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(54) **INTELLIGENT DEVICE FOR WASTE COLLECTION**

(57) An intelligent device (100, 200) for waste collection comprising:
- an upper portion (102a, 202a) comprising at least one internal compartment (102, 202) for inserting the waste;
- a lower portion comprising a plurality of waste collectors (103, 203);
- a central portion comprised between the upper portion (102a, 202a) and the lower portion; and
- a system for recognizing the type of waste included in the upper portion and configured to arrange the waste in the correct position in correspondence with the correct waste collectors (103, 203);
- a rotary actuator of at least a portion of the intelligent device (100, 200).

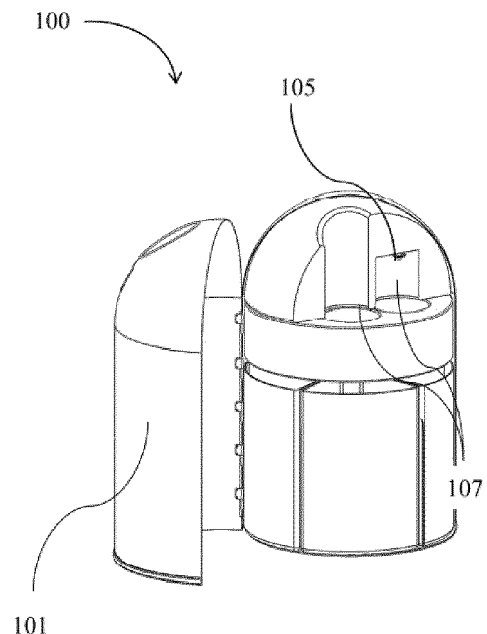


Fig. 2B

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Description

[0001] The present invention is related to an intelligent device for waste collection.

[0002] In particular, the present invention is related to an intelligent device for waste collection of the type suitable for simplify separation of different materials for recycling.

[0003] As is known, there are several types of intelligent devices for waste collection.

[0004] A first known type is shown in the patent application WO2018013903A1, which describes a sorting waste system which comprises several sensors for automatically determine the type of waste and to arrange it in the right bin, said bin could be a bin for recyclable waste or for non-recyclable waste.

[0005] If the system determines that the waste is of recyclable type, the waste will be arranged in the specific bin. If, instead, the waste doesn't meet the recyclability threshold, the system will arrange the waste in a bin for non-recyclable waste.

[0006] A second known type is shown in the patent application US10406564B1 which describes a bin for recycling which organizes and temporarily stores different types of waste. The container for sorting waste comprises a hollow housing having an upper wall, a lower wall and at least a side wall. The upper wall comprises a housing to lay down waste, while the lower part of the housing comprises several compartments, each of which is specific for a particular waste. When waste is inserted in the upper portion, it is temporarily held and then it is conveyed on a ramp for weighing (by a scale) and then it is scanned by a sensor to determine its composition.

[0007] A third type is cited in the patent application US9272842B1 which describes an apparatus to identify and sorting part of recycling of plastic bottles and aluminium bottles. The invention simplifies the sorting process of recyclable material in the bin, to facilitate the next sorting phases. After sorting of the material, the bin compresses waste to increase capacity. The modular arrangement of the invention allows to simply replace each bin.

[0008] However, these devices have the drawback to not interact with a user during the use and the selection of recyclable waste.

[0009] Scope of the present invention is to provide an intelligent device for waste collection able to identify waste by artificial intelligence classifying objects in a different way, discerning the material and the objects.

[0010] According to the present invention, it is realised an intelligent device for waste collection, as defined in claim 1.

[0011] For a better understanding of the present invention, it is described a preferred embodiment, as a not limiting example, referring to the enclosed drawings, in which:

- figure 1 shows a tridimensional view of an intelligent

device for waste collection, according to the invention;

- figures 2A-2B show internal tridimensional views of a first embodiment of the intelligent device for waste collection of figure 1, according to the invention;
- figure 3 shows an upper view in section of a first embodiment of the intelligent device for waste collection of figure 1, according to the invention;
- figure 4 shows a detail of an internal view of the intelligent device for waste collection when waste is inserted into the device of figure 1, according to the invention;
- figures 5a-5b show internal views of a first embodiment of the intelligent device for waste collection when waste is inserted into the device of figure 1, according to the invention;
- figure 6 shows a view of a first embodiment of the intelligent device for waste collection of figure 1 with disassembled bins, according to the invention;
- figures 7.a e 7.b show views of a second embodiment of the intelligent device for waste collection, according to the invention;
- figure 8 shows an operational scheme of functioning of the second embodiment of the intelligent device for waste collection, according to the invention.

