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# (54) AUTOMATIC CLEANING APPARATUS

(57) An automatic cleaning apparatus, comprising a moving platform (100), a position determination device (121), and a fitting structure (300) for fitting the position determination device (121) to the moving platform (100). The position determination device (121) comprises a position determination element and a cover lid (340), wherein the position determination element comprises a rotor (320) and a motor (330); the cover lid (340) covers the top of the rotor (320), and comprises a circular top face (341), a bottom circular ring (342), and a plurality of connectors (343), which connect the circular top face (341) and the bottom circular ring (342); and a first gap is formed between the bottom circular ring (342) and an outer peripheral face of the rotor (320). The fitting structure (300) comprises an annular shielding member (350) attached to an inner side of the bottom circular ring (342), and a second gap is formed between the annular shielding member (350) and the outer peripheral face of the rotor (320), the second gap being smaller than the first gap. The fitting structure (300) can be adapted to a miniaturized position determination device (121).

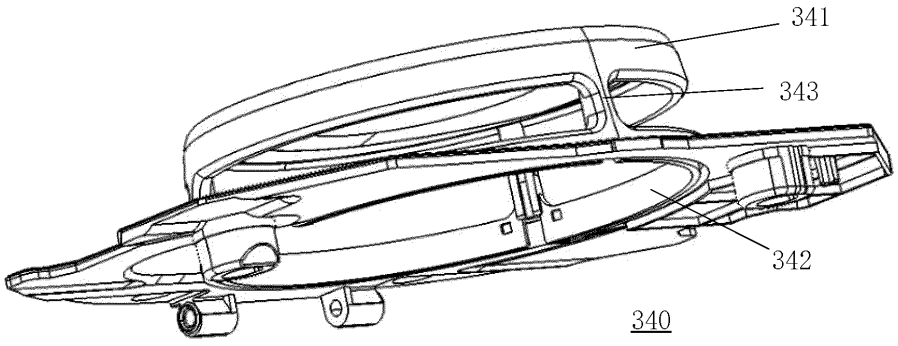


**FIG. 6**

EP 4 464 223 A1

## Description

### CROSS-REFERENCE TO RELATED APPLICATION

**[0001]** This application claims priority to the Chinese Patent Application No. 202220065971.4, filed on January 11, 2022, which is incorporated herein by reference in its entirety as a part of the present application.

### TECHNICAL FIELD

**[0002]** The present disclosure relates to the technical field of cleaning robots, and in particular to an automatic cleaning apparatus.

### BACKGROUND

**[0003]** Cleaning robots include sweeping robots, mopping robots, sweeping and mopping robots, etc. In the process of traveling, the cleaning robots need to detect surrounding obstacles in order to plan traveling routes based on the obstacles, avoid the obstacles, etc.

**[0004]** In the prior art, a position determining device for a cleaning robot to detect the obstacles include a laser distance sensor (LDS), a camera, a line laser sensor, an ultrasonic sensor, etc. Each position determining device has its own advantages and disadvantages. The position determining devices, due to their complex structures and large sizes, need to occupy large assembly space of the cleaning robots, which hinders the arrangement of other components of the cleaning robots. In addition, the assembly space cannot be adjusted according to the different sizes of the position determining devices, which is inconvenient for flexible application of the position determining devices.

### SUMMARY

**[0005]** An embodiment of the present disclosure provides an automatic cleaning apparatus, including a mobile platform, a position determining device and an assembling structure for assembling the position determining device on the mobile platform.

**[0006]** The position determining device includes a position determining element and a cover.

**[0007]** The position determining element includes a rotor and a motor, wherein the rotor is configured to transmit and/or receive a detection signal while continuously rotating, and the motor is configured to be connected to the rotor by means of a power transmission structure to provide a driving force for the rotor.

**[0008]** The cover covers a top of the rotor and includes a circular top surface, a bottom ring and a plurality of connectors connecting the circular top surface to the bottom ring, wherein a first gap is formed between the bottom ring and an outer peripheral surface of the rotor.

**[0009]** The assembling structure includes an annular shielding member attached to an inner side of the bottom ring, a second gap is formed between the annular shielding member and the outer peripheral surface of the rotor, and the second gap is smaller than the first gap.

### BRIEF DESCRIPTION OF THE DRAWINGS

**[0010]** The accompanying drawings, which are incorporated into the specification and constitute a part of the specification, show embodiments consistent with the present disclosure, and are used to explain the principles of the present disclosure together with the specification. Apparently, the accompanying drawings in the following description show merely some embodiments of the present disclosure, and those of ordinary skill in the art can also derive other accompanying drawings from these accompanying drawings without creative efforts. In the accompanying drawings:

FIG. 1 is an oblique view of an automatic cleaning apparatus according to some embodiments of the present disclosure;

FIG. 2 is a schematic diagram of a bottom structure of the automatic cleaning apparatus according to some embodiments of the present disclosure;

FIG. 3 is an overall structural diagram of a position determining element according to some embodiments of the present disclosure;

FIG. 4 is an enlarged structural diagram of the position determining element according to some embodiments of the present disclosure.

FIG. 5 is a structural diagram of a module support according to some embodiments of the present disclosure;

FIG. 6 is a structural diagram of a cover according to some embodiments of the present disclosure;

FIG. 7 is a partial cross-sectional structural diagram of the cover according to some embodiments of the present disclosure;

FIG. 8 is a structural diagram of an annular shielding member according to some embodiments of the present disclosure; and

FIG. 9 is a partially enlarged structural diagram of the annular shielding member according to some embodiments of the present disclosure.

**[0011]** Reference numerals are described as below: mobile platform 100, rearward portion 110, forward portion 111, perception system 120, buffer 122, cliff sensor 123, control system 130, driving system 140, driving wheel assembly 141, steering assembly 142, cleaning module 150, dry cleaning module 151, side brush 152, assembling part 200, assembling structure 300, assembling support 310, rotor 320, motor 330, cover 340, rotor accommodating part 311, motor accommodating part 312, first arc-shaped sidewall 3111, second arc-shaped sidewall 3121, motor roller 331, conveyor belt 332, first opening 3122, bottom surface 3124 of motor accommodating part, first support rib 3123, second opening 3112,

second support rib 3113, bottom surface 3114 of rotor accommodating part, circular top surface 341, bottom ring 342, connector 343, annular shielding member 350, insert member 351, first socket 3431, second socket 3432, third socket 3433, ridge 3511, T-shaped protrusion 3512, limiting groove 3434, limiting protrusion 3513.

## DETAILED DESCRIPTION

**[0012]** To make the objectives, technical solutions and advantages of the present disclosure clearer, the present disclosure will be further described in detail below with reference to the accompanying drawings. It is obvious that the described embodiments are only some, but not all of the embodiments of the present disclosure. All other embodiments acquired by those of ordinary skills in the art without creative efforts based on the embodiments in the present disclosure are within the protection scope of the present disclosure.

**[0013]** The terms used in the embodiments of the present disclosure are for the purpose of describing particular embodiments only and are not intended to limit the present disclosure. The singular forms "a/an", "said" and "the" used in the embodiments of the present disclosure and the appended claims are intended to include the plural forms as well, unless otherwise indicated clearly in the context. The term "a plurality of" generally includes at least two.

**[0014]** It should be understood that, the term "and/or" used herein only describes an association relationship between associated objects, and indicates that there may be three kinds of relationships. For example, A and/or B may indicate three cases: A alone, B alone, and A and B together. In addition, the character "/" herein generally indicates an "or" relationship between the contextual objects.

**[0015]** It should be understood that, although the terms first, second, third, etc. may be used to describe objects in the embodiments of the present disclosure, these objects should not be limited to these terms. These terms are only used to distinguish objects. For example, "first" may also be referred to as "second" without departing from the scope of the embodiments of the present disclosure. Similarly, "second" may also be referred to as "first".

**[0016]** It should also be noted that, the terms "including", "comprising", or any other variants thereof are intended to cover the nonexclusive inclusion, such that a commodity or device including a series of elements includes not only those elements, but also other elements not listed explicitly or elements inherent to such a commodity or device. Without more limitations, the element defined by the phrase "including a ..." does not exclude the existence of other same elements in the commodity or device including the element.

**[0017]** Example embodiments of the present disclosure will be described in detail below with reference to the accompanying drawings.

**[0018]** An embodiment of the present disclosure provides an automatic cleaning apparatus. As an example, FIGS. 1 to 2 exemplarily show schematic structural diagrams of the automatic cleaning apparatus.

**[0019]** As shown in FIGS. 1 to 2, the automatic cleaning apparatus may be a vacuum ground sucking robot, or may be a ground mopping/brushing robot, or may be a window climbing robot, or the like. The automatic cleaning apparatus may include a mobile platform 100, a perception system 120, a control system 130, a driving system 140, a cleaning module 150, an energy system 160 and a human-computer interaction system 170.

