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(54) **SANDING MACHINE**

(57) Provided is a sander. The sander includes an airflow element rotatable about a central axis along a preset direction of rotation to generate a dust removal airflow; an electric motor for providing a power source for the airflow element; and a battery pack for providing an energy source for the electric motor. When the sander is in a load-free state, the working duration of the sander when the battery pack consumes 10 WH of energy is defined as the power supply time T of the sander; and the product of the load-free rotational speed N of the electric motor and the functional time T of the sander is greater than or equal to 63000 rpm.min and less than or equal to 120000 rpm.min. The sander has low dust suction resistance and a long battery life.

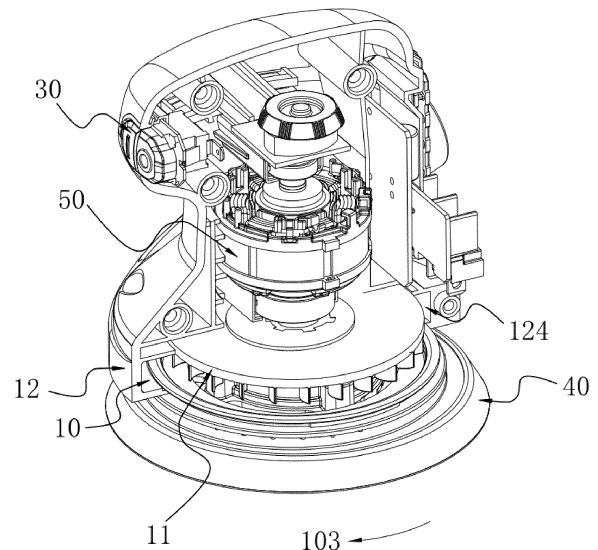


FIG. 2

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Description

[0001] This application claims priority to Chinese Patent Application No. CN 202111192829.2 filed with the China National Intellectual Property Administration (CNIPA) on Oct. 13, 2021, the disclosure of which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] The present application relates to a push self-driven traveling machine.

BACKGROUND

[0003] A sander is a power tool for the sanding operation and is often used for sanding uneven or unevenly thick wall surfaces, desk surfaces, and the like to obtain a surface with target smoothness. The sander is also referred to as a belt sander, a grinder, or a polisher. A handheld sander is an important category of sanders and is widely used in various industries due to advantages such as the compact size and portability.

[0004] The sander produces dust when performing the sanding operation. The dust can be sucked into the interior of the sander housing and discharged in a specific direction. Therefore, the smaller the dust suction resistance, the higher the dust collection efficiency of the sander.

SUMMARY

[0005] To solve the deficiencies in the existing art, an object of the present invention is to provide a sander with low dust suction resistance and a long battery life.

[0006] To achieve the preceding object, the present application adopts the technical solutions described below. A sander includes an airflow element rotatable about a central axis along a preset direction of rotation to generate a dust removal airflow; an electric motor for providing a power source for the airflow element; and a battery pack for providing an energy source for the electric motor. When the sander is in a load-free state, the working duration of the sander when the battery pack consumes 10 WH of energy is defined as the power supply time T of the sander; and the product of the load-free rotational speed N of the electric motor and the functional time T of the sander is greater than or equal to 63000 rpm.min and less than or equal to 120000 rpm.min.

[0007] A sander includes an airflow element rotatable about a central axis along a preset direction of rotation to generate a dust removal airflow; an electric motor for providing a power source for the airflow element; a battery pack for providing an energy source for the electric motor; and a housing configured to accommodate the airflow element and guide the dust removal airflow generated by the airflow element. A guide wall is formed on the back of the housing, the distance from the guide wall

to the central axis is defined as a first distance D1, and the first distance D1 gradually increases along the preset direction of rotation; and an inner wall includes a first end and a second end along a plane perpendicular to the central axis, the guide wall connects the first end to the second end, and the distance from the first end to the central axis is greater than or equal to 40 mm and less than or equal to 60 mm.

[0008] A sander includes an airflow element rotatable about a central axis along a preset direction of rotation to generate a dust removal airflow; an electric motor for providing a power source for the airflow element; a battery pack for providing an energy source for the electric motor; and a housing configured to accommodate the airflow element and guide the dust removal airflow generated by the airflow element. The housing includes an upper sidewall and a lower sidewall opposite to the upper sidewall; and the distance from the lower sidewall to the upper sidewall along a direction of the central axis is defined as a third distance D3, and the third distance D3 gradually increases along the preset direction of rotation.

BRIEF DESCRIPTION OF DRAWINGS

[0009]

FIG. 1 is a perspective view of a sander according to the present application;

FIG. 2 is a perspective view of the sander shown in FIG. 1 with part of a housing removed;

FIG. 3 is a plan view of the whole sander shown in FIG. 1;

FIG. 4 is a sectional view of the sander shown in FIG. 3 along an A-A direction;

FIG. 5 is a sectional view of the sander shown in FIG. 3 along a B-B direction;

FIG. 6 is a partial enlarged view of the sectional view of the sander in FIG. 5;

FIG. 7 is a simplified sectional view of an airflow element and a dust removal housing in the present application;

FIG. 8 is another simplified sectional view of an airflow element and a dust removal housing in the present application;

FIG. 9 is a perspective view of a centrifugal fan in the sander shown in FIG. 1;

FIG. 10 is a perspective view of the centrifugal fan shown in FIG. 9 from another perspective;

FIG. 11 is a plan view of the centrifugal fan shown in FIG. 9;

FIG. 12 is a partial enlarged view of the centrifugal fan shown in FIG. 11; and

FIG. 13 is a perspective view of part of a dust removal housing in FIG. 3.

DETAILED DESCRIPTION

[0010] The present invention is described below in detail in conjunction with drawings and examples.

[0011] FIG. 1 shows a sander 100 with a dust removal device 10, and the sander 100 can drive a functional element to move, where the functional element may be sandpaper so that the sander 100 can sand and smooth surfaces of workpieces of various materials through the functional element. The sander 100 generates a large amount of debris during the grinding process, and the debris is sucked into the dust removal device 10 during the grinding process. The dust removal device 10 discharges the debris to a preset position. A user mounts a dust collection device at the preset position so as to discharge the debris discharged from the dust removal device 10 into the dust collection device, thereby achieving a dust collection effect. Therefore, it is extremely necessary to provide the airflow dust removal device 10 for dust removal on the sander 100. At the same time, it is to be noted that the dust removal device 10 is not only used on the sander 100 but also used on other power tools that require dust collection and/or dust removal. Further, the dust removal device 10 may be integrally formed with the power tool. Alternatively, the dust removal device 10 may be separated from the power tool, that is, the power tool and the dust removal device 10 are two separate machines and mate with each other during operation to implement the functions of dust collection and/or dust removal.

[0012] The sander 100 is used as an example for the description below. For ease of description, the upper, lower, left, right, front, and rear are defined as shown in FIG. 1.

[0013] As shown in FIGS. 1 to 6, the sander 100 includes a housing 20, a switching assembly 30, a base plate assembly 40, a power assembly 50, the dust removal device 10, an eccentric element 60, and an energy source 70.

[0014] The housing 20 forms the appearance of the sander 100, and the housing 20 is formed with at least a handle portion 21, an accommodation portion 22, and a bracket portion 23. The handle portion 21 is used for the user to hold, where an end of the handle portion 21 is connected to the accommodation portion 22, and the other end of the handle portion 21 may be used for connecting an external power cable or may form a connecting seat for mounting a portable direct current power supply such as a battery pack. The accommodation portion 22

is located between the handle portion 21 and the bracket portion 23, an accommodation cavity is formed inside the accommodation portion 22, and the power assembly 50 is at least partially disposed in the accommodation cavity.

5 The bracket portion 23 is used for covering the dust removal device 10 and at least part of the base plate assembly 40.

[0015] The switching assembly 30 may be mounted on the housing 20. Specifically, the switching assembly 30 is mounted on the handle portion 21 so that it is relatively convenient for the user to trigger the switching assembly 30 when the user holds the handle portion 21.

[0016] The power assembly 50 can be driven by the switching assembly 30. The power assembly 50 includes an electric motor 51. The electric motor 51 serves as the prime mover of the sander 100 and is disposed in the housing 20. The electric motor 51 includes a motor shaft 52 for outputting power, and the motor shaft 52 rotates around a motor axis 101. In this example, the motor axis 101 extends basically along an up and down direction.

[0017] The dust removal device 10 includes an airflow element 11 drivable by the electric motor 51. That is, the airflow element 11 is drivable by the electric motor 51 to rotate about a central axis 102. When rotating, the airflow element 11 can generate an airflow for dust removal. In this example, the central axis 102 extends basically along the up and down direction.

[0018] The eccentric element 60 surrounds the motor shaft 52, and the eccentric element 60 is eccentrically disposed relative to the motor shaft 52. The eccentric element 60 is mounted to the motor shaft 52 and fixedly connected to the motor shaft 52. It is to be noted that the eccentric element 60 being eccentrically disposed relative to the motor shaft 52 means that the eccentric element 60 has an axis, and the axis is parallel to the motor axis 101 of the motor shaft 52 and has a distance d from the motor axis 101 of the motor shaft 52. The distance d exists so that when the motor shaft 52 rotates, the eccentric element 60 can transmit the rotation of the motor shaft 52 into the rotation and revolution of other components connected to the eccentric element 60. In this example, the axis of the eccentric element 60 basically coincides with the central axis 102.