[0012] The intelligent device 100, 200 for waste collection according to the invention comprises:

- An upper portion 102a, 202a comprising at least one internal compartment 102, 202 for inserting the waste by a user;
- A lower portion comprising a plurality of waste collectors 103, 203;
- A central portion comprised between the upper portion 102a, 202a and the lower portion, said central portion being rotatable about a central axis for the first embodiment of device 100, while it is fixed for the second embodiment of device 200;
- A system for recognizing the type of waste inserted by a user into the upper portion 102a, 202a;
- A rotary actuator able to rotate at least a portion of the intelligent device 100,200.

[0013] With reference to figures 1-3, it is shown a first embodiment of an intelligent device 100 for waste collection, comprising an external casing 101, part of which is fixed, while a second part 101a, hinged to the first part, is configured to be openable with a door and allow the access to an internal portion of the device 100. The upper portion of the external casing 101, preferably the upper portion of the first part openable of the external casing 101, comprises a hole 101b for inserting waste into the intelligent device 100.

[0014] Inside, the device 100 according to the first embodiment comprises:

- an upper portion 102a fixed where is defined an in-

- ternal compartment 102 for inserting waste;
- a lower portion 103a comprising a plurality of waste collectors 103, comprising hollow bodies each of which having substantially cylindrical shape open at the top;
 - and a central portion comprised between the upper portion 102a fixed and the lower portion 103a, the central portion comprising a waste filtering device 104 configured to rotate after the insertion of waste made by a specific material detected, for example paper, and to rotate dragging the waste during the movement, as long as the waste will be nearby one of waste collectors 103 addressed to collect the specific material (in this example, paper).

[0015] Moreover, the upper portion 102a fixed comprises an internal camera 105 facing the rotatable waste filtering device 104 and configured to recognize the type of waste inserted in the hole 101b and the internal compartment 102 for waste inserting.

[0016] According to an aspect of the invention, the intelligent device 100,200 comprises at an upper portion thereof a digital screen 106, 206 configured to communicate the filling level of the waste collectors 103, 203, the weight of the waste inserted, the waste material thrown into the hole 101b, 201b and temporarily present in the internal compartment 102, 202.

[0017] According to an aspect of the invention, the digital screen 106, 206 is configured furthermore to display messages by pop-up window, for example suggestions on what to preferably not drop (for example: organic, liquids), the maximum size of waste that could be dropped in the device 100,200, suggestions on how to "crumple" or "compress" waste before to drop it, in order to minimise the waste volume and better exploit the volume of waste collectors 103, 203 and help the environment (because of lower emissions CO₂ due to the fewer number of travels on street for supporting the logistic system of disposal), suggestions on how to reduce the environmental impact and instruct the user on valorization of waste, by messages as: "Do you know that from capsules of bottles it is possible to obtain..? Or "Do you know that waste like.. actually is not differentiable?".

[0018] According to an aspect of the invention, the device 100, 200 comprises a system for recognizing the type of waste dropped, discerning waste by the following categories: PLASTIC, PAPER, GLASS, ALUMINIUM. If a waste inserted in the hole 101b is not recognised as a material of the preceding categories, or better, is recognised with a reliability below a specific threshold (called "minimum threshold of recognition"), it would be automatically organized as "Not classifiable" and would be arranged, by rotation of the rotatable waste filtering device 104, in a specific collector for undifferentiated recycling, comprised between the plurality of waste collectors 103.

[0019] According to an aspect of the invention, the rotatable waste filtering device 104 comprises a plurality

of compartments 104a for waste, shown in figure 3 and figure 5a. Each compartment 104a is a compartment obtained internally to the rotatable waste filtering device 104, having a substantially cylindrical shape and having at a lower edge at least a lid 107, which could be alternatively opened to allow the passage of a waste from the compartment 104a to the waste collector 103 below and closed to block the passage of waste if its material detected is not corresponding to the waste collector 103 below during the rotation of the rotatable waste filtering device 104.

[0020] Each compartment 104a having a respective lid 107, is placed during the rotation of the rotatable waste filtering device 104, nearby each waste collectors 103 of the lower portion of device 100.

