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(54) **SENSOR AND METHOD FOR DETECTING RESOURCE USAGE IN A DISPENSER, DISPENSER, AND SYSTEM AND METHOD FOR MONITORING RESOURCE USAGE IN A DISPENSER**

(57) The invention relates to a sensor for detecting resource usage in a dispenser, in particular in a wash-room dispenser, a dispenser, in particular a washroom dispenser, and a method for detecting resource usage in a dispenser, in particular in a washroom dispenser. Further, the invention relates to a system and method for monitoring resource usage in the dispenser. The sensor comprises a first and a second pair of an emitter and a

receiver of radiation, wherein each of the two pairs is adapted to detect the presence of a resource by receiving via the receiver radiation emitted by the emitter which has been reflected by the resource, and wherein the first pair is adapted and arranged to detect the presence of a resource at a higher resource level than the second pair.

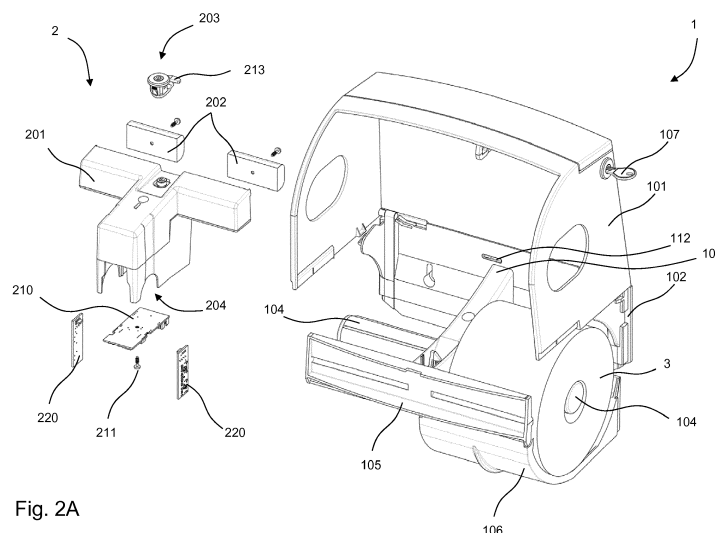


Fig. 2A

## Description

**[0001]** The invention relates to a sensor for detecting resource usage in a dispenser, in particular in a washroom dispenser, a dispenser, in particular a washroom dispenser, and a method for detecting resource usage in a dispenser, in particular in a washroom dispenser. Further, the invention relates to a system and method for monitoring resource usage in the dispenser.

**[0002]** Dispensers, sensors, and methods for detecting and monitoring resource usage in a dispenser, in particular in a washroom dispenser, are known, for example, from WO 2015/086055 A1, WO 2015/010143 A1, WO 2015/165731 A1, WO 2014/035307 A1, WO 2014/027030 A2, WO 2013/016748 A1, WO 2013/016747 A1, WO 2013/113129 A1, WO 2006/065514 A1, WO 2006/065515 A2 or WO 2005/065509 A1.

**[0003]** Existing dispensers, sensors, systems and methods, however, usually are expensive and often require the exchange of dispensers to newer ones with the respective features. Further, the detection and monitoring of resource usage is not always accurate and reliable.

**[0004]** Therefore, it is an object of the present invention to provide a sensor for detecting resource usage in a dispenser, a dispenser, a method for detecting resource usage in a dispenser, and a system and method for monitoring resource usage in the dispenser, which reduce or eliminate one or more of the above-mentioned disadvantages. In particular, it is an object of the present invention to provide a sensor for detecting resource usage in a dispenser, a dispenser, a method for detecting resource usage in a dispenser, and a system and method for monitoring resource usage in the dispenser, which are reliable and/or cost-efficient.

**[0005]** According to a first aspect of the invention, it is provided a sensor for detecting resource usage in a dispenser, in particular in a washroom dispenser, comprising a first and a second pair of an emitter and a receiver of radiation, wherein each of the two pairs is adapted to detect the presence of a resource by receiving via the receiver radiation emitted by the emitter which has been reflected by the resource, and wherein the first pair is adapted and arranged to detect the presence of a resource at a higher resource level than the second pair.

**[0006]** The sensor according to the invention is suitable for detecting resource usage in a dispenser, in particular in a washroom dispenser. In particular, the resource of which the usage can be detected can be a washroom product, such as toilet tissue, toilet paper, paper towel, towel, diapers, wet wipes, or the like. Further, in particular, the dispenser preferably is suitable for dispensing such a washroom product. According to the present invention, it is particularly preferred to detect the usage of a resource, which is suitable to reflect radiation, in particular radiation as further detail below. The detection principle according to the invention is based on reflection of radiation by the resource.

**[0007]** The sensor comprises two pairs of an emitter and a receiver of radiation, which are adapted and arranged to detect the presence of a resource by emitting radiation by the emitter, which radiation is then reflected by the resource, and then received by the receiver.

**[0008]** The first and second pair of an emitter and a receiver of radiation are arranged such that the first pair detects the presence of a resource in a dispenser at a resource level, in particular a first resource level, which is higher than the resource level, in particular a second resource level, at which the second pair of an emitter and a receiver of radiation detects the presence of the resource. In particular, the first pair is adapted and arranged to detect the presence of a resource by receiving via a receiver of the first pair emitted by an emitter of the first pair which has been reflected by the resource at a first resource level, and the second pair is adapted and arranged to detect the presence of a resource by receiving via a receiver of the second pair emitted by an emitter of the second pair which has been reflected by the resource at a second resource level, wherein the first resource level is higher than the second resource level. In this way, two different resource levels can be detected by the sensor.

**[0009]** In case no presence of the resource is detected by one of the pairs, this corresponds preferably to the detection of the absence of the resource. In particular, the absence of the resource preferably leads to the radiation not being reflected any more in a way suitable for the receiver to receive it.

**[0010]** The sensor according to the invention has several advantages. For example, an instance where the first pair of an emitter and a receiver of radiation does not detect the presence of a resource anymore, can be used as an indication that the resource has been used in an amount such that the resource level does not reach the high or first resource level anymore. Under the assumption that the resource has been provided in a certain amount or a certain full resource level in the beginning, an instance where the first pair does not detect the presence of a resource anymore means that the resource has been used in an amount which corresponds to the consumption of resource leading to a drop in resource level from a full resource level to the first, high resource level.

**[0011]** Similarly, an instance where the second pair of an emitter and a receiver of radiation does not detect the presence of a resource at a second, low resource level, indicates that an amount of resource has been consumed corresponding to the drop in the resource level from them first, high resource level to the second, low resource level.

**[0012]** Preferably, the sensor is adapted to keep the time and/or to provide timestamps, such that preferably the time elapsed between an instance where the first pair does not detect the presence of a resource anymore and an instance where the second pair does not detect the presence of a resource anymore can be determined. When the remaining amount of resource at the second,

low resource level is known, the remaining time until the resource is fully consumed, can be estimated.

**[0013]** Similarly, the sensor can be used to determine a resource usage by detecting the amount of resource supplied to a reservoir of used resource. This embodiment is particularly preferred for reusable resources, like a towel product, which is washable and can be reused. Such a reusable resource can be provided in the form of a roll, which is used by pulling or unrolling the resource from the roll. Often, with such products, the used resource is collected on a further roll, which is empty in the beginning and on which the used resource is collected by rolling the use resource up. In this case, the sensor can be used to detect the amount of used resource accumulating on the roll.

**[0014]** Preferably, three or more pairs of an emitter and a receiver of radiation are provided, which are arranged and adapted corresponding to the first and second pair. In particular, it is preferred that three or more pairs are adapted and arranged to detect the presence of a resource at different resource levels. With such an embodiment, information about resource usage can be obtained in a very detailed manner. Further, in particular when the sensor is arranged and adapted to keep the time and/or to provide timestamps, detailed estimates about resource usage over time and/or time remaining until a certain resource level is reached, are possible.

**[0015]** Preferably, the main detection direction of a pair of an emitter and a receiver substantially corresponds to the direction in which the radiation is emitted and/or received. For example, when the directions of emission and receipt of radiation are angled towards each other, the main detection direction can be understood as the angle bisector of those two directions. In particular, the main detection directions of the two pairs of an emitter and a receiver of radiation preferably are parallel to each other. Further preferably, the main detection direction one pair or all pairs of an emitter and a receiver is/are substantially horizontal in an operating position of the sensor and/or the dispenser.

**[0016]** According to a preferred embodiment, one single radiation emitting element forms the first emitter of the first pair and the second emitter of the second pair. In this embodiment, the two pairs comprise only one single radiation emitting element, which acts as the emitter of the first pair and the emitter of the second pair. Preferably, the arrangement of the first and second pair is chosen such that it is suitable for the angle of radiation of the single radiation emitting element and/or the angle of reflection of the resource. For example, the single radiation emitting element can be positioned between the receivers of the first and second pair. This embodiment is particularly cost-efficient, since the number of radiation emitting elements can be lower than the number of pairs of emitters and receivers of radiation. Further, it can be preferred that one single radiation emitting element forms the emitter of more than two pairs of emitters and receivers of radiation.

**[0017]** Preferably, a pair of an emitter and a receiver of radiation can comprise two receiving elements of radiation, in particular to phototransistors. This redundant provision of two receiving elements of radiation for the receiver of a pair can enhance reliability and detection accuracy.

**[0018]** In a further preferred embodiment, the two pairs of an emitter and a receiver of radiation are adapted to emit and receive electromagnetic radiation and/or acoustic radiation, in particular visible light and/or ultrasound. Further preferably, the two pairs of an emitter and a receiver of radiation are adapted to emit and receive pulsed radiation. The pulse length can be a predetermined interval, for example a constant or varying interval. Preferably, the interval can have a duration of several minutes or several hours. The interval can be chosen such that a predetermined number of pulses is emitted per minute or per hour. Preferably, the time between pulses is at least one minute, preferably at least 2 minutes, or at least 5 minutes, or at least 10 minutes, in order to reduce energy consumption.

**[0019]** Preferably, the emitters are formed by one or more radiation emitting elements, preferably light emitting diodes (LEDs). Further preferably, the receivers are formed by phototransistors. In particular, it is preferred that the phototransistors are operated in reverse direction.