[0019] The motor shaft 52 can drive the base plate assembly 40 so that the base plate assembly 40 can swing relative to the housing 20. Specifically, the base plate assembly 40 is fixedly connected to the eccentric element 60, that is to say, the motor shaft 52 transmits power to the base plate assembly 40 through the eccentric element 60. The base plate assembly 40 includes a base plate with a through hole. The base plate includes an upper surface and a lower surface that are opposite to each other. The through hole penetrates the upper surface and the lower surface. The lower surface is disposed on a side away from the eccentric element 60 relative to the upper surface. The lower surface is used for mounting the functional element such as the sandpaper and is provided with multiple through holes. Driven by the motor

shaft 52 and the eccentric element 60, the base plate can move eccentrically. When the base plate moves eccentrically, the surface of a workpiece to be sanded can be continuously rubbed with the sandpaper, thereby implementing the function of sanding and polishing the workpiece to be sanded.

[0020] The energy source 70 is used for providing a source of energy for the sander 100. The energy source 70 may be alternating current power or direct current power such as the battery pack or another portable mobile power supply.

[0021] The dust removal device 10 further includes a dust removal housing 12 fixedly connected to or integrally formed with the housing 20. The dust removal housing 12 is configured to accommodate the airflow element 11, that is, the inner wall of the dust removal housing 12 forms a first space 110 for accommodating the airflow element 11. The inner wall of the dust removal housing 12 further forms a guide channel 13 for guiding the dust removal airflow. In this example, the housing 20 forms the preceding dust removal housing 12. Specifically, when the sander 100 starts to operate, the motor shaft 52 drives the airflow element 11 to rotate about the central axis 102 along a preset direction of rotation 103, and the airflow element 11 generates negative pressure during the rotation process, so as to suck the air on the lower surface into the first space 110 through the through holes. At this time, the rotating airflow element 11 throws the sucked airflow out along the outer periphery of the airflow element 11. The flowing airflow sucks the debris generated during the grinding process of the sandpaper into the first space 110 through the through holes, and the guide channel 13 formed by the dust removal housing 12 guides the flow direction of the airflow with the debris and guides the airflow to the preset position. An air outlet 14 is provided at the preset position and is used for discharging the airflow with the debris out of the first space 110. It is to be noted that in the example in which the dust removal device 10 is separated from the power tool, the dust removal housing 12 of the dust removal device 10 is separated from the housing 20. It is to be noted that the preset direction of rotation 103 refers to the direction of rotation of the airflow element 11 when the electric motor 51 drives the airflow element 11 to rotate. To facilitate the description of the technical solutions, in the present application, the preset direction of rotation 103 is defined as a first direction shown in FIG. 2.

[0022] Further, the dust removal housing 12 includes a first housing portion 121 and a second housing portion 122, and the first housing portion 121 and the second housing portion 122 are detachably and fixedly connected, that is, the first space 110 is formed by fixedly connecting the first housing portion 121 to the second housing portion 122. Since the sander 100 generates strong vibrations when operating, to ensure the connection stability between the first housing portion 121 and the second housing portion 122, the first housing portion 121 and the second housing portion 122 are fixedly connect-

ed through a fixing member 123, where the fixing member 123 for fixing is disposed outside the first space 110, that is to say, the fixing member 123 is not disposed in the guide channel 13. In this manner, the following can be avoided: the fixing member 123 is disposed in the guide channel 13, affecting the circulation of the dust removal airflow, increasing the dust suction resistance of the sander 100, and affecting the dust suction effect.

[0023] An upper sidewall 125 and a lower sidewall 126 that are oppositely disposed along the direction of the central axis 102 and a guide wall 124 for guiding the flow direction of the dust removal airflow are formed on the inner wall of the dust removal housing 12. The guide wall 124 is disposed between the upper sidewall 125 and the lower sidewall 126 and connects the upper sidewall 125 to the lower sidewall 126. The guide wall 124 is disposed in the circumferential direction of the airflow element 11. The guide wall 124, the upper sidewall 125, and the lower sidewall 126 basically form the preceding guide channel 13. The airflow element 11 has a plane of rotation P when rotating about the central axis 102. The upper sidewall 125 is located in the plane of rotation P, and the central axis 102 is perpendicular to the plane of rotation P. It is to be noted that the case referred to in the present application where the guide wall 124, the upper sidewall 125, and the lower sidewall 126 form the preceding guide channel 13 is not strictly limited to the case where the guide channel 13 is formed by only the guide wall 124, the upper sidewall 125, and the lower sidewall 126, part of the guide channel 13 is allowed to be formed by other components, and the guide part of the guide channel 13 that mainly achieves the dust removal airflow is formed by the guide wall 124, the upper sidewall 125, and the lower sidewall 126.

[0024] Along the direction perpendicular to the central axis 102, the distance from the guide wall 124 to the central axis 102 is defined as a first distance D1, where the first distance D1 gradually increases along the preset direction of rotation 103, that is to say, along the preset direction of rotation 103, the distance between the guide wall 124 and the central axis 102 gradually increases, that is, the guide channel 13 gradually increases along the preset direction of rotation 103, that is to say, along the direction of the plane of rotation P, the width of the upper sidewall 125 in the preset direction of rotation 103 gradually increases. In this manner, the dust suction resistance when the dust removal airflow circulates along the guide channel 13 can be reduced, the dust suction performance can be improved, the energy consumption of the sander 100 during operation can be reduced, and the working time of the sander 100 can be extended. It is to be noted that the gradual increase here refers to an increase according to a certain rule, which may be a linear rule or a nonlinear rule.

[0025] The airflow element 11 has the farthest end 111, where the farthest end 111 refers to an end of the airflow element 11 farthest from the central axis 102 in the direction of the plane of rotation P. Without the influence

of an external force, the farthest end 111 of the airflow element 11 forms a circle when rotating about the central axis 102 along the preset direction of rotation 103. The distance from the guide wall 124 to the preceding circle is defined as a second distance D2, where along the direction of the plane of rotation P, the second distance D2 gradually increases along the preset direction of rotation 103. It is to be noted that the airflow element 11 is not necessarily regular, that is to say, at least one farthest end 111 exists. As an example, the outer periphery of the airflow element 11 is approximately triangular (as shown in FIG. 8). As another example, the outer periphery of the airflow element 11 is approximately rectangular (as shown in FIG. 7). Of course, in some other examples, the outer periphery of the airflow element 11 is approximately polygonal. In this example, the outer periphery of the airflow element 11 is approximately circular, that is, the distance from the outer periphery of the airflow element 11 to the central axis 102 along the direction of the plane of rotation P is basically the same. That is, it is to be understood that the radius of the circle formed during the rotation of the airflow element 11 along the preset direction of rotation 103 is basically consistent with the radius of the circle formed by the outer periphery of the airflow element 11. That is to say, the distance from the inner wall of the dust removal housing 12 to the outer periphery of the airflow element 11 gradually increases along the preset direction of rotation 103. In this example, the airflow element 11 is specifically a centrifugal fan 15.

[0026] The air outlet 14 is formed on the first housing portion 121 or the second housing portion 122. The air outlet 14 is used for discharging the airflow in the guide channel 13 out of the first space 110. The air outlet 14 is formed by the guide wall 124 and the upper sidewall 125. Along the direction of the plane of rotation P, the ratio of the width of the air outlet 14 to the radius of the airflow element 11 is greater than or equal to 1 and less than or equal to 1.5. In the case where other conditions remain unchanged, the larger the radius of the airflow element 11, the larger the air volume of the generated dust removal airflow so that the dust collection efficiency of the sander 100 can be improved. That is, within the same unit of time, the larger the radius of the airflow element 11, the higher the dust collection efficiency of the sander 100. Similarly, under the same conditions, the larger the width of the air outlet 14, the larger the air output at the same time. Therefore, the larger the width of the air outlet 14, the higher the dust collection efficiency of the sander 100. The width of the air outlet 14 and the radius of the airflow element 11 are set within the preceding range, thereby facilitating the discharge of the dust removal airflow in the first space 110. Further, in this example, on the plane of rotation P, the width of the air outlet 14 is greater than or equal to 40 mm and less than or equal to 65 mm. It is to be noted that the width of the air outlet 14 refers to the farthest distance (that is, L shown in FIG. 4) between the sidewalls forming the air outlet 14 in the direction along the plane of rotation P and perpendicular

to the central axis 102. Further, the ratio of the width of the air outlet 14 to the radius of the airflow element 11 is greater than or equal to 1.1 and less than or equal to 1.3. The ratio of the width of the air outlet 14 to the radius of the airflow element 11 is set within the preceding range so that not only is the dust collection efficiency of the sander 100 high, but also the following is guaranteed: the area of the projection of the guide channel 13 of the sander 100 on the plane of rotation P is too large, the overall dimension of the sander 100 is too large, and the sander 100 is inconvenient to operate.