**[0020]** The mobile platform 100 may be configured to move automatically along a target direction on an operating surface. The operating surface may be a surface to be cleaned by the automatic cleaning apparatus. In some embodiments, the automatic cleaning apparatus may be a ground mopping robot, and thus the automatic cleaning apparatus operates on a ground, and the ground is the operating surface. The automatic cleaning apparatus may also be a window cleaning robot, and thus the automatic cleaning apparatus operates on an outer surface of glass of a building, and the glass is the operating surface. The automatic cleaning apparatus may also be a pipe cleaning robot, and thus the automatic cleaning apparatus operates on an inner surface of a pipe, and the inner surface of the pipe is the operating surface. For the purpose of presentation only, the following description in the present application takes a ground mopping robot as an example for illustration.

**[0021]** In some embodiments, the mobile platform 100 may be an autonomous mobile platform, or a non-autonomous mobile platform. The autonomous mobile platform refers to that the mobile platform 100 itself can automatically and adaptively make an operational decision based on an unexpected environmental input; and the non-autonomous mobile platform itself cannot adaptively make an operational decision based on an unexpected environmental input, but can execute a given procedure or operate according to a certain logic. Correspondingly, when the mobile platform 100 is the autonomous mobile platform, the target direction may be determined autonomously by the automatic cleaning apparatus; and when the mobile platform 100 is the non-autonomous mobile platform, the target direction may be set manually or may be set by a system. When the mobile platform 100 is the autonomous mobile platform, the mobile platform 100 includes a forward portion 111 and a rearward portion 110.

**[0022]** The perception system 120 includes a position determining device 121 located on the mobile platform 100, a buffer 122 located in the forward portion 111 of the mobile platform 100, cliff sensors 123 and sensing devices such as an ultrasonic sensor (not shown), an infrared sensor (not shown), a magnetometer (not shown), an accelerometer (not shown), a gyroscope (not shown) an odometer (not shown), and the like located at a bottom of the mobile platform 100, for providing various position information and motion state information of the automatic

cleaning apparatus to the control system 130.

**[0023]** In order to describe behaviors of the automatic cleaning apparatus more clearly, directions are defined as follows: the automatic cleaning apparatus may travel on the ground by various combinations of movements relative to the following three mutually perpendicular axes defined by the mobile platform 100, i.e., a transversal axis Y, a front-rear axis X and a center vertical axis Z. A forward driving direction along the front-rear axis X is designated as "forward", and a rearward driving direction along the front-rear axis X is designated as "rearward". The transversal axis Y is substantially along a direction of an axis center defined by a center point of a driving wheel assembly 141 extending between a right wheel and a left wheel of the automatic cleaning apparatus. The automatic cleaning apparatus may rotate around the Y axis. It is referred to as "pitch up" when the forward portion of the automatic cleaning apparatus is tilted upward and the rearward portion thereof is tilted downward, and it is referred to as "pitch down" when the forward portion of the automatic cleaning apparatus is tilted downward and the rearward portion thereof is tilted upward. In addition, the automatic cleaning apparatus may rotate around the Z axis. In a forward direction of the automatic cleaning apparatus, it is referred to as "turn right" when the automatic cleaning apparatus is tilted to the right of the X axis, and it is referred to as "turn left" when the automatic cleaning apparatus is tilted to the left of the X axis.

**[0024]** As shown in FIG. 2, the cliff sensors 123 are provided at the bottom of the mobile platform 100 and in front and rear of the driving wheel assembly 141, respectively, for preventing the automatic cleaning apparatus from falling off when the automatic cleaning apparatus retreats, so as to avoid a damage to the automatic cleaning apparatus. The aforementioned "front" refers to a side same as a travelling direction of the automatic cleaning apparatus, and the aforementioned "rear" refers to a side opposite to the travelling direction of the automatic cleaning apparatus.

**[0025]** The position determining device 121 includes, but is not limited to, a camera or a laser distance sensor (LDS).

**[0026]** Various components in the perception system 120 may operate independently, or operate together to achieve a target function more accurately. The surface to be cleaned is identified by the cliff sensors 123 and the ultrasonic sensor to determine physical properties of the surface to be cleaned, including a surface medium, a degree of cleanliness, and the like, and may be determined more accurately in combination with the camera, the LDS, or the like.

**[0027]** For example, the ultrasonic sensor may determine whether the surface to be cleaned is a carpet. If the ultrasonic sensor determines that the surface to be cleaned is made of a carpet material, the control system 130 controls the automatic cleaning apparatus to perform cleaning in a carpet mode.

**[0028]** The forward portion 111 of the mobile platform 100 is provided with the buffer 122. During cleaning, when the driving wheel assembly 141 propels the automatic cleaning apparatus to travel on the ground, the buffer 122 detects one or more events (or objects) in a travelling path of the automatic cleaning apparatus via a sensor system, e.g., an infrared sensor, and the automatic cleaning apparatus may control the driving wheel assembly 141 based on the event (or object), such as obstacle or wall, detected by the buffer 122 to cause the automatic cleaning apparatus to respond to the event (or object), for example, to move away from the obstacle.

**[0029]** The control system 130 is disposed on a main circuit board in the mobile platform 100, and includes a computing processor such as a central processing unit or an application processor, that communicates with a non-transitory memory such as a hard disk, a flash memory or a random-access memory. The application processor is configured to receive environmental information sensed by the plurality of sensors and transmitted from the perception system 120, to draw a simultaneous map of an environment where the automatic cleaning apparatus is located using a positioning algorithm e.g., simultaneous localization and mapping (SLAM), based on obstacle information fed back by the LDS, and to autonomously determine a travelling path based on the environmental information and the environmental map, and then to control the driving system 140 to perform operations, such as travelling forward, travelling backward, and/or steering based on the autonomously determined travelling path. Further, the control system 130 may also determine whether to activate the cleaning module 150 to perform a cleaning operation based on the environmental information and the environmental map.

**[0030]** Specifically, the control system 130 may, based on distance information and speed information which are fed back by the buffer 122, the cliff sensors 123 and the sensing devices such as the ultrasonic sensor, the infrared sensor, the magnetometer, the accelerometer, the gyroscope and the odometer, comprehensively determine a current operation state of the ground sweeping robot, such as crossing a threshold, getting on a carpet, locating at an edge of a cliff, being stuck from above or below, having a full dust box or being picked up, and will also give specific next-step action strategies for different situations, so that the operation of the automatic cleaning apparatus is more in line with requirements of an owner and provides better user experience. Further, the control system can plan the most efficient and reasonable cleaning path and cleaning mode based on the simultaneous map drawn by the SLAM, thereby greatly improving the cleaning efficiency of the automatic cleaning apparatus.

**[0031]** The driving system 140 may execute a driving command based on specific distance and angle information, such as x, y, and theta components, to manipulate the automatic cleaning apparatus to travel across the ground. As shown in FIG. 2, the driving system 140 includes the driving wheel assembly 141, and may control a left wheel and a right wheel simultaneously. In order

to control the motion of the automatic cleaning apparatus more precisely, the driving system 140 preferably includes a left driving wheel assembly and a right driving wheel assembly. The left driving wheel assembly and the right driving wheel assembly are arranged symmetrically along a transversal axis defined by the mobile platform 100.

**[0032]** In order for the automatic cleaning apparatus to move on the ground more stably or have a higher movement ability, the automatic cleaning apparatus may include one or more steering assemblies 142, wherein the steering assembly 142 may be a driven wheel or a driving wheel, and structurally includes but is not limited to a universal wheel. The steering assembly 142 may be located in front of the driving wheel assembly 141.

**[0033]** The energy system 160 includes a rechargeable battery, such as a nickel-hydride battery and a lithium battery. The rechargeable battery may be connected to a charging control circuit, a battery pack charging temperature detecting circuit and a battery undervoltage monitoring circuit, wherein the charging control circuit, the battery pack charging temperature detecting circuit and the battery undervoltage monitoring circuit are then connected to a single-chip microcomputer control circuit. A host of the automatic cleaning apparatus is connected to a charging pile through a charging electrode disposed on a side of or below a body of the automatic cleaning apparatus for charging.

**[0034]** The human-computer interaction system 170 includes keys that are on a panel of the host and used by a user to select functions. The human-computer interaction system 170 may further include a display screen and/or an indicator light and/or a horn that present to the user a current state or function option of the automatic cleaning apparatus. The human-computer interaction system 170 may further include a mobile client program. For a route navigation type cleaning apparatus, a mobile client may present a map of the environment where the apparatus is located and a position of the apparatus to the user, which may provide richer and more user-friendly function items to the user.

