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(71) Applicant (for all designated States except US): **FUNDACION UNIVERSIDAD DEL NORTE** [CO/CO]; Km. 5 Antigua via a Puerto Colombia, Atlántico (CO).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **EGEA BERMEJO, Eduardo** [CO/CO]; Km. 5 Antigua via a Puerto Colombia (CO). **SANJUAN MEJIA, Marco** [CO/CO]; Km. 5 Antigua via a Puerto Colombia (CO).

(74) Agent: **OLARTE, Carlos, R.**; Diagonal 34 No. 5-28, Bogotá (CO).

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(54) Title: SURFACE-DEPOSITED PARTICLE AND SUBSTANCE SAMPLING, DILUTION AND ANALYSIS DEVICE

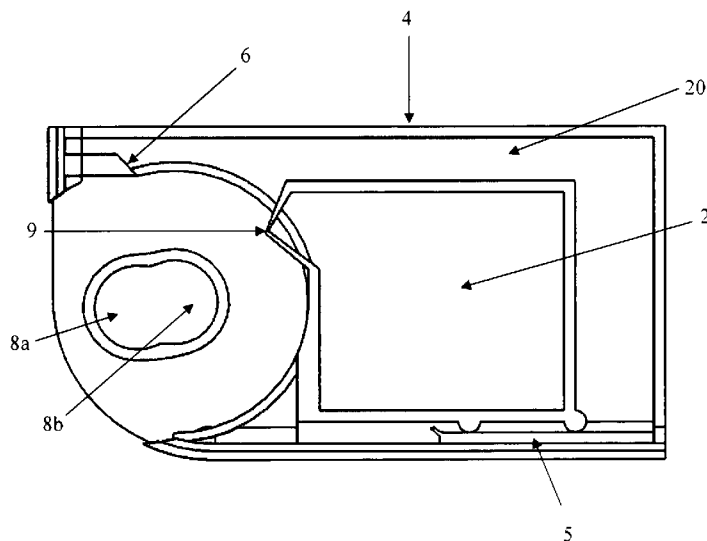


Figure 3

(57) Abstract: The present invention is related to providing a device for sampling, diluting and analyzing particles and substances normally located on surfaces, wherein said device comprises a collection system which, through a rotating collecting surface and a scraper gather the sample. The device also comprises a tank-like storage system to store the diluting solution and a dilution chamber that permits the sample to mix with the solution and be diluted. This mixture is subsequently placed in contact with a detection system which is capable of discerning the presence or not of the substance being sampled.

SURFACE- DEPOSITED PARTICLE AND SUBSTANCE SAMPLING, DILUTION AND ANALYSIS DEVICE

5

Field of the invention

Surface-deposited substance and particle sample collection and its latter analysis through dilution and reaction is of interest in the chemical, pharmaceutical, health, security, and criminology sectors, amongst others.

10

The prior art contemplates several attempts to provide surface particle and substance sampling. However, these devices comprise two or more units, require liquid or solid handling or dispensing, or the collection of very small substance or particle quantities rubbing a small, fixed and saturable surface against the surface containing the matter of

15 interest.

20

Referring to Figure 1A, document US2004180451 discloses a diagnostic testing device for collecting and testing substances comprising a housing (100), a filter (101) configured to capture substances entrained in an air flow (102) and a reservoir (103) for storing and evaluating the substances captured on the filter (101). The collecting mechanism of this invention requires air flow (102) which implies additional powered devices in order to collect substances. The air flow (102) may let undesirable particles to flow within the device and affect the results of the analysis. Additionally, this invention retains the measured particles directly on the filter, preventing the device

25 providing the possibility of a prior dilution.

30

As shown in Figure 1B, document DE19909891 discloses an immunoassay device comprising a housing (150) with an elevated portion having a central opening (151) containing a swab stick for sampling and reaction zone (152) with signal zones in capillary communication with the swab stick and a window in the housing above the reaction zone (152). This device does not provide the possibility of a prior dilution and also saturates the sampling surface with the substance of interest. This may increase the possibility of erroneous readings.

Summary of the invention

The invention generally comprises a device that allows for the collection of surface-deposited substance or particle samples, storage thereof, dilution of said substances in solution or test liquid, and analysis thereof in an analysis chamber. This device operates
5 as a self-contained unit requiring no direct handling of the material to be analyzed of the dilution agent. This device allows for the prior verification of the amount of particles or material to be analyzed.

10 The device uses a rotational collection surface, which allows for repetitive substance or particle collection and separation in a manner that the amount of material to be collected is limited by the storage capacity, not by the collecting capacity.

This device also allows for the use of a controlled amount of liquid for dilution and does
15 not generate waste containers. The amount of liquid stored in the container is determined as a function of the detection concentration threshold for the specific product to be analyzed. In a preferred embodiment, once the sampling unit or units, comprising the device, have been used, it is discarded as a whole. Another advantage of the device is it is self-contained. It does not require any accessories nor additional units
20 (such as vacuums or the like).

Description of the Figures

Figure 1A is a lateral view of a device described in US2004180451.

25

Figure 1B is a lateral view of a device described in DE19909891.

Figure 2A is an isometric view of a preferred embodiment of the claimed device.

30 Figure 2B shows an exploded isometric view of a preferred embodiment of the claimed device.

Figure 3 shows a lateral internal view of a preferred embodiment of the claimed device.

Figure 4A shows the configuration of the device in Figure 3 at the moment of collection.

5 Figure 4B shows the configuration of the device in Figure 3 at the moment of dilution and analysis.

Figure 5A shows the transport path of the solution in the device of Figure 3.

10 Figure 5B shows an inferior view of the device of Figure 3 displaying the result reading mechanism.

Figure 6 shows a preferred embodiment of the invention, wherein the device comprises four detection mechanisms.

15 Figure 7 is an isometric view of another preferred embodiment of the claimed device.

Figure 8 shows a lateral internal view of the device in Figure 7.

20 Figure 9A is a section view of the device in Figure 7 showing the closed position of the eyelash.

Figure 9B is a section view of the device in Figure 7 showing the open position of the eyelash.

25 Figure 10A shows the configuration of the device in Figure 8 at the moment of collection.

Figure 10B shows the configuration of the device in Figure 8 at the moment of reception of the sample.

30

Figure 11A shows a lateral view of the device in Figure 8 with the movable pin in a closed position.

Figure 11B shows a lateral view of the device in Figure 8 with the movable pin in a open position.

Figure 12 shows an inferior view of the device of Figure 8 displaying the result reading mechanism.

Figure 13 shows another embodiment of the invention, wherein the device comprises four detection mechanisms.

Detailed Description of the Invention

The present invention is a device generally comprising four parts corresponding to: i) a collection system for sample collection; ii) a storage system containing the necessary fluid(s) for dilution or reaction of the sample; iii) a dilution chamber; and iv) a detection system for sample reception and analysis.

Referring to Figures 2A, 2B and 3, there is shown a first embodiment wherein the device (1) includes:

- i) a storage tank (2);
- ii) a roll (3);
- iii) a cover base (4);
- iv) a dilution chamber (20);
- v) a membrane (5);
- vi) a cap (6);
- vii) a track (8); and
- viii) a scraper (7).

The storage tank (2) contains the fluid(s) for dilution or reaction of the sample and comprises a breakable protrusion (9).

Dilution chamber (20) is a closed volume defined by the internal walls of device (1), roll (3) in the sample preparation position, scraper (7) and membrane (5).

The cap (6) serves as support for the membrane (5) and as a seal for the solution contained in the storage tank (2). The material, both of the cover base (4) and cap (6), is preferably a polymer due to its low cost and convenience provided when manufacturing using molds. In preferred embodiments, the polymer of the device's structure is partially translucent in order to let the user observe the volume of the collected sample, the sample's dilution liquid and the detection results.

Referring to Figures 3, 4A and 4B, roll (3) is made of a rough material working as an adhesive such that when rotating the roll (3) over the sample surface, the particulates adheres to the surface of the roll (3). The material of the roll surface allows the particulates to be adhered to the roll (3) while device (1) is moved over the sample surface. The roll surface material should also let the sampled particles to be removed easily when making contact with the scraper (7). A preferred material is Ethyl Vinyl Acetate. A preferred porosity of roll material is 15 μm , although this will necessarily vary with the type of substance being sampled.

Cover base (4) has a track (8) (cap (6) also has an equivalent counterpart track on its inside surface) that guides the axis of roll (3) from the first position (8a) (when the device (1) is sampling) to the second position (8b) (when the device (1) proceeds with the sample preparation). Roll (3) can be located in one of these positions.