[0027] Along the direction of the plane of rotation P, the inner wall of the dust removal housing 12 includes at least a structural section 127 that satisfies the Archimedean spiral equation, that is, the inner wall of the guide channel 13 includes at least one section whose extension direction satisfies the Archimedean spiral equation, that is to say, the interior of the guide channel 13 may be formed by connecting multiple structural sections 127 that satisfy different rules (as shown in FIGS. 7 and 8), where the different rules may be linear rules or nonlinear rules, or the multiple structural sections 127 may include both the linear rules and nonlinear rules. Further, to facilitate design and manufacturing, the inner wall of the guide channel 13 extends in the form of an Archimedean spiral, and the extension direction satisfies the Archimedean spiral equation. In this example, two ends of the inner wall forming the air outlet 14 are defined as a first end 141 and a second end 142, where the extension direction of the guide wall 124 connecting the first end 141 to the second end 142 satisfies the polar coordinate equation of the Archimedean spiral, and the equation is that $D1 = a1 + b1\theta$. That is to say, the first end 141 may be approximated as the starting point of the Archimedean spiral, and the second end 142 may be approximated as the end point of the Archimedean spiral, that is, the inner wall of the dust removal housing 12 increases equidistantly from the first end 141 along the preset direction of rotation 103. Further, the distance from the central axis 102 to the first end 141 is greater than or equal to 40 mm and less than or equal to 60 mm, and the corresponding increase of D1 in unit angle of the inner wall along the preset direction of rotation 103 is greater than 1.3 mm and less than 1.8 mm, that is, a1 is greater than or equal to 40 mm and less than or equal to 60 mm, and b1 is greater than 1.3 mm and less than 1.8 mm. It is to be noted that the width of the preceding air outlet 14 may be referred to as the distance L between the first end 141 and the second end 142. Further, along the direction of the plane of rotation P, the distance D between the fixing member 123 and the central axis 102 is greater than $a1 + b1\theta$. That is to say, the fixing member 123 is disposed on the outer side of the guide channel 13 surrounded by the polar coordinate equation of the Archimedean spiral. That is, the installation position for installation and fixation is disposed on the outer side of the guide channel 13. In this manner, the following case can be avoided: the installation position affects the extension direction of the

guide wall 124 and thus affects the airflow guide.

[0028] As shown in FIG. 13, along the direction of the central axis 102, the distance from the lower sidewall 126 to the upper sidewall 125 is defined as a third distance D3, where the third distance D3 gradually increases along the preset direction of rotation, that is to say, along the preset direction of rotation 103, the distance from the lower sidewall 126 to the upper sidewall 125 gradually increases, that is, the volume of the guide channel 13 gradually increases along the preset direction of rotation 103, that is to say, along the preset direction of rotation 103, the height from the upper sidewall 125 to the lower sidewall 126 gradually increases. In this manner, the dust suction resistance when the dust removal airflow circulates along the guide channel 13 can be reduced, the dust suction performance can be improved, the energy consumption of the sander 100 during operation can be reduced, and the working time of the sander 100 can be extended. It is to be noted that the gradual increase here refers to an increase according to a certain rule, which may be a linear rule or a nonlinear rule.

[0029] The upper sidewall 125 includes at least one connecting section 129 that satisfies an Archimedean spiral direction, that is to say, the upper sidewall may be formed by connecting multiple connecting sections 129 that satisfy different rules, where the different rules may be linear rules or nonlinear rules, or the multiple structural sections 127 may include both the linear rules and nonlinear rules. Further, to facilitate design and manufacturing, the upper sidewall 125 extends in the form of an Archimedean spiral, the extension direction satisfies the Archimedean spiral equation, that is, $D3 = a3 + b3\theta$, the first end 141 may be approximated as the starting point of the Archimedean spiral, that is, the upper sidewall 125 extends upward from the first end 141, and the lower sidewall 126 is approximated as a plane perpendicular to the central axis 102. Further, the distance from the upper sidewall 125 to the lower sidewall 126 at the first end 141 is greater than or equal to 6 mm and less than or equal to 10 mm, and the corresponding increase of the distance from the upper sidewall 125 to the lower sidewall 126 in unit angle along the preset direction of rotation 103 is greater than 0.5 mm and less than 2 mm, that is, a3 is greater than or equal to 6 mm and less than or equal to 10 mm, and b3 is greater than 0.5 mm and less than 2 mm. In this example, the inner wall of a dust removal channel 13 gradually extends outward from the first end 141, and the upper sidewall 125 gradually extends upward from the first end 141. As another feasible example, the upper sidewall 125 gradually extends upward from the first end 141 so that the volume of the dust removal channel 13 gradually increases, and the dust suction resistance of the dust removal airflow in the dust removal channel 13 is reduced, thereby improving the dust suction performance.

[0030] When the sander 100 is in a load-free state, the working duration of the sander 100 when the battery pack consumes 10 WH of energy is defined as the functional

time T of the sander 100, and the product of the load-free rotational speed N of the electric motor 51 and the functional time T of the sander 100 is greater than or equal to 63000 rpm.min and less than or equal to 120000 rpm.min. In an example, the product of the load-free rotational speed N of the electric motor 51 and the functional time T of the sander 100 is greater than or equal to 70000 rpm.min and less than or equal to 115000 rpm.min. In other examples, the product of the load-free rotational speed N of the electric motor 51 and the functional time T of the sander 100 is greater than or equal to 77000 rpm.min and less than or equal to 110000 rpm.min. In this example, the functional time T of the sander 100 is greater than or equal to 7 min and less than or equal to 11 min.

[0031] As shown in FIGS. 5 and 6, the sander 100 further includes a counterweight 80 for achieving the mass balance and torque balance of the base plate. Along the direction of the central axis 102, the counterweight 80 is located between the centrifugal fan 15 and the base plate, and the counterweight 80 and the eccentric element 60 are detachably and fixedly connected, that is to say, the eccentric element 60 and the counterweight 80 move synchronously, and the counterweight 80 can rotate about the axis with the eccentric element 60. The counterweight 80 and the centrifugal fan 15 are two separate components, and the counterweight 80 is disposed on the lower side of the centrifugal fan 15. It may also be understood as that the centroid of the counterweight 80 is close to the base plate so that the distance from the centroid of the counterweight 80 to the base plate can be reduced, the torque between the counterweight 80 and the base plate can be reduced, and the weight of the counterweight 80 for balancing the torque can be reduced. It may also be understood as that no additional weight is required to balance the torque so that the following case can be avoided: the weight of the counterweight 80 is added to balance other weights. In other words, the torque can be counteracted simply through the configuration of other very light weights, and thus only an additional weight having the same weight as the other weights needs to be configured on the counterweight 80. Therefore, it can be seen that through the preceding arrangement, the weight of the counterweight 80 can be greatly reduced, thereby reducing the weight of the sander 100, facilitating user operation, reducing the weight of the whole machine, reducing the fatigue of the user, and reducing the energy consumption of the sander 100.

[0032] In this example, the eccentric element 60 is integrally formed with the centrifugal fan 15, that is, the centrifugal fan 15 is formed with the eccentric element 60. The centrifugal fan 15 is mounted on the motor shaft 52 and can be driven by the motor shaft 52 to rotate. Of course, in other words, the centrifugal fan 15 is the eccentric element 60. Specifically, the centrifugal fan 15 is made of a material with a density less than 6.5 g/cm³. Since the weight is proportional to the density, the smaller

the density, the smaller the weight of the centrifugal fan 15, that is, the weight of the centrifugal fan 15 is effectively reduced, thereby reducing the weight of the sander 100. Preferably, when the centrifugal fan 15 is made of a material with a density greater than or equal to 1 g/cm^3 and less than or equal to 3 g/cm^3 , the weight of the centrifugal fan 15 can be reduced while structural strength is satisfied. Furthermore, the centrifugal fan 15 may be made of aluminum so that costs are saved while the weight of the centrifugal fan 15 is reduced.

[0033] It is to be noted that when the electric motor 51 drives the centrifugal fan 15 to rotate, the centrifugal fan 15 generates a moment of inertia, that is to say, when the centrifugal fan 15 rotates, a force of constraint is formed to keep the centrifugal fan 15 rotating about the motor axis 101. The force of constraint restricts the sander 100 to rotate along the up and down direction when the sander 100 tends to move in a certain direction that intersects with the up and down direction. That is to say, the user applies a force to the sander 100 to make the sander 100 move along a certain direction that intersects with the up and down direction, the force of constraint makes the sander 100 tend to move in the opposite direction of the movement of the sander 100, requiring the user to apply a larger force to overcome the force of constraint and causing inconvenience in operation, and operating like this for a long time easily causes fatigue to the user and affects the working efficiency. The moment of inertia is proportional to the weight of the centrifugal fan 15. The greater the weight of the centrifugal fan 15, the greater the moment of inertia and the greater an effect on the user. Therefore, through the preceding arrangement, the moment of inertia can be reduced, thereby improving user experience.

[0034] Further, the range of the product of the weight of the centrifugal fan 15 and the square of the outer diameter of the centrifugal fan 15 is greater than or equal to $3000 \text{ g}\cdot\text{mm}^2$ and less than or equal to $10000 \text{ g}\cdot\text{mm}^2$. The outer diameter refers to the diameter of an outer edge 159 of the centrifugal fan 15. The range of the product of the weight of the centrifugal fan 15 and the square of the outer diameter of the centrifugal fan 15 is set within the preceding range so that the moment of inertia generated when the centrifugal fan 15 rotates can be effectively reduced, the effect of the force of constraint during the operation of the user can be reduced, and thus the working efficiency can be improved.