**[0035]** As shown in FIG. 2, the cleaning module 150 may include a dry cleaning module 151.

**[0036]** The dry cleaning module 151 includes a rolling brush, a dust box, a fan and an air outlet. The rolling brush having a certain interference with the ground sweeps up garbage on the ground and rolls up the garbage to the front of a dust suction inlet between the rolling brush and the dust box, and then the garbage is sucked into the dust box by air having a suction force, which is generated by the fan and passes through the dust box. A dust removal capacity of the ground sweeping robot may be characterized by a dust pickup efficiency (DPU) of the garbage. The DPU is affected by a structure and material of the rolling brush, by a utilization rate of the air in an air channel formed by the dust suction inlet, the dust box, the fan, the air outlet and connecting components between the four, and by a type and power of the fan, which is a complex systematic design problem. Compared to an ordinary plug-in vacuum cleaner, the improvement of the dust removal capacity is more meaningful for an automatic cleaning apparatus with limited energy because the improvement of the dust removal capacity directly and effectively reduces requirements for energy, that is, the original cleaning apparatus that may clean 80 square meters of the ground with charging for once may be evolved to clean 180 square meters or more with charging for once. Furthermore, the service life of the battery with the reduced number of charging times will also be greatly increased, so that the frequency of replacing the battery by the user will also be decreased. More intuitively and importantly, the improvement of the dust removal capacity is the most obvious and important user experience, as the user will directly come to a conclusion of whether the thorough cleaning is achieved. The dry cleaning module may further include a side brush 152 having a rotary shaft angled relative to the ground, for moving debris into a region of the rolling brush of the cleaning module 150.

**[0037]** As an optional cleaning module, the automatic cleaning apparatus may further include a wet cleaning module configured to clean at least a part of the operating surface in a wet cleaning manner. The wet cleaning module includes a water tank, a cleaning head, a driving unit and the like, wherein water in the water tank flows to the cleaning head along a waterway, and the cleaning head is driven by the driving unit to clean at least a part of the operating surface. In the related art, the automatic cleaning apparatus includes a position determining device. The position determining device includes a position determining element and a cover. Usually, the position determining element configured in the automatic cleaning apparatus has a fixed size, and the dimension of the position determining element is basically matched with an assembling space. However, when the application apparatus needs to reduce the dimension of the position determining element, it is necessary to either redevelop a mold or adjust the position of devices around the assembling space of the position determining element, which brings great inconvenience to flexible application of the position determining element.

**[0038]** Therefore, an embodiment of the present disclosure provides an automatic cleaning apparatus in which a miniaturized position determining element can be assembled in the original assembling space. The position determining device according to an embodiment includes, but is not limited to, a camera or a laser ranging device (laser distance sensor, LDS). For the convenience of understanding, the position determining device according to the present embodiment is described by taking the LDS as an example. In the embodiment, the structures and position relationships of an assembling support, a rotor, a motor, a cover, etc., are reasonably set, so that the application of the position determining device is more flexible. The same structure has the same technical effects, and some technical effects are not repeated

herein. Specifically, as shown in FIG. 3, the automatic cleaning apparatus includes an assembling part 200, an assembling structure 300 and a position determining element 400 which are disposed on a frame. The positioning determining element 400 is assembled at the assembling part 200 through the assembling structure 300. The assembling part 200 is usually a part of the frame and includes one or more screw holes. The assembling structure 300 includes one or more corresponding screw holes, and the position determining element 400 is assembled at the assembling part 200 through bolts. The parts in the automatic cleaning apparatus for assembling the assembling structure 300 and the position determining element 400 may be taken as the assembling part 200. Usually, after the design of each component of the automatic cleaning apparatus is completed, the position and the dimension thereof are fixed, and correspondingly, a space position of the reserved assembling part 200 is also fixed. In this way, when the automatic cleaning apparatus needs to replace the position determining element with a smaller dimension, the reserved assembling part 200 cannot be adapted. Therefore, the assembling structure and the structure of the position determining element of the automatic cleaning apparatus in the embodiment of the present disclosure are improved as follows.

**[0039]** As shown in FIG. 4, the assembling structure 300 includes an assembling support 310. The position determining device includes a rotor 320, a motor 330, a cover 340, etc. The assembling support 310 is fixed to the assembling part 200 through screw holes around the support. The rotor 320 and the motor 330 are disposed inside the assembling support 310; and the cover 340 covers the top of the rotor 320, and plays a shielding and protection role. The rotor 320 protrudes from the top surface of the automatic cleaning apparatus, and the rotor 320 continuously rotates and scans in a 360-degree range to continuously detect obstacles in a traveling process of the automatic cleaning apparatus. As shown in FIG. 5, the assembling support 310 includes a rotor accommodating part 311 and a motor accommodating part 312. The rotor accommodating part 311 includes a first arc-shaped sidewall 3111, and the first arc-shaped sidewall 3111 may be a circular arc-shaped sidewall or an arc-shaped sidewall of other curvatures. The circular arc-shaped sidewall is at least a part of a circle. As shown in FIG. 5, the first arc-shaped sidewall 3111 may be a large part of a circular structure, and for example, may be a part within the range of 180-270 degrees. The motor accommodating part 312 includes a second arc-shaped sidewall 3121, and the second arc-shaped sidewall 3121 may be a part of a circular structure, or spliced by arc-shaped structures of different radians, or spliced by the circular structure or a radian structure with a linear structure, which is not limited herein. The first arc-shaped sidewall 3111 of the rotor accommodating part and the second arc-shaped sidewall 3121 of the motor accommodating part are smoothly connected, and are approximately divided into the rotor accommodating part 311 and the motor accommodating part 312 at MN as shown in FIG. 5. An opening area formed by the first arc-shaped sidewall 3111 is larger than an opening area formed by the second arc-shaped sidewall 3121. The position determining element 400 includes the rotor 320, and a rotating shaft of the rotor 320 is approximately disposed at a geometric center of the rotor accommodating part 311. When the first arc-shaped sidewall 3111 is the circular arc-shaped sidewall, the geometric center of the rotor accommodating part 311 corresponds to the center of the circle where the first arc-shaped sidewall 3111 is located. When the first arc-shaped sidewall 3111 is a combined structure of a plurality of arcs of different curvatures, the geometric center of the rotor accommodating part 311 corresponds to the center of the circle where the arc with the largest radian is located, as shown at A in FIG. 5. The rotor 320 is configured to continuously rotate while sending and/or receiving detection signals, such as visible light and/or invisible light. In this case, compared with a rotor in a traditional position determining element, the rotor 320 has a smaller diameter, that is, it is farther away from the first arc-shaped sidewall 3111 of the rotor accommodating part, but is still assembled at the geometric center of the rotor accommodating part 3111, to ensure the structural symmetry and the stability after rotation. The position determining element 400 includes the motor 330. An output shaft of the motor 330 is approximately disposed at the position where the rotor accommodating part 311 meets the motor accommodating part 312, that is, approximately disposed on the connecting line between a geometric center of the motor accommodating part and the geometric center of the rotor accommodating part, as shown at B in FIG. 5, and specifically, is approximately disposed in the connecting line between the geometric center C of the motor accommodating part and the geometric center A of the rotor accommodating part, excluding point A and point C, that is, disposed closer to the geometric center A of the rotor accommodating part than the geometric center C of the motor accommodating part. Thus, the motor and the rotor in the miniaturized position determining element are closer, the internal accommodating structure of the assembling support is more adaptive to the motor and the rotor of the position determining element, the stability is enhanced, the size of a transmission element such as a belt is reduced, and the energy loss and raw material cost are reduced. In some embodiments, the position where the rotor accommodating part 311 meets the motor accommodating part 312 is approximately located at the center of the smooth connection position of the first arc-shaped sidewall 3111 and the second arc-shaped sidewall 3121, that is, approximately located on the MN connecting line. When the second arc-shaped sidewall 3121 is the circular arc-shaped sidewall, the geometric center of the motor accommodating part 312 corresponds to the center of the circle where the second arc-shaped sidewall 3121 is located. When the second arc-shaped sidewall 3121 is a combined struc-

ture of a plurality of arcs of different curvatures, the geometric center of the motor accommodating part 312 corresponds to the center of the circle where the arc with the largest radian is located, as shown at C in FIG. 5. The motor 330 is configured to be connected to the rotor through a transmission structure 332 such as a belt to provide a driving force for the rotor. The motor 330 drives the rotor 320 through a motor roller 331 and the transmission structure 332, and the transmission structure 332 may be a belt, a metal belt, an organic material belt, etc. A rotating shaft of the motor 330 is in hard connection with the motor roller 331, and the motor roller 331 rotates freely under driving of the motor rotating shaft.

**[0040]** In some embodiments, the position determining device is a laser ranging device. The position determining element is a laser ranging element, and the laser ranging element performs distance or position detection by continuously rotating and sending and receiving laser signals.

