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(54) Title: METHOD TO DETERMINE THE FLUID VOLUME AS DISCHARGED FROM A FLUID CONTAINER AND DISPENSER

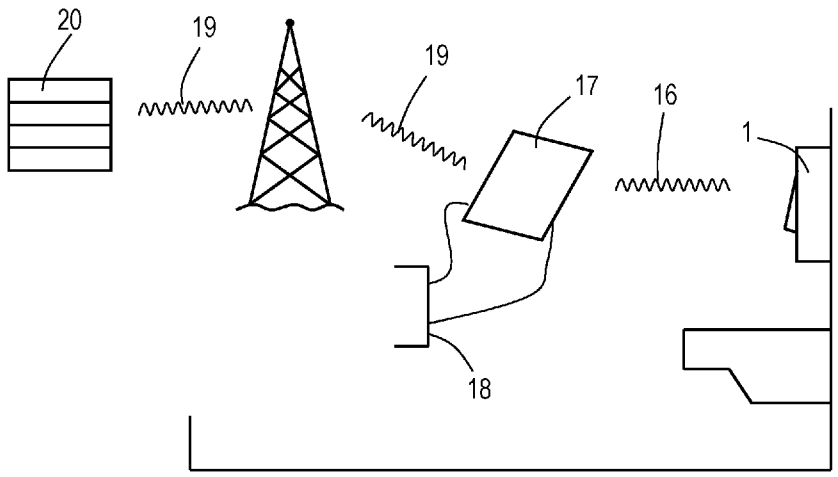

Fig.2

(57) Abstract: The invention is directed to a method to determine the fluid volume as discharged from a fluid container by activating a moveable actuator, wherein the displacement of the moveable actuator is measured in time by one or more magnetometer sensors resulting in displacement data and wherein the volume of fluid as discharged is determined by using the displacement data. Also a dispenser is claimed suited for the method.

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[Continued on next page]

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— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

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METHOD TO DETERMINE THE FLUID VOLUME AS DISCHARGED FROM A FLUID CONTAINER AND DISPENSER

The invention is directed to a method to determine the fluid volume as discharged from a fluid container by activating a moveable actuator and to a dispenser suited for such a method.

In many applications a need is present for checking the contents of a fluid container. This may be the person having to replace an empty fluid container by a full fluid container. Also from a management point of view, it can be difficult to know in advance how much filled fluid containers should be ordered and kept in stock. For these reasons, there is a need for monitoring the actual use of the fluid and for signalling in some suitable manner to a central service office or to the local person instructed to replace the empty fluid containers if a particular fluid container needs refilling. One aspect of the above is the measurement or prediction of the volume of fluid as discharged from a fluid container over time. One such a method is described in EP-A-2322068. In this publication a method is described wherein the amount of fluid is determined by first generating electricity using the movement of the manually operated actuator. The amount of fluid discharged is calculated using at least one feature of the energy thus generated.

US2015/035678 describes a method wherein a gyroscope sensor measures the change in the angle of a lever or actuator when the dispenser is used. The sensor is positioned in the lever or actuator of the dispenser. This measurement provides information on how much soap is dispensed by the user. Furthermore, data is collected which allows one to predict when a fluid container needs to be replaced by a new one. The publication also refers to a magnetometer and accelerometer which is used to detect when an enclosure of the dispenser is opened or closed. A skilled person would find disclosed a so-called Micro-Electro-Mechanical Sensors (MEMS) which combines the afore mentioned sensors. The magnetometer in such a sensor measures changes in the earth magnetic field.

A disadvantage of the method and dispenser is that the accuracy is not high enough to predict the volume of soap as discharged from the fluid container over time. The present inventions aims to provide a more accurate method and dispenser.

This is achieved by the following method and fluid dispenser. Method to determine the fluid volume as discharged from a fluid container by activating a moveable actuator, wherein the displacement of the moveable actuator is measured in time by a magnetometer which measures the magnetic force of a magnetic material positioned near the magnetometer resulting in displacement data and wherein the volume of fluid as discharged is determined by using the displacement data.