**[0020]** It is further preferred that the two pairs of an emitter and a receiver of radiation are arranged on a single support element, in particular on one circuit board, preferably a printed circuit board.

**[0021]** In a further preferred embodiment, a main detection direction of the two pairs of an emitter and a receiver of radiation is a substantially orthogonal to a main direction of resource usage. For example, when stacks of folded products, like tissues or towels, is present in the dispenser, a main direction of resource usage is usually in a substantially vertically downward direction, where the folded product is consumed through a dispensing opening, which is usually directed downwards in an operating position of the dispenser. In such a case, the sensor preferably is arranged such that the detection direction is orthogonal to the direction of usage. For example, when the main direction of usage is substantially vertically downwards, the main detection direction can be arranged substantially horizontally. In this way, the side of the stack of folded products can form the reflection plane for reflecting the radiation.

**[0022]** In a further preferred embodiment, in case the resource is provided as a roll, a main detection direction of the two pairs of an emitter and a receiver of radiation is substantially parallel to an axis of rotation of the roll. For example, resources like toilet paper, towels or paper towels etc. can be provided as a roll, which is rotating about an axis of rotation in order to consume the resource. In such a case, the main detection direction preferably is parallel to the axis of rotation.

**[0023]** In particular, it can be preferred that a distance

between the pairs and the resource in the main detection direction or parallel thereto is substantially constant.

**[0024]** These embodiments have the advantage over sensors, which have a varying distance between the detector and the resource and/or which have a main detection direction parallel to the main direction of usage, that the detection is more accurate and/or reliable and/or the sensor can be less expensive, since it only needs to be suitable for a predetermined detection range, which is much smaller than in other sensors.

**[0025]** In particular, it is preferred that the two pairs of an emitter and a receiver of radiation are arranged spaced from each other in a main direction of resource usage. Further, it can be preferred that the two pairs of an emitter and a receiver of radiation are arranged in a linear pattern and/or in a matrix pattern. Preferably, the arrangement and/or position of the pairs is adapted to the form of resource to be detected and the way in which the resource will be consumed. In particular, it is preferred that the arrangement and/or position of the pairs is adapted to allow for a sufficiently accurate and/or reliable detection of different resource levels.

**[0026]** Further preferably, a control unit is provided, adapted to control the activation and/or deactivation of the two pairs of an emitter and a receiver of radiation. In particular, the control unit can be adapted to control the activation and/or deactivation of the two pairs individually. Further, it is preferred that the control unit is adapted such that in a new detection cycle, only the pair of an emitter and a receiver of radiation is activated, which is arranged such that it will detect an absence of the resource first. Further still, it is preferred that the control unit is adapted to activate the pair of an emitter and a receiver of radiation which is arranged such that it will be the next pair to detect the absence of the resource after the previous pair has detected an absence of a resource. It is further preferred that the control unit is adapted to deactivate the pair of an emitter and a receiver of radiation for the rest of the present detection cycle which has detected an absence of a resource.

**[0027]** Individual or all embodiments relating to the control unit can have several advantages. Generally, a control unit which is adapted to control the activation and/or deactivation of the pairs of an emitter and a receiver of radiation, in particular the control unit which is adapted for individual control of the pairs, can lead to significant savings in energy consumption when one or several pairs which are not needed at a certain stage, in particular in a certain stage of the detection cycle, are deactivated.

**[0028]** A detection cycle can be understood as the period between the provision of resource corresponding to a full level and the full usage of the resource, i.e. corresponding to an empty level. When the dispenser is then again provided with a new resource supply, preferably corresponding to a full level, a new detection cycle starts.

**[0029]** Preferably, the control unit controls the pairs such that the first pair is activated in the beginning of a

detection cycle. When the first pair has detected the absence of the resource, i.e. does not detect the presence of the resource anymore, the next pair is activated. Further preferably, in case that three or more pairs are provided, the first two pairs can be activated in the beginning of a detection cycle and then the next two pairs can be activated once the first pair and/or second pair and has detected the absence of the resource. This activation of two pairs at a time is particularly advantageous when the emitters of two adjacent pairs are formed by one single radiation emitting element.

**[0030]** In a further preferred embodiment, the two pairs of an emitter and receiver of radiation are covered by a protective layer permeable for radiation. In case three or more pairs are provided, preferably all pairs are covered by a protective layer permeable for radiation. Preferably, the protective layer consists of or contains a thermoplastic polymer, in particular polycarbonate. The advantage of covering the pairs is that wear and dirt can be reduced. Since the protective layer preferably is arranged in the path of the radiation to be emitted and received, a protective layer permeable for radiation is preferred.

**[0031]** In a further preferred embodiment, the control unit is arranged on another support element than the two pairs of an emitter and a receiver of radiation or the control unit is arranged on the same support element with the two pairs of an emitter and a receiver of radiation. For example, it can be preferred that the two pairs are arranged on a single support element together with a control unit. Further, it can be preferred that the two pairs are produced on a single support element together with the control unit, wherein the single support element is then separated into two support elements during manufacture. This can be particularly preferred in case the support element is a printed circuit board, which can be separated at a predetermined breaking point, for example. In particular, it is preferred to have the design of the printed circuit board such that after separation, one circuit board containing the two pairs and a further circuit board containing the control unit is created.

**[0032]** In a further preferred embodiment, the sensor is adapted to detect the exchange of a resource in the dispenser. For example, an empty resource level can be detected when none of the pairs detects the presence of a resource. Further for example, a full resource level can be detected when all pairs or at least the first pair detects the presence of a resource. In particular, an exchange of a resource in the dispenser can be detected if all pairs detect the absence of a resource and, subsequently, all pairs or at least the first pair detects the presence of a resource. Preferably, in case that all pairs have detected the absence of a resource, a new detection cycle is started. Preferably, in the beginning of a new detection cycle, the pairs are subsequently activated from the first pair onwards until at least one pair detects the presence of a resource. In this way, also the provision of a new resource supply which does not reach the full resource level can be detected.

**[0033]** Further it is preferred that the control unit is adapted to perform a test run, preferably at predetermined time intervals. A preferred time interval for a test run can be at a predetermined number of instances per day or per hour. In such a test run, preferably, all pairs are activated and deactivated successively in order to determine the actual or current resource level. Preferably, in a test run the pairs are subsequently activated from the first pair onwards. Further preferably, the pairs are subsequently deactivated from the first pair onwards in a test run.

**[0034]** Preferably, after the test run, at least that pair is activated, which detects the presence of a resource and corresponds to the highest resource level that has been detected during the test run. In case a higher resource level has been detected in the test run than before the test run, preferably a new detection cycle is started and/or an exchange of the resource is detected.

**[0035]** These embodiments relating to test runs are particularly preferred to ensure that the exchange of a resource is detected even if the exchange happens between two pulses of radiation.

**[0036]** In a further preferred embodiment, the detecting range of the pairs of an emitter and a receiver of radiation is sufficiently short to detect the absence of a resource when no resource is present even in a closed dispenser housing. In particular, the detecting range of the pairs of an emitter and a receiver of radiation is adapted for the, preferably constant, distance between the pairs and the resource, which forms the reflection plane for the radiation.

**[0037]** A further preferred embodiment is characterized in that four or more pairs of an emitter and a receiver of radiation are provided for detecting the usage of at least two resource supplies. Preferably, at least two pairs are arranged on two opposite sides of the sensor. Preferably, the sensor is adapted to be placed between two resource supplies. Further preferably, the provision and/or arrangement of pairs of an emitter and a receiver of radiation are symmetric on opposite sides of the sensor.

**[0038]** Further preferably, the sensor is adapted to be removably installed within a dispenser and/or to be installed within a dispenser as a retrofit. This embodiment has the advantage that existing dispensers can be used with the sensor.

**[0039]** It is particularly preferred that the sensor is adapted to be installed tool-free within a dispenser and/or to be positioned within a dispenser via form-fit and/or a snap-fit connection and/or a plug connection. This embodiment provides for a particularly easy and cost efficient way to mount the sensor in or on a dispenser.

**[0040]** In a further preferred embodiment, the sensor and/or the dispenser comprises a spacer for spacing the two pairs of an emitter and a receiver of radiation in a minimum distance from the resource. This design has the advantage that contact between the resource and the pairs of an emitter and a receiver of radiation can be

reliably avoided in order to prevent the pairs of an emitter and a receiver from getting overly worn or covered with dirt. Further, the spacer can enhance detection reliability by ensuring that a preferred distance between the pairs and the resource is kept. Further preferably, the sensor and/or the dispenser comprises a stop for spacing the two pairs of an emitter and a receiver of radiation in a maximum distance from the resource. This also has the advantage that a preferred (maximum) distance between the pairs and the resource can be kept.

**[0041]** In case the sensor is adapted to detect the usage of at least two resource supplies, it can be preferred that two opposite spacers are provided for spacing each of the two pairs in a minimum distance from the respective resource supplies.

**[0042]** It is further preferred that the sensor is adapted to be positioned on a rotation axis of a resource provided as roll. For example, toilet paper dispensers can be arranged such that two rolls of toilet paper are arranged on a rotation axis, for example in the form of a bar or rod. Further, also paper towel or towel dispensers can be arranged such that at least one roll of paper towel or towel is arranged on a rotation axis, for example in the form of a bar or rod. It is preferred, that also the sensor can be positioned on such a rotation axis, in particular a rotation axis which has the form of a bar or rod. Preferably, the housing of the sensor has a form, for example a recess, shaped to fit on to such a rotation axis.

**[0043]** Further preferably, the sensor has a retention element for connecting and/or fixing the sensor to the dispenser, preferably in a releasable manner.