[0021] According to an aspect of the invention, the rotatable waste filtering device 104 is configured to carry out a rotational movement with a fixed angle as to allow waste to reach, placed on one of lids 107 that can be opened, a "recognition zone" placed nearby the internal camera 105, and to reach near the right waste collector 103. Moreover, the device 100 is configured to cause the opening of the specific lid 107 corresponding to the compartment 104a where waste is placed, so to let it fall in the arranged waste collector 103, as shown in figure 3. The lid 107 is automatically opened when the compartment 104a, where it is present a specific waste made by a material comprised in a specific category (for example plastic), is positioned above the waste collector 103 arranged to collect the specific material (for example, the plastic collector).

[0022] According to another aspect of the invention, the device 100, 200 comprises level sensors of waste in each waste collector 103, 203. The digital screen 106, 206 communicates information about filling/collection detected by level sensors.

[0023] According to an aspect of the invention, as shown in figure 6, waste collectors 103, 203 are detachable from the lower portion of the container 100, 200 when the portion that could be opened 101a, 201a is in open configuration.

[0024] According to another aspect of the invention, waste collectors 103, 203 are positioned on a bin holder structure which, once unblocked, allows the rotation of waste collectors 103, 203 about the axis of symmetry of the device 100, 200.

[0025] According to a first embodiment, the device 100 comprises a single internal compartment 102 for inserting waste. Every time waste is thrown, one at a time, is automatically activated the rotation of the rotating waste filtering device 104 to sort waste. Waste just thrown is dragged in the following angular position, below the internal camera 105, said "recognition zone", then the rotating waste filtering device 104 carries out a new rotation until to position, on the basis of the material detected by the internal camera 105, the waste inserted in the waste collector 103 assigned for that specific material.

[0026] According to a second embodiment, shown in

figure 7, the device 200 comprises an external casing 201 divided in:

- A fixed upper portion comprising a plurality of internal compartments 202 for inserting waste;
- A lower portion automatically rotating about a central axis and comprising a plurality of waste collectors 203; and
- A fixed central portion comprised between the upper portion and the lower portion and comprising a plurality of waste housings 204a within which there is waste after it is released through internal compartments 202 for inserting waste and to be conveyed in corresponding waste collectors 203.

[0027] Moreover, the upper portion of the container comprises an internal camera 205 facing the fixed upper portion and configured to recognise the type of waste inserted into the hole 201b and into the internal compartment 202 for waste insertion.

[0028] When waste is inserted in one of internal compartments 202 and being recognised by the internal camera 105, 205, which is placed above in respect of the plurality of internal compartments 202, the plurality of waste collectors 203 placed on a rotating platform rotates until, rotation after rotation, the right waste collector 203 reaches below waste made by the material that has to be released inside thereof by lids 107, 207. In this case internal compartments for waste insertion 202 could be already suitable for differentiated collection (recycling) by the use of different colors or all same colors; in the first case, the user is further facilitated in the recycling.

[0029] According to an aspect of the invention, for both the first and the second embodiment, there are conferred labels to waste, changing the type of classification on the basis of the place of installation.

[0030] Advantageously according to the inventions, the rotating system for sorting or the rotating waste filtering device 104, and the rotation system of waste collectors 203 allows to reduce the necessary components to generate motion, comprising in fact a single rotary actuator, without the need of guides for linear translations, and to maximize the ration volume/encumbrance by using a cylindrical shape.

[0031] Advantageously, moreover, the time to wait between the insertion of a waste and the following one is reduced as much as possible. The time to wait for sorting is related only to the time for recognition by an artificial intelligence algorithm used and it is not related to the path of release of waste. It is therefore possible to optimize consumption because it is possible to execute up to three different actions with equal position of rotating filter.

[0032] According to an aspect of the invention, the device 100, 200 is connected to the internet and when one of waste collectors 103,203 is full at 80%, will be sent a notification to a mobile device, typically to an operator, to communicate that shortly it will be the moment to empty

the device 100, 200.

[0033] A second notification is sent when the collector will be full at 100%. If for example the collector for plastic is full at 100% (because any operator has not emptied it), the device 100 will communicate it by the digital screen 106, highlighting with red color that the collector for plastic is full and therefore it is not possible to throw more plastic. If a user throws anyway a plastic waste into the device 100, 200, it could be possible to do it anyway. In this case the device 100,200 will treat waste internally to the housing 104a, 204a, without release it. This allow to continue to insert further non-plastic waste and sorting it in other collectors instead of to stop completely the device 100,200.

[0034] In use, every time that the waste filtering device 104, or sorter 104, 204 performs a movement,

- i) A free housing 104a is placed below the load compartment to allow the user to throw waste,
- ii) Waste is recognised in the specific zone where is present the internal camera 105 and
- iii) Waste (present in another compartment) is unloaded in the specific waste collector 103.