[0035] Furthermore, the total weight of the centrifugal fan 15 and the electric motor 51 is less than or equal to 400 g. In the internal structure of the sander 100, the electric motor 51 and the centrifugal fan 15 are much heavier than other components, that is to say, the electric motor 51 and the centrifugal fan 15 mainly contribute to the weight of the sander 100. The structures and positions of the counterweight 80 and the centrifugal fan 15 are configured such that the weight of the centrifugal fan 15 is greatly reduced, a lighter sander 100 with a smaller moment of inertia is obtained, the energy consumption

of the sander 100 is reduced, and the working duration of the sander 100 is extended. In some examples, the weight of the centrifugal fan 15 is less than or equal to 100 g. In some other examples, the weight of the centrifugal fan 15 is less than or equal to 80 g. In other examples, the weight of the centrifugal fan 15 is less than or equal to 60 g.

[0036] As shown in FIGS. 9 to 12, the centrifugal fan 15 is specifically of a backward-inclined type. The centrifugal fan 15 includes a bottom plate 151 and multiple fan blade portions 152 basically perpendicular to the surface of the bottom plate 151. Along the direction of the central axis 102, the fan blade portions 152 are disposed below the bottom plate 151 and near the base plate. The bottom plate 151 is rotatable about the central axis 102, the bottom plate 151 is connected to the motor shaft 52 of the electric motor 51, the motor shaft 52 can drive the bottom plate 151 to rotate, and the multiple fan blade portions 152 are evenly distributed around the central axis 102. Further, the fan blade portions 152 extend outward from the central axis 102, and along the direction of the central axis 102, the fan blade portions 152 extend from the bottom plate 151 toward the base plate. The multiple fan blade portions 152 are fixedly connected to or integrally formed with the bottom plate 151. In this example, the multiple fan blade portions 152 and the bottom plate 151 are integrally formed into one part. The fan blade portion 152 extends along a curve, where the extension direction of the curve is opposite to the preset direction of rotation 103 of the centrifugal fan 15, that is, the fan blade portion 152 extends along a second direction opposite to the first direction. It is to be noted that the centrifugal fan 15 includes at least three fan blade portions 152.

[0037] Each fan blade portion 152 has an inner concave surface that is concave toward the inside of the fan blade portion 152 and an outer convex surface that protrudes toward the outside of the fan blade portion 152. Each fan blade portion 152 has a first fan blade surface 153 and a second fan blade surface 154. The first fan blade surface 153 corresponds to the outer convex surface, and the second fan blade surface 154 corresponds to the inner concave surface. The first fan blade surface 153 and the second fan blade surface 154 are basically perpendicular to the plane of rotation P. In the preset direction of rotation 103, the first fan blade surface 153 is disposed on the front side of the second fan blade surface 154, and the first fan blade surface 153 and the second fan blade surface 154 form a front edge 155 and a rear edge 156 that are opposite. Along the direction of the plane of rotation P, the front edge 155 is away from the central axis 102 relative to the rear edge 156, that is, the rear edge 156 is close to the central axis. The distance from the front edge 155 to the central axis 102 is equal to the distance from the outer edge 159 of the base plate to the central axis 102. In this example, it is to be understood that the front edge 155 is in at least partial contact with the outer edge 159 of the bottom plate 151. It is to

be noted here that the equality mentioned here is not strictly limited to the case where the distance from the front edge 155 to the central axis 102 is completely equal to the distance from the outer edge 159 of the bottom plate 151 to the central axis, but as long as the error is within the allowable range, it is to be understood that the distance from the front edge 155 to the central axis 102 is equal to the distance from the outer edge 159 of the base plate to the central axis 102. Of course, in other examples, the front edge 155 is not limited to be in contact with the outer edge 159 of the bottom plate 151, and the front edge 155 may not be in contact with the outer edge 159 of the bottom plate 151, that is, the distance from the front edge 155 to the central axis 102 is less than the distance from the outer edge 159 of the base plate to the central axis 102. Of course, in other examples, the distance from the front edge 155 to the central axis 102 is greater than the distance from the outer edge 159 of the bottom plate 151 to the central axis 102, that is, along the axial direction of the bottom plate 151, the fan blade portions 152 protrude from the bottom plate 151.

[0038] To further elaborate on the specific structure of the centrifugal fan 15, it is defined here that a coordinate system is established with a certain point on the central axis 102 as the origin, with a direction of a line between the central axis 102 and the axis as the X-axis, and with a direction perpendicular to the direction of the line between the central axis 102 and the axis as the Y-axis, a projection of the first fan blade surface 153 of the fan blade portion 152 on a plane formed by the X-axis and the Y-axis is defined as a first projection line 157, a projection of the second fan blade surface 154 of the fan blade portion 152 on the plane formed by the X-axis and the Y-axis is defined as a second projection line 158, and the first projection line 157 and the second projection line 158 are both arc lines in the plane formed by the X-axis and the Y-axis. Specifically, the first projection line 157 may be a smooth arc section or may be formed by connecting several smooth arc sections, and the curved transition between the arc sections is relatively uniform. Similarly, the second projection line 158 may be a smooth arc section or may be formed by connecting several smooth arc sections, where the arc sections are smoothly connected. It is to be noted that the curvature of the first projection line 157 and the curvature of the second projection line 158 are not limited, that is to say, the first projection line 157 and the second projection line 158 may be formed in the same manner or different manners. Through the preceding arrangement, the curved transition between the first fan blade surface 153 and the second fan blade surface 154 is relatively uniform and smooth overall; during the rotation of the bottom plate 151, the resistance encountered by the dust removal airflow across the fan blade portions 152 can be greatly reduced, the air output of the rotating centrifugal fan 15 can be increased, and the noise during operation can be reduced.

[0039] A tangent at a position of the first projection line

157 farthest from the central axis 102 is defined as a first tangent line 1571, and a tangent line at an intersection of the outer edge 159 of the bottom plate 151 and the first projection line 157 is defined as a second tangent line 1581. The included angle between the first tangent line 1571 and the second tangent line 1581 is greater than or equal to 20 degrees and less than or equal to 45 degrees. The included angle between the first tangent line 1571 and the second tangent line 1581 is set within the preceding range so that the air output and noise suppression effect of the centrifugal fan 15 can be significantly optimized. That is to say, the included angle is set within the preceding range so that the dust collection effect of the sander 100 can be further optimized, and the noise can be reduced, thereby improving the user experience. Further, the included angle α between the first tangent line 1571 and the second tangent line 1581 is greater than or equal to 30 degrees and less than or equal to 40 degrees, thereby making the preceding effect better. In the plane formed by the X-axis and the Y-axis, an endpoint of the first projection line 157 near the outer edge 159 of the bottom plate 151 is defined as A, and an endpoint of the first projection line 157 near the central axis 102 is defined as B. Similarly, an endpoint of the second projection line 158 near the outer edge 159 of the bottom plate 151 is defined as C, and an endpoint of the second projection line 158 near the central axis 102 is defined as D. In the present application, the first projection line 157 and the second projection line 158 are basically parallel, that is to say, the distance L1 between the endpoint A and the endpoint B of the first projection line 157 is basically the same as the distance L2 between the endpoint C and the endpoint D of the second projection line 158. The ratio of the radius of the centrifugal fan 15 to the distance L1 between the endpoint A and the endpoint B of the first projection line 157 is greater than or equal to 4 and less than or equal to 7.5. The ratio is set within the preceding range so that while the dust suction effect of the centrifugal fan 15 is satisfied, the weight of the fan can be reduced, thereby further reducing the energy consumption of the whole machine and extending the working duration of the sander 100. Further, if the ratio of the radius of the centrifugal fan 15 to the distance between the endpoint A and the endpoint B of the first projection line 157 is greater than or equal to 4.5 and less than or equal to 6.5, the effect is better. The distance L1 between the endpoint A and the endpoint B of the first projection line 157 is greater than or equal to 5 mm and less than or equal to 11 mm.

Claims

1. A sander, comprising:

an airflow element rotatable about a central axis along a preset direction of rotation to generate a dust removal airflow;