The following is the method of use of the first embodiment (1):

Step 1: Sample collection

Referring to Figure 4A, device (1) is placed on the sample surface (200) and the roll (3) is rotated by a forward motion (10) and rolls in counterclockwise direction (14). Sample (11) is collected by roll (3) along its rough surface as it rolls and is removed by scraper (7). The forward motion (10) will continue in this fashion over the zone needing analysis until the required sample quantity is obtained in order to achieve detection (the sample amount can be measured using a volume indicator visible through a transparent cap (6)). The sample collected (11) is stored between the scraper (7) and the device's wall as shown in Figure 4B.

Step 2: Sample preparation

Referring to Figure 4B, after obtaining the needed amount for the corresponding detection reading, a force (17) is applied on the device (1) when it is still on the surface where the sample is collected. This displaces roll (3) along track (8) from, referring to Figure 3, position (8a) to position (8b). When this displacement occurs, and because tank (2) comprises a protrusion (9) into the zone where roll (3) arrives at its final position (8b), and said protrusion (9) is weakened by a lesser thickness together with a layout prone for concentrating stresses, tank (2) breaks at or around protrusion (9).

When protrusion (9) of tank (2) is broken, roll (3) seals dilution chamber (20). At the same time, the solvent exits the tank (2) and floods the collected sample (11). The dilution chamber (20) works as a cavity for housing the dilution liquid together with the collected sample.

Subsequently, device (1) is separated from the surface, and keeping the same inclination with respect to the surface, it is shaken in order to achieve a substantially homogenous solution inside the dilution chamber (20).

Step 3: Sample analysis

After shaking the sample and homogenizing it, device (1) is rotated until reaching the position shown in Figure 5A; this way, the solution (16) is directed towards the membrane (5) along path (18). Through the membrane (5), part of the solution is absorbed, this way reacting with the components fixed therein and providing the desired dilution results. The results (13) are shown in the bottom side of the device (1) as shown in Figure 5B. Membrane (5) is obviously designed to secure the required detection for the type of material being sampled. For example, if the purpose is detecting a specific kind of mite protein, the membrane (5) should contain a solution that reacts when that kind of mite protein is present in the dilution, showing the results on one side of the membrane (5).

Referring to Figure 6, an additional embodiment is described wherein the device (1) is provided with interconnecting means that allow the connection of two or more devices

allowing the final commercial embodiment be a single-body multi-testing multi-component system.

Referring now to Figure 7, an additional preferred embodiment (30) is disclosed. This embodiment also comprises four distinguishing parts corresponding to: i) a collection and sealing system for sample collection; ii) a storage system containing the necessary fluid(s) for dilution or reaction of the sample; iii) a dilution chamber; and iv) a detection system.

10 The embodiment (30) of Figures 7 and 8 includes the following elements:

- i) a storage tank (2);
- ii) a roll (3);
- iii) a cover base (4);
- 15 iv) a membrane (5);
- v) three contact stops (25);
- vi) a cap (6);
- vii) an eyelash (22) that allows the entry of the dilution fluid into the dilution chamber (20);
- 20 viii) a scraper (7);
- ix) an orifice (21) for the passage of the dilution fluid from the storage tank (2) to the dilution chamber (20);
- x) an orifice (22) for the passage of the diluted sample located in the diluting chamber (20) to the membrane (5); and
- 25 xi) a sliding pin (19) that isolates the membrane (5) from the dilution in a first position, and in a second position places membrane (5) in contact with the diluted sample.

Referring to Figure 8, scraper (7) is located next to the dilution chamber (20). This configuration provides more space to let diluting chamber (20) accumulate more sample to be analyzed.

Referring to Figures 9A and 9B, eyelash (22) is the element that allows the access of the dilution fluid located in storage tank (2) into the diluting chamber (20) when moved

from an initial position (31a) to a second position (31b). Continuing with Figures 9A and 9B, eyelash (22) is in a closed position until collecting of the sample is completed. When force (26) is applied, eyelash (22) is moved by the operator from the closed position (31a) to the open position (31b) letting the dilution fluid flow into the dilution chamber (20) avoiding the breakage of the tank (2). Storage tank (2) is an independent structure that avoids any part breaking and also ensures that the dilution liquid will be totally verted into the diluting chamber (20) avoiding any liquid leakage.

Continuing with Figures 10A and 10B, cover base (4) comprises three contact stops (25) that guarantee that when roll (3) slides along track (8) from the initial position (8a) to the second position (8b), the sealing of the dilution chamber (20) by means of the roll's sheath pressure against the contact stops (25) of device (30). Here, the surface of roll (3) works as a hydraulic sealing system and as an element of adhesion such that the roll (3) permits the adhesion of the material collected. In preferred embodiments, the material of roll (3) is Ethyl Vinyl Acetate among other natural rubbers.

Referring to Figures 11A and 11B, there is disclosed a membrane (5) integrated into a sliding pin (19). After the dilution liquid is homogeneously mixed with the sample (11), membrane (5) can be moved from the first position (27a) to the second position (27b), exposing the membrane (5) to the dilution liquid (12). In preferred embodiments, a filter paper is located between the detection and sample reception zone (20) and the membrane (5), in order to allow the passage of substances of interest and restrict the passage of substances that would affect the analysis.

The following is the method of use of the second embodiment (30):

Step 1: Sample collection

The device of the second embodiment (30) follows the same procedure to collect sample (11) of the device (1). Roll (3), as shown in Figure 10A, is placed on the surface (200) needing analysis and the roll is rotated by a forward motion (10). As the device (30) is moved forward, the roll (3) is rotated by a forward motion (10) and rolls in clockwise direction (14). Sample (11) is collected by roll (3) along its rough surface as it rolls and is removed by scraper (7). The forward motion (10) will continue in this

fashion over the zone needing analysis until the required sample quantity is obtained in order to achieve detection. The sample collected (11) is stored between the scraper (7) and the device's wall as shown in Figure 10A.

5 **Step 2: Sample preparation**

After obtaining the needed amount for the corresponding sample (11), a force (17) is applied on the device (30) when it is still on the surface where the sample is collected. This displaces roll (3) along track (8) from the position (8a) to the position (8b). When
10 this displacement occurs, the walls of the roll (3) and the device (30) seal the interior of dilution chamber (20).

Step 3: Dilution of the sample

15 After dilution chamber (20) is isolated, eyelash (22) is pressed in direction (26), allowing the passage of the dilution liquid into dilution chamber (20). The second embodiment (30) ensures that the dilution liquid is almost totally verted into the dilution chamber (20), substantially avoiding any liquid leakage regardless of the inclination of the device. Afterwards, the equipment is shaken in order to achieve a homogenous
20 solution inside.

Step 4: Sample analysis

Referring to Figures 11A and 11B, after shaking the sample and homogenizing it, the
25 sliding pin (19) that isolates the membrane (5) from the mixed liquid dilution (16) is slid from the first position (27a) to the second position (27b) letting the membrane (5) come into contact with the mixed solution (16). Once the mixed solution (16) is absorbed by the membrane (5), this reacts and shows the results in the output indicator (13) located in the bottom of the device (30).

30

The aforementioned embodiments are provided with interconnecting means that allow the connection of two or more devices allowing the final commercial embodiment be a single-body multi-testing device as shown in Figures 6 and 13. Additional embodiments may provide multiple storage tanks (2) within the cover base (4) in order

to provide multiple dilution liquids for multiple reactions. Likewise, the construction of such embodiment requires an eyelash (22) capable of allowing the flood of diluting liquid into the diluting chamber (20).

- 5 The aforementioned constitutes a complete and detailed disclosure of different embodiments to practice the inventive concept herein claimed. Any skilled person in the art will understand that variations may be carried out without departing from the scope and spirit of the invention. The scope of the invention is defined by the following claims that shall be interpreted in accordance with what was disclosed herein.

CLAIMS

- 5 1. A substance sampling, dilution and detection device, comprising:
- a- a sample collection system;
 - b- a dilution chamber operatively connected to the sample collection system and disposed to receive the substance being sampled and a dilution liquid;
 - 10 c- a dilution liquid storage system operatively connected to the dilution chamber; and
 - d- a detection system operatively connected to the dilution chamber and disposed to receive a mixture of the substance being sampled and the detection liquid, in order to determine the presence of the
15 substance being sampled.
2. The device of Claim 1, wherein the collection system comprises:
- a- a rotating collecting surface with a central axle; and
 - 20 b- a scraper.
3. The device of Claim 2, wherein the axle of the rotating collection surface can shift along a track groove.
- 25 4. The device of Claim 2, wherein the dilution liquid storage system contains a weakened area in order to facilitate breakage and spillage of the dilution liquid into the dilution chamber.
- 30 5. The device of Claim 4, wherein the collecting surface axle, upon shifting along the track groove, breaks the weakened area of the dilution liquid storage system.
6. The device of Claim 2, wherein the rotating collecting surface is rough.