**[0044]** According to a further preferred embodiment, the control unit is adapted to communicate with an external communication unit in a bidirectional way, preferably in a wireless way. Preferably, information about resource usage can be transmitted from the sensor to the external communication unit. Further preferably, information, such as software updates, can be transmitted from the external communication unit to the sensor. It is further preferred that the external communication unit is adapted and arranged to communicate, preferably in a bidirectional way, with a plurality of sensors and/or a plurality of dispensers. For example, the wireless communication can be realized by a Bluetooth connection between the external communication unit and the sensor. Further preferably, the external communication unit is adapted and arranged to communicate, preferably in a wireless way, such as Bluetooth, to a backend unit, in particular in order to exchange client specific and/or process related information. Further preferably, a system to detect resource usage further comprises mobile devices like tablets or smart phones, which can receive and/or send information from and/or to the sensor, for example via a backend unit and/or the external communication unit.

**[0045]** It is further preferred that the sensor is adapted for energy supply via batteries. This provides for an independent and easy provision of energy. Further prefer-

ably, the control unit is adapted to detect the charge of batteries used in the sensor and preferably to send information about the charge of batteries to an external communication unit.

**[0046]** The control unit preferably is adapted to record data about resource usage, preferably in multiple detection cycles, and preferably store the data and/or send the data to an external communication unit.

**[0047]** According to a further aspect of the invention, it is provided a dispenser, in particular a washroom dispenser, comprising a sensor as described herein.

**[0048]** According to a further aspect of the invention, it is provided a system for monitoring resource usage in at least one dispenser, in particular in at least one washroom dispenser, comprising at least one dispenser as described herein and at least one external communication unit.

**[0049]** According to a further aspect of the invention, it is provided a method for detecting resource usage in a dispenser, in particular in a washroom dispenser, comprising, preferably providing a sensor as described herein, detecting the presence of a resource by receiving via a receiver of a first pair of an emitter and a receiver of radiation emitted by an emitter of the first pair of an emitter and a receiver of radiation which has been reflected by the resource at a first resource level; detecting the presence of a resource by receiving via a receiver of a second pair of an emitter and a receiver of radiation emitted by an emitter of the second pair of an emitter and a receiver of radiation which has been reflected by the resource at a second resource level; wherein the first resource level is higher than the second resource level.

**[0050]** According to a further aspect of the invention, it is provided a method for monitoring resource usage in at least one dispenser, in particular in at least one washroom dispenser, comprising detecting the presence of a resource via at least one dispenser as described herein and transmitting information about the resource usage to at least one external communication unit.

**[0051]** As to the advantages, preferred embodiments and details of these further aspects and their preferred embodiments, reference is made to the corresponding advantages, preferred embodiments and details described above.

**[0052]** Preferred embodiments of the invention shall now be described with reference to the attached drawings, in which

Fig. 1A: shows a three-dimensional front view of an exemplary embodiment of a washroom dispenser with a sensor according to the invention;

Fig. 1B: shows a front view of the washroom dispenser according to figure 1A;

Fig. 1C: shows a three-dimensional back view of the washroom dispenser according to figure 1A;

Fig. 1D: shows a side view of the washroom dispenser according to figure 1A;

Fig. 1E: shows a top view of the washroom dispenser according to figure 1A;

Fig. 1F: shows a section along A-A as indicated in figure 1 E;

Fig. 2A: shows a three-dimensional exploded view of the washroom dispenser according to figure 1A;

Fig. 2B: shows a three-dimensional front view of the sensor according to figure 2A;

Fig. 2C: shows a front view of the sensor according to figure 2A;

Fig. 2D: shows a side view of the sensor according to figure 2A;

Fig. 2E: shows a section of the sensor according to figure 2A; and

Fig. 2F: shows a top view of the sensor according to figure 2A.

**[0053]** In the figures, elements with the same or comparable functions are indicated with the same reference numerals.

**[0054]** In figures 1 in figures 1A through 2A, a washroom dispenser 1, namely a dispenser for the resource toilet paper provided as a roll, is shown.

**[0055]** The dispenser 1 comprises a sensor 2 for detecting resource usage in the dispenser 1. The sensor 2 is shown in more detail in figures 2B through 2F. The dispenser 1 comprises a housing with a top cover 101, a back wall 102 and a bottom half cover 106. The top cover 101 can be closed, as shown in figures 1A through 1F, or it can be opened, as shown in figure 2A. In the closed position, the top cover 101 can be locked with key 107.

**[0056]** The half bottom cover 106 can be slid along the back wall 102 and the front element 105 depending on which one of the two toilet paper rolls 3 (only one roll 3 is shown in figure 2A) shall be covered and which one shall be accessed by a user. The dispenser 1 is suitable for receiving two resource supplies in the form of toilet paper rolls 3 on rotation axes 104 in the form of bars or rods. The rotation axes 104 are provided on the bridge 103 connecting the front element 105 to the back wall 102.

**[0057]** On the lower side of the rotation axes 104 two biasing elements 114, 115 are provided, as can be seen in particular in figures 1B, 1C and 1F. When a toilet paper roll 3 is slid over a rotation axis 104, the biasing elements 114, 115 will bias the toilet paper roll 3 downwards, such

that the toilet paper roll 3 will be positioned directly on the top side of the rotation axis 104, as can be seen in particular in figure 2A.

**[0058]** On the bridge 103, a sensor 2 is releasably positioned, as can be seen in particular in figures 1C, 1F and 2A. Sensor 2 is suitable for retrofitting existing dispensers 1. The sensor 2 comprises a housing 201, which can be closed by back elements 202. On the lower side of the housing, the shape of the sensors 2 is adapted to rotation axis 104 via recesses 204.

**[0059]** The sensor 2 comprises a retention element 203 with a hook 213. The retention element 203 is positioned such that the hook 213 can fit into an opening 112 of the back wall 102 in order to connect the sensor 2 to the dispenser 1. Preferably, the retention element 203 can be operated from a closed into an open position only with a special tool in order to avoid unauthorized removal of the sensor 2. However, apart from this optional special tool for operating the retention element 203, the sensor 2 is adapted to be installed tool-free within the dispenser 1. Further, the sensor 2 is adapted to be positioned within the dispenser 1 via form fit in the form of recesses 204.

**[0060]** The sensor 2 comprises two support elements in the form of printed circuit boards 220, which are arranged symmetric on opposite sides of the sensor 2. The sensor 2 comprises a further support element in the form of a printed circuit board 210, which comprises the control unit.

**[0061]** Preferably, the three printed circuit boards 220, 210 have been manufactured as one single support element and then have been separated during manufacture. The two printed circuit boards 220 preferably are slid into corresponding racks in the sensor 2. The printed circuit board 210 can be fixed on the inside of sensor 2 with fastening element 211.

**[0062]** As can be seen in particular in figure 2D, on each of the printed circuit boards 220 eight pairs of an emitter and a receiver of radiation are provided, corresponding to eight different resource levels 310, 320, 330, 340, 350, 360, 370, 380 of the toilet paper roll 3. Of course, less than or more than eight pairs corresponding to an according number of different resource levels are possible.

**[0063]** As can be seen in particular in figure 2D, the eight pairs of an emitter and a receiver of radiation comprise eight receiving elements of radiation P1, P2, P3, P4, P5, P6, P7, P8, in particular eight phototransistors, and four radiation emitting elements D1, D2, D3, D4, in particular four light emitting diodes (LEDs). One single radiation emitting element is provided as an emitter for more than one pair. In the embodiment shown in figure 2D, the first radiation emitting element D1 and the first two receiving elements of radiation P1, P2 form the first two pairs for the two resource levels 310, 320. The second radiation emitting element D2 and the third and fourth receiving elements of radiation P3, P4 form the next two pairs for the two resource levels 330, 340. The third radiation emitting element D3 and the fifth and sixth receiv-

ing elements of radiation P5, P6 form the next two pairs for the two resource levels 350, 360. Finally, the fourth radiation emitting element D4 and the seventh and eighth receiving elements of radiation P7, P8 form the next two pairs for the two resource levels 370, 380. The provision of one single radiation emitting element as emitter for more than one pair can save cost and energy consumption.

**[0064]** The main detection direction of the pairs of an emitter and a receiver of radiation is substantially parallel to the axis of rotation 104 of the toilet paper roll 3. In this way, a distance between the pairs and the resource in form of toilet paper roll 3 is substantially constant. In particular, also when the resource is more and more consumed and the resource level sinks, the distance between the pairs and the resource in the main detection direction of parallel thereto remains substantially constant. This has the advantage that pairs of an emitter and a receiver of radiation can be used, which have a narrowly defined detection range. Therefore, also when the housing of the dispenser 1 is closed, and no toilet paper roll 3 is present or its resource level has sunk, the pairs will detect that no resource is present although the housing sidewalls 101 are in detection direction. Preferably, the detection range of the pairs is smaller than the distance to a housing sidewall 101.

**[0065]** With reference to figure 2D, the detection preferably works as follows. When no toilet paper roll 3 or a toilet paper roll 3 with resource level lower than resource level 380 is present on rotation axis 104, none of the eight pairs detects the presence of a resource. Then, after a new toilet paper roll 3 has been placed on rotation axis 104, and in case the new toilet paper roll 3 as a full resource level, all pairs can detect the presence of a resource, as long as they are activated. If a toilet paper roll 3 is provided, which has a medium resource level, then only the pairs positioned up to the actual resource level of the toilet paper roll 3 can detect the presence of a resource.

**[0066]** Preferably, when at least one pair of an emitter and a receiver of radiation detects the presence of a resource after all pairs have detected the absence of a resource, a new detection cycle starts. Preferably, the control unit on circuit board 210 is adapted to individually activate and deactivate the pairs, in particular such that in a new detection cycle, only the first pair is activated, which is arranged such that it will detect an absence of the resource first. The control unit is further preferably adapted to activate the next pair, which is arranged such that it will be the next pair to detect the absence of the resource after the previous pair has detected an absence of a resource, next.

**[0067]** Further preferably, the sensor 2, in particular the control unit, is adapted to keep the time and/or to provide timestamps. In this way, the time elapsed from the detection of an absence of the resource from one pair to the next can be determined and thus the remaining time until the resource will be fully consumed or the time

until a further (lower) resource level will be reached, can be estimated.

**[0068]** Preferably, in predetermined time intervals, for example several times a day, depending on frequency of usage of the dispenser, a test run is performed, in which all pairs are successively activated and deactivated in order to detect and/or confirm the current, correct resource level.