- an electric motor for providing a power source for the airflow element; and
 a battery pack for providing an energy source for the electric motor;
 wherein when the sander is in a load-free state, a working duration of the sander when the battery pack consumes 10 WH of energy is defined as functional time T of the sander; and
 a product of a load-free rotational speed N of the electric motor and power supply time T of the sander is greater than or equal to 63000 rpm.min and less than or equal to 120000 rpm.min.
2. The sander of claim 1, wherein the product of the load-free rotational speed N of the electric motor and the power supply time T of the sander is greater than or equal to 77000 rpm.min and less than or equal to 110000 rpm.min.
3. The sander of claim 1, further comprising:
 a housing configured to accommodate the airflow element and guide the dust removal airflow generated by the airflow element, wherein the housing comprises an upper sidewall and a lower sidewall opposite to the upper sidewall; and a distance from the lower sidewall to the upper sidewall along a direction of the central axis is defined as a third distance D3, and the third distance D3 gradually increases along the preset direction of rotation.
4. The sander of claim 3, wherein the upper sidewall comprises at least one connecting section that satisfies an Archimedean spiral.
5. The sander of claim 4, wherein a guide wall is formed on an inner wall of the housing, a distance from the guide wall to the central axis is defined as a first distance D1, and the first distance D1 gradually increases along the preset direction of rotation; and the inner wall comprises at least a structural section that satisfies an Archimedean spiral equation along a plane perpendicular to the central axis.
6. The sander of claim 4, wherein a farthest end of the airflow element from the central axis forms a circle when the airflow element rotates about the central axis along the preset direction of rotation;
 wherein a guide wall is formed on an inner wall of the housing, a distance from the guide wall to the circle is defined as a second distance D2, and the second distance D2 gradually increases along the preset direction of rotation; and the inner wall comprises at least a structural section that satisfies an Archimedean spiral equation along a plane perpendicular to the central axis.
7. The sander of claim 4, wherein the airflow element comprises:
 a bottom plate rotatable around the central axis; and
 a plurality of fan blade portions fixedly connected to or integrally formed with the bottom plate; wherein a fan blade portion of the plurality of fan blade portions extends along a curve, and an extension direction of the curve is opposite to the preset direction of rotation of the airflow element.
8. The sander of claim 7, wherein the airflow element comprises:
 the bottom plate rotatable around the central axis; and
 the plurality of fan blade portions fixedly connected to or integrally formed with the bottom plate;
 wherein a first fan blade surface and a second fan blade surface of the fan blade portion are defined, and the first fan blade surface is disposed on a front side of the second fan blade surface along the preset direction of rotation; two opposite ends of the first fan blade surface and two opposite ends of the second fan blade surface separately merge into a front edge and a rear edge, and the front edge is away from the central axis relative to the rear edge; and an outer edge of the bottom plate at least partially contact with the front edge.
9. The sander of claim 8, further comprising:
 an eccentric element driven by the electric motor, wherein the eccentric element has an axis deviating from the central axis; and
 a base plate drivable by the electric motor; wherein a coordinate system is established with a certain point on the central axis as an origin, with a direction of a line between the central axis and the axis as an X-axis, and with a direction perpendicular to the direction of the line between the central axis and the axis as a Y-axis;
 a projection of the first fan blade surface on a plane formed by the X-axis and the Y-axis is defined as a first projection line, and a tangent line at a position of the first projection line farthest from the central axis is defined as a first tangent line;
 in the plane formed by the X-axis and the Y-axis, a tangent line at an intersection of the outer edge of the bottom plate and the first projection line

is defined as a second tangent line; and
 an included angle between the first tangent line
 and the second tangent line is greater than or
 equal to 20 degrees and less than or equal to
 45 degrees.

10. The sander of claim 9, wherein
 in the plane formed by the X-axis and the Y-axis, an
 endpoint of the first projection line near the outer
 edge of the bottom plate is defined as A, and an
 endpoint of the first projection line near the central
 axis is defined as B, wherein a ratio of a radius of
 the airflow element to a distance L1 between the
 endpoint A and the endpoint B of the first projection
 line is greater than or equal to 4 and less than or
 equal to 7.5.

11. A sander, comprising:

an airflow element rotatable about a central axis
 along a preset direction of rotation to generate
 a dust removal airflow;
 an electric motor for providing a power source
 for the airflow element;
 a battery pack for providing an energy source
 for the electric motor; and
 a housing configured to accommodate the air-
 flow element and guide the dust removal airflow
 generated by the airflow element;
 wherein a guide wall is formed on a back of the
 housing, a distance from the guide wall to the
 central axis is defined as a first distance D1, and
 the first distance D1 gradually increases along
 the preset direction of rotation; and
 an inner wall comprises a first end and a second
 end along a plane perpendicular to the central
 axis, the guide wall connects the first end to the
 second end, and a distance from the first end to
 the central axis is greater than or equal to 40
 mm and less than or equal to 60 mm.

12. The sander of claim 11, wherein

the first end and the second end are provided
 with air outlets for dust removal and air exhaust;
 and
 a ratio of a distance between the air outlets along
 the plane perpendicular to the central axis to a
 distance from the central axis to a farthest end
 of the airflow element is greater than or equal to
 1 and less than or equal to 1.5.

13. The sander of claim 12, wherein

the housing comprises an upper sidewall and a
 lower sidewall opposite to the upper sidewall;
 a distance from the lower sidewall to the upper
 sidewall along a direction of the central axis is

defined as a third distance D3, and the third dis-
 tance D3 gradually increases along the preset
 direction of rotation; and
 the upper sidewall comprises at least one con-
 necting section that satisfies an Archimedean
 spiral direction.

14. The sander of claim 11, wherein
 a range of a product of weight of the airflow element
 and a square of an outer diameter of a centrifugal
 fan is greater than or equal to 3000 g·mm² and less
 than or equal to 10000 g·mm².

15. A sander, comprising:

an airflow element rotatable about a central axis
 along a preset direction of rotation to generate
 a dust removal airflow;
 an electric motor for providing a power source
 for the airflow element;
 a battery pack for providing an energy source
 for the electric motor; and
 a housing configured to accommodate the air-
 flow element and guide the dust removal airflow
 generated by the airflow element;
 wherein the housing comprises an upper side-
 wall and a lower sidewall opposite to the upper
 sidewall; and
 a distance from the lower sidewall to the upper
 sidewall along a direction of the central axis is
 defined as a third distance D3, and the third dis-
 tance D3 gradually increases along the preset
 direction of rotation.