[0035] These actions occur in parallel, for every step of the waste filtering device 104. In summary, it is exploited to the maximum the plurality of actions that could be done for every positioning of waste filtering device 104 (positioning = energy consumption). More in particular, waste is inserted in the specific internal compartment for inserting waste 102, 202 and then it falls, by gravity, into the device 100, 200, inside one of the housings of rotating waste filtering device 104, or inside of fixed internal compartments 202; then, waste is photographed by the internal camera 105, 205 and then it is placed, by movement of waste for the first embodiment or by rotation of collectors placed below for the second embodiment, nearby the specific waste collector. For the first embodiment, indeed, moving for only a click, the rotating waste filtering device 104 places waste below the internal camera 105 nearby the so-called recognition zone. Computer Vision algorithms and multispectral imaging techniques allow to recognise the object and/or the material comprised in waste inserted for to allocate it then to the specific waste collector. If waste corresponds to the right collector, the lid 107 for drain will open and waste will fall into the right waste collector 103, as showed in figures 5A-5b. If, instead, waste is not present at the right waste collector 103 during the recognition moment, the lid 107 remains closed and the rotating waste filtering device 104 will rotate until waste and the specific waste collector 103 will correspond, in this position the lid 107 will be automatically opened. Therefore, the device 100 remains stationary until a second waste will be thrown by a user through the loading opening. As soon as this happens, the waste filtering device 104 executes a further click and the first waste will be near to another waste collector. The algorithm queries the artificial intelligence system

verifying if it is possible to release the first waste. If the first waste is above the right drain collector, the result will be YES. Otherwise, the first waste will not be released. Sooner or later, the first waste will execute, click by click, a 360° rotation, namely a complete rotation, and inevitably it will be above the drain collector to be released. The lid 107 of the housing 104a, where have been inserted the waste made by paper or aluminium, will open only when the housing will be exactly above the collector for paper or aluminium. Finally, when it is the time of emptying, waste collectors 103 detachable allow to the user to remove the single full waste collector 103. The operator therefore could rotate the bin holder. This allows to extract collectors from a favorite side of the device 100.

[0036] Moreover, the intelligent device 100,200 for waste collection according to the invention allows to sort not only categories plastic, paper, glass and aluminium, but also subcategories for plastic (for example: HDPE, PET, etc.) updating the software of the system and adapting it to the type of material to be recognized or it could be executed a distinction for object, for example "Bottles", "Packagings", "Electronic Materials", etc.

[0037] It is clear, lastly, that the intelligent device for waste collection according to the described and illustrated invention could be modified without, for this reason, exit from the scope of protection of the present invention, as defined by the enclosed claims.

Claims

1. Intelligent device (100, 200) for waste collection comprising:

- an upper portion (102a, 202a) comprising at least one internal compartment (102, 202) for inserting the waste;
- a lower portion comprising a plurality of waste collectors (103, 203);
- a central portion comprised between the upper portion (102a, 202a) and the lower portion; and
- a system for recognizing the type of waste included in the upper portion and configured to arrange the waste in the correct position in correspondence with the correct waste collectors (103, 203);
- a rotary actuator of at least a portion of the intelligent device (100, 200).

2. Intelligent device (100, 200) according to claim 1, **characterized in** comprising waste level sensors in the various waste collectors (103, 203).

3. Intelligent device (100, 200) according to claim 1, **characterized in** comprising an external casing (101, 201) comprising a first fixed part and a second part, hinged to the first, configured to be openable with a door and allow the access to an internal portion

of the device (100, 200), said second part comprising in an upper portion thereof a hole (101b, 201b) suitable for inserting waste into the intelligent device (100,200).

4. Intelligent device (100, 200) according to claim 1, **characterized in that** the waste collectors (103, 203) are reversibly detachable from the lower portion of the external casing (101, 201).

5. Intelligent device (100, 200) according to claim 1, **characterized in** comprising in an upper portion thereof a digital screen (106, 206) configured to communicate the filling level of the waste collectors (103, 203), the weight of the waste inserted, the waste material thrown into the hole (101b, 201b) and temporarily present in the internal compartment (102, 202).