**[0041]** In some embodiments, as shown in FIG. 5, the motor accommodating part 312 further includes a first opening 3122 and a first support rib 3123. The first opening 3122 is located in a bottom surface 3124 of the motor accommodating part 312 and configured to accommodate the motor 330. The first support rib 3123 extends inward to the edge of the first opening 3122 along the inner side of the sidewall 3121 of the motor accommodating part. A geometric center B of the first opening 3122 is closer to the geometric center A of the rotor accommodating part than the geometric center C of the motor accommodating part. The geometric center B of the first opening 3122 is approximately located at the center of the circle where the arc of the first opening 3122 is located, and the geometric center C of the motor accommodating part is approximately located at the center of the circle where the sidewall 3121 of the motor accommodating part is located. For a motor having a traditional size, its mounting position is usually located at the geometric center C of the motor accommodating part. However, when the structure of the position determining element is reduced as a whole and the rotor 320 is still located at the geometric center A of the rotor accommodating part, in order to reduce a transmission loss, improve the transmission efficiency and improve the stability during the belt transmission, the motor 330 may be assembled close to the rotor. In this case, a rotation gap between the motor 330 and the rotor 320 remains almost unchanged, which can maintain considerable transmission efficiency, is suitable for more miniaturized position determining elements, does not need additional mold making, reduces the cost, achieves a shorter distance between the motor and the rotor, and saves a transmission apparatus such as a belt, Further, the cost and the transmission resistance are reduced, improving the transmission efficiency. In this case, in order to enhance the stability and rigidity of the assembling support 310, it is necessary to additionally provide the first support rib 3123, especially the farther away from the motor, the longer the first support rib 3123 is.

**[0042]** In some embodiments, as shown in FIG. 5, the rotor accommodating part 311 further includes a second opening 3112 and a second support rib 3113. The second opening 3112 is located in a bottom surface 3114 of the rotor accommodating part 311 and configured to accommodate the rotor 320. The second support rib 3113 extends inward to the edge of the second opening 3112 along the inner side of the sidewall 3111 of the rotor accommodating part, and can enhance the stability and rigidity of the assembling support 310. A geometric center of the second opening 3112 corresponds to the geometric center of the rotor accommodating part 311, and is located at the center of the circle where the sidewall 3111 of the rotor accommodating part is located, so as to ensure the structural symmetry and the stability of the rotor after rotation.

**[0043]** In some embodiments, as shown in FIG. 5, the second opening is communicated with the first opening, and the area of the second opening is greater than the area of the first opening. The second opening is communicated with the second opening to reduce a processing technology of the support structure, and the communication between the openings is also convenient for the motor to drive the rotor to rotate through the transmission structure.

**[0044]** In some embodiments, as shown in FIG. 6, the position determining device further includes the cover 340, which covers the top of the rotor 320. The cover 340 can shield stray light, dust, impurities, and the like that enter the position determining device, and can also shield internal parts of the position determining device, which plays an aesthetic role. After equipped with a pivot structure, the cover 340 may also avoid hanging obstacles. The cover 340 includes a circular top surface 341, a bottom ring 342 and a plurality of connectors 343 connecting the circular top surface 341 and the bottom ring 342. In some embodiments, the bottom ring 342 has a bottom plate extending horizontally from the bottom thereof, the bottom ring 342 and the bottom plate are fixedly connected or integrally formed, and the bottom plate is used for pivotal connection between the cover 340 and the top surface of the mobile platform. A first gap is formed between the bottom ring 342 and the outer peripheral surface of the rotor 320, and interspaces are formed between the plurality of connectors 343, so as to send and/or receive detection signals, such as visible light and/or invisible light, through rotation of the rotor. In addition, since the rotor structure in the present embodiment is a miniaturized rotor, and the dimension of the cover 340 is equivalent to that of a cover in a traditional position determining device, and thus the first gap is larger than a traditional gap.

**[0045]** In some embodiments, in order to solve the technical problems caused by an excessively large first gap, such as the entrance of stray light, dust and impurities, and the problem of the exposure of internal parts of the position determining device, the dimension of the

cover may be reduced as a whole to reduce the distance of the first gap. For example, in some embodiments, the cover 340 includes the circular top surface 341, the bottom ring 342 and the plurality of connectors 343 connected to the circular top surface 341 and the bottom ring 342. The bottom ring 342 has the bottom plate extending horizontally from the bottom thereof, the bottom ring 342 and the bottom plate are fixedly connected or integrally formed, and the bottom plate is used for the pivotal connection between the cover 340 and the top surface of the mobile platform. A second gap is formed between the bottom ring 342 and the outer peripheral surface of the rotor 320. The second gap is smaller than the first gap, and the second gap enables the bottom ring 342 to be as close as possible to the outer peripheral surface of the rotor 320, for example, with a distance of 1-5 mm, without affecting the rotation of the rotor.

**[0046]** As shown in FIGS. 7 to 9, in some embodiments, in order to solve the technical problems caused by the excessively large first gap, the assembling structure 300 further includes an annular shielding member 350 which is attached to the inner side of the bottom ring 342. A second gap is formed between the annular shielding member 350 and the outer peripheral surface of the rotor 320, and the second gap is smaller than the first gap. The second gap is used for enabling the rotor to rotate flexibly. The second gap enables the annular shielding member 350 to be as close as possible to the outer peripheral surface of the rotor 320, for example, with a distance of 1-5 mm, without affecting the rotation of the rotor.

**[0047]** In some embodiments, as shown in FIG. 8, the annular shielding member 350 has a width extending in a radial direction and a height extending in an axial direction, and the width of the annular shielding member is greater than the height of the annular shielding member. The width of the annular shielding member 350 extending in the radial direction is wide enough to shield the incident stray light due to the excessively large size of the first gap. The height of the annular shielding member 350 extending in the axial direction can facilitate the assembling of the annular shielding member 350 on the inner side of the bottom ring 342.

**[0048]** In some embodiments, as shown in FIG. 8, the annular shielding member 350 includes insert member(s) 351 matching the connector(s) 343. After the insert member(s) 351 is(are) inserted into the connector(s) 343, the annular shielding member 350 is attached to the inner side of the bottom ring 342, and the insert member(s) 351 and the connector(s) 343 are disposed in one-to-one correspondence. A third socket 3433 is disposed below the connector 343, and a T-shaped protrusion 3512 is disposed below each insert member 351. After the insert member 351 is inserted into the inner sidewall of the corresponding connector 343, the thickness of the connector 343 is increased, thereby reducing the distance of the first gap. Therefore, the stray light entering the rotor 320 can be further reduced.

**[0049]** In some embodiments, as shown in FIG. 7, the inner wall of the connector 343 includes a first socket 3431, and the outer wall of the insert member 351 includes a ridge 3511 matching the first socket 3431. After the ridge 3511 is inserted into the first socket 3431, the annular shielding member 350 is attached to the inner side of the bottom ring 342. After the ridge 3511 is inserted into the first socket 3431, the circumferential stability of the annular shielding member 350 is guaranteed. In some embodiments, as shown in FIG. 7, the bottom ring includes: a second socket 3432 extending circumferentially along the bottom surface of the bottom ring, and the third socket 3433 located in the inner surface of the bottom ring 342; and the second socket 3432 is communicated with the third socket 3433. As shown in FIG. 9, the annular shielding member 350 includes the T-shaped protrusion 3512 protruding outward along the outer wall of the annular shielding member 350. After the T-shaped protrusion 3512 is inserted into the third socket 3433, the annular shielding member 350 is attached to the inner side of the bottom ring 342. When assembling the annular shielding member 350, the T-shaped protrusion 3512 is inserted along the bottom of the second socket 3432 and then pushed upward to be inserted into the third socket 3433, which further stabilizes the annular shielding member 350 in the circumferential direction and the radial direction.

**[0050]** In some embodiments, as shown in FIG. 7, the bottom ring 343 further includes limiting grooves 3434 disposed in the inner surface of the bottom ring 343, and the limiting grooves 3434 are symmetrically disposed in two sides of the third socket 3433. The annular shielding member 350 further includes limiting protrusions 3513 disposed on two sides of the T-shaped protrusion 3512. When the annular shielding member 350 is attached to the inner side of the bottom ring 342, the limiting protrusions 3513 are adapted to the limiting grooves 3434. The cooperation between the limiting protrusions 3513 and the limiting grooves 3434 further defines the position of the annular shielding member 350.

**[0051]** As for the automatic cleaning apparatus according to the embodiment of the present disclosure, in the position determining device, through the assembling support of a corresponding structure, the position determining element with a dimension smaller than that of a traditional position determining element can also be assembled in the assembling part with a dimension equivalent to the traditional dimension, which brings convenience to the application of changing the dimension of the position determining element according to application requirements.

**[0052]** In some embodiments, the annular shielding member has a width extending in a radial direction and a height extending in an axial direction, and the width of the annular shielding member is greater than the height thereof.

**[0053]** In some embodiments, the annular shielding member includes an insert member matching the con-

nector, and after the insert member is inserted into the connector, the annular shielding member is attached to the inner side of the bottom ring.