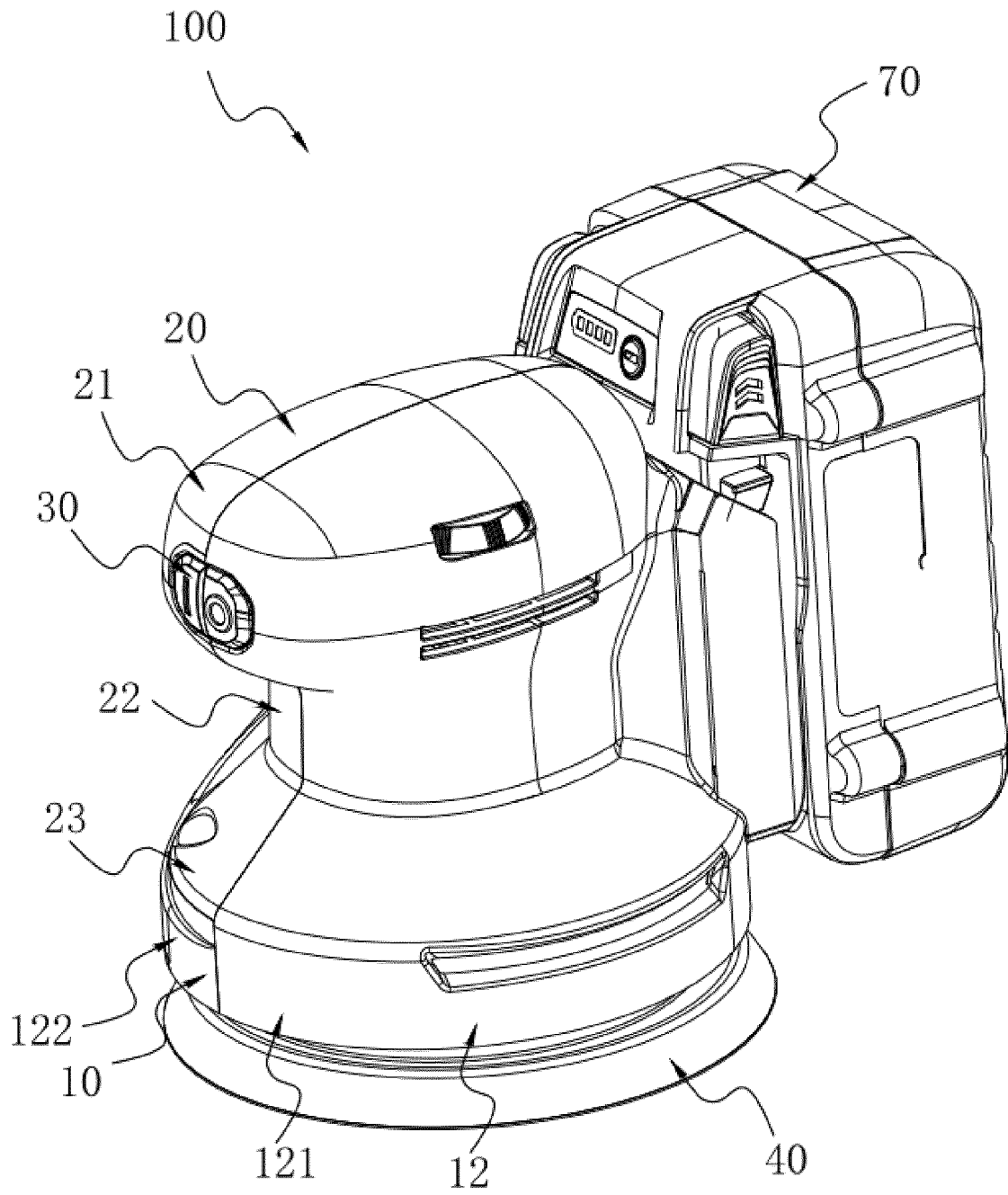


FIG. 1

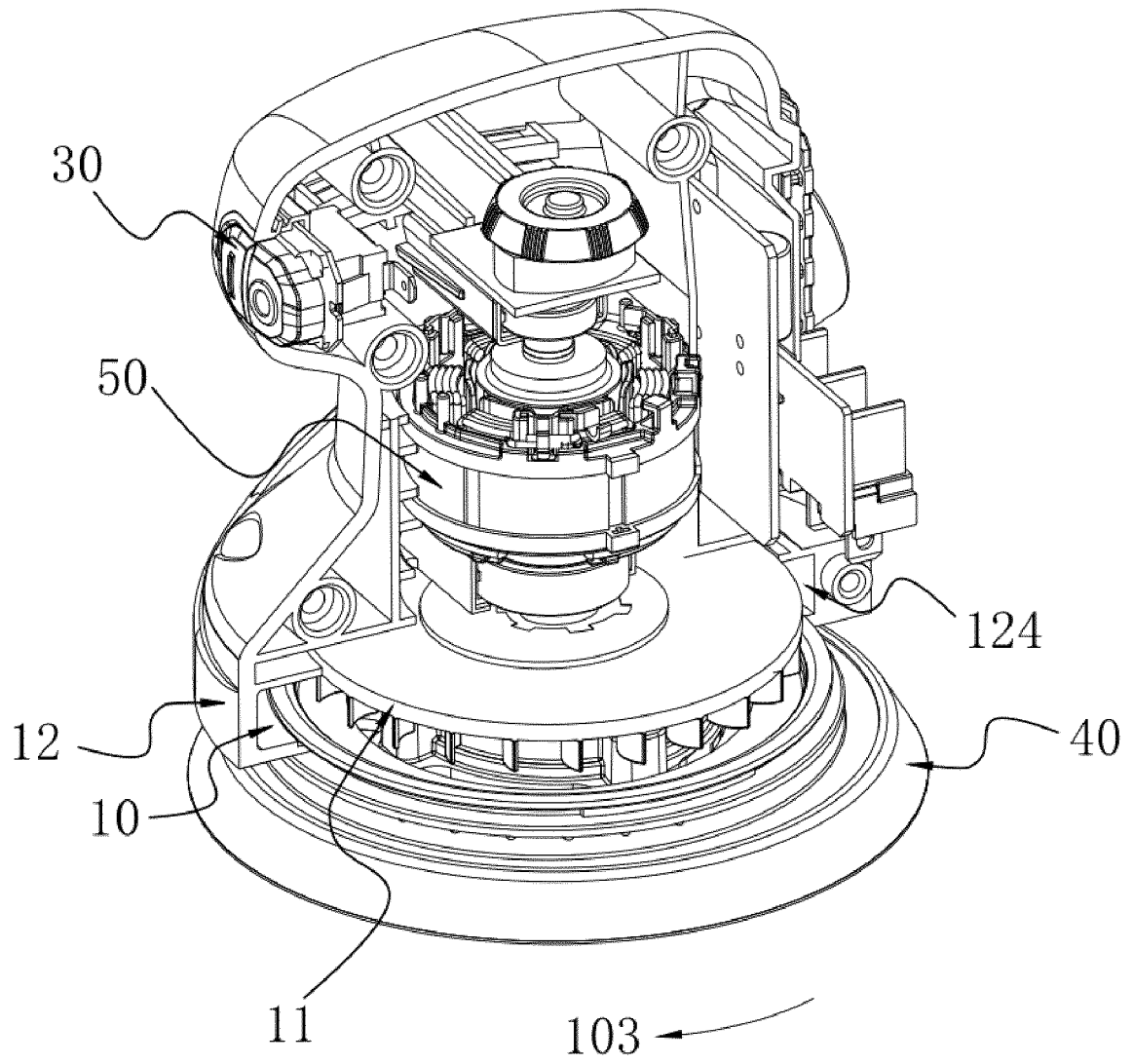


FIG. 2

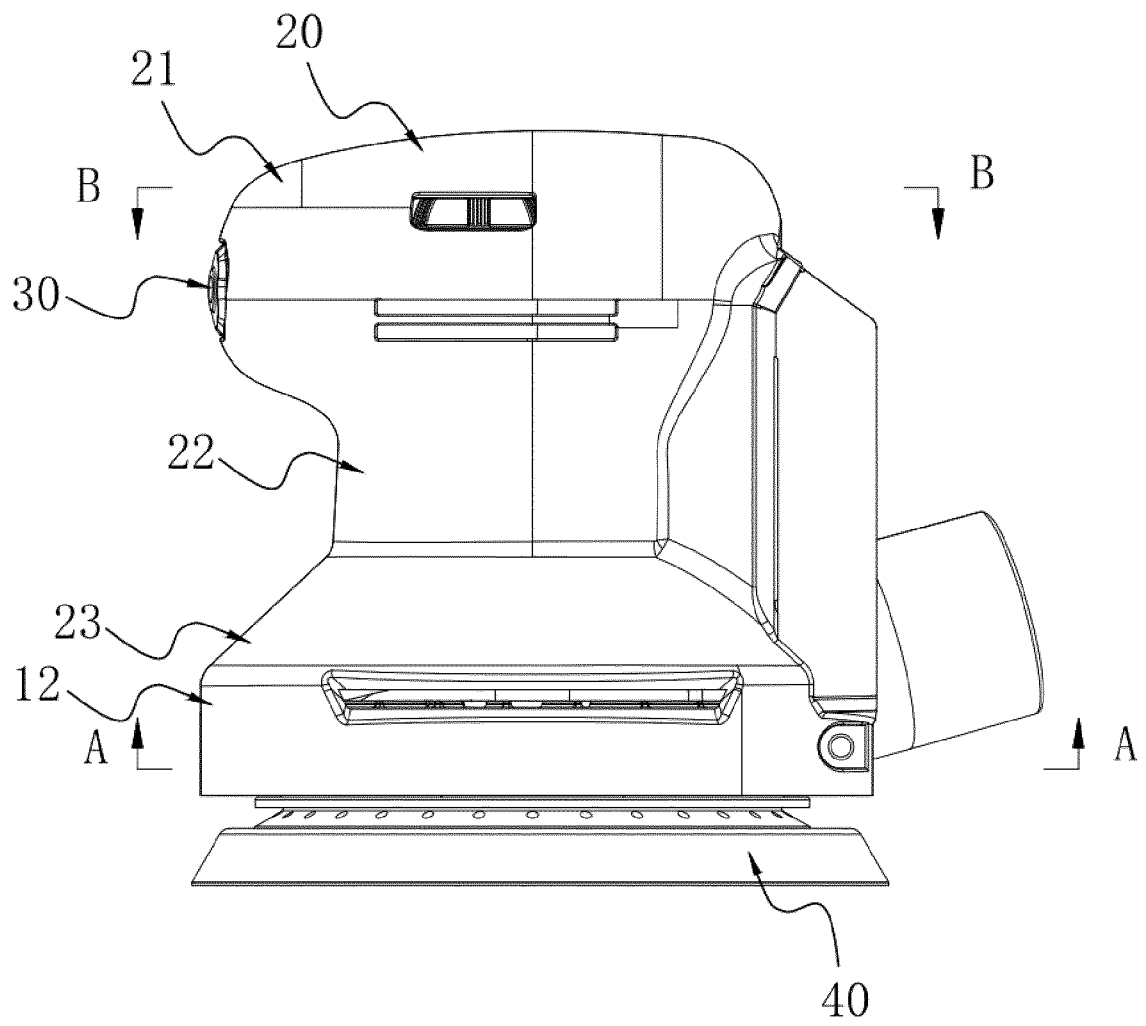


FIG. 3

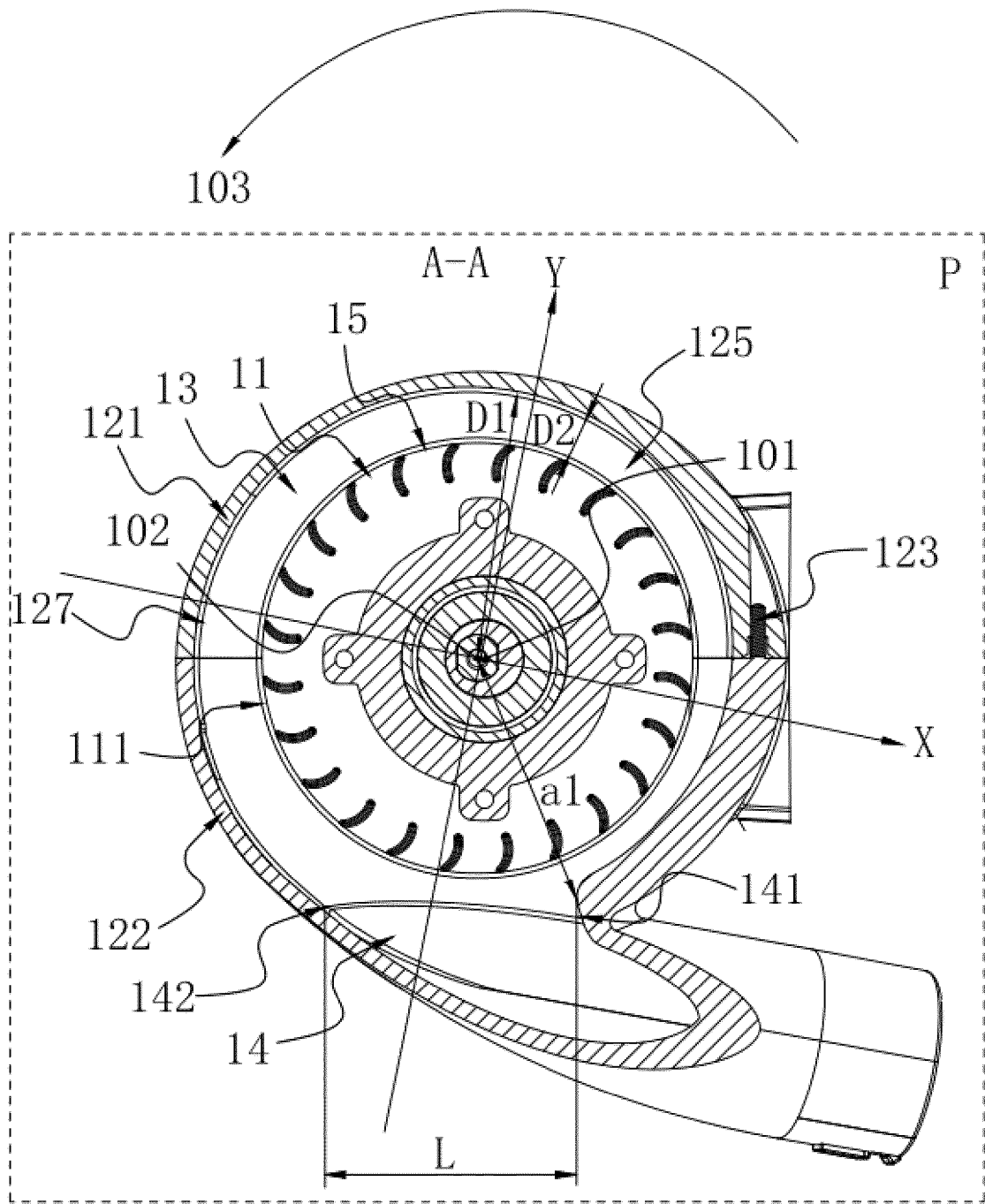