6. Intelligent device (100, 200) according to claim 1, **characterized in that** said upper portion (102a, 202a) is fixed and said central portion consists of a waste filtering device (104) capable of rotating around a central axis after the detection of a waste in the upper portion and the detection of the waste material by means of the detection system, until said waste is positioned in correspondence with a corresponding collector among the plurality of waste collectors (103), said waste filtering device (104) comprising a plurality of housings (104a) each of which having a substantially cylindrical shape and, in one of its lower ends, at least one lid (107) which can be opened automatically when the recognition system and the waste filtering device (104) position a waste in correspondence to a waste collector (103, 203) destined for the detected material.

7. Intelligent device (100, 200) according to claim 1, **characterized in that** said upper portion is fixed and comprises a plurality of waste internal insertion compartments (202) and an internal camera (105, 205), said lower portion being automatically rotatable around to a central axis and comprises the plurality of waste collectors (203), and said central portion being fixed and comprising a plurality of waste housings (204a) each comprising a lid (207) at the bottom.

8. Intelligent device (100, 200) according to claim 1, **characterized in that** the waste is discharged into an undifferentiated collector if it is recognized with a margin of error below a predefined minimum recognition threshold.

9. Intelligent device (100, 200) according to claim 1, **characterized in that** the central portion comprises a plurality of openable discs, each located in correspondence with one of the waste collectors (203).

10. Intelligent device (100, 200) according to claim 1, **characterized in** being connected to the internet and managed by means of an artificial intelligence algorithm configured to process the images detected by the internal camera (105, 205) and start the rotation of at least one portion of the device (100, 200) and the opening of one of the lids (107, 207) corresponding to the waste collector (103, 203) reserved for the detected waste material.
11. Intelligent device (100, 200) according to claim 10, **characterized in** being configured to send to a mobile device a first notification when one of the waste collectors (103, 203) is 80% full and a second notification when the waste collector (103, 203) is 100% full.

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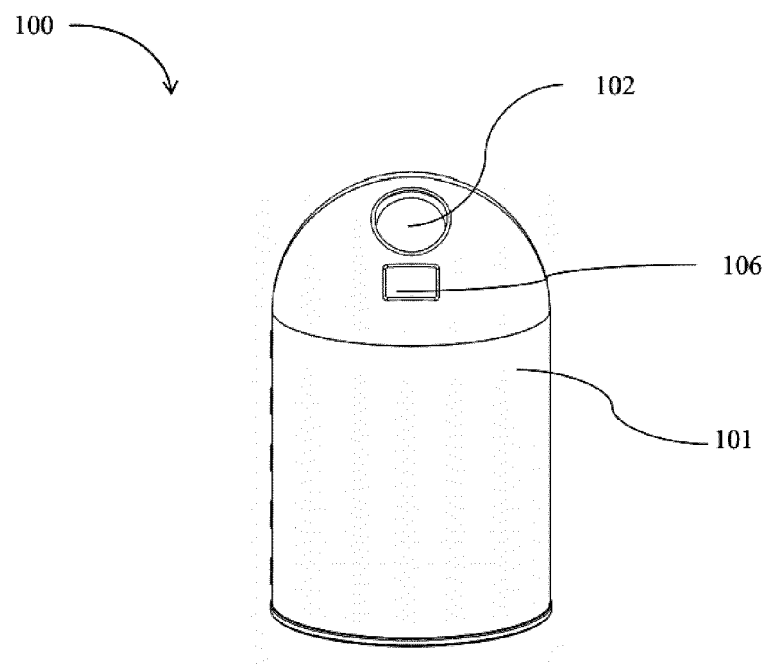