**[0054]** In some embodiments, an inner wall of the connector includes a first socket, an outer wall of the insert member comprises a ridge matching the first socket, and after the ridge is inserted into the first socket, the annular shielding member is attached to the inner side of the bottom ring.

**[0055]** In some embodiments, the bottom ring includes a second socket extending circumferentially along a bottom surface of the bottom ring and a third socket located in an inner surface of the bottom ring, and the second socket is communicated with the third socket; and

the annular shielding member includes a T-shaped protrusion protruding outward along an outer wall of the annular shielding member, and the annular shielding member is attached to the inner side of the bottom ring after the T-shaped protrusion is inserted into the third socket.

**[0056]** In some embodiments, the third socket is disposed below the connector, and the T-shaped protrusion is disposed below the insert member.

**[0057]** In some embodiments, the bottom ring further includes limiting grooves formed in the inner surface of the bottom ring, and the limiting grooves are symmetrically disposed at two sides of the third socket; and

**[0058]** the annular shielding member further includes limiting protrusions disposed at two sides of the T-shaped protrusion, and when the annular shielding member is attached to the inner side of the bottom ring, the limiting protrusions are adapted to the limiting grooves.

**[0059]** In some embodiments, the assembling structure further includes an assembling support, and the assembling support includes:

a rotor accommodating part, the rotor accommodating part including a circular arc-shaped sidewall; and
a motor accommodating part, the motor accommodating part including an arc-shaped sidewall, wherein the circular arc-shaped sidewall of the rotor accommodating part and the arc-shaped sidewall of the motor accommodating part are smoothly connected, and an opening area formed by the circular arc-shaped sidewall is larger than an opening area formed by the arc-shaped sidewall;
wherein a rotating shaft of the rotor is approximately disposed at a geometric center of the rotor accommodating part, and an output shaft of the motor is approximately disposed on a connecting line between a geometric center of the motor accommodating part and the geometric center of the rotor accommodating part.

**[0060]** In some embodiments, the motor accommodating part further includes:

a first opening located in a bottom surface of the motor accommodating part and configured to accommodate the motor; and
a first support rib extending inward to an edge of the first opening along an inner side of a sidewall of the motor accommodating part;
wherein a geometric center of the first opening is closer to the geometric center of the rotor accommodating part than the geometric center of the motor accommodating part.

**[0061]** In some embodiments, the rotor accommodating part further includes:

a second opening located in a bottom surface of the rotor accommodating part and configured to accommodate the rotor; and
a second support rib extending inward to an edge of the second opening along an inner side of a sidewall of the rotor accommodating part;
wherein a geometric center of the second opening corresponds to the geometric center of the rotor accommodating part.

**[0062]** In some embodiments, the second opening is communicated with the first opening, and an area of the second opening is greater than an area of the first opening.

**[0063]** In some embodiments, the bottom ring has a bottom plate extending horizontally from a bottom thereof, and the bottom plate is configured for a pivotal connection between the cover and a top surface of the mobile platform.

**[0064]** In some embodiments, the position determining device is a laser ranging device, the position determining element is a laser ranging element, and the detection signal is a laser signal.

**[0065]** Compared with the prior art, the embodiments of the present disclosure have the following technical effects.

**[0066]** According to the automatic cleaning apparatus provided by the embodiments of the present disclosure, during assembly of the position determining device, through the assembling support and/or the annular shielding member with a corresponding structure, the position determining element with the dimension smaller than that of a traditional position determining device can also be assembled in the assembling part with the dimension equivalent to the traditional dimension, which brings convenience to the application of changing the dimension of the position determining element according to application requirements.

**[0067]** Finally, it should be noted that various embodiments in the specification are described in a progressive manner, each embodiment focuses on the differences from other embodiments, and the same or similar parts among the various embodiments may refer to one another.

**[0068]** The above embodiments are only used for illustrating the technical solutions of the present disclosure and are not intended to limit the present disclosure. Although the present disclosure has been described in detail with reference to the foregoing embodiments, those of ordinary skills in the art should understand that, they can still make modifications to the technical solutions described in the foregoing embodiments or make equivalent substitutions to part of the technical features; and these modifications or substitutions do not make the essence of the corresponding technical solutions deviate from the spirit and scope of the technical solutions of the various embodiments of the present disclosure.

## Claims

1. An automatic cleaning apparatus, comprising a mobile platform, a position determining device and an assembling structure for assembling the position determining device on the mobile platform, wherein:

   the position determining device comprises a position determining element and a cover;
   the position determining element comprises a rotor and a motor, wherein the rotor is configured to transmit and/or receive a detection signal while continuously rotating, and the motor is configured to be connected to the rotor by means of a power transmission structure to provide a driving force for the rotor;
   the cover covers a top of the rotor and comprises a circular top surface, a bottom ring and a plurality of connectors connecting the circular top surface to the bottom ring, wherein a first gap is formed between the bottom ring and an outer peripheral surface of the rotor; and
   the assembling structure comprises an annular shielding member attached to an inner side of the bottom ring, a second gap is formed between the annular shielding member and the outer peripheral surface of the rotor, and the second gap is smaller than the first gap.

2. The automatic cleaning apparatus according to claim 1, wherein the annular shielding member has a width extending in a radial direction and a height extending in an axial direction, and the width of the annular shielding member is greater than the height thereof.

3. The automatic cleaning apparatus according to claim 2, wherein the annular shielding member comprises an insert member matching the connector, and after the insert member is inserted into the connector, the annular shielding member is attached to the inner side of the bottom ring.

4. The automatic cleaning apparatus according to claim 3, wherein an inner wall of the connector comprises a first socket, an outer wall of the insert member comprises a ridge matching the first socket, and after the ridge is inserted into the first socket, the annular shielding member is attached to the inner side of the bottom ring.

5. The automatic cleaning apparatus according to claim 4, wherein:

   the bottom ring comprises a second socket extending circumferentially along a bottom surface of the bottom ring and a third socket located in an inner surface of the bottom ring, and the second socket is communicated with the third socket; and
   the annular shielding member comprises a T-shaped protrusion protruding outward along an outer wall of the annular shielding member, and the annular shielding member is attached to the inner side of the bottom ring after the T-shaped protrusion is inserted into the third socket.

6. The automatic cleaning apparatus according to claim 5, wherein the third socket is disposed below the connector, and the T-shaped protrusion is disposed below the insert member.

7. The automatic cleaning apparatus according to claim 6, wherein:

   the bottom ring further comprises limiting grooves formed in the inner surface of the bottom ring, and the limiting grooves are symmetrically disposed at two sides of the third socket; and
   the annular shielding member further comprises limiting protrusions disposed at two sides of the T-shaped protrusion, and when the annular shielding member is attached to the inner side of the bottom ring, the limiting protrusions are adapted to the limiting grooves.

8. The automatic cleaning apparatus according to any one of claims 1-7, wherein the assembling structure further comprises an assembling support, and the assembling support comprises:

   a rotor accommodating part, the rotor accommodating part comprising a circular arc-shaped sidewall; and
   a motor accommodating part, the motor accommodating part comprising an arc-shaped sidewall, wherein the circular arc-shaped sidewall of the rotor accommodating part and the arc-shaped sidewall of the motor accommodating part are smoothly connected, and an opening

area formed by the circular arc-shaped sidewall is larger than an opening area formed by the arc-shaped sidewall;
wherein a rotating shaft of the rotor is approximately disposed at a geometric center of the rotor accommodating part, and an output shaft of the motor is approximately disposed on a connecting line between a geometric center of the motor accommodating part and the geometric center of the rotor accommodating part.

**9.** The automatic cleaning apparatus according to claim 8, wherein the motor accommodating part further comprises:

a first opening located in a bottom surface of the motor accommodating part and configured to accommodate the motor; and
a first support rib extending inward to an edge of the first opening along an inner side of a sidewall of the motor accommodating part;
wherein a geometric center of the first opening is closer to the geometric center of the rotor accommodating part than the geometric center of the motor accommodating part.

**10.** The automatic cleaning apparatus according to claim 9, wherein the rotor accommodating part further comprises:

a second opening located in a bottom surface of the rotor accommodating part and configured to accommodate the rotor; and
a second support rib extending inward to an edge of the second opening along the inner side of the sidewall of the rotor accommodating part;
wherein a geometric center of the second opening corresponds to the geometric center of the rotor accommodating part.

**11.** The automatic cleaning apparatus according to claim 10, wherein the second opening is communicated with the first opening, and an area of the second opening is greater than an area of the first opening.

**12.** The automatic cleaning apparatus according to any one of claims 1-11, wherein the bottom ring has a bottom plate extending horizontally from a bottom thereof, and the bottom plate is configured for a pivotal connection between the cover and a top surface of the mobile platform.