7. The device of Claim 2, wherein the collecting surface works as an adherent.

8. The device of Claim 1, wherein the storage system may have one or more
5 cavities for containing different types of solutions for dilution or reaction.

9. The device of Claim 3, where upon breakage of the dilution liquid storage system, the collecting surface works as a seal for the dilution chamber.

10 10. The device of Claim 1, wherein the detection system is comprised of a membrane incorporating an element capable of detecting the presence of the substance being sampled by the device.

11. The device of Claim 1, wherein the device has means to connect itself
15 with other similar devices so as to conform a multicomponent system.

12. The device of Claim 1, wherein the device is made of a polymer material.

13. The device of Claim 12, wherein the polymer is partially or completely
20 translucent.

14. The device of Claim 1, which also includes a collected sample volume indicator.

25 15. The device of Claim 3, wherein the sample collection system comprises three contact stops that come into contact with the collecting surface when the axle of the collecting surface shifts along the track groove.

16. The device of Claim 1, wherein the detection system is comprised by a
30 sliding pin and a membrane.

17. The device of Claim 16, wherein, in a first position, the sliding pin isolates the membrane from the dilution chamber, and in a second position, places the membrane in contact with the mixture in the dilution chamber.

18. The device of Claim 1, wherein the dilution liquid storage system spills its content into the dilution chamber upon opening of a valve.

5 19. A method to analyze and detect the presence of a substance in a single device, comprising:

- a- collecting a sample;
- b- mixing the sample with a dilution liquid inside a dilution
10 chamber; and
- c- exposing the sample-dilution liquid mixture to means for detecting the presence of the substance being sampled.

20. The method of Claim 19, characterized because the method uses the
15 device of Claim 1.

21. The method of Claim 19, wherein the means for detecting the presence of the substance being sampled is a membrane containing an element capable of detecting the presence of the substance being sampled.
20

Abstract

The present invention is related to providing a device for sampling, diluting and analyzing particles and substances normally located on surfaces, wherein said device comprises a collection system which, through a rotating collecting surface and a scraper gather the sample. The device also comprises a tank-like storage system to store the diluting solution and a dilution chamber that permits the sample to mix with the solution and be diluted. This mixture is subsequently placed in contact with a detection system which is capable of discerning the presence or not of the substance being sampled.