FIG. 4

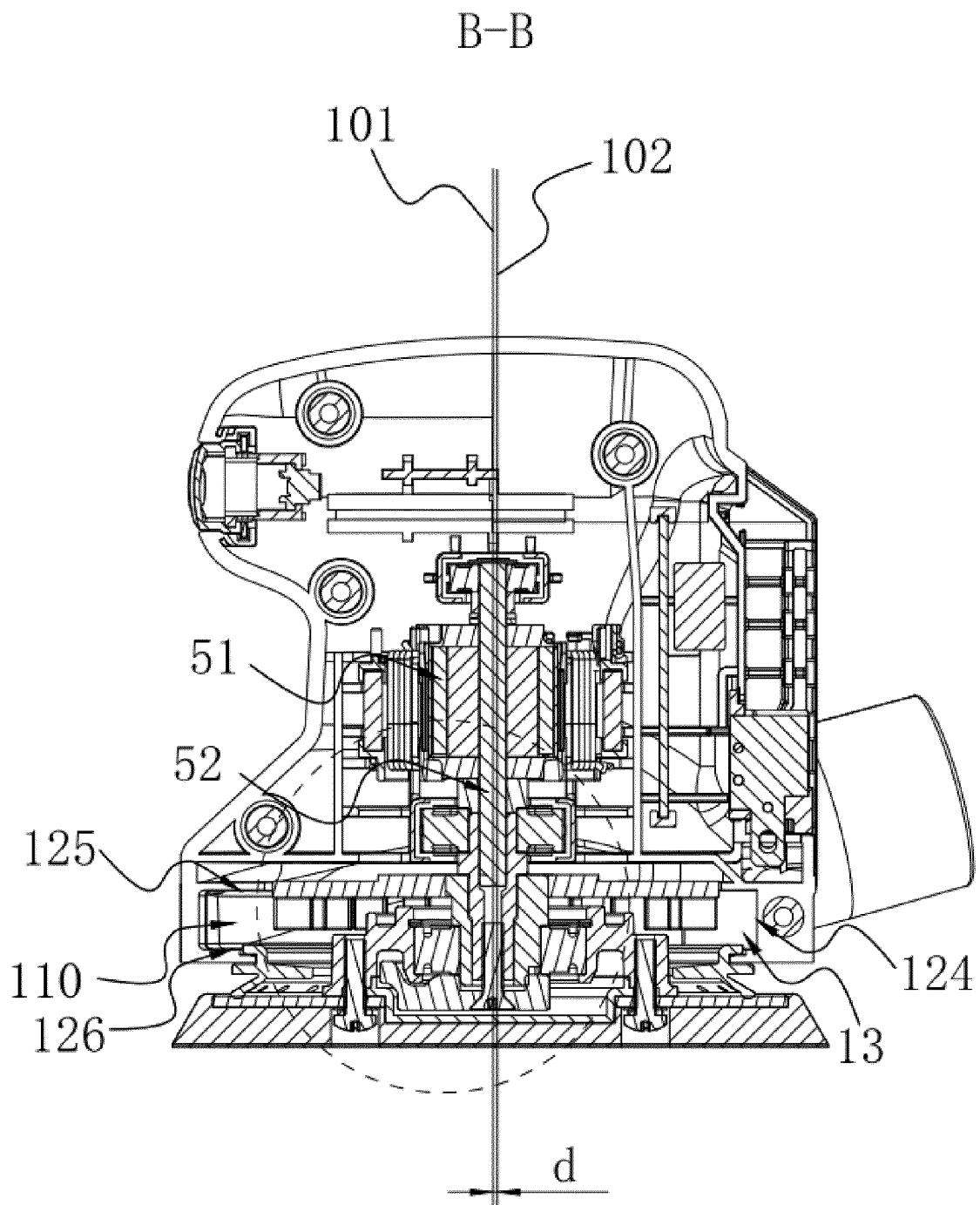


FIG. 5

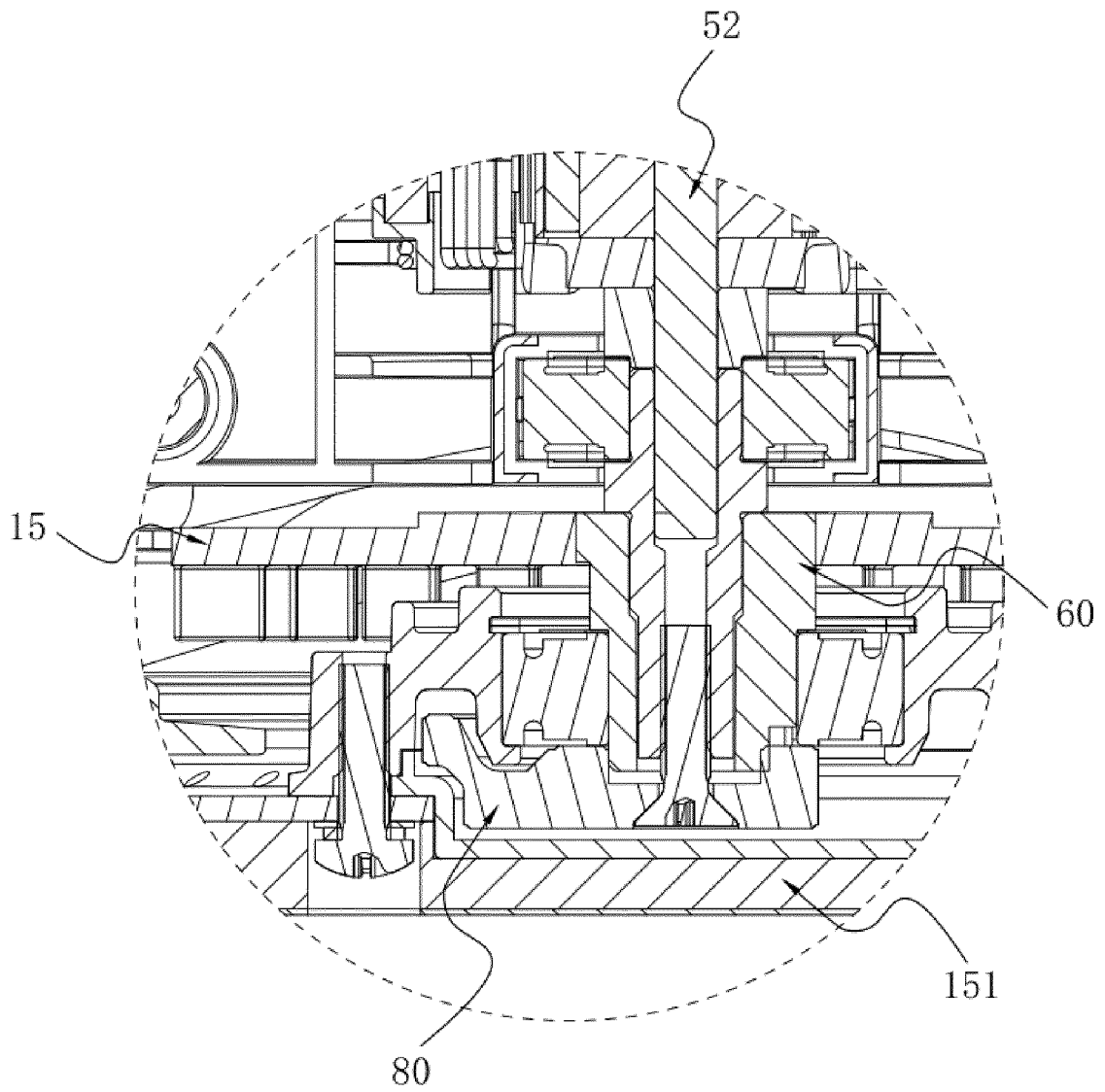


FIG. 6

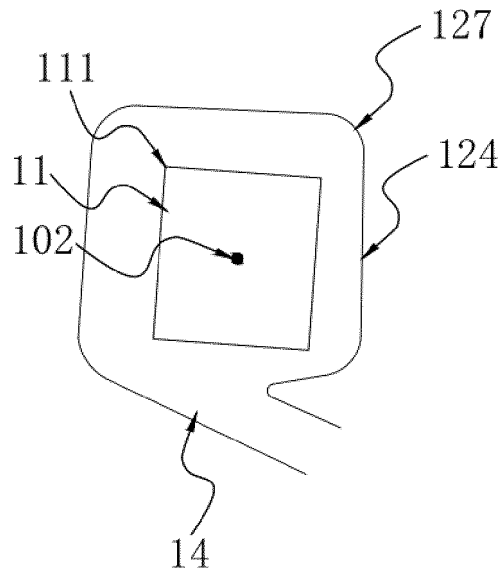


FIG. 7