**13.** The automatic cleaning apparatus according to any one of claims 1-12, wherein the position determining device is a laser ranging device, the position determining element is a laser ranging element, and the detection signal is a laser signal.

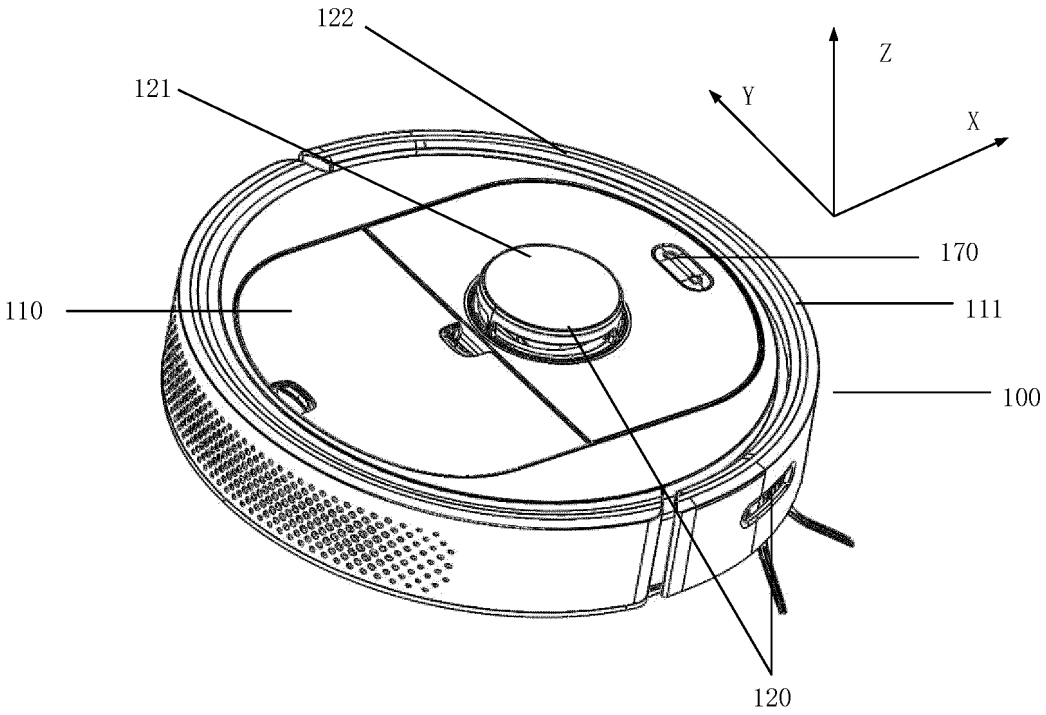


FIG. 1