Fluid dispenser comprising a fluid container, a fluid or foam pump fluidly connected to the fluid container, a moveable actuator connected to the pump such to manually actuate the pump, a magnetometer and a magnetic material positioned near the magnetometer, wherein the magnetometer is suited to measure the position of the moveable actuator, a data storage and a wireless communication means suited to communicate data from the storage to an external device.

Applicants have tried to optimise the process of US2015/035678 and found that the use of the accelerometer provided some improvement in accuracy over the use of a gyroscope sensor. The improvement however was not enough for the process to be commercially applicable. The magnetometer using the earth magnetic field did not provide an improvement in accuracy. It could detect large movements which makes it suitable for detecting if the cover of a dispenser is opened as described in US2015/035678. It was not suited to measure the relatively smaller movements of a moveable actuator for measuring displacement data suited to determine the volume of fluid as discharged. Applicants now found that using a magnetometer in combination with a magnetic material, a magnet, and not using the earth magnetic field a significantly more accurate process is obtained to measure the volume of fluid discharged from a fluid container. Further advantages will be described below.

The fluid container is suitably fluidly connected to a pump suited to discharge fluid from the fluid container. Such arrangements are well known and examples will be described below. In addition to a pump or in the absence of a pump the fluid container may comprise a fluid as present at an elevated pressure. The force causing the fluid to be discharged from the fluid container results from the pressure difference between the environment to which the fluid is discharged and the more elevated pressure within the fluid container. Examples of such fluid containers are consumable fluid, i.e. drinks, containers. Such containers may be pressurised by any inert pressurized gas, such as for example nitrogen and preferably carbon dioxide. The discharge of fluids from such containers may be actuated by using a tap as the actuator. The tap may be provided with the magnetometer- magnetic material combination according to this invention.

The magnetometer will measure the movement of the magnetic material. The magnetic force measured is the magnetic force caused by the magnetic material positioned near the magnetometer. The magnetic material may for example be part of the moveable actuator and the sensor may be positioned in a stationary position nearby or vice versa. Preferably the magnetic material is part of the moveable actuator. The actuator may move horizontally, vertically, under an angle or in a rotational direction. The magnetometer measures a displacement of the actuator, i.e. its absolute or incremental angle of rotation and/or its absolute position and displacement or the incremental displacement relative to a reference point. Preferably the actuator moves along a horizontal pivot. For such a dispenser the magnetic material is preferably connected to the horizontal pivot. This allows to measure the absolute and/or incremental angle of rotation of the pivot, preferably by making use of the Hall effect. More preferably the magnetic material rotates with the pivot and comprises a north pole and a south pole in two or more radial sections of the material and wherein the magnetometer is positioned in a stationary position and co-axial to the pivot axis and which magnetometer measures the displacement of the moveable actuator in time by measuring the absolute and/or incremental angle of rotation of the pivot making use of the Hall effect.

In use, a user will typically start using the actuator when the actuator is in its starting position. The starting position is the position to which the actuator returns after use. For

example resilient means, like a spring, may be present which bring the actuator to its starting position when no force is exercised on the actuator. This is referred to as the negative displacement in contrast to the positive displacement which results in a pumping action and discharge of the fluid. When using the magnetometer it may measure the displacement in the positive and negative directions and thus exactly know the length of the displacement of each stroke of the actuator and the position at which said stroke starts and ends. Thus even if the actuator is repeatedly used in one session, i.e. in one user interaction, an accurate measurement can be made of the displacement in both positive and negative directions. When this displacement data is used in combination with the known pump characteristics a more accurate estimation can be made of the volume discharged in one such a session.

The method is suitably used to determine the fluid volume as discharged from a fluid container, which is part of a soap or foam dispenser. Such a soap or foam dispenser will be used by multiple users and multiple times. The displacement data will thus comprise data as measured during multiple user sessions. The displacement data may be stored on a computer-readable storage media, such as RAM or Flash memory, located at the fluid container and pump. Preferably the storage medium and the one or more inertial navigation sensors are combined in one functional unit.

Each type of pump will have different characteristics as to the volume of fluid discharged as a function of the displacement of the actuator. For a given pump type such pump characteristics can be determined by measuring the volume of fluid discharged for a large number of actuator displacements. This data set can for example be used to build a mathematical model or a table, which can be used as a predetermined pump characteristics. Suitably the volume of fluid as discharged is determined using the predetermined pump characteristics. The pump characteristics provide an estimate of the volume of fluid as discharged by the pump for the measured displacement data.