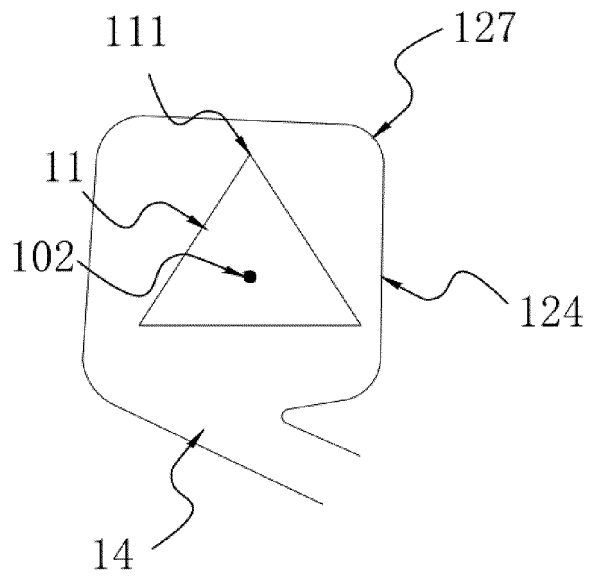


FIG. 8

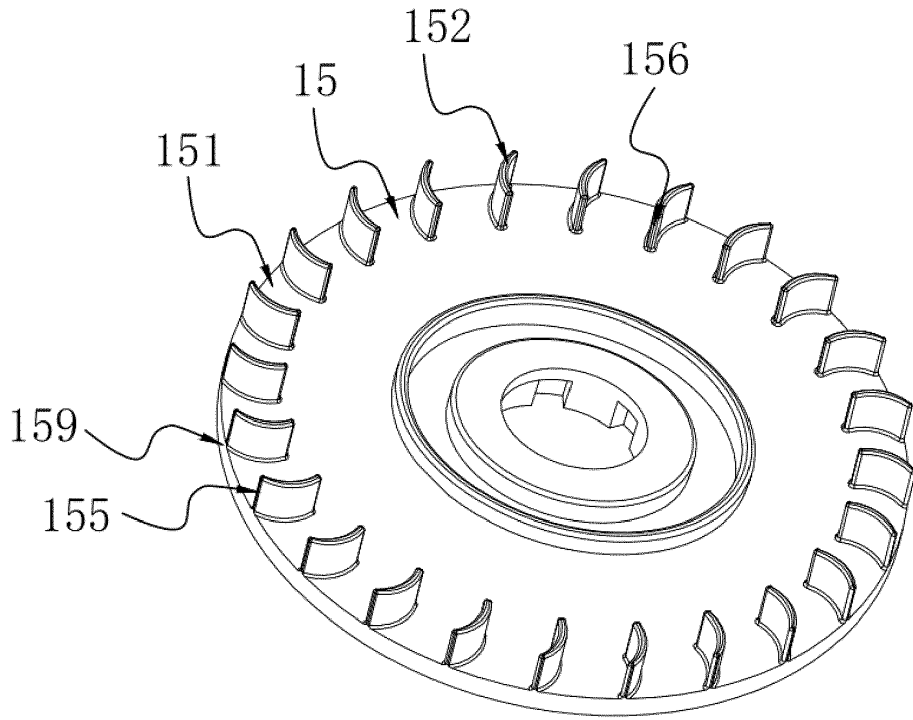


FIG. 9

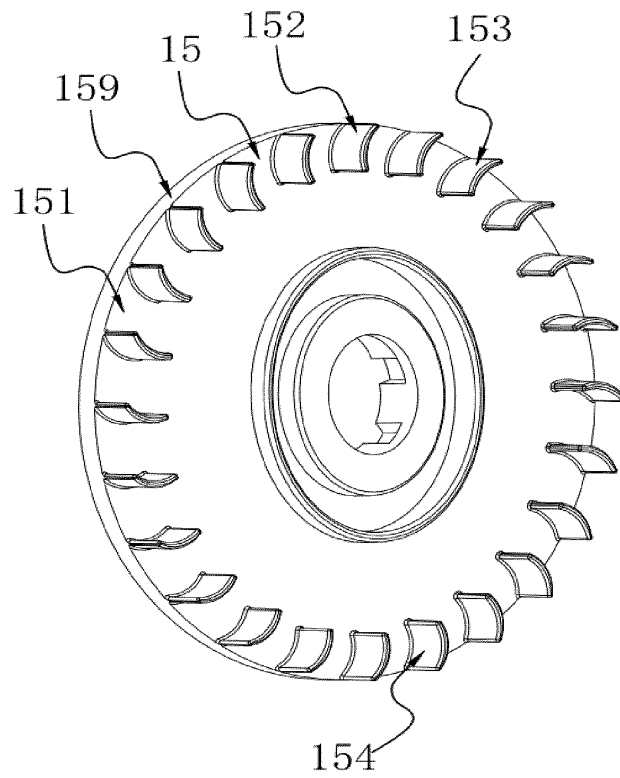


FIG. 10

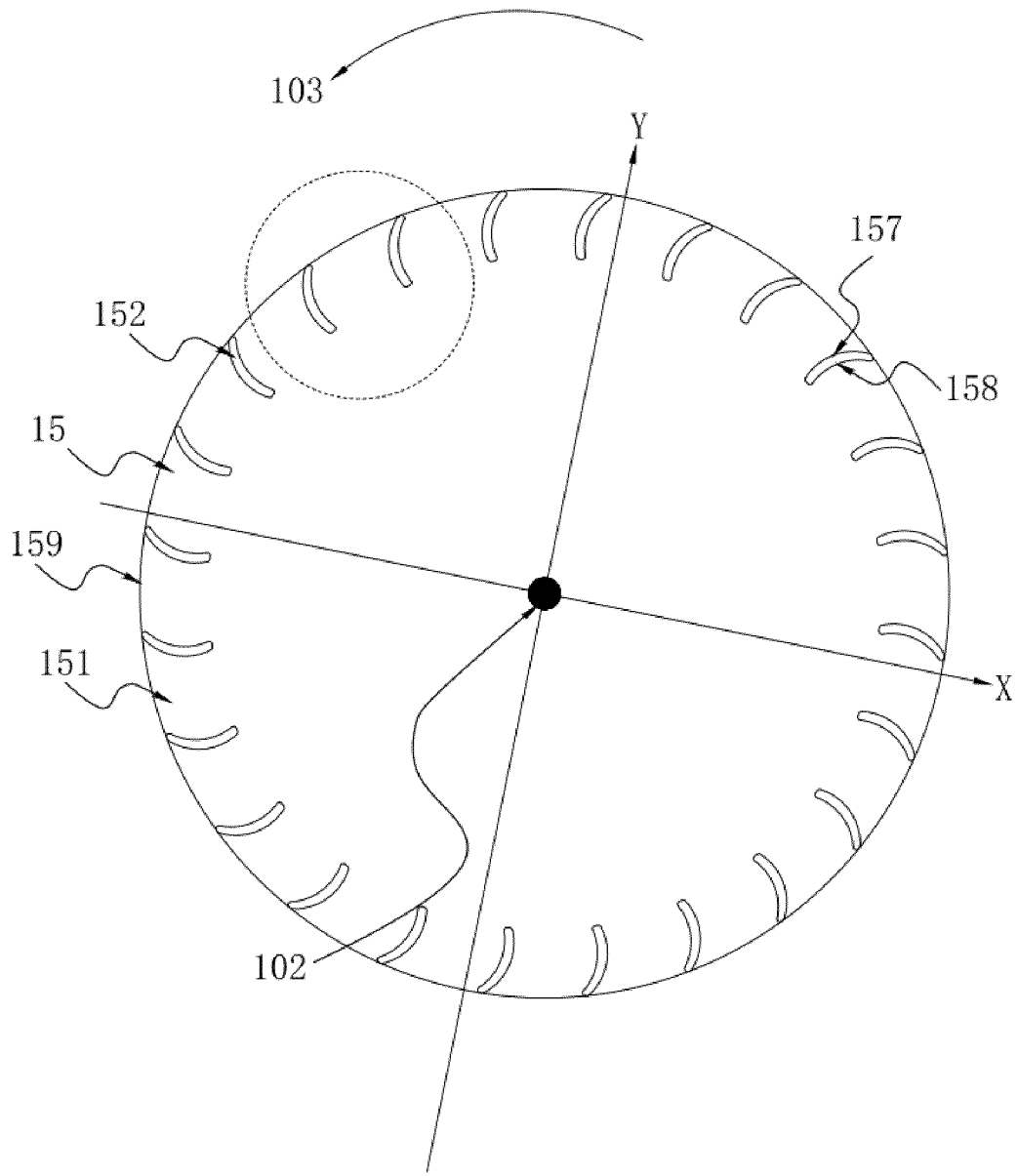


FIG. 11