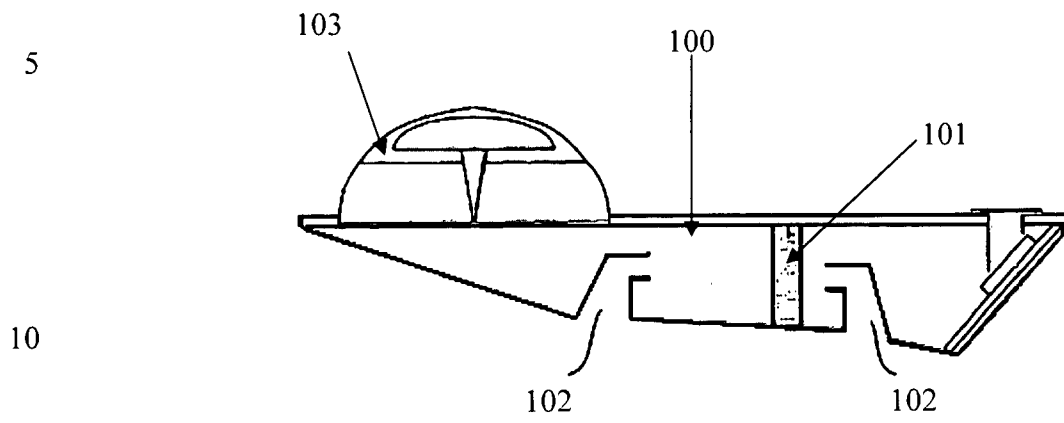


FIGURE 1A

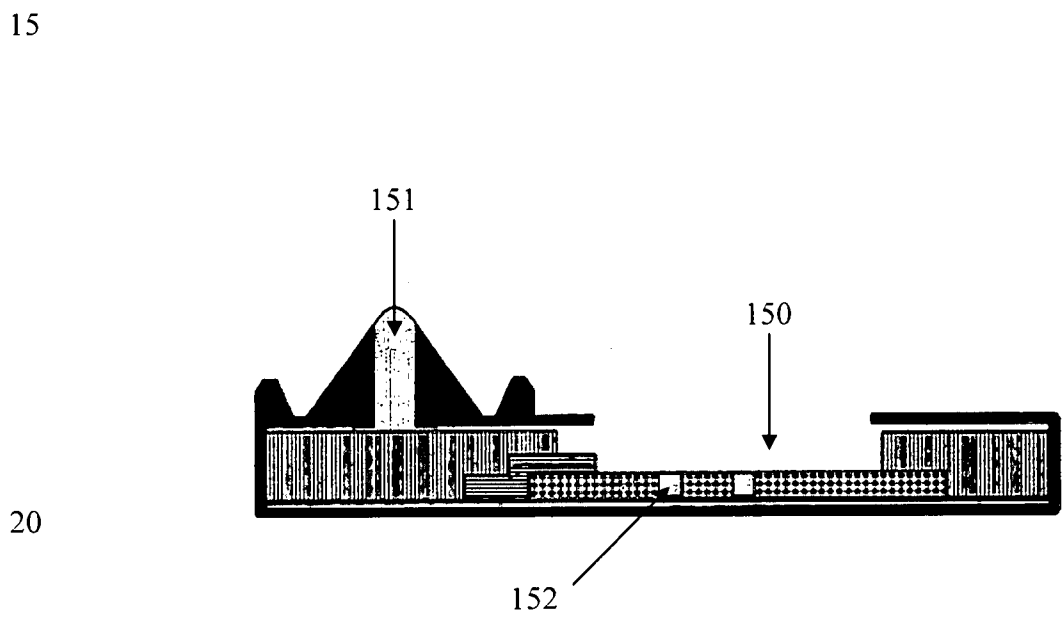


FIGURE 1B

5

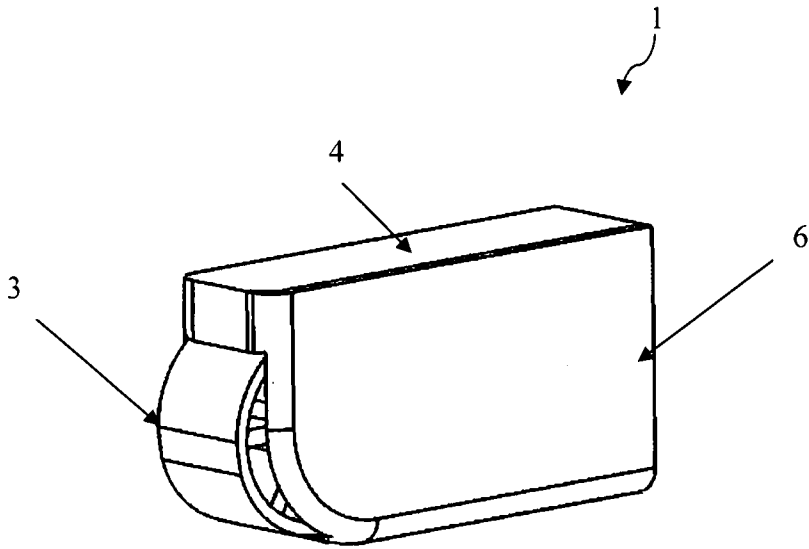


Figure 2A

10

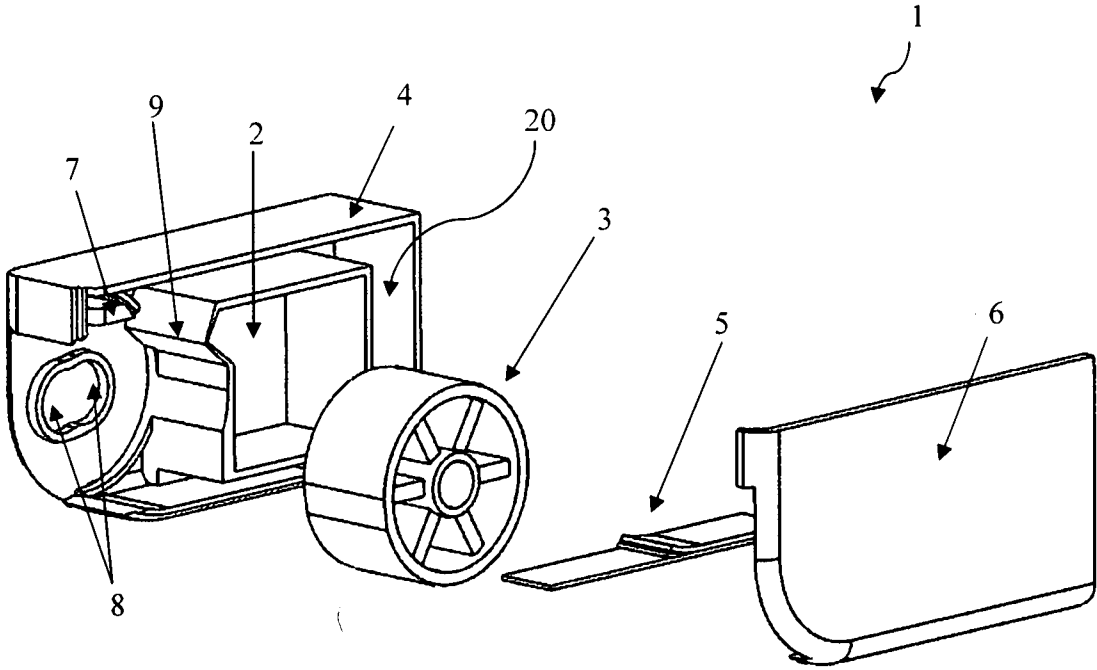


Figure 2B

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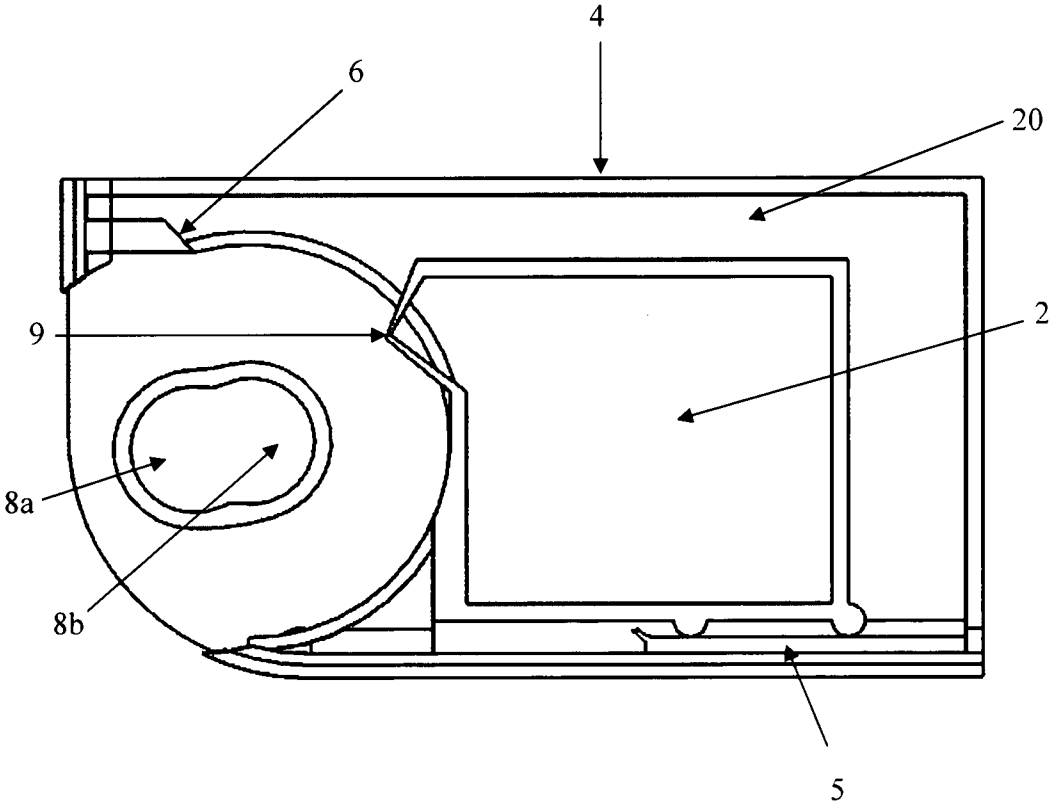


Figure 3

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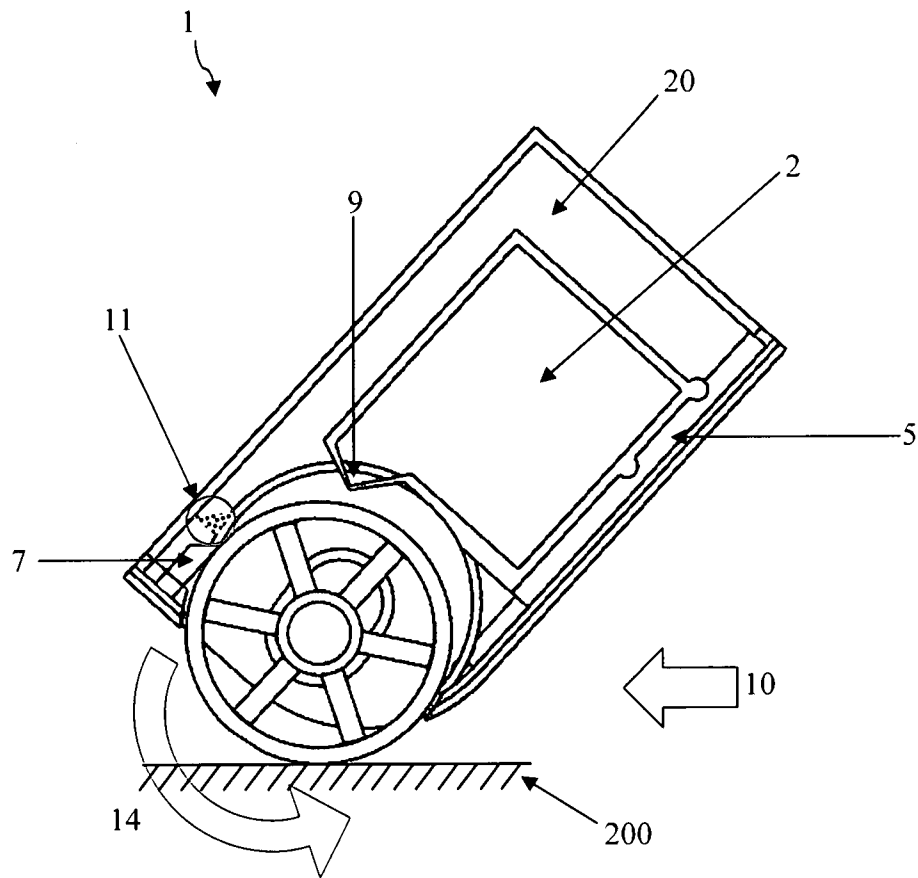


