall onto the detector. In this case, water fills the spaces between the fibres in at least a part of the mat 3 and accumulates in one or more of the depressions 2. Thus an electrical  
25 connection between a conductor of the first set and a conductor of the second set is made. The monitoring unit 6 detects these connections and displays the location of the leak.

For a more robust detector, the element 1 may be replaced by a flat waterproof element  
30 having no depressions.

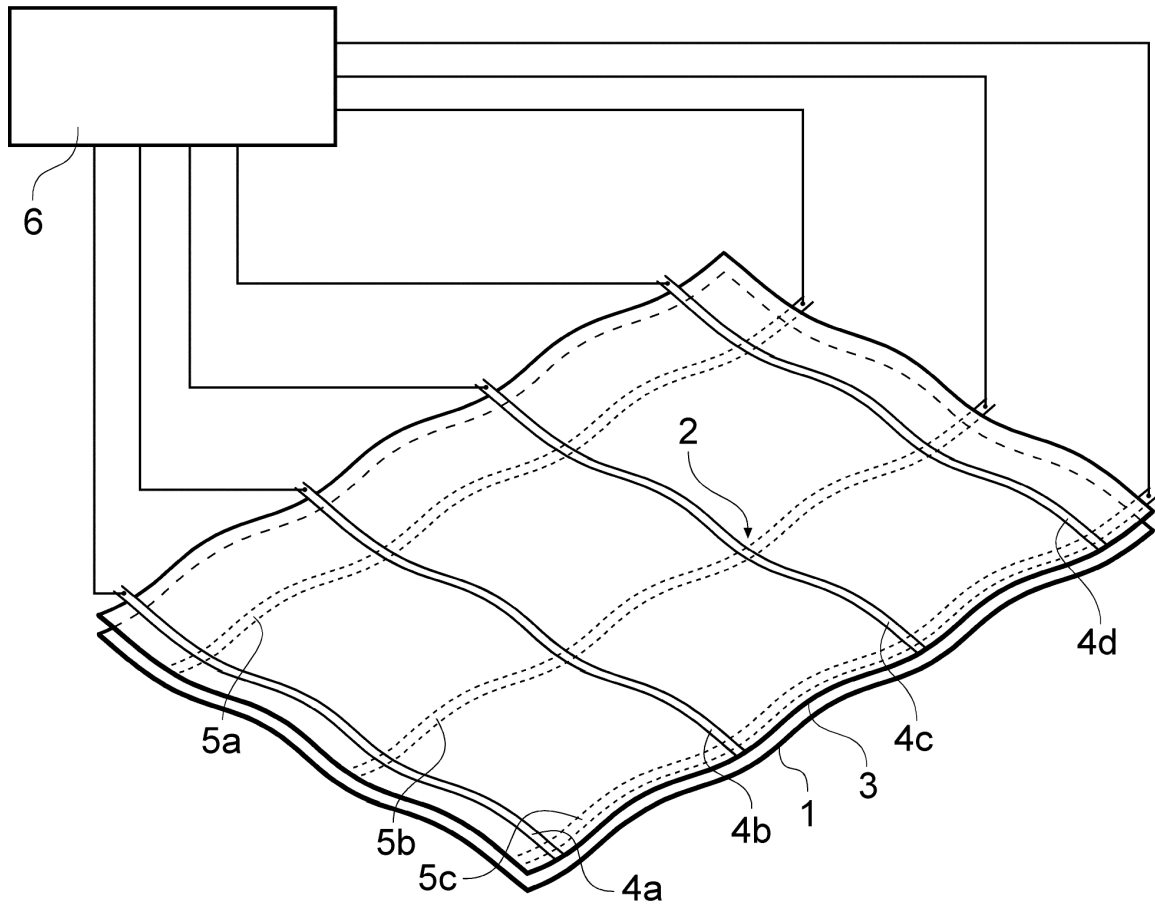


Fig. 1

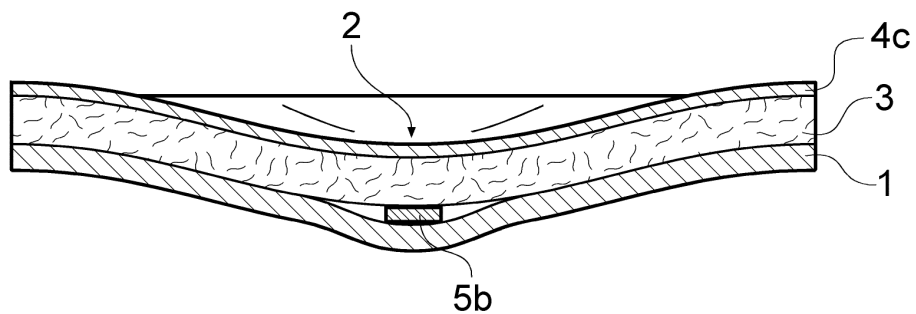


Fig. 2

**Letter from the applicant**

Dear Ms Candy Date,

In spite of the rather negative communication you forwarded to us from the EPO we are still very keen to obtain protection for our application.

Our detectors are particularly successful in industrial environments. Unlike the cup of D1, the relatively flat form of our detectors enables them to be used on uneven surfaces without tipping over.

Please take all necessary steps to obtain the best protection for all our embodiments,  
regards,

Ms Anne Melder  
Patent Department, "Leakaway Ltd".