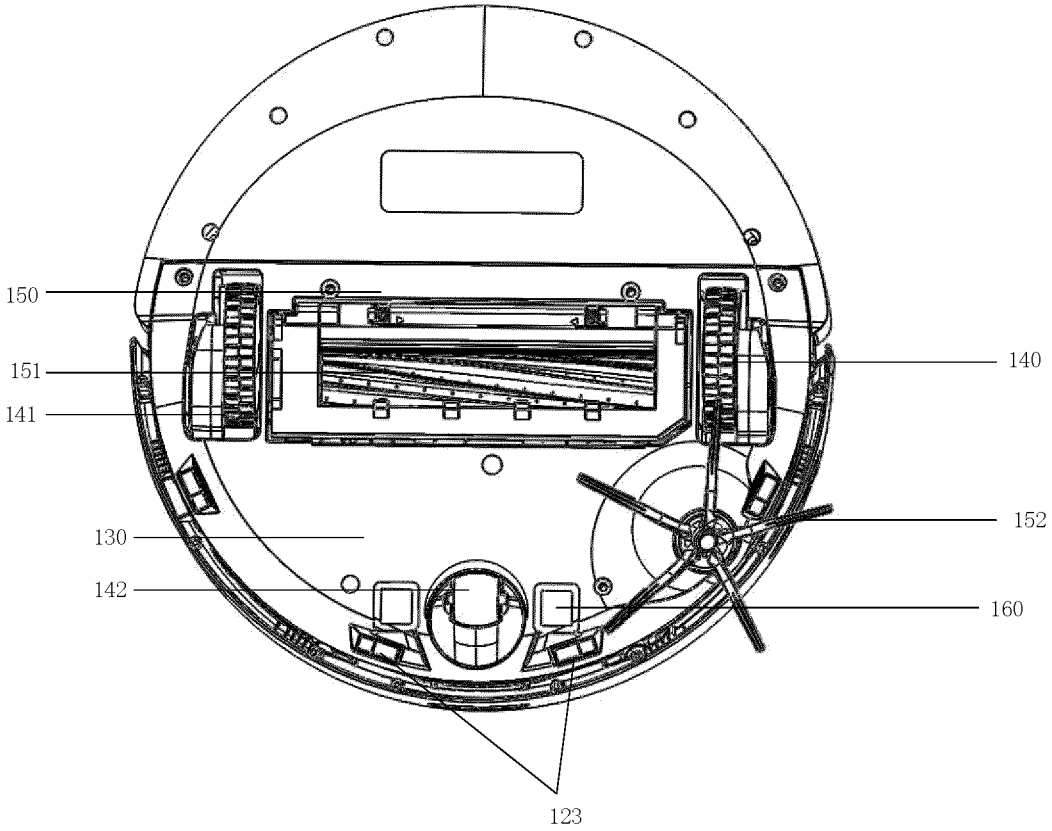


FIG. 2

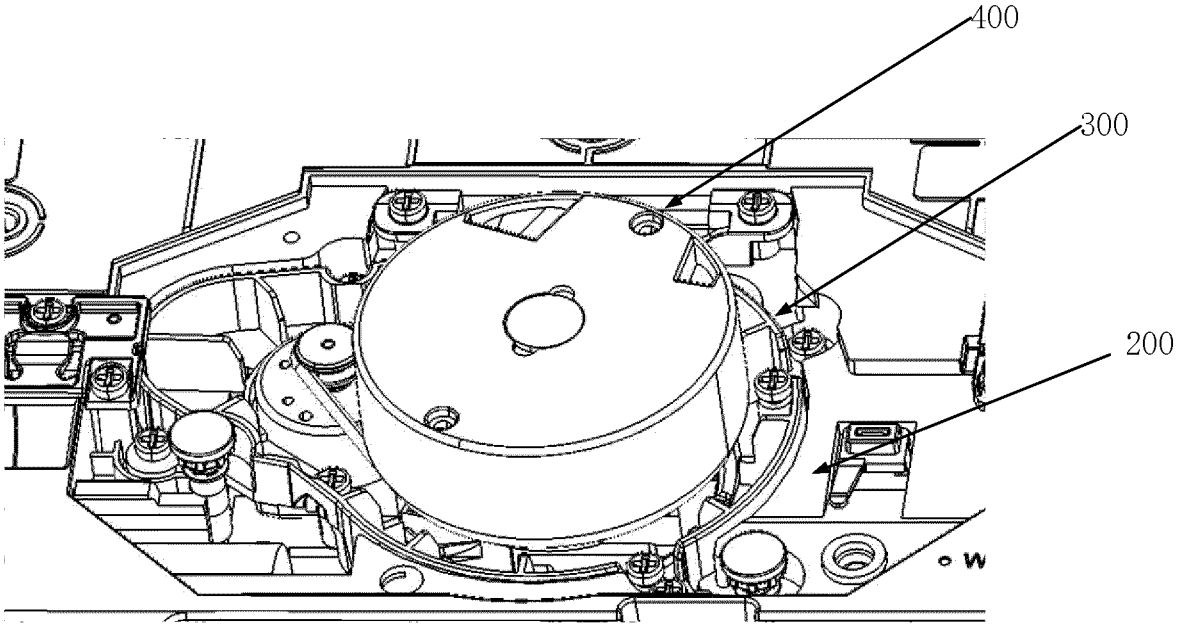


FIG. 3

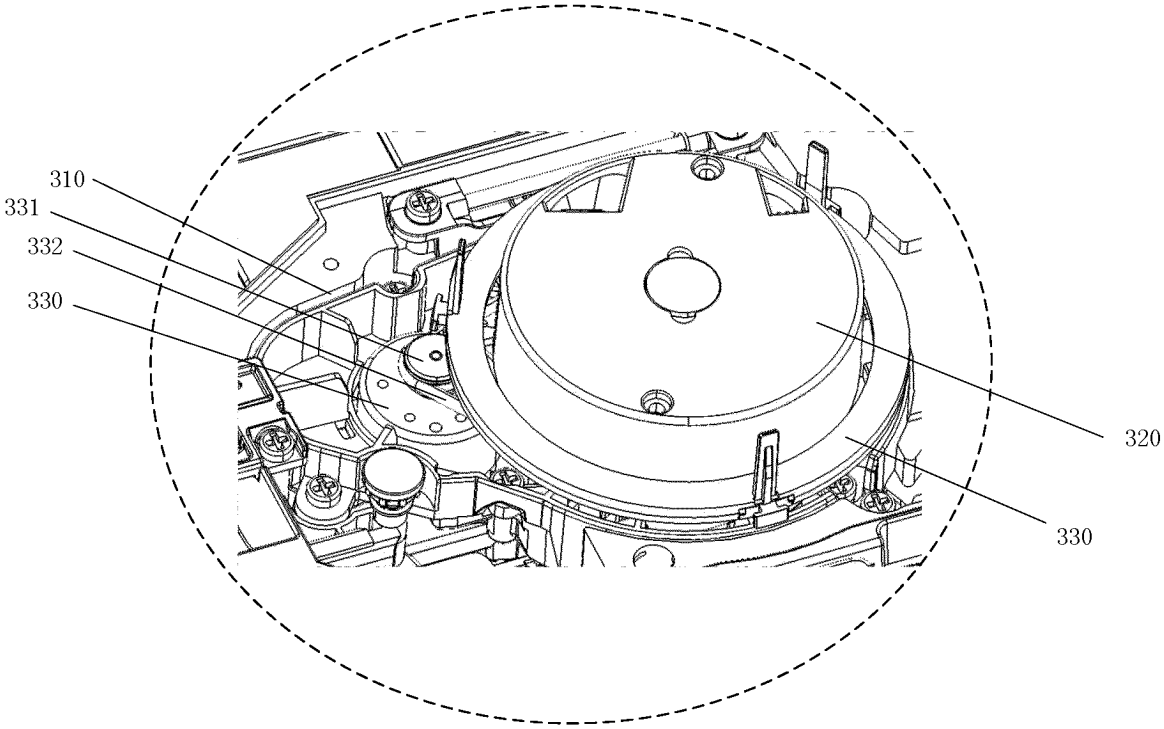
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FIG. 4

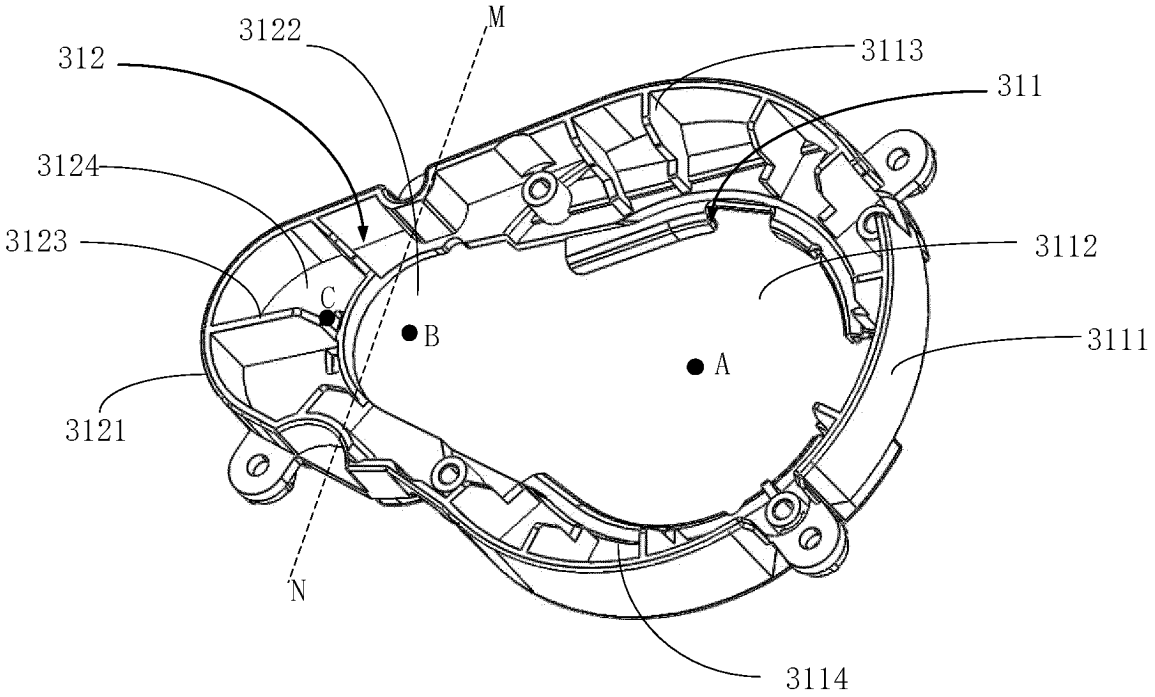
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FIG. 5