Figure 4A

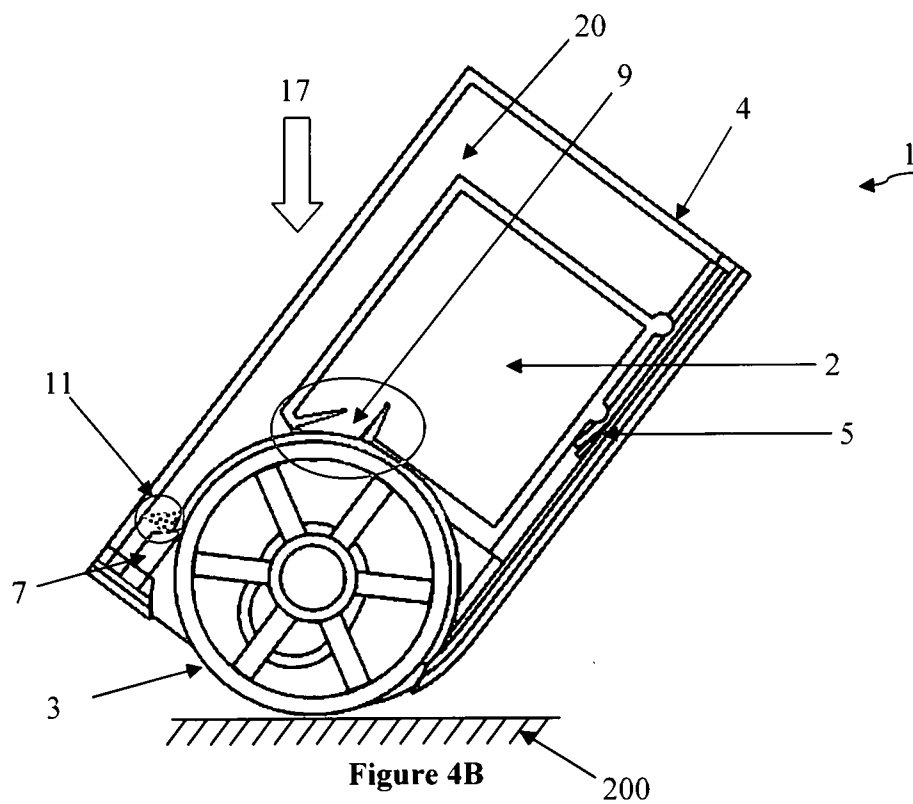
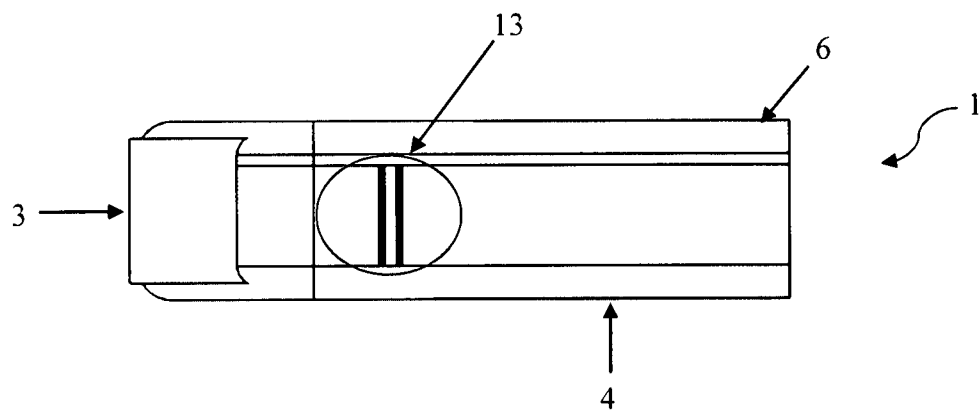
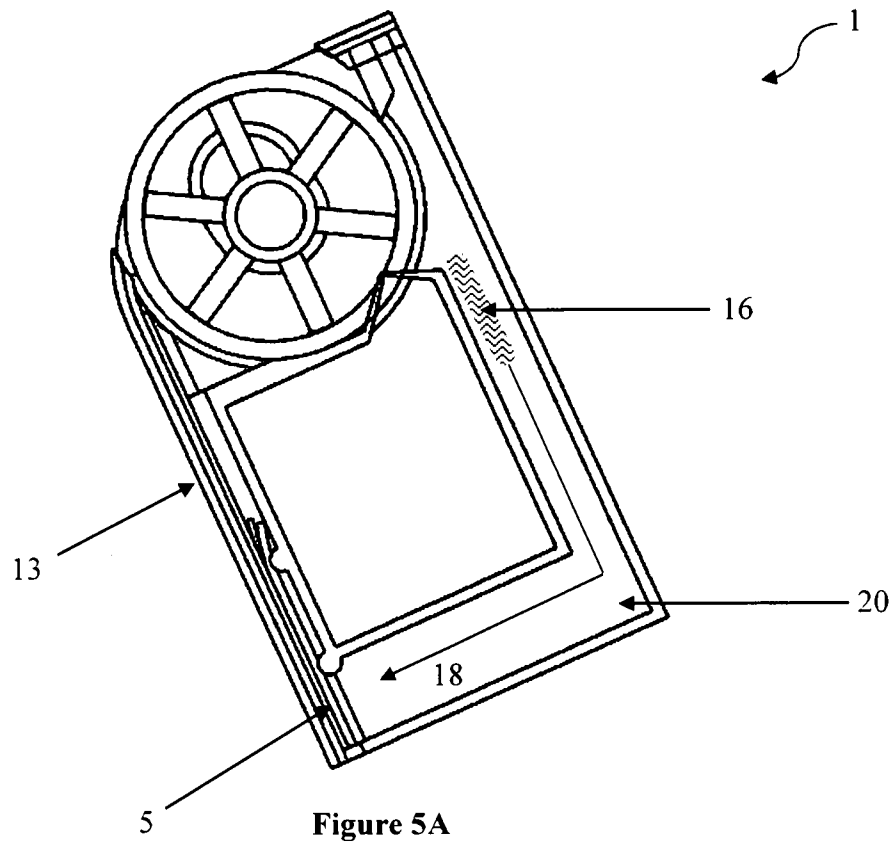
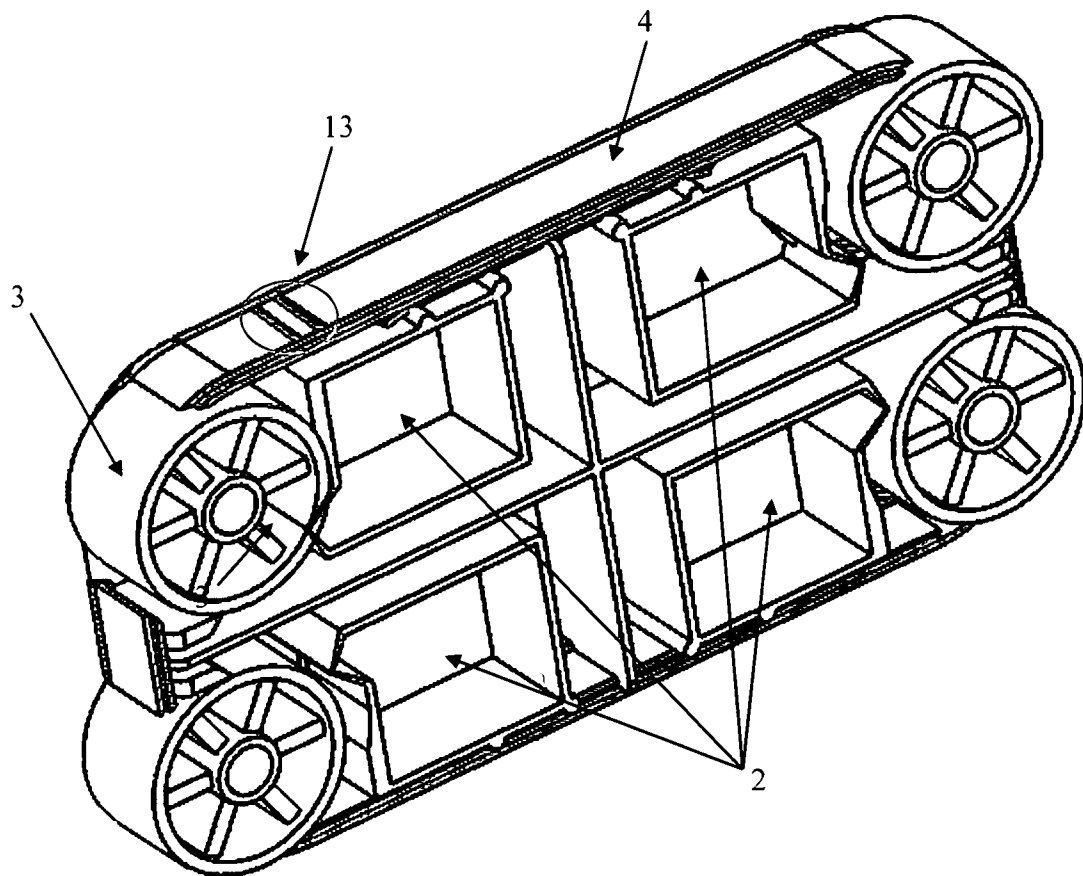