Suitably the determination using the predetermined pump characteristics is performed on a processor present at the fluid container and pump and wherein the resultant volume of fluid as discharged data are stored on a computer-readable storage

media located at the fluid container and pump. The processor is suitably a microcontroller configured to execute software stored on memory. The software is suited to calculate the volume of fluid as discharged using stored displacement data and stored pump characteristics as input and suited to store the calculated volume of fluid as discharged data on memory.

Suitably the stored displacement data and/or volume fluid as discharged data are continuously or intermittently communicated by a wireless communication to an external device. Such communication may be any wireless communication and suitably a low energy communication means. This is advantageous because no connection to the grid nor large batteries will then be required. Preferably the low energy communication means is a so-called wireless personal area network (PAN) system such as for example INSTEON, IrDA, Wireless USB, Bluetooth, WIFI, Z-Wave, ZigBee or a Low Power Wide Area Network (LPWAN). The external device may be any device which can store this data, manipulate this data and/or re-transmitted this data or optionally manipulated data to a next device. For example, the low energy communication typically communicates with an external device in the proximity of the fluid pump and fluid container. To collect data from multiple fluid pumps and fluid containers it may be preferred that the external device comprises a so-called gateway and which gateway can re-transmit this data or optionally manipulated data to a next device. The gateway may be a dedicated gateway positioned in the proximity of the fluid pump and fluid container or be part of a mobile device such as a tablet, a mobile phone or laptop computer. The gateway can communicate to the next device via a cable network, wireless communication, such as WIFI, broadband internet access or any other computer networking technology.

The next device may be may be a computer server. For example the external device which collects the data when in the proximity of a plurality of different pump and fluid containers may be a tablet, laptop or mobile phone which re-transmit the data to a computer server. The data will be processed by software running on the computer server and the manipulated data may be presented on the tablet or mobile phone. The software running on the computer server may be a centralised inventory management logic which can determine the optimal strategy for replacing fluid containers and/or maintaining a

sufficient inventory of replacement fluid containers. This is advantageous for the users of the soap or foam dispensers using the method according to the invention because they can predict when fluid containers need replacement. This information is also useful for the provider of the replacement fluid containers because it is known how much replacement fluid containers are required to continue operation and keep stock low.

Preferably the data as generated by the software running on the computer server will be presented on the tablet, laptop or mobile phone as a virtualised output of the software running on the computer server. This is advantageous because less computing power is then required for the external mobile devices and the most up to date information is available for every user.

Alternatively with respect to the above it is also possible that the external device uses the stored displacement data and/or volume fluid as discharged data to determine if or when the fluid container needs to be refilled or replaced by another fluid container comprising fluid. For this purpose the external device should have enough computing power to perform this determination.

Communication with this external device may be initiated automatically when the external device is in the proximity of the fluid pump-fluid container combination.

The magnetometer sensors, optional storage medium, processor and wireless communication means may require electrical energy to function. Preferably a battery is used such as a lithium ion battery. In some cases it may be preferred to use a relatively small battery, such as a replaceable battery like a 3 volt coin cell CR2032 or CR2450 battery. The required energy may also be generated using photovoltaic or by the movement of the actuator as illustrated in the prior art publication.

The invention shall be illustrated making use of the following non-limiting Figures. The method according to the invention is suitably used in combination with a soap or foam dispenser. Figure 1 shows a foam dispenser 1 consisting of a housing 2, foam pump 3 and actuator 4. Actuator 4 can move along a horizontal pivot 5. The foam pump 3 may for