**[0069]** The sensor 2 and the dispenser 1 have several advantages. By providing a sensor 2 suitable for retrofit, existing dispensers 1 can be reused. Since the sensor 2 is adapted for bidirectional communication with an external communication unit, information about resource usage can be transmitted from the sensor and information, for example software updates, can be received by the sensor 2. Further, the orientation of the main detection direction leads to a very reliable and accurate detection of resource usage and, at the same time, provides for a substantially constant distance between the pairs and the resource and thus a small necessary detection range. Additionally, the arrangement and positioning of the pairs of an emitter and a receiver of radiation is such that energy consumption is particularly low. This is further enhanced in case the radiation is pulsed.

#### Claims

1. A sensor for detecting resource usage in a dispenser, in particular in a washroom dispenser, comprising a first and a second pair of an emitter and a receiver of radiation, wherein each of the two pairs is adapted to detect the presence of a resource by receiving via the receiver radiation emitted by the emitter which has been reflected by the resource, and wherein the first pair is adapted and arranged to detect the presence of a resource at a higher resource level than the second pair.
2. A sensor according to the preceding claim, wherein one single radiation emitting element forms the first emitter of the first pair and the second emitter of the second pair.
3. A sensor according to at least one of the preceding claims, wherein the two pairs of an emitter and a receiver of radiation are adapted to emit and detect electromagnetic radiation and/or acoustic radiation, in particular visible light and/or ultrasound.
4. A sensor according to at least one of the preceding claims, wherein a main detection direction of the two pairs of an emitter and a receiver of radiation is substantially orthogonal to a main direction of resource usage; and/or in case the resource is provided as a roll, a main detection direction of the two pairs of an emitter and
- a receiver of radiation is substantially parallel to an axis of rotation of the roll.
5. A sensor according to at least one of the preceding claims, wherein a control unit is provided, adapted to control the activation and/or deactivation of the two pairs of an emitter and a receiver of radiation.
6. A sensor according to at least one of the preceding claims, wherein the control unit is adapted such that in a new detection cycle, only the pair of an emitter and a receiver of radiation is activated, which is arranged such that it will detect an absence of the resource first.
7. A sensor according to at least one of the preceding claims, wherein the two pairs of an emitter and a receiver of radiation are covered by a protective layer permeable for radiation.
8. A sensor according to at least one of the preceding claims, wherein the sensor is adapted to be removably installed within a dispenser and/or to be installed within a dispenser as a retrofit.
9. A sensor according to at least one of the preceding claims, wherein the control unit is adapted to communicate with an external communication unit in a bidirectional way, preferably in a wireless way.
10. A sensor according to at least one of the preceding claims, wherein the sensor is adapted for energy supply via batteries.
11. A sensor according to at least one of the preceding claims, wherein the control unit is adapted to detect the charge of batteries used in the sensor and preferably to send information about the charge of batteries to an external communication, unit and/or the control unit is adapted to record data about resource usage, preferably in multiple detection cycles, and preferably store the data and/or send the data to an external communication unit.
12. A dispenser, in particular a washroom dispenser, comprising a sensor according to at least one of the preceding claims.
13. A system for monitoring resource usage in at least one dispenser, in particular in at least one washroom dispenser, comprising at least one dispenser according to the preceding claim and at least one external communication unit.



14. A method for detecting resource usage in a dispenser, in particular in a washroom dispenser, comprising detecting the presence of a resource by receiving via a receiver of a first pair of an emitter and a receiver of radiation emitted by an emitter of the first pair of an emitter and a receiver of radiation which has been reflected by the resource at a first resource level; detecting the presence of a resource by receiving via a receiver of a second pair of an emitter and a receiver of radiation emitted by an emitter of the second pair of an emitter and a receiver of radiation which has been reflected by the resource at a second resource level; wherein the first resource level is higher than the second resource level.
15. A method for monitoring resource usage in at least one dispenser, in particular in at least one washroom dispenser, comprising detecting the presence of a resource via at least one dispenser according to the preceding claim 12 and transmitting information about the resource usage to at least one external communication unit.

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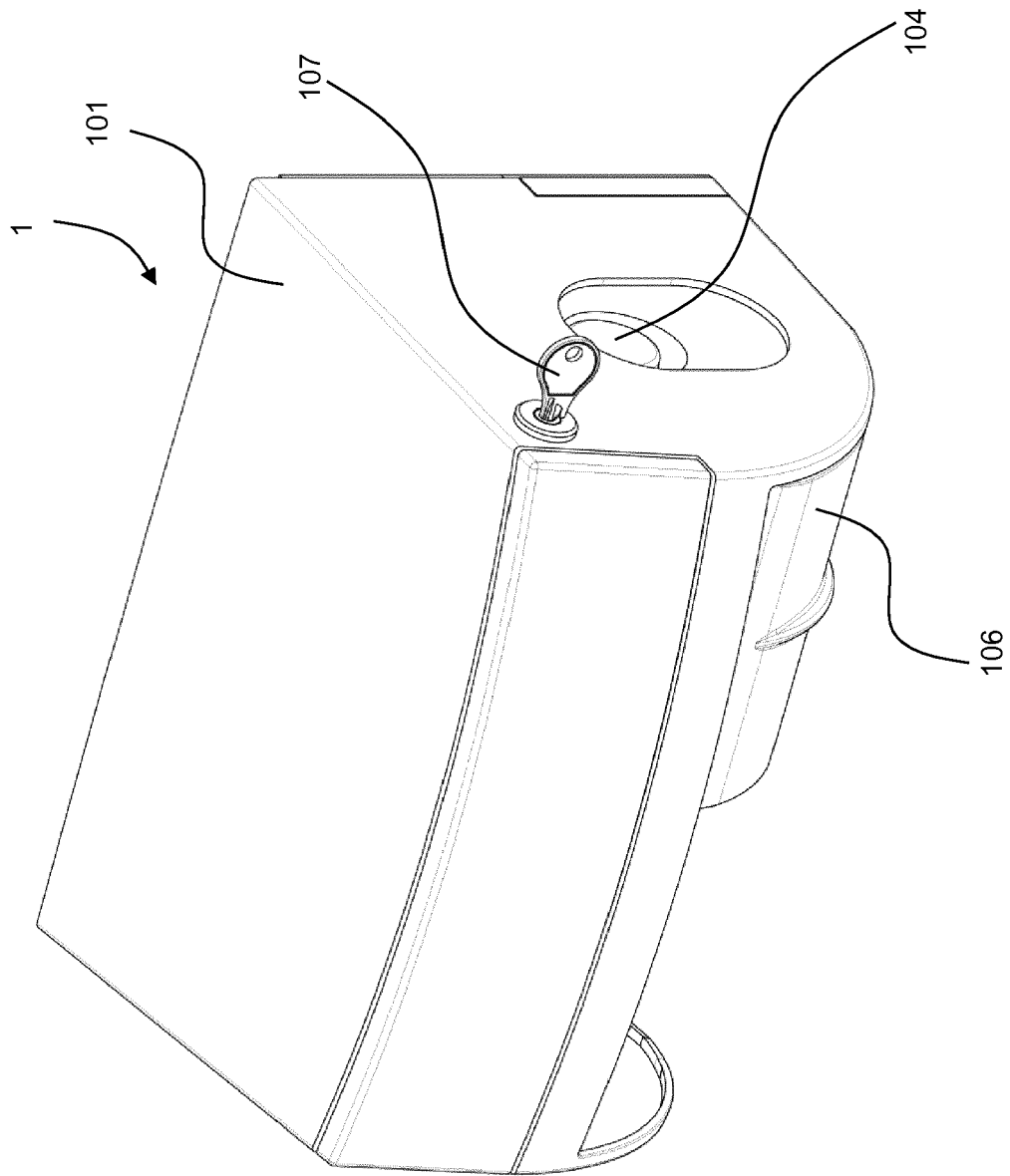