Figure 4B



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Figure 6

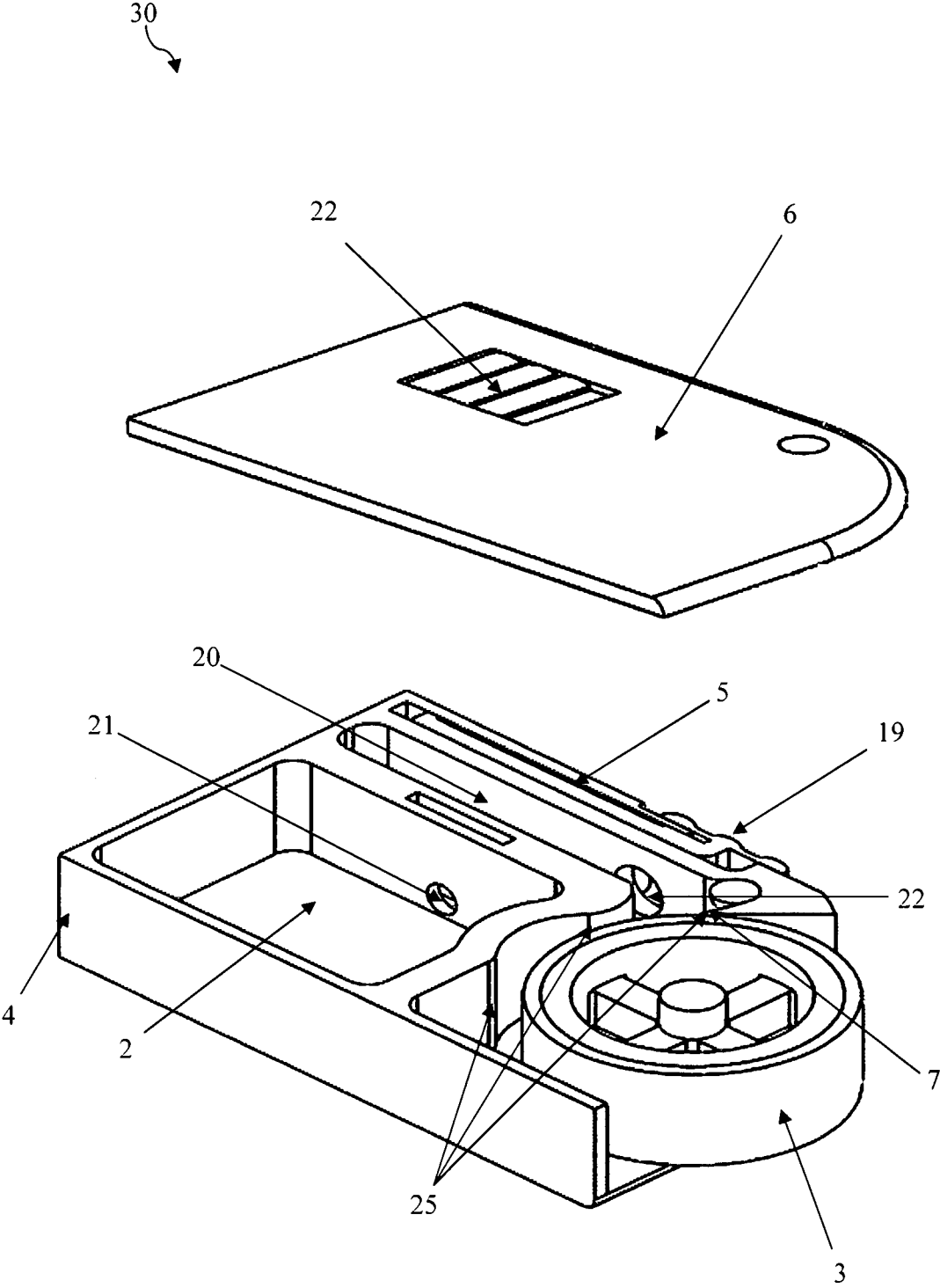
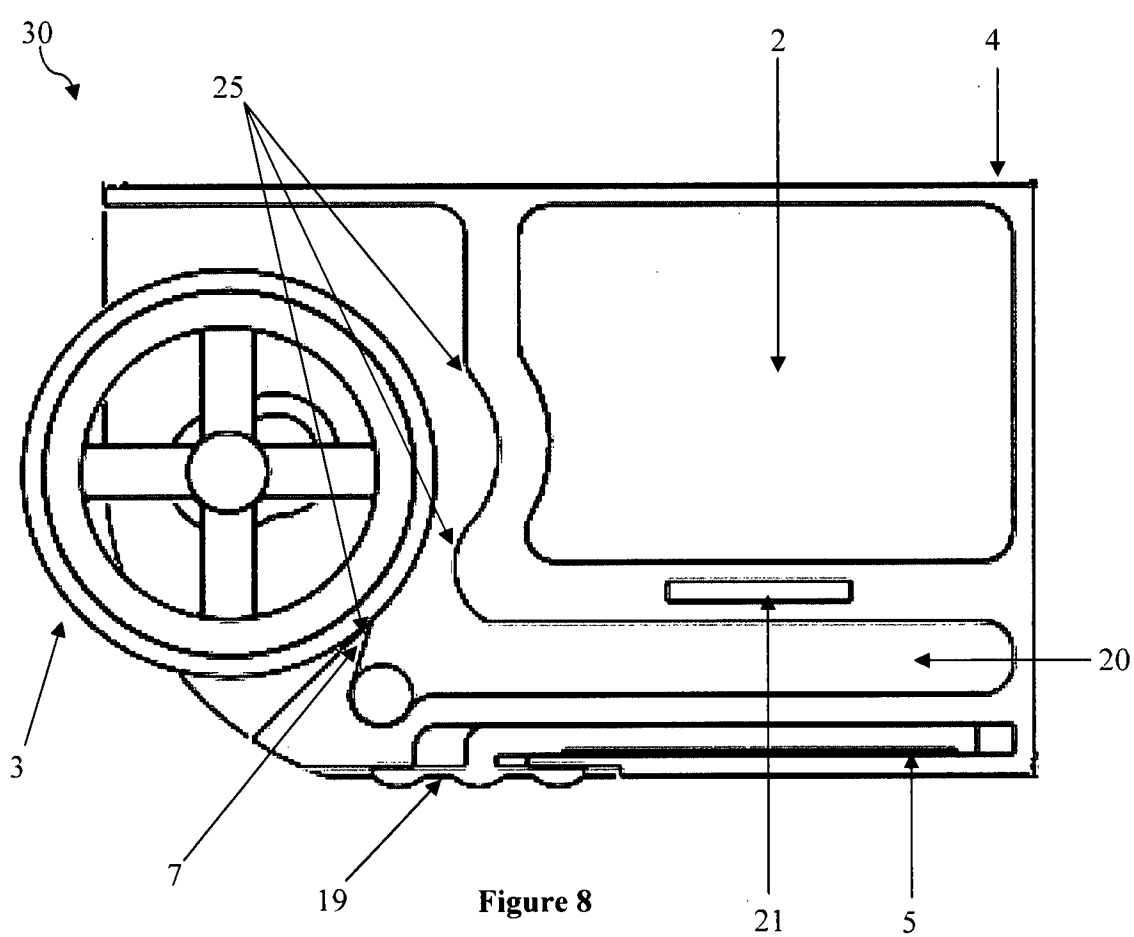


Figure 7

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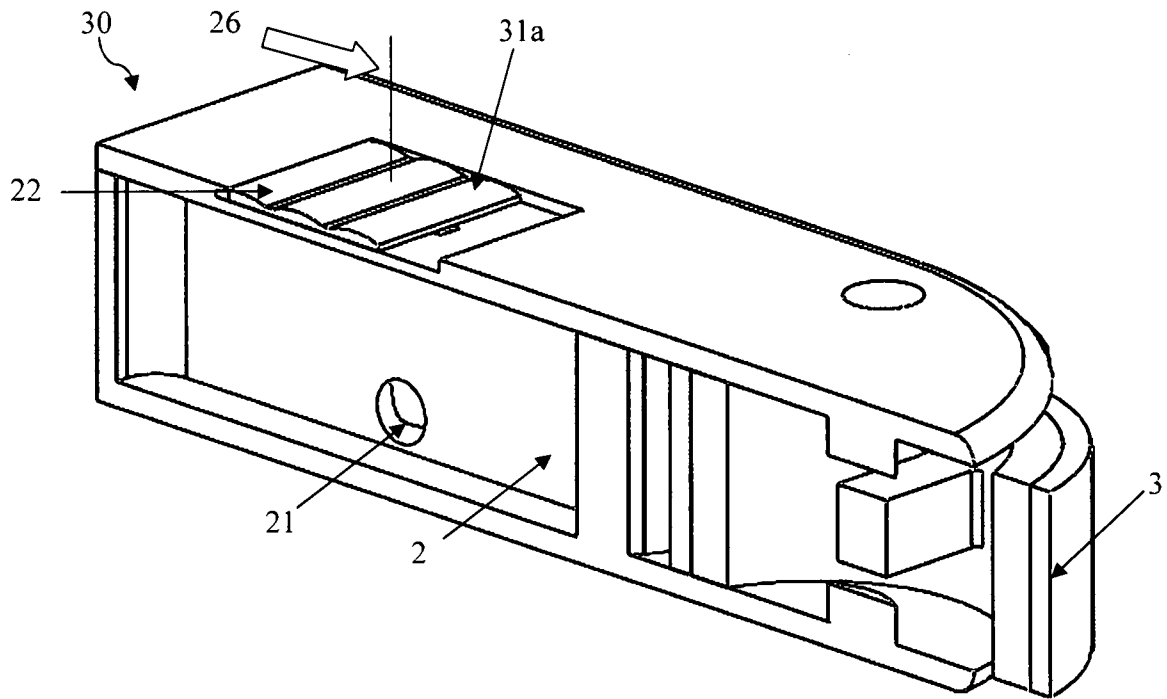