example be a foam pump as described in US6053364. Such a foam pump is fluidly connected to a fluid reservoir (not shown for clarity reasons) via a coupling piece 6 and a plug 7. Plug 7 may be sealed into an opening of the fluid reservoir. The fluid reservoir is preferably a flexible plastic bag. The actuator 4 is provided with a flexible bar 8 which acts as the resilient member to bring the actuator back to its starting position. When the actuator 4 moves in its positive direction it pushes pump 4 inwards via extension 9 and liquid will be discharged from the liquid container via plug 7. When the actuator 4 moves back in its negative direction due to the force of the flexible bar 8 the pump head 11 is pulled outwardly by extension 10 of actuator 4. Housing 2 is further provided with openings 12 to attach the housing to a vertical wall. The combined pump 3, coupling piece 6, plug 7 and fluid container is placed into the housing 2 of the dispenser 1 by opening the actuator 4 under a large angle creating an opening for placing this combination in the housing. By snapping the coupling piece into holder 13 the combination is fixed in a well-defined manner within the dispenser housing. In this manner it is possible to quickly replace a used combination with a re-fill combination.

Figure 1 also shows a unit 14 comprising a magnetometer sensor, a battery and means for a wireless communication by means of Bluetooth. The magnetometer can measure the absolute and incremental angle with the vertical and thus provide an accurate position of the actuator. The magnetic material (not shown) is connected to the stationary housing 2. This enables the measurement of the displacement of the actuator. When the actuator is opened for replacing the pump and fluid container combination a very large angle will be measured. This information can also be used.

In a preferred embodiment a dispenser is used as in Figure 1 except in that the magnetic material is part of the pivot 5. This dispenser does not necessarily have a sensor 14 as part of the actuator. This is advantageous because it makes fabrication of the actuator simpler. The magnetic material 21 rotates with the pivot 5 and comprises a north pole 22 and a south pole 23 in two or more radial sections of the material as shown in Figure 3. The magnetometer 24 is positioned in a stationary position to housing 2 and co-axial to the pivot axis 25 and which magnetometer 24 measures the displacement of the moveable actuator

in time by measuring the absolute and/or incremental angle of rotation of the pivot 5 making use of the Hall effect.

Figure 2 shows a dispenser of Figure 1 as part of a toilet environment communicating by means of a Blue Tooth communication 16 with a mobile external device 17, such as a tablet or mobile phone. The communication is initiated when the user 18 enters the toilet environment. The Bluetooth communication 16 will have to be in its advertisement mode in order to initiate the connection with the mobile device 17. The advertisement mode may be activated every 0.1 to 10 seconds, i.e. the minimum time at which a user will typically be in the space, or alternatively activated when the light is turned on using a light sensor which may be part of the set of sensors comprised in one device. The mobile external device may provide user 18 information regarding the fluid volume as discharged from a fluid container of dispenser 1 and provide information if the fluid container needs to be replaced by another fluid container comprising fluid. Such communications is preferably by means of an output screen provided by the mobile device. The mobile device may be provided with software suited to manipulate the received data via communication 16 to obtain the above information and/or instructions. The data received by the mobile device 17 may be sent via a broad band internet communication 19 to a central computer server 20. The software running on central computer server 20 can manipulate data received from different dispensers.

The invention is also directed to the above described fluid dispenser, as for example shown in Figure 1, and comprising a fluid container, a fluid or foam pump fluidly connected to the fluid container, a moveable actuator connected to the pump such to manually actuate the pump, a magnetometer and a magnetic material positioned near the magnetometer, wherein the magnetometer is suited to measure the position of the moveable actuator, a data storage and a wireless communication means suited to communicate data from the storage to an external device. The fluid dispenser may comprise of a rear body which is suited to be fixed to a vertical wall and an actuator pivotally engaged along a horizontal pivot when fixed to such a wall. Preferably the magnetic material is connected to or is a part of the horizontal pivot. More preferably the magnetic material comprises a north pole and a south pole in two or more radial sections of the material and

wherein the magnetometer is positioned in a stationary position and co-axial to the pivot axis and connected to the rear body as for example shown in Figure 3. The magnetometer sensors are suitably those described earlier. In general the preferred embodiments described for the method also apply for the fluid dispenser if so applicable. The fluid dispenser is suitably used in the method according to the invention.

The invention shall be further illustrated by making use of the following Examples.