Fig. 1A

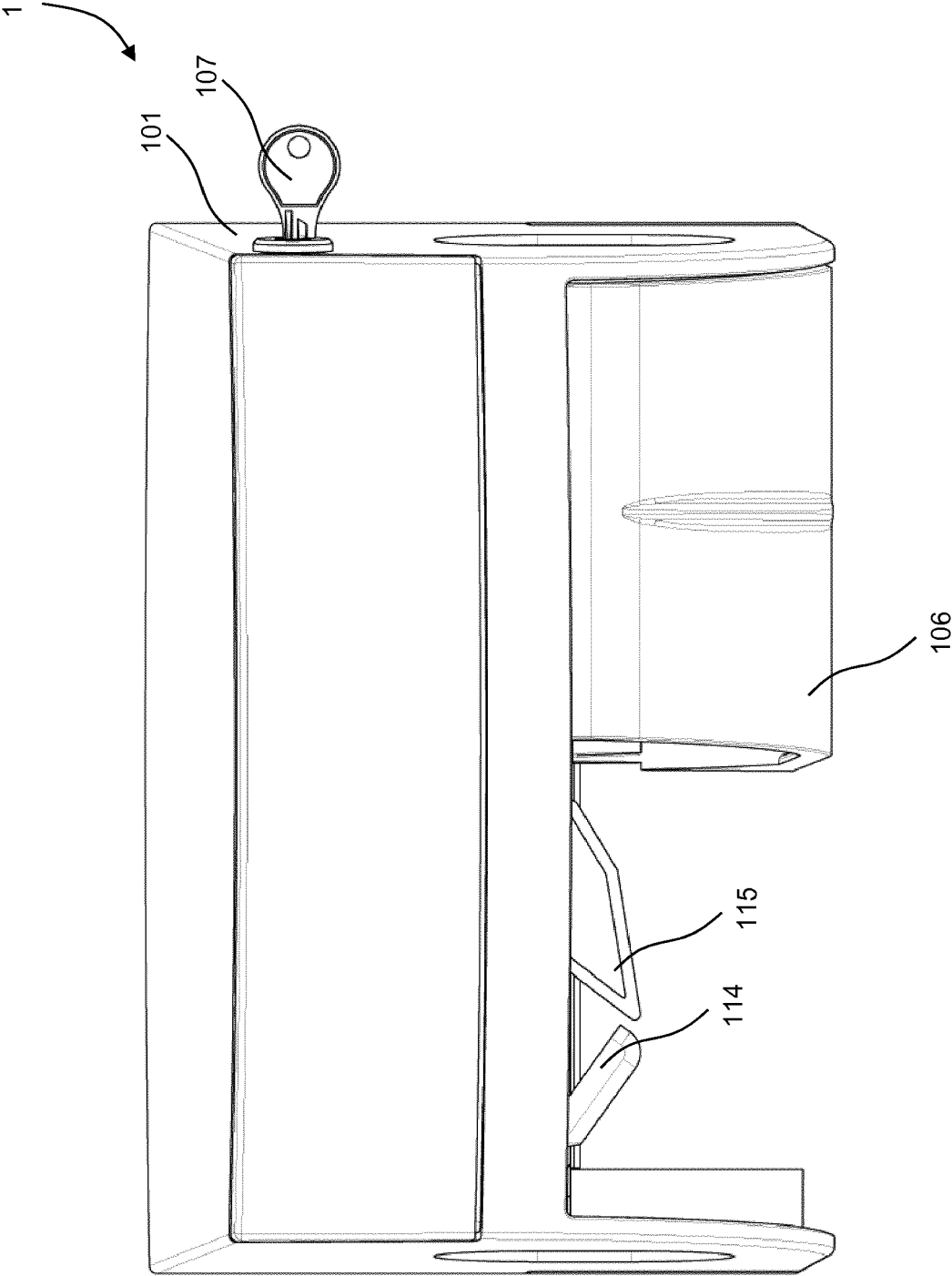


Fig. 1B

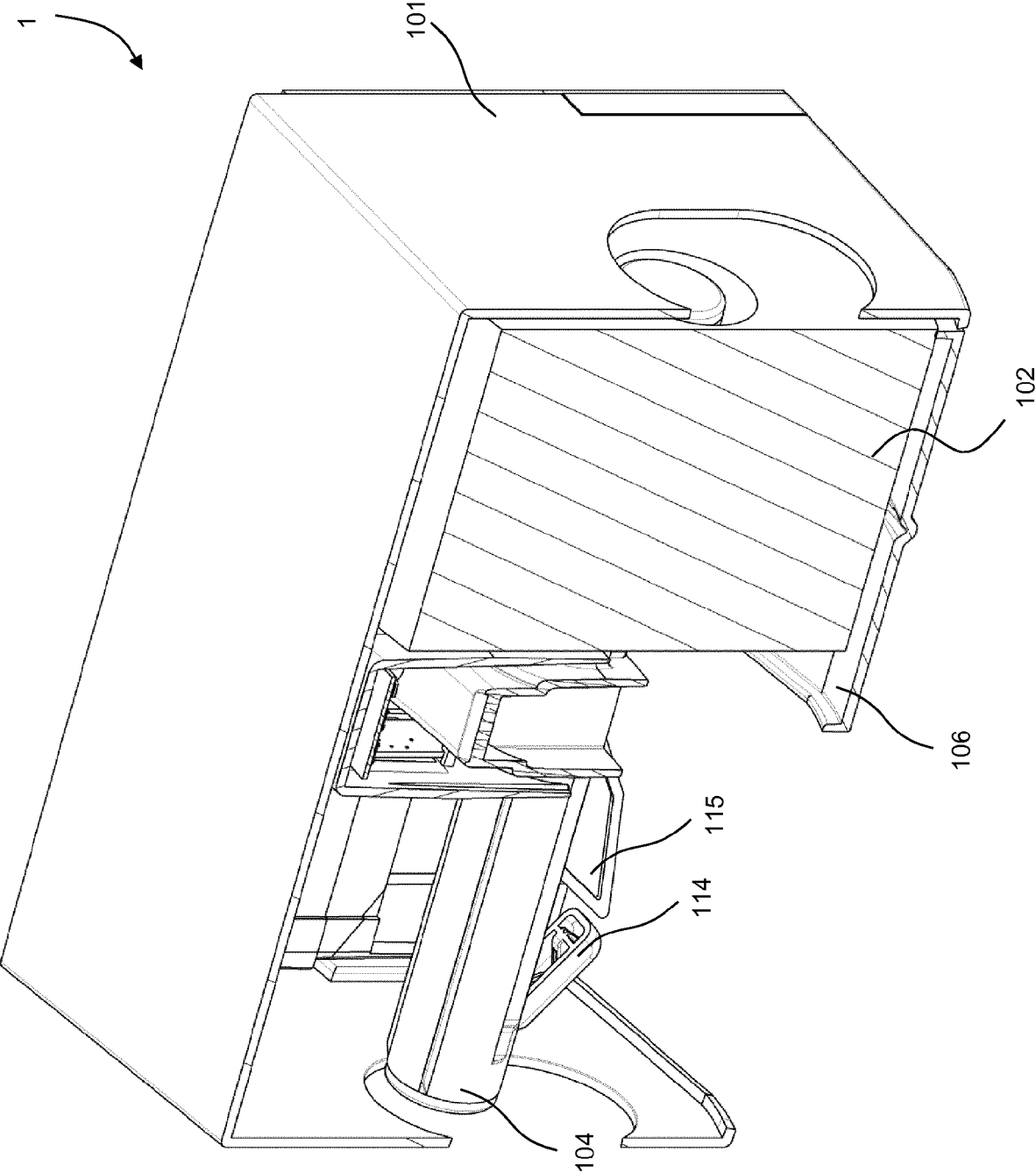


Fig. 1C

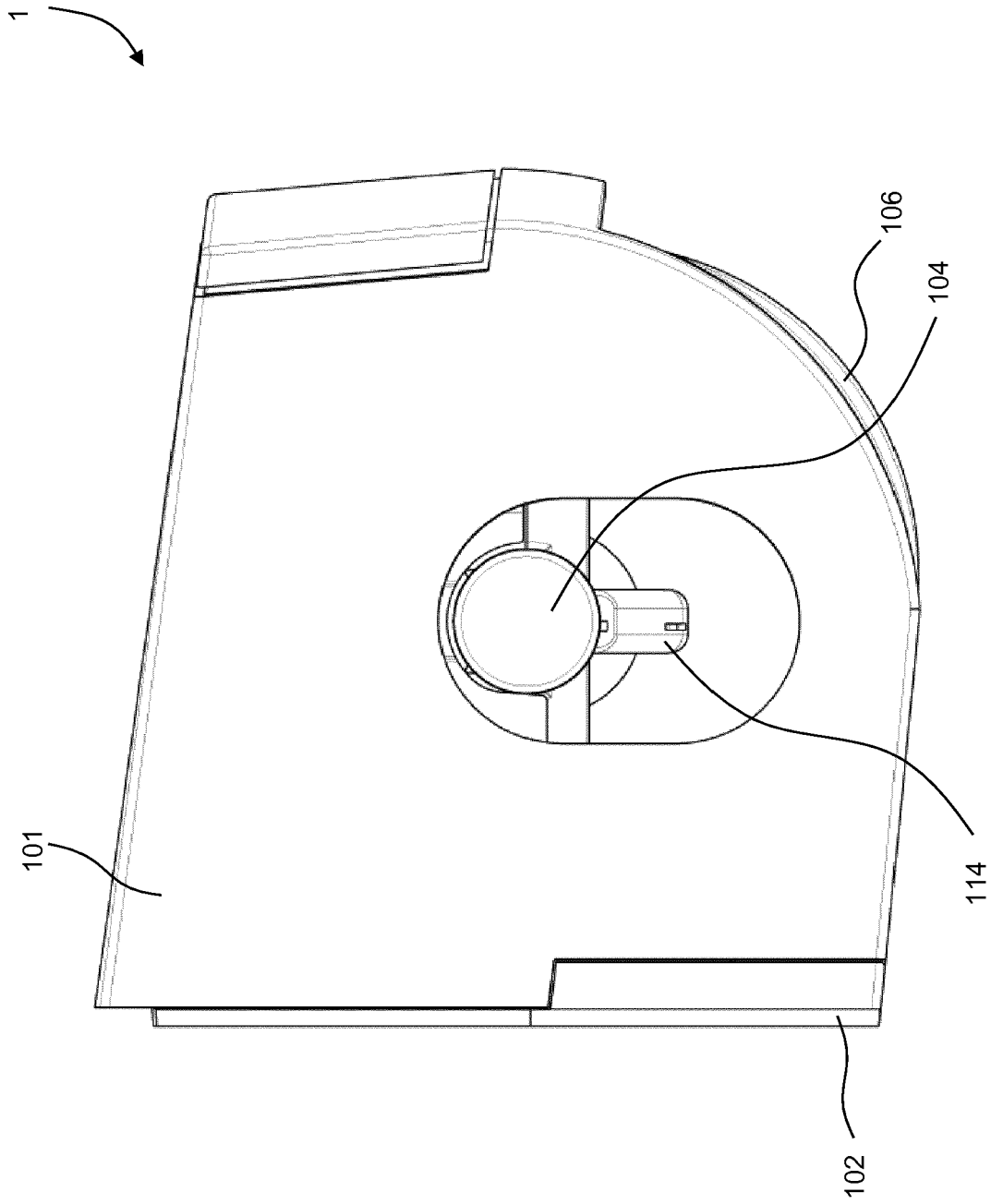


Fig. 1D

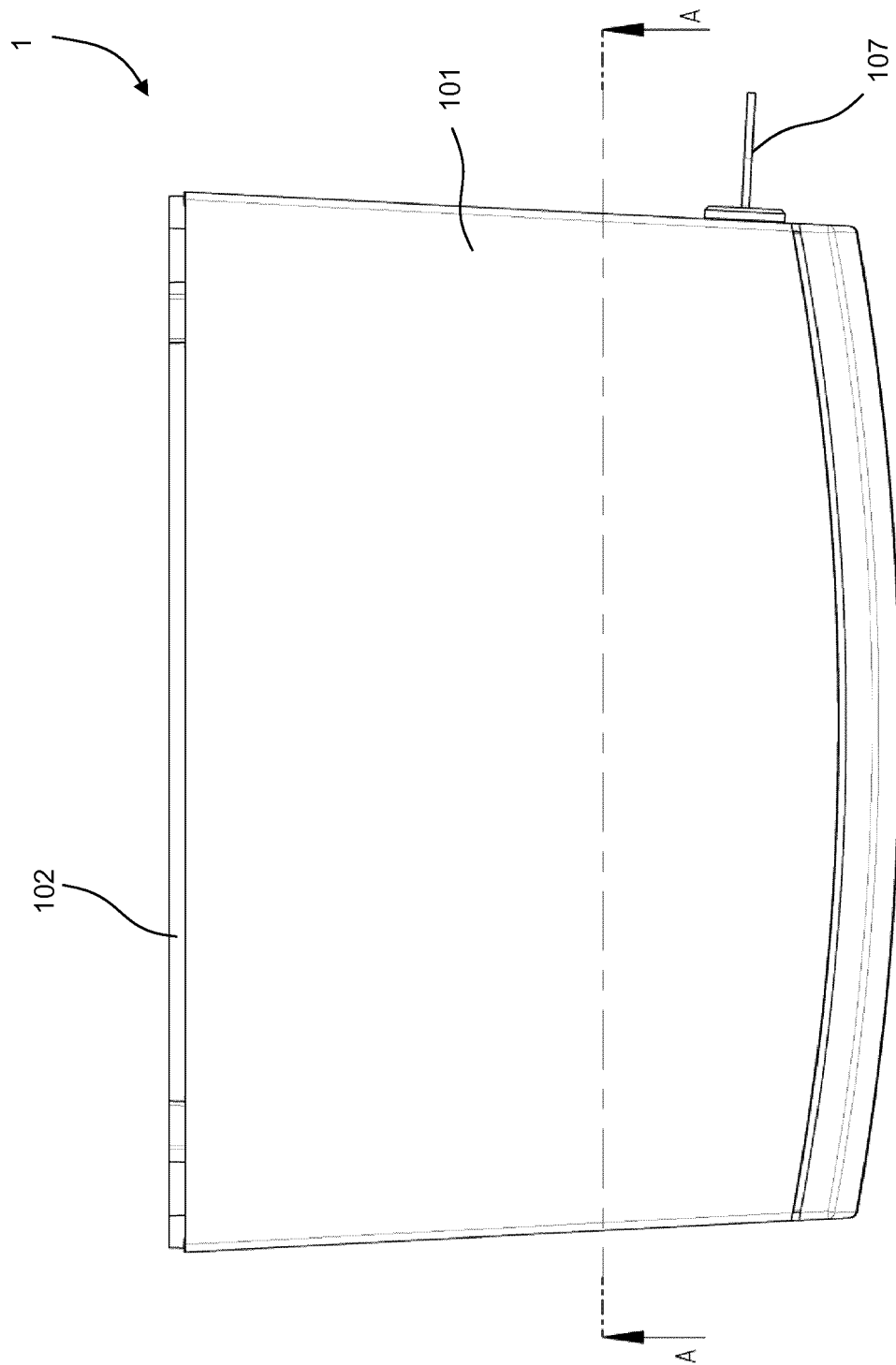


Fig. 1E

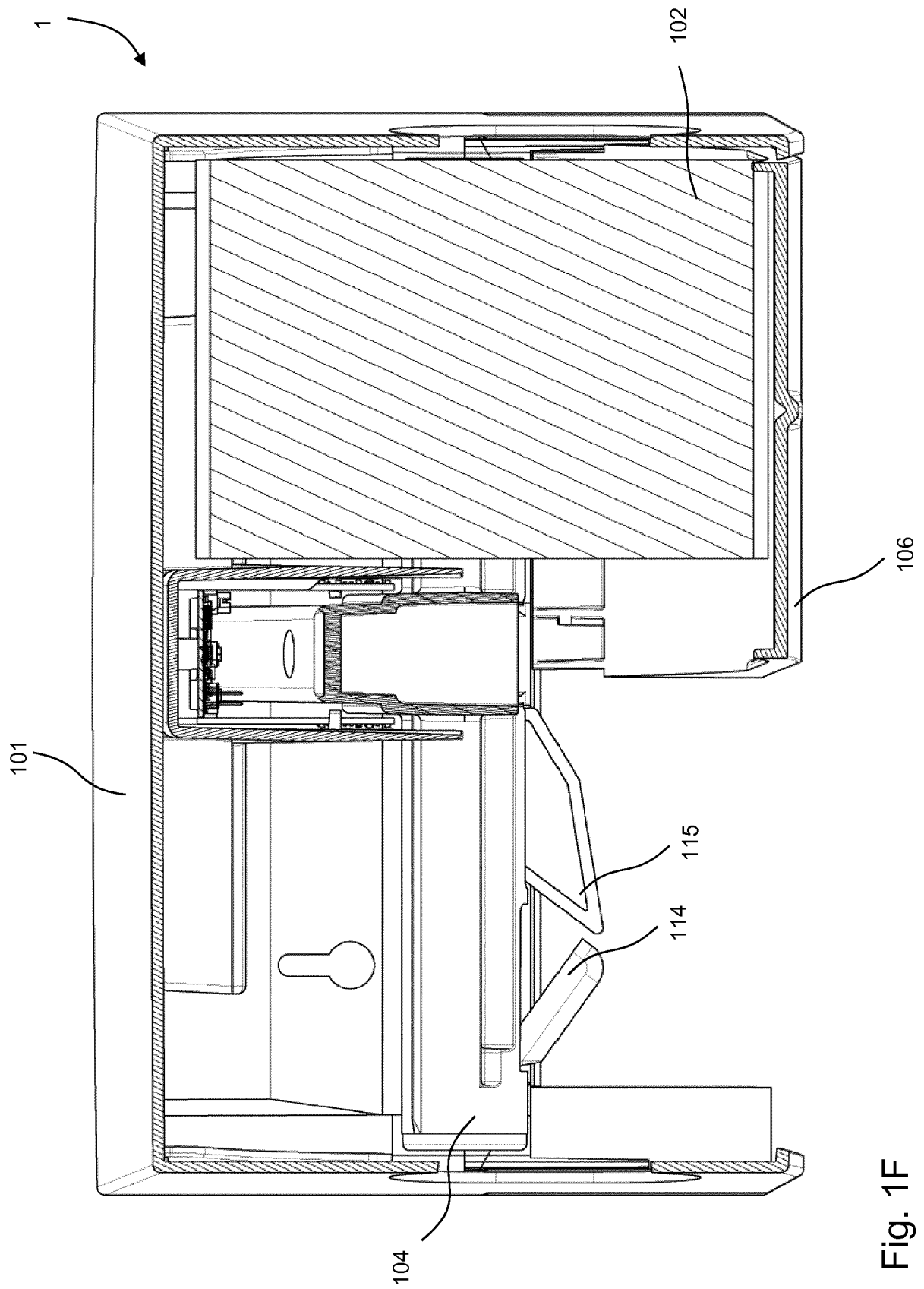


Fig. 1F

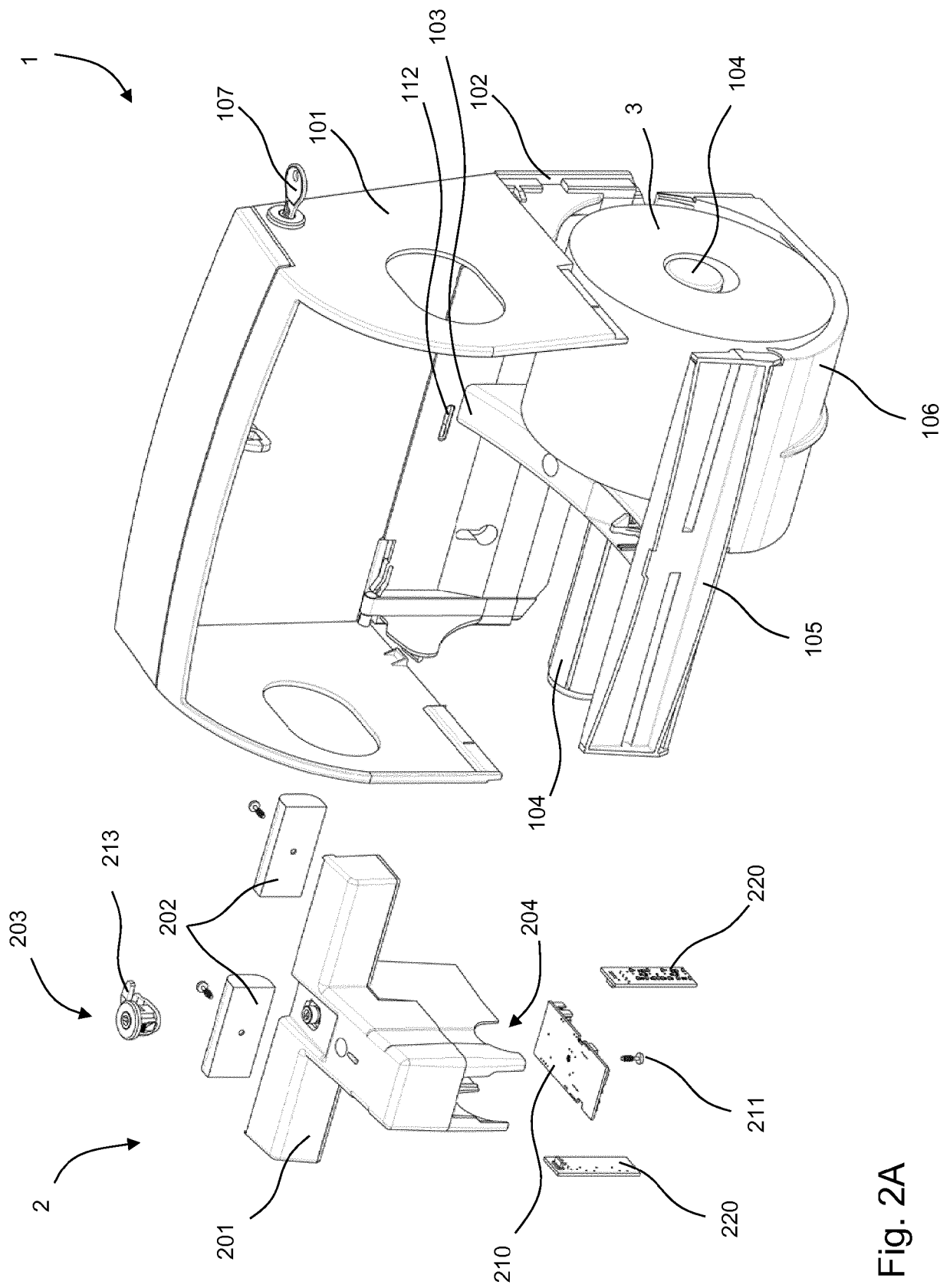