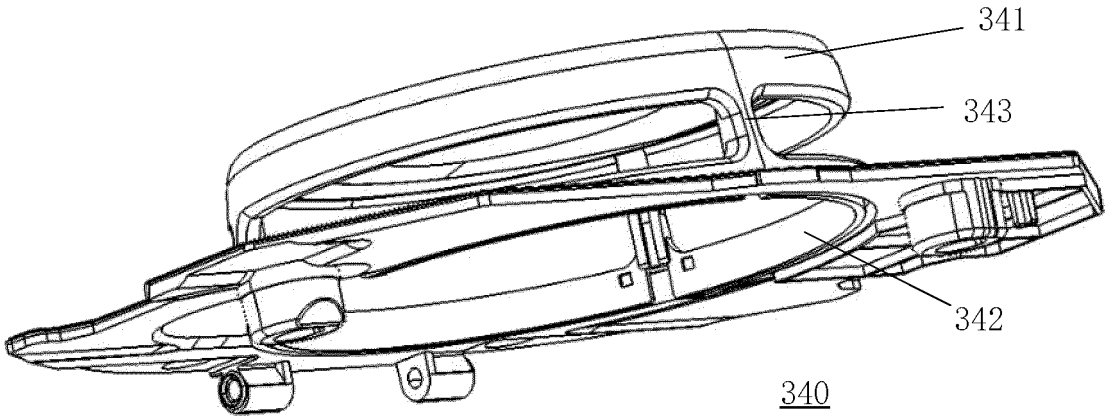


FIG. 6

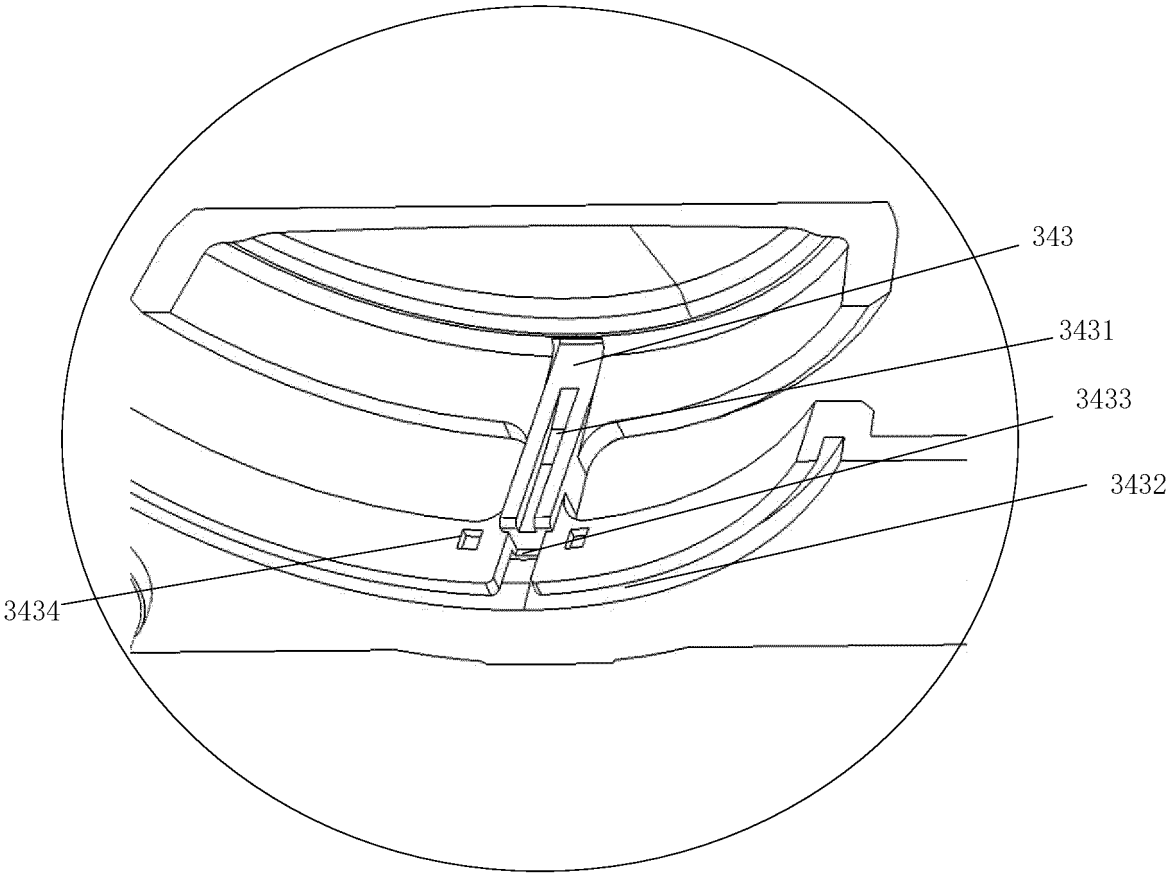


FIG. 7

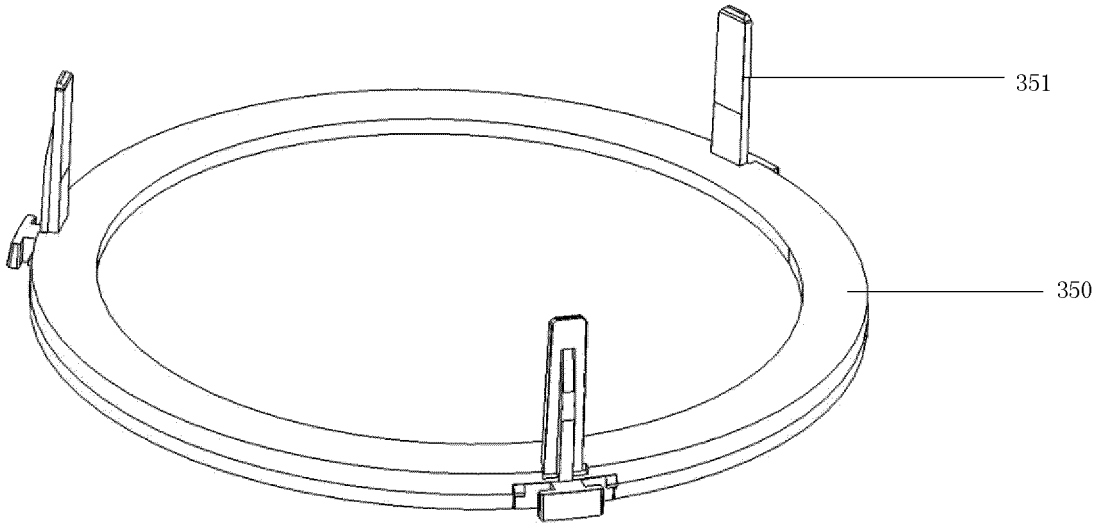


FIG. 8

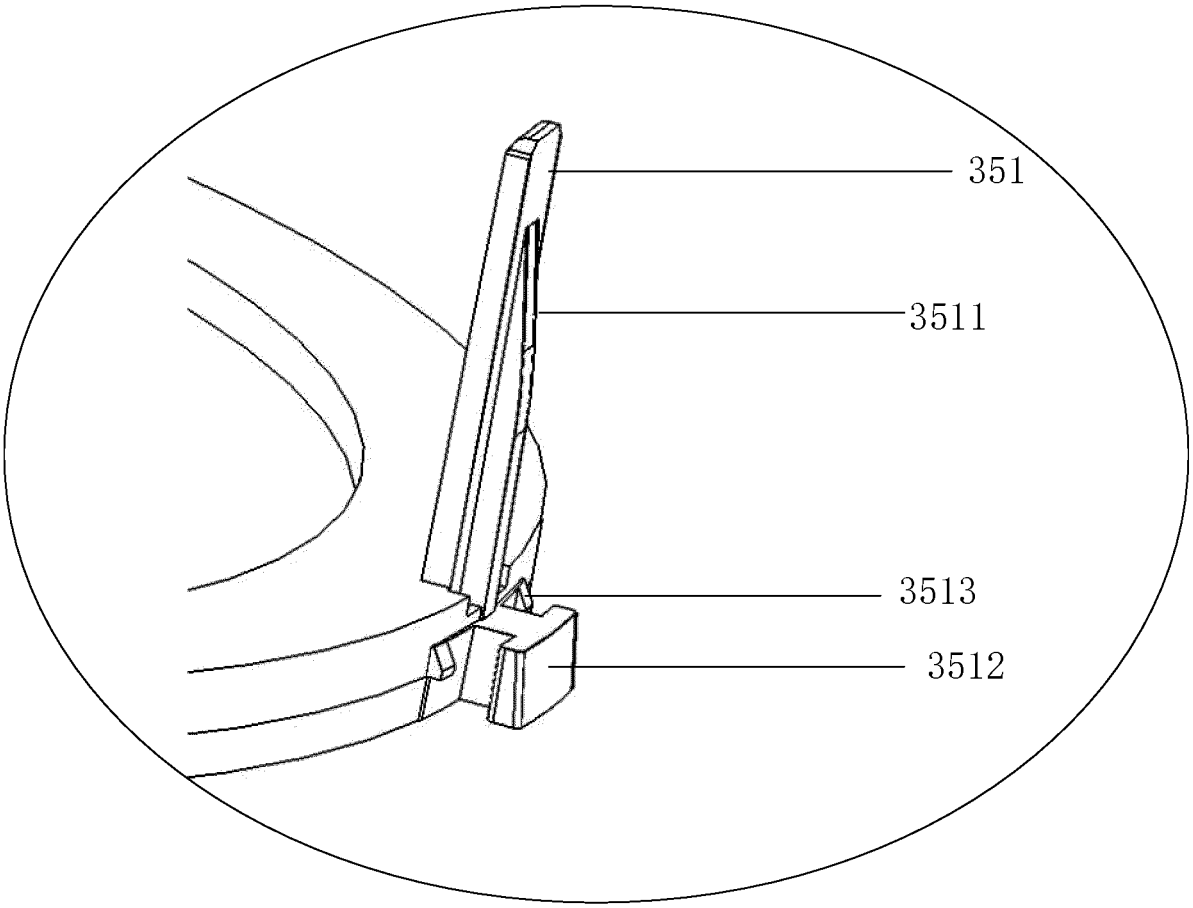


FIG. 9

## INTERNATIONAL SEARCH REPORT

International application No.
**PCT/CN2022/088289**

**A. CLASSIFICATION OF SUBJECT MATTER**

A47L 11/24(2006.01)i

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)

A47L; G01S

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)

CNTXT, ENTXTC, ENTXT, VEN: 清洁机器人, 自动清洁设备, 扫地机器人, 拖地机器人, 位置确定, 定位, 测距, 感知, 探测, 激光, 雷达, 盖, 罩, 转子, 转动, 旋转, 圆环, 环形, 圈, 遮挡, 阻隔, 间隙, 空隙, 间距, robot, sweep+, clean+, distance, measur+, detect+, sens+, laser, radar, cover, lid, rotor, rotat+, block+, circle, spacing

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| Y | CN 111973085 A (BEIJING XIAOMI MOBILE SOFTWARE CO., LTD. et al.) 24 November 2020 (2020-11-24)<br>description, paragraphs 81-113, and figures 1-13 | 1-13 |
| Y | CN 105988120 A (XIAOMI TECHNOLOGY CO., LTD. et al.) 05 October 2016 (2016-10-05)<br>description, paragraphs 33-39, and figures 1-5 | 1-13 |
| A | CN 211633143 U (SHARKNINJA (CHINA) TECHNOLOGY CO., LTD.) 09 October 2020 (2020-10-09)<br>entire document | 1-13 |
| A | CN 209518837 U (SHENZHEN SILVER STAR INTELLIGENT TECHNOLOGY CO., LTD.) 22 October 2019 (2019-10-22)<br>entire document | 1-13 |
| A | CN 205697572 U (ZHANG ZHENGKUN) 23 November 2016 (2016-11-23)<br>entire document | 1-13 |

☑ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| **28 July 2022** | **08 August 2022** |

| Name and mailing address of the ISA/CN | Authorized officer |
|---|---|
| **China National Intellectual Property Administration (ISA/CN)**<br>**No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088, China** | |
| Facsimile No. **(86-10)62019451** | Telephone No. |

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2022/088289

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
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| A | US 2019282054 A1 (LG ELECTRONICS INC.) 19 September 2019 (2019-09-19)<br>entire document | 1-13 |
| E | CN 216984738 U (BEIJING ROBOROCK TECHNOLOGY CO., LTD.) 19 July 2022 (2022-07-19)<br>description, paragraphs 45-78, and figures 1-9 | 1-13 |

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**INTERNATIONAL SEARCH REPORT**
**Information on patent family members**

International application No.
**PCT/CN2022/088289**

| Patent document cited in search report | Publication date (day/month/year) | Patent family member(s) | Publication date (day/month/year) |
|---|---|---|---|
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Form PCT/ISA/210 (patent family annex) (January 2015)

## REFERENCES CITED IN THE DESCRIPTION

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