Comparative Experiment A

A InvenSense MPU-9250 sensor as obtained from InvenceSense Inc, San Jose, California was placed in the moveable actuator as shown in Figure 1. In a professional test bench using FESTO Motorcontroller device provided with a FESTO cylinder we used to move the actuator such to pump a volume of soap from the liquid container. The actuator was pushed 150 or 200 times at different frequencies, at different temperatures and at different strokes wherein 100% is a full stroke meaning that the actuator is pushed to its maximum position. The angular absolute and relative displacements of the actuator was measured using the accelerometer of the InvenSense MPU-9250 sensor. An optimal algorithm was made to translate the displacement data to fluid discharge data expressed in ml. The results are presented in the Table.

Example 1.

Experiment A was repeated except that a AMS AS 5600 (Rotation Sensor) as obtained from Ams AG, Austria was connected to the housing at a position co-axial to pivot 5 of Figure 1. A magnet was connected to pivot 5, which magnet rotates together with the pivot when the actuator is pushed. This set-up is schematically presented in Figure 3. This example illustrates the process according to the invention. The distance between the magnet and the exterior of the sensor was 3 mm. An optimal algorithm was made to translate the displacement data to fluid discharge data expressed in ml. The results are presented in the Table below. These results show a significantly more accurate prediction of the number of pushes and the volume of fluid discharged when measured according to Example 1 (the invention) as compared to the results of Experiment A.

Table

Run	Number of pushes	Start position of actuator stroke	End position of actuator stroke	# Push per second	Actual fluid discharge (ml)	Measured pushes Experiment A	Measured discharge (ml) Experiment A (% deviation)	Measured pushes Example 1 with AMS AS 5600	Measured discharge Example 1 (ml) (% deviation)
1	200	0%	100%	1	7.9	199	62.1 (27%)	200	75.2 (5%)
2	200	0	80%	1	60.1	199	47.5 (26%)	200	63.4 (-5%)
3	200	0	60%	1	39.8	195	28.1 (42%)	200	39.2 (2%)
4	200	25%	100%	1	67.1	201	50 (34%)	200	65.9 (2%)
5	200	50%	100%	1	41.0	132	17.2 (138%)	200	39.2 (5%)
6	150	0	100%	2	59.8	150	49.7 (20%)	150	56.1 (7%)
7	150	0	60%	2	29.4	114	23.4 (26%)	150	30.7 (-4%)
8	150	0	100%	3	56.7	150	49.2 (15%)	150	55.7 (2%)
9	150	0	60%	3	29.1	150	20.9 (39%)	150	26.7 (9%)

CLAIMS

1. Method to determine the fluid volume as discharged from a fluid container by activating a moveable actuator, wherein the displacement of the moveable actuator is measured in time by a magnetometer which measures the magnetic force of a magnetic material positioned near the magnetometer resulting in displacement data and wherein the volume of fluid as discharged is determined by using the displacement data.

2. Method according to claim 1, wherein the fluid container is fluidly connected to a pump suited to discharge fluid from the fluid container.

3. Method according to any one of claims 1-2, wherein the fluid container comprises a fluid as present at an elevated pressure and wherein a force causing the fluid to be discharged from the fluid container results from the pressure difference between the environment to which the fluid is discharged and the more elevated pressure within the fluid container.

4. Method according to any one of claims 1-3, wherein the actuator moves along a horizontal pivot and wherein the magnetic material is part of the moveable actuator.

5. Method according to claim 4, wherein the magnetic material is connected to the horizontal pivot.

6. Method according to claim 5, wherein the magnetic material rotates with the pivot and comprises a north pole and a south pole in two or more radial sections of the material and wherein the magnetometer is positioned in a stationary position and co-axial to the pivot axis and which magnetometer measures the displacement of the moveable actuator in time by measuring the absolute and/or incremental angle of rotation of the pivot making use of the Hall effect.

7. Method according to any one of claims 1-6, wherein the displacement data are stored on a computer-readable storage media located at the fluid container and pump.

8. Method according to any one of claims 2-7, wherein the volume of fluid as discharged is determined using a predetermined pump characteristics, which pump characteristics provide an estimate of the volume of fluid as discharged by the pump for the measured displacement data.

9. Method according to claim 8, wherein the determination using the predetermined pump characteristics is performed on a processor present at the fluid container and pump and wherein the resultant volume of fluid as discharged data are stored on a computer-readable storage media located at the fluid container and pump.