Fig. 1

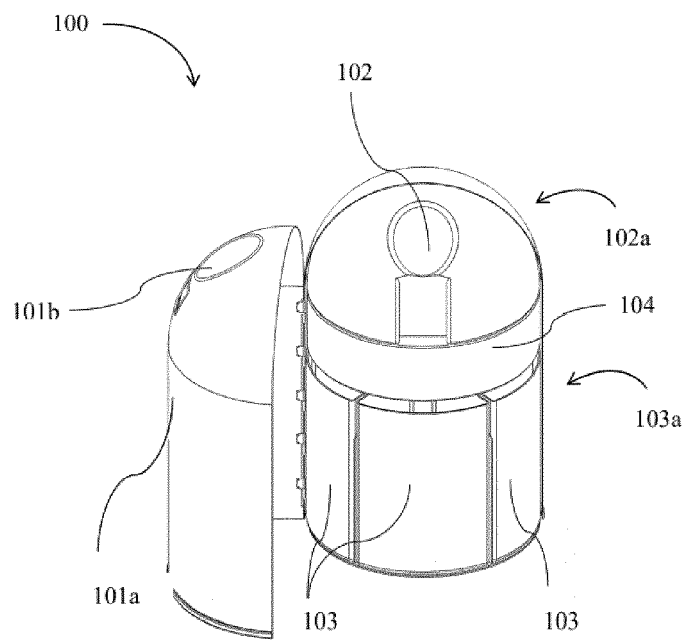


Fig. 2A

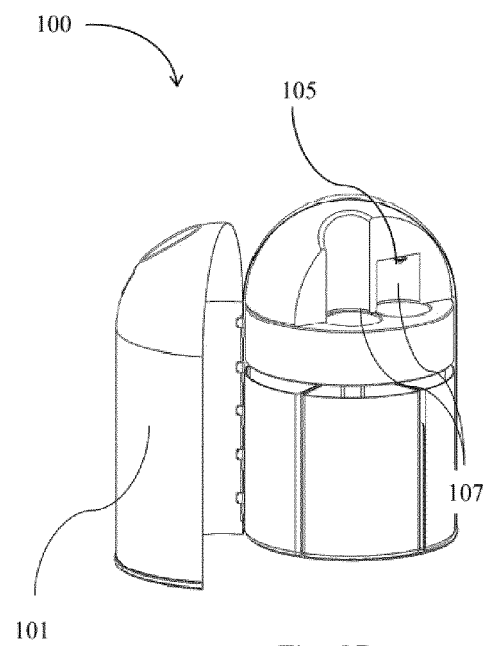


Fig. 2B

Fig. 2

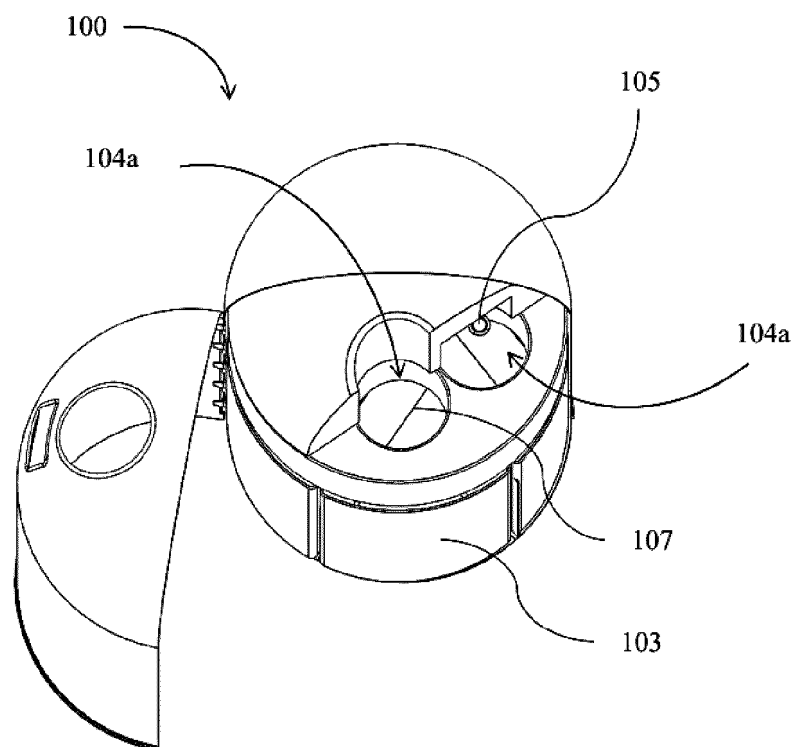


Fig. 3

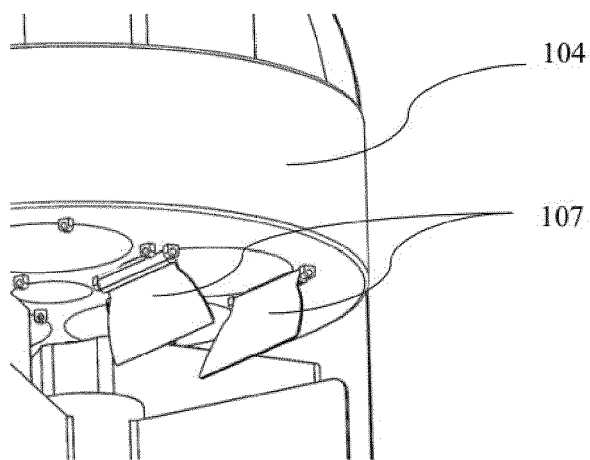


Fig. 4

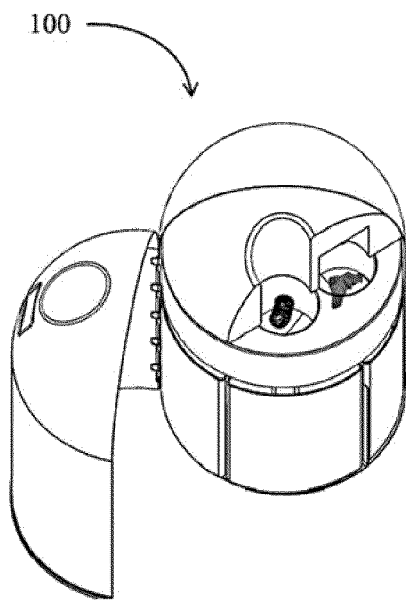


Fig. 5a

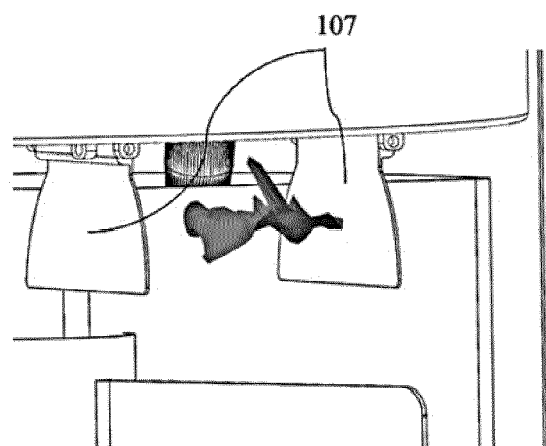


Fig. 5b

Fig. 5

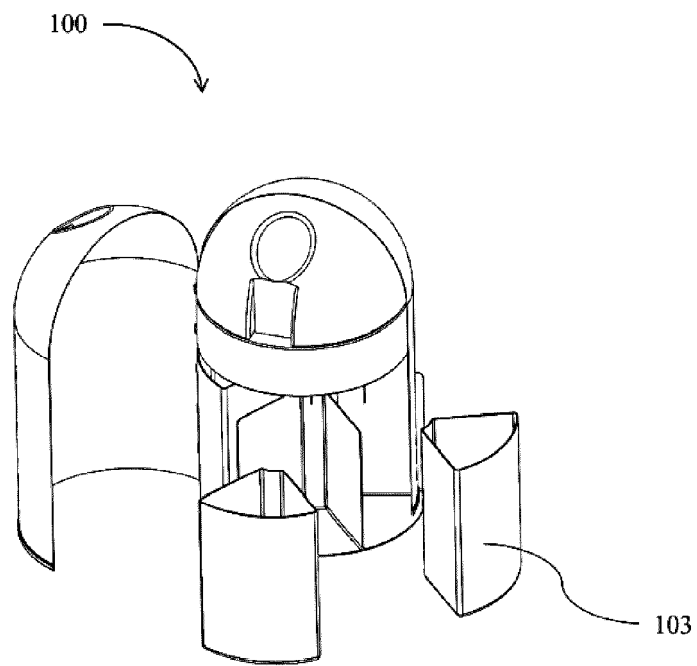


Fig. 6

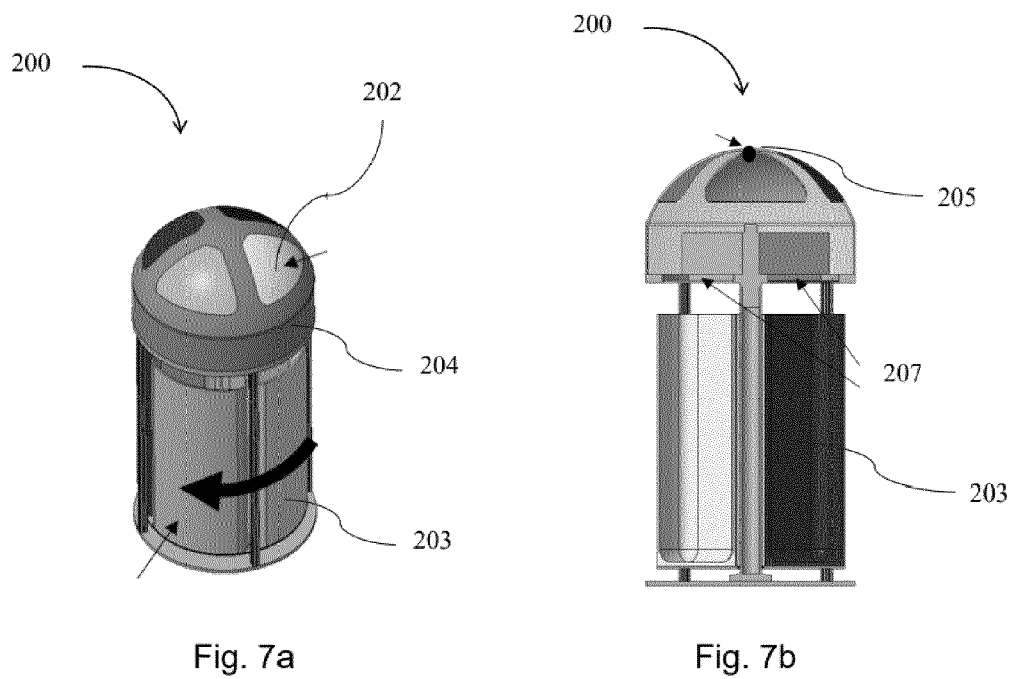


Fig. 7

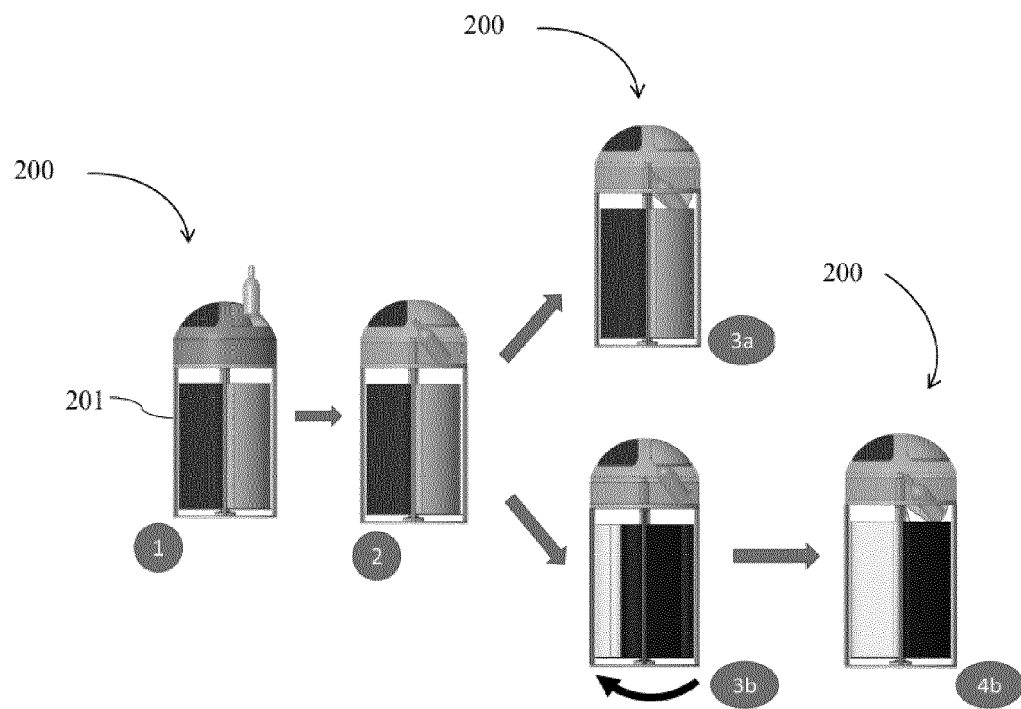


Fig. 8



EUROPEAN SEARCH REPORT

Application Number

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	CN 110 697 285 A (UNIV MINJIANG) 17 January 2020 (2020-01-17) * paragraph [0029] - paragraph [0032]; figure 1 *	1-11	INV. B65F1/00
X	CN 110 861 852 A (SHIJIAZHUANG POSTS AND TELECOMMUNICATIONS TECHNICAL COLLEGE CHINA POST) 6 March 2020 (2020-03-06) * paragraph [0050] - paragraph [0054]; figures 1-4 *	1-11	
			TECHNICAL FIELDS SEARCHED (IPC)
			B65F
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 2 February 2022	Examiner Luepke, Erik
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02-02-2022

10	Patent document cited in search report	Publication date	Patent family member(s)	Publication date
	CN 110697285 A	17-01-2020	NONE	

15	CN 110861852 A	06-03-2020	NONE	

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- US 10406564 B1 [0006]
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