Figure 9A

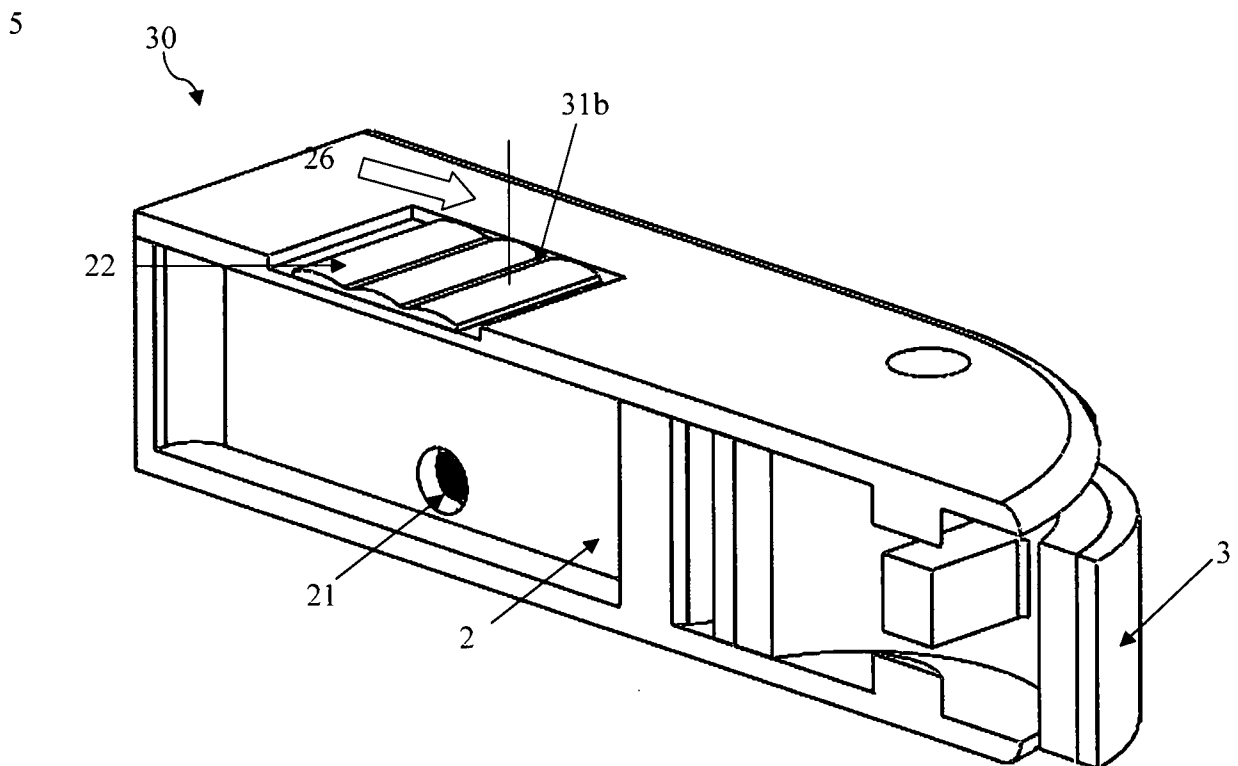


Figure 9B

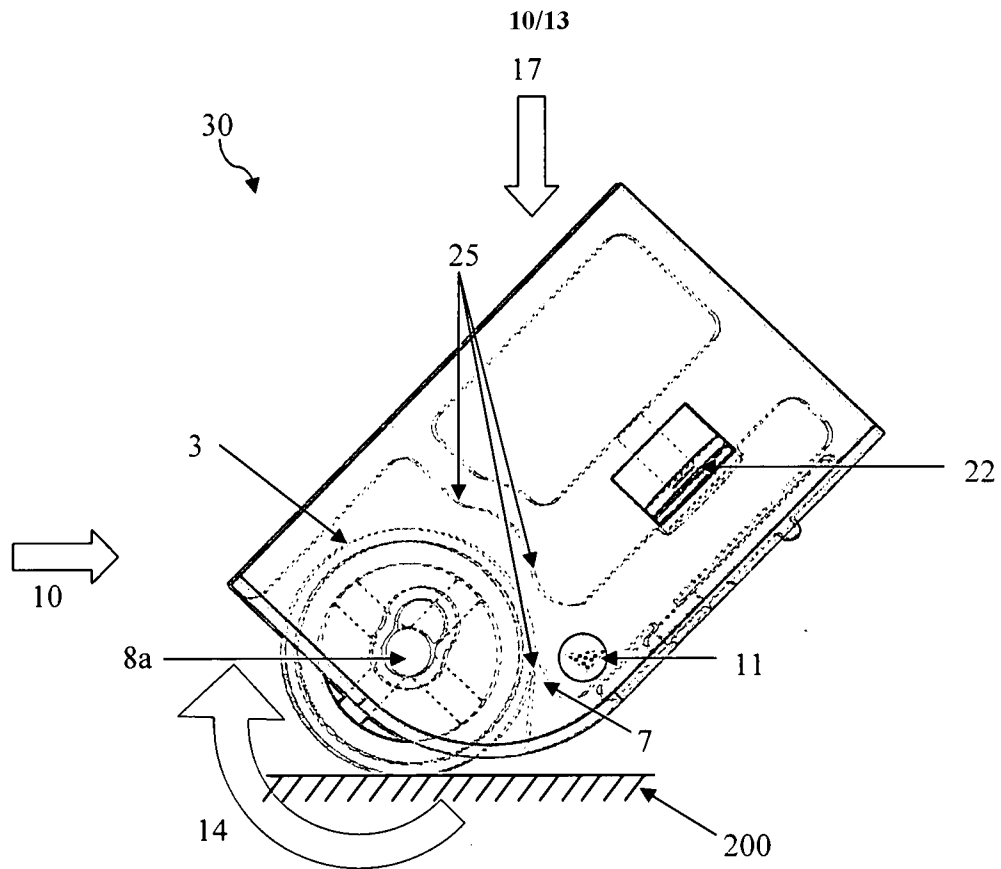


Figure 10A

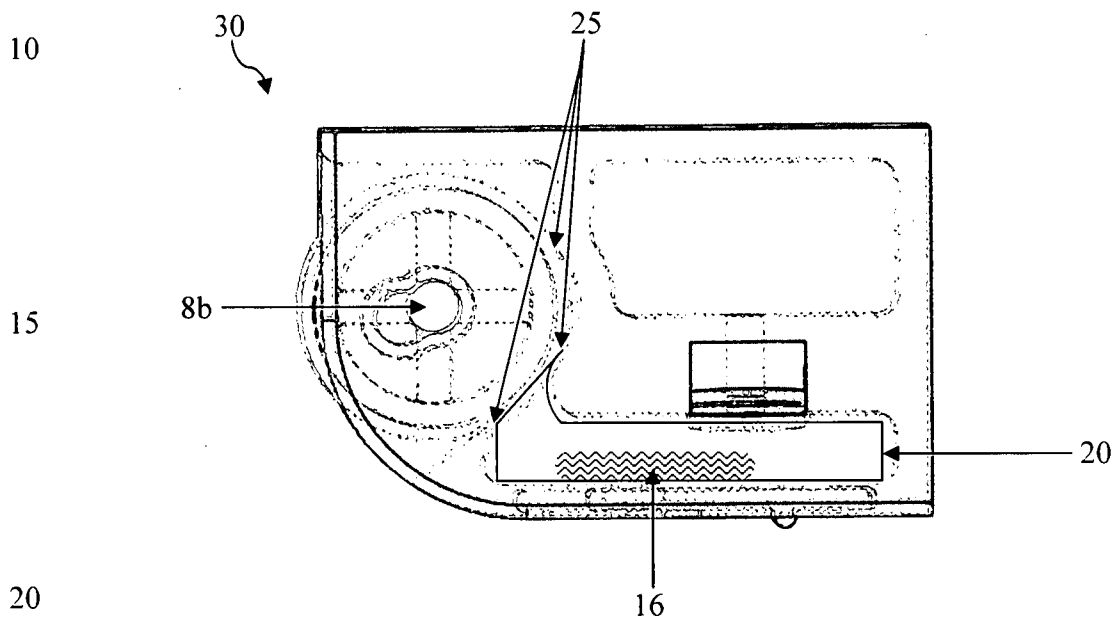


Figure 10B

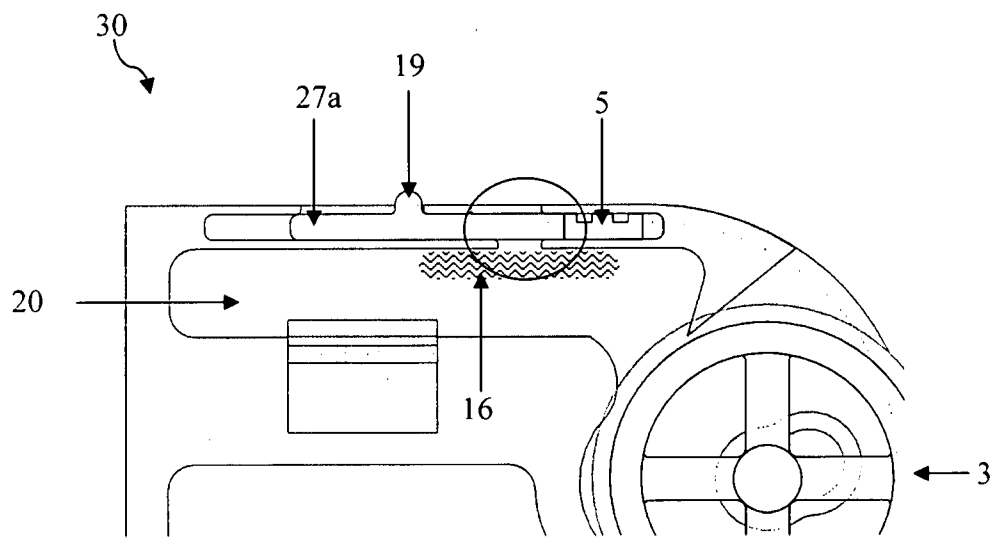


Figure 11A

5

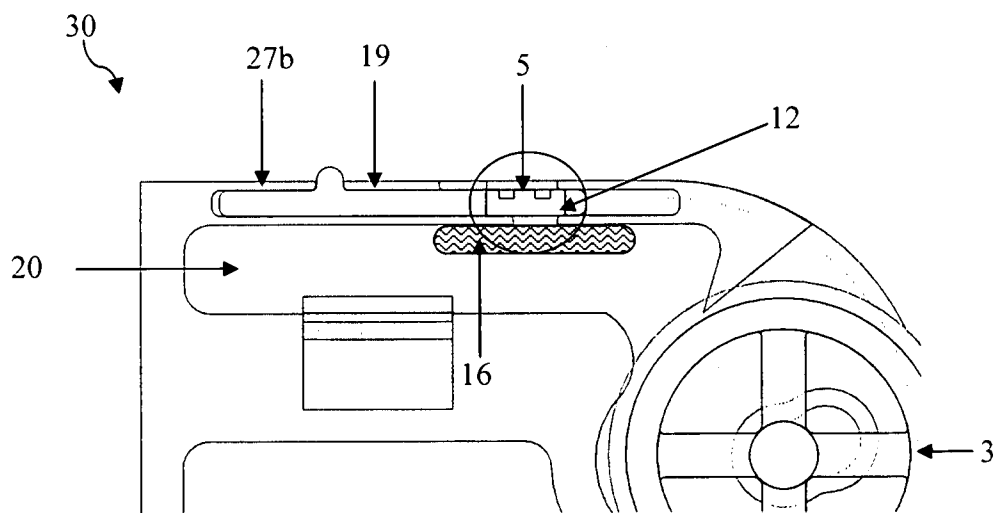


Figure 11B

10

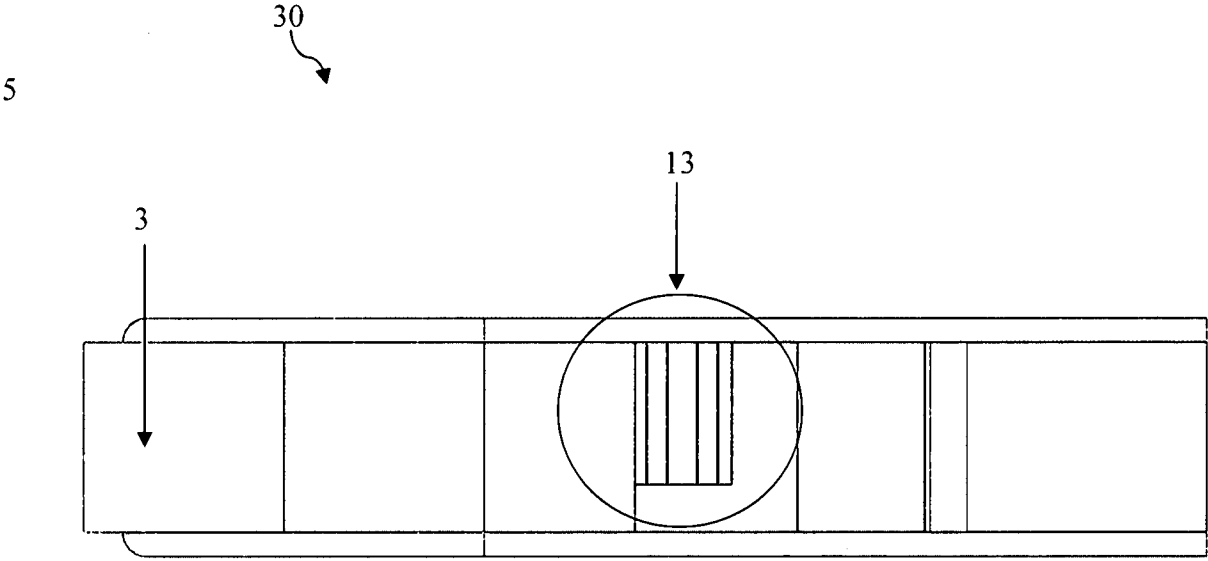


Figure 12

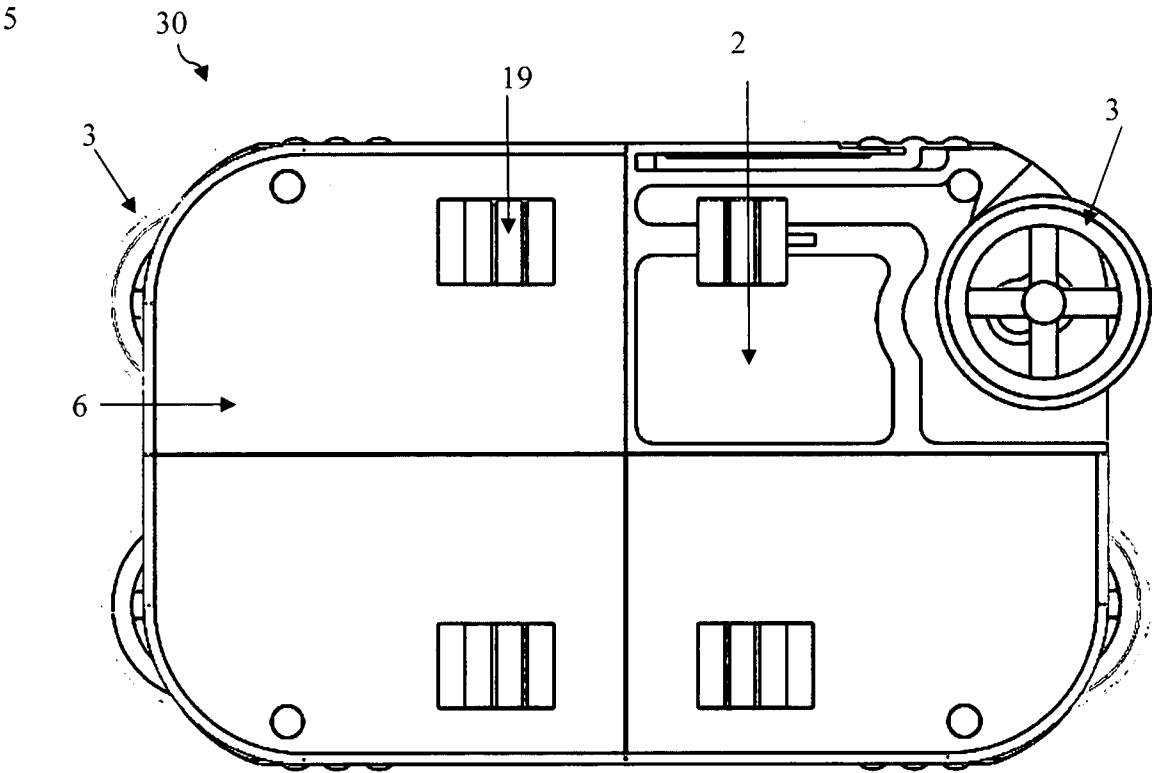


Figure 13

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2010/000176

A. CLASSIFICATION OF SUBJECT MATTER
INV. G01N33/487 B01L3/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G01N B01L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, BIOSIS, EMBASE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2007/100500 A2 (IQUUM INC [US]; CHEN SHUQI [US]; CHEN LINGJUN [US]) 7 September 2007 (2007-09-07)	1,19,20
Y	claims 1,27 paragraph [0047]	2-18,21
Y	----- WO 01/11374 A2 (BIOSTAR INC [US] THERMO BIOSTAR INC [US]) 15 February 2001 (2001-02-15)	2-18,21
A	claims 1-10 ----- DE 199 09 891 C1 (DRAEGER SICHERHEITSTECH GMBH [DE]) 11 January 2001 (2001-01-11) cited in the application the whole document ----- -/--	1-21

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Jones, Laura

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International application No

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