10. Method according to any one of claims 7-9, wherein the stored displacement data and/or volume fluid as discharged data are continuously or intermittently communicated by a wireless communication to an external device.

11. Method according to claim 10, wherein the device is a mobile device.

12. Method according to any one of claims 10-11, wherein the wireless communication is by means of a low energy communications means.

13. Method according to claim 12, wherein the low energy communication means is by means of a wireless personal area network (PAN) or a Low Power Wide Area Network (LPWAN).

14. Method according to any one of claims 10-13, wherein the external device uses the stored displacement data and/or volume fluid as discharged data to determine if or when the fluid container needs to be refilled or replaced by another fluid container comprising fluid.

15. Method according to claim 14, wherein the external device communicates the received data or further data to a centralised inventory management logic running on a next external device which centralised inventory management logic is programmed to provide an output directed to if or when the fluid container needs to be refilled or replaced by another fluid container comprising fluid.

16. Method according to claim 15, wherein the external mobile device is a tablet, laptop or mobile phone and wherein the output provided by the next external device is presented on the tablet, laptop or mobile phone as a virtualised output.

17. Method according to any one of claims 15-16, wherein the next external device is a computer server.

18. Method according to any one of claims 2-17, wherein the pump, actuator and fluid container are part of a soap or foam dispenser.

19. Fluid dispenser comprising a fluid container, a fluid or foam pump fluidly connected to the fluid container, a moveable actuator connected to the pump such to manually actuate the pump, a magnetometer and a magnetic material positioned near the magnetometer, wherein the magnetometer is suited to measure the position of the moveable actuator, a data storage and a wireless communication means suited to communicate data from the storage to an external device.

20. Fluid dispenser according to claim 19, wherein the fluid dispenser comprises of a rear body which is suited to be fixed to a vertical wall and an actuator pivotally engaged along a horizontal pivot, when fixed to such a wall and wherein the magnetic material is connected to or is a part of the horizontal pivot.

21. Fluid dispenser according to claim 20, wherein the magnetic material comprises a north pole and a south pole in two or more radial sections of the material and wherein the magnetometer is positioned in a stationary position and co-axial to the pivot axis and connected to the rear body.

22. Fluid dispenser according to claim 21, wherein the distance between the exterior of the magnetometer and the magnetic material is less than 5 mm.