Fig. 2A



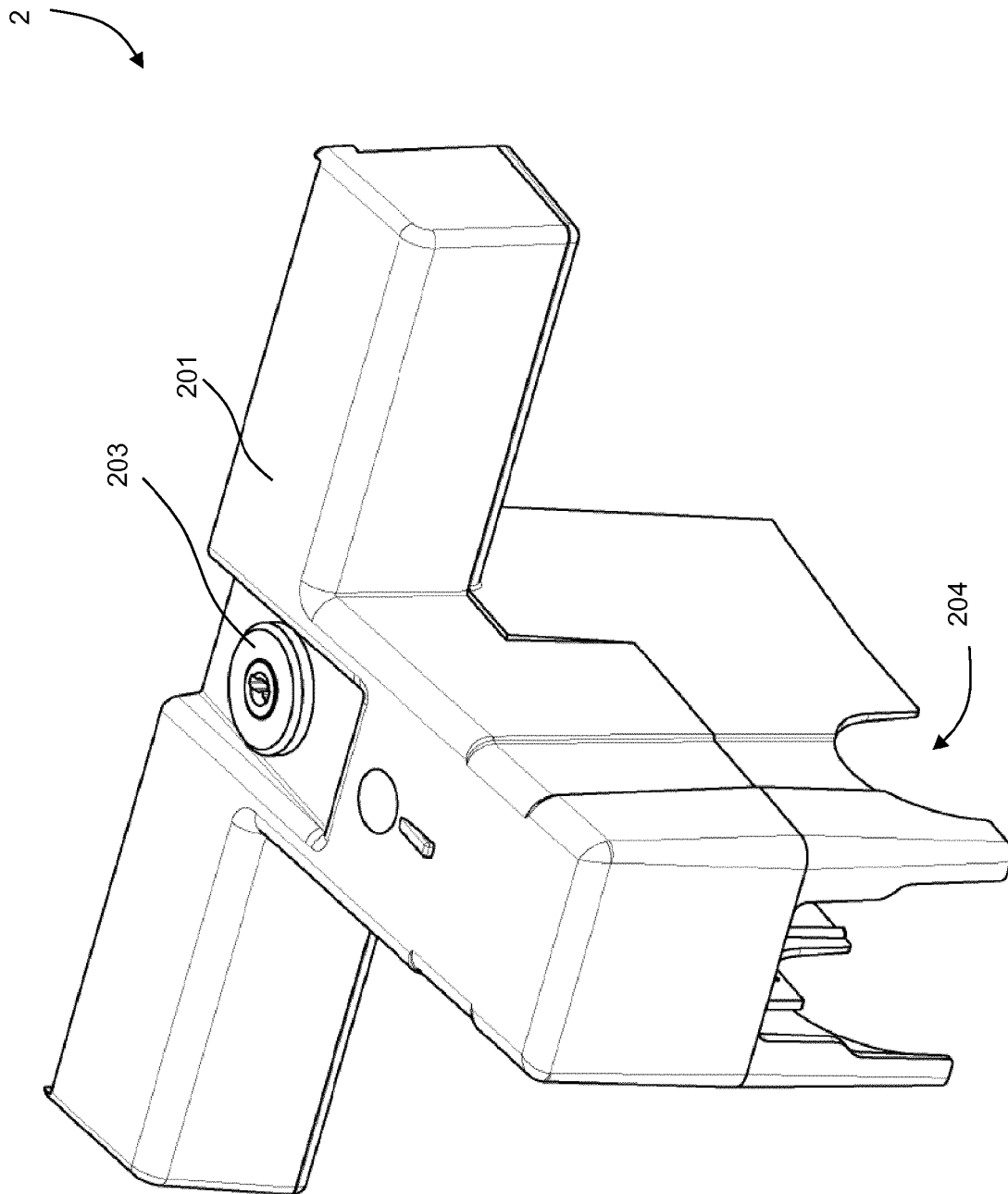


Fig. 2B

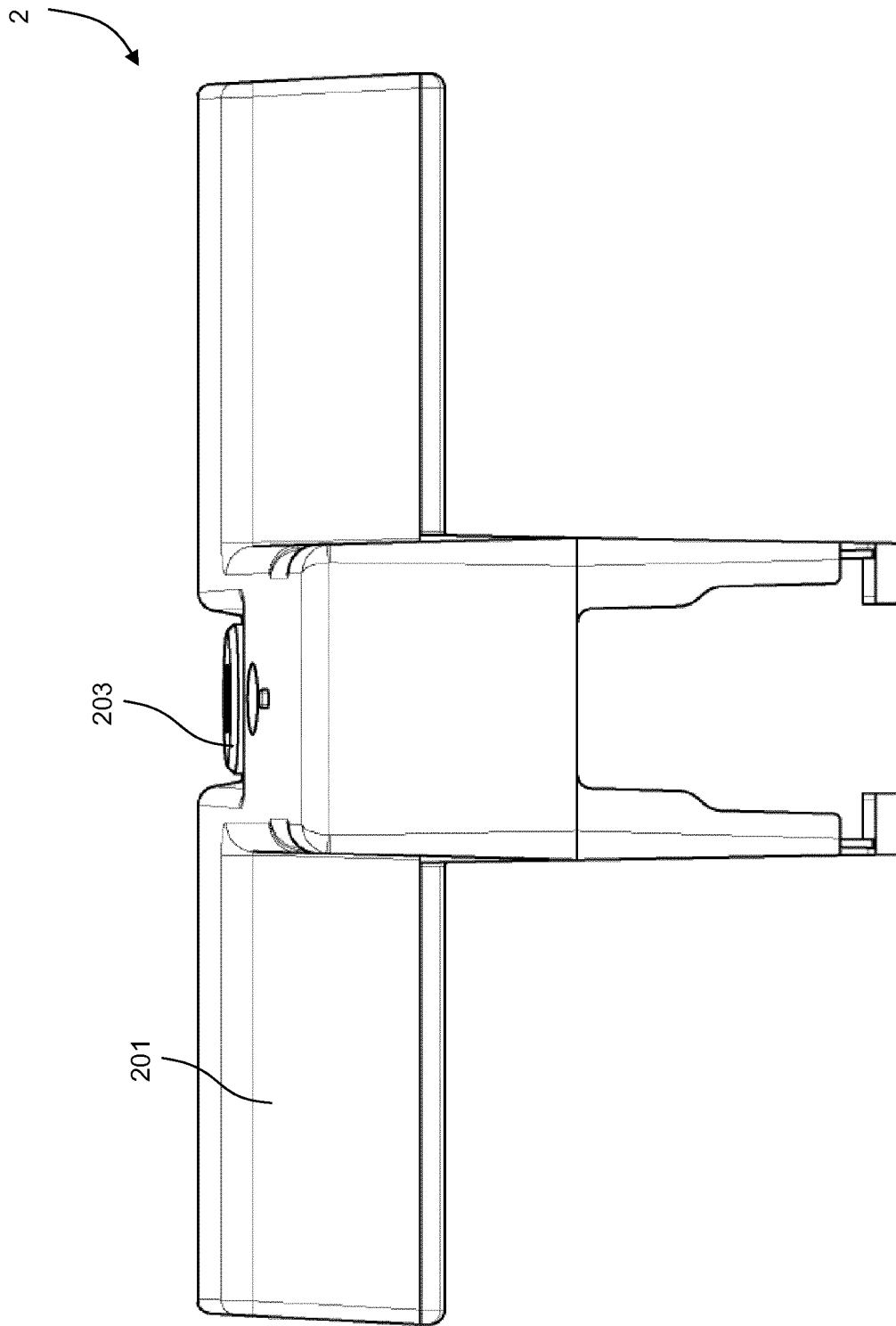


Fig. 2C

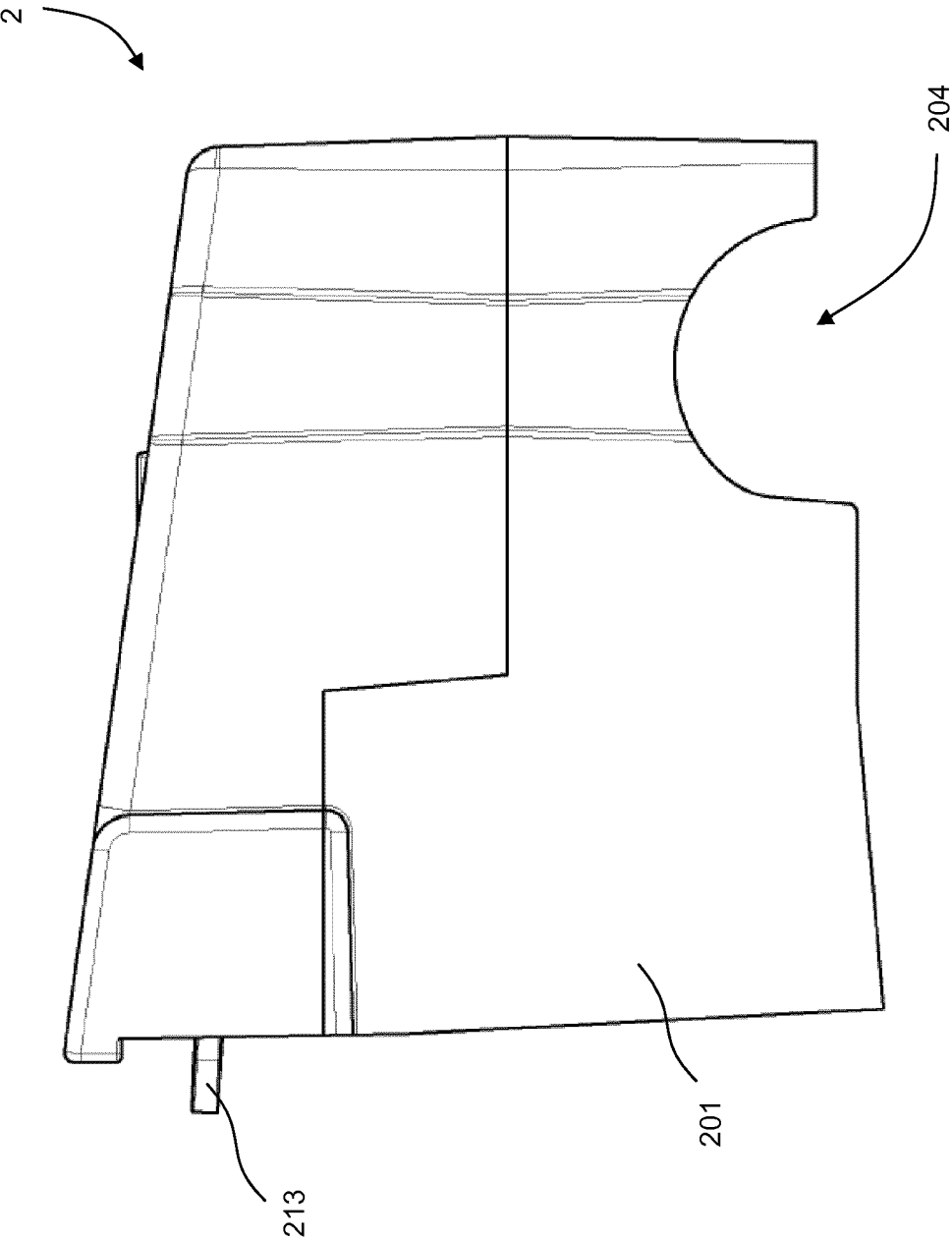


Fig. 2D

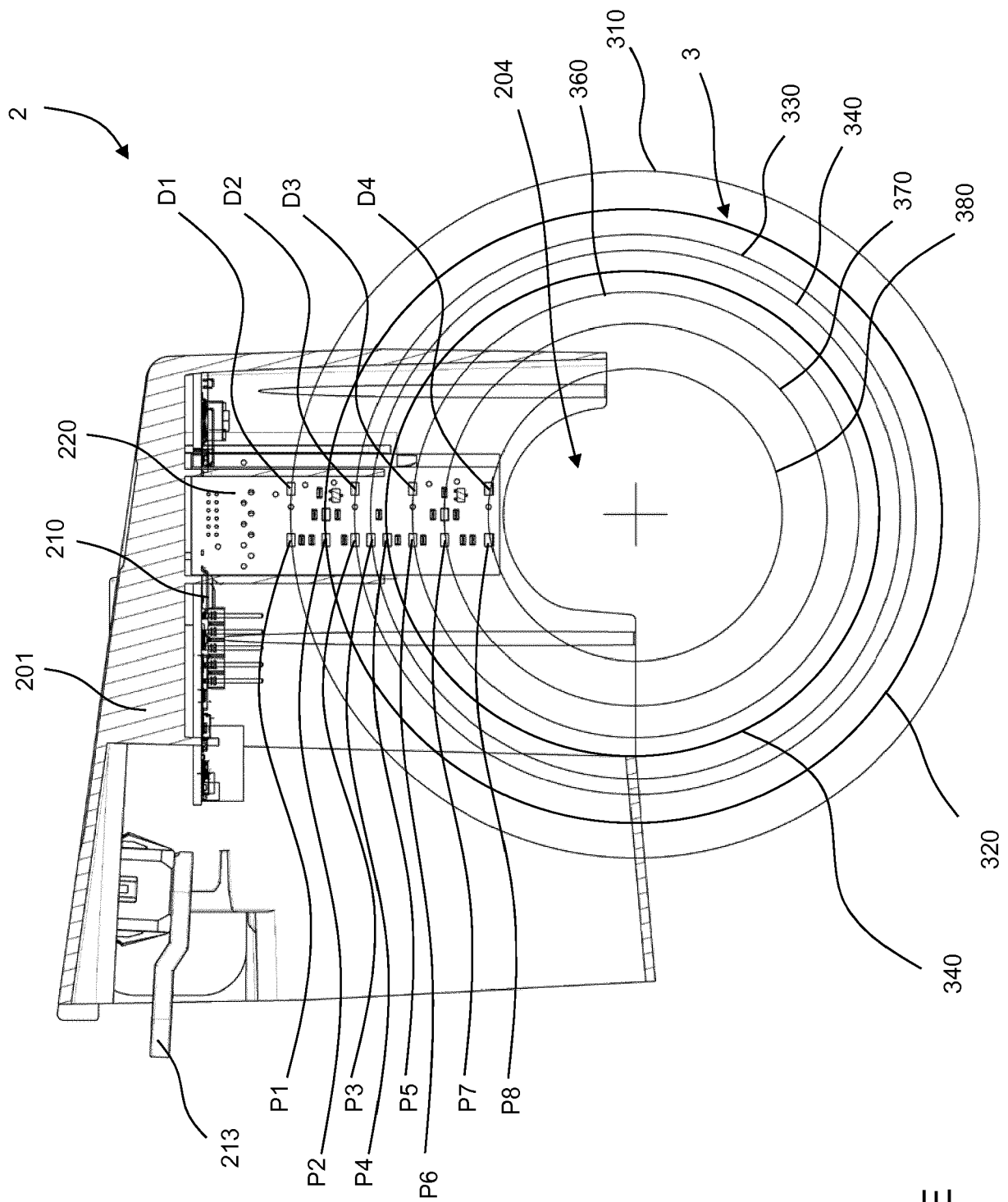


Fig. 2E

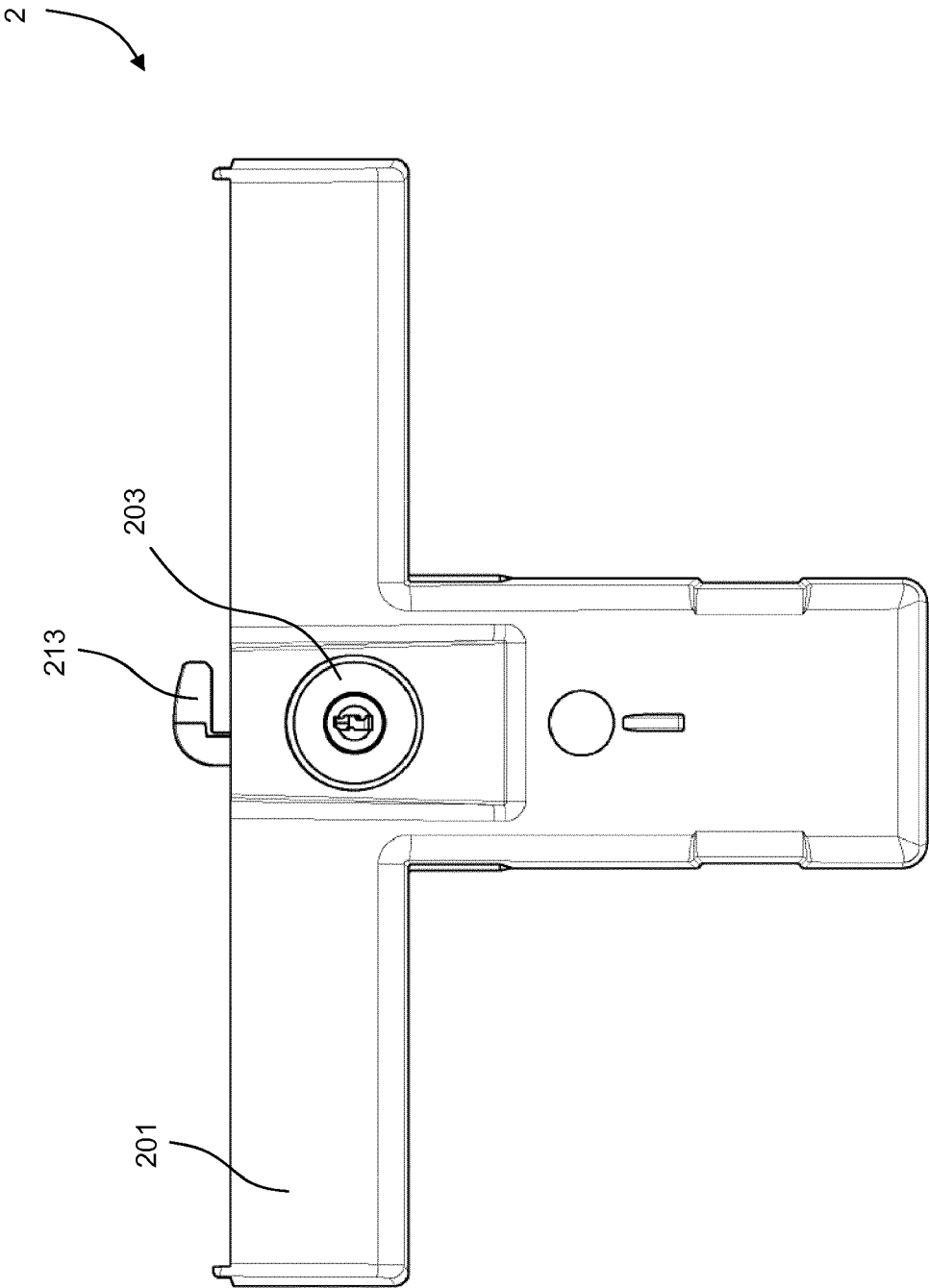


Fig. 2F



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| DOCUMENTS CONSIDERED TO BE RELEVANT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                 |                                                            |                                         |
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| Place of search<br><b>The Hague</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                 | Date of completion of the search<br><b>31 October 2016</b> | Examiner<br><b>van de Beek-Duijker</b>  |
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