23. Use of a fluid dispenser according to any one of claims 19-22 in a method according to any one of claims 1-18.

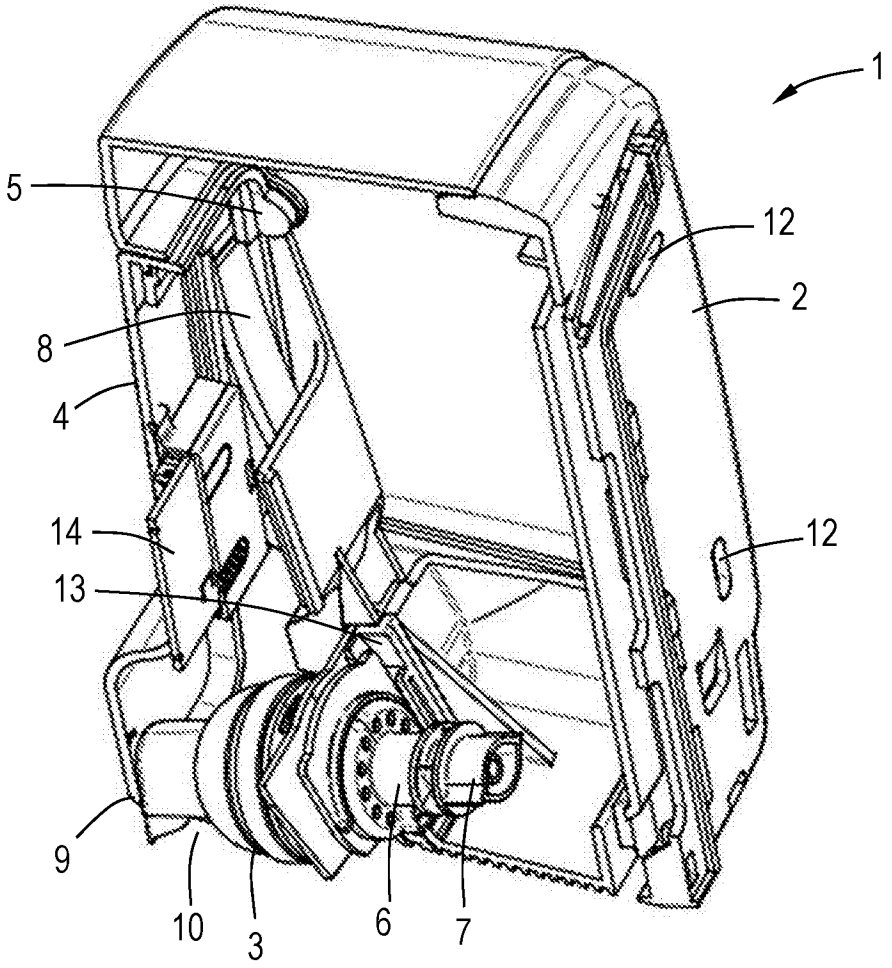


Fig.1

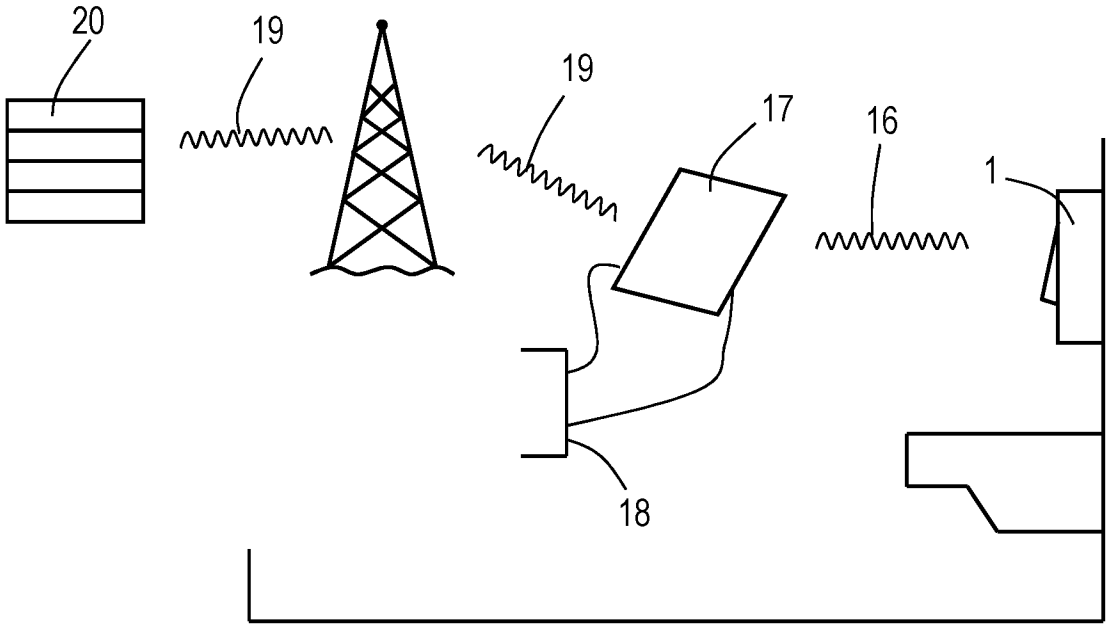
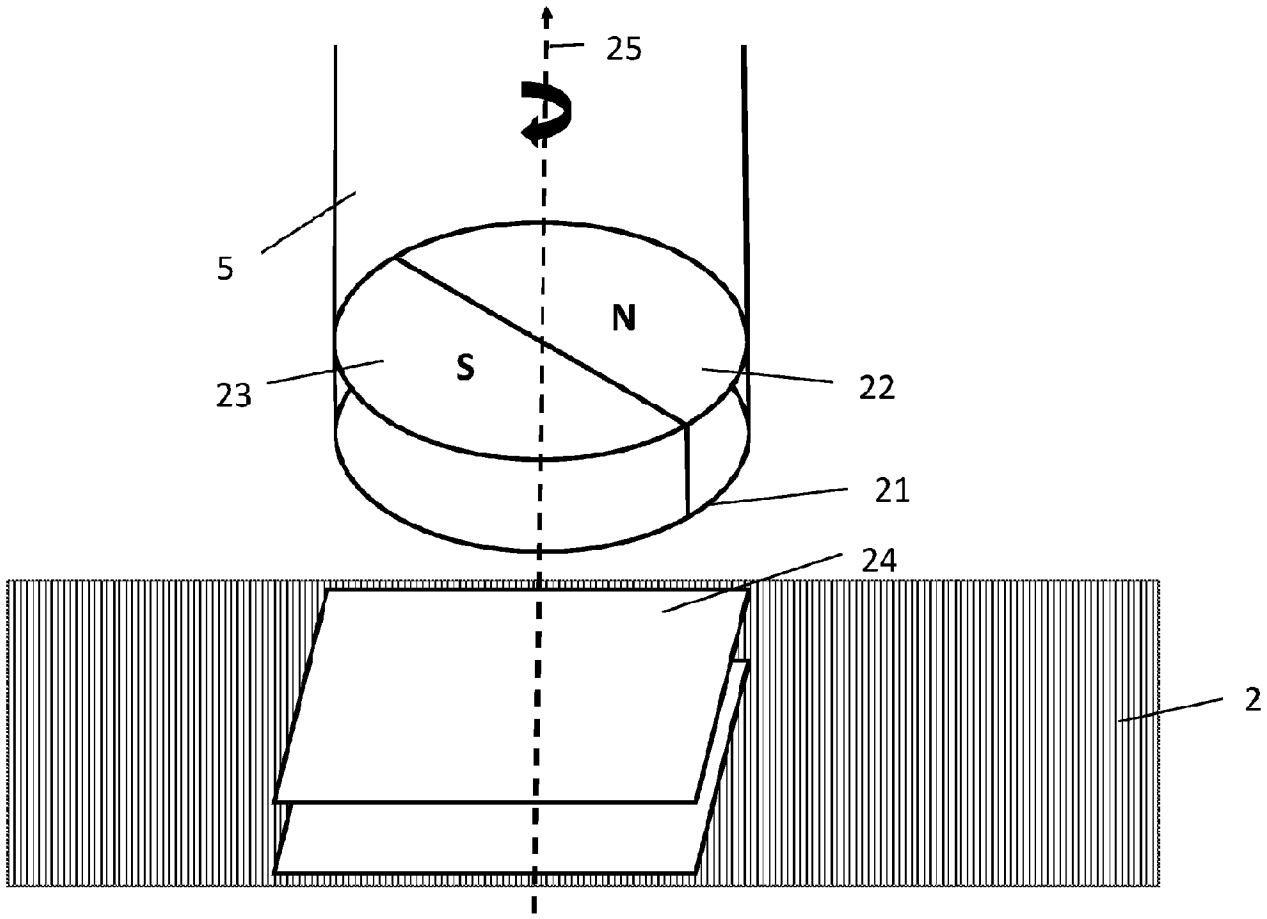


Fig.2

Fig. 3



INTERNATIONAL SEARCH REPORT

International application No
PCT/NL2017/050269

A. CLASSIFICATION OF SUBJECT MATTER
INV. G01F13/00
ADD. G01F11/00

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)
G01F A47K

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 practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 2008/149663 A1 (JOYCE JONATHAN LIVINGSTON [US] ET AL) 26 June 2008 (2008-06-26) figures 1,2 paragraphs [0007], [0013]-[0015],[0020]-[0024],[0027],[0029], [0034],[0043] -----	1-5, 7-13,18, 19,23 14-17, 20-22
X	US 2016/074587 A1 (SEARLE GARY [US] ET AL) 17 March 2016 (2016-03-17) figures 3,4 paragraphs [0001],[0007],[0008],[0043],[0045],[0047], [0048] ----- -/--	1-3, 7-13,19, 23

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
6 October 2017	13/10/2017

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Stitou, Adel

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Form PCT/ISA/210 (second sheet) (April 2005)

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 2012/241470 A1 (SNODGRASS DAVID [US] ET AL) 27 September 2012 (2012-09-27) figure 14 paragraphs [0023],[0024] -----	4,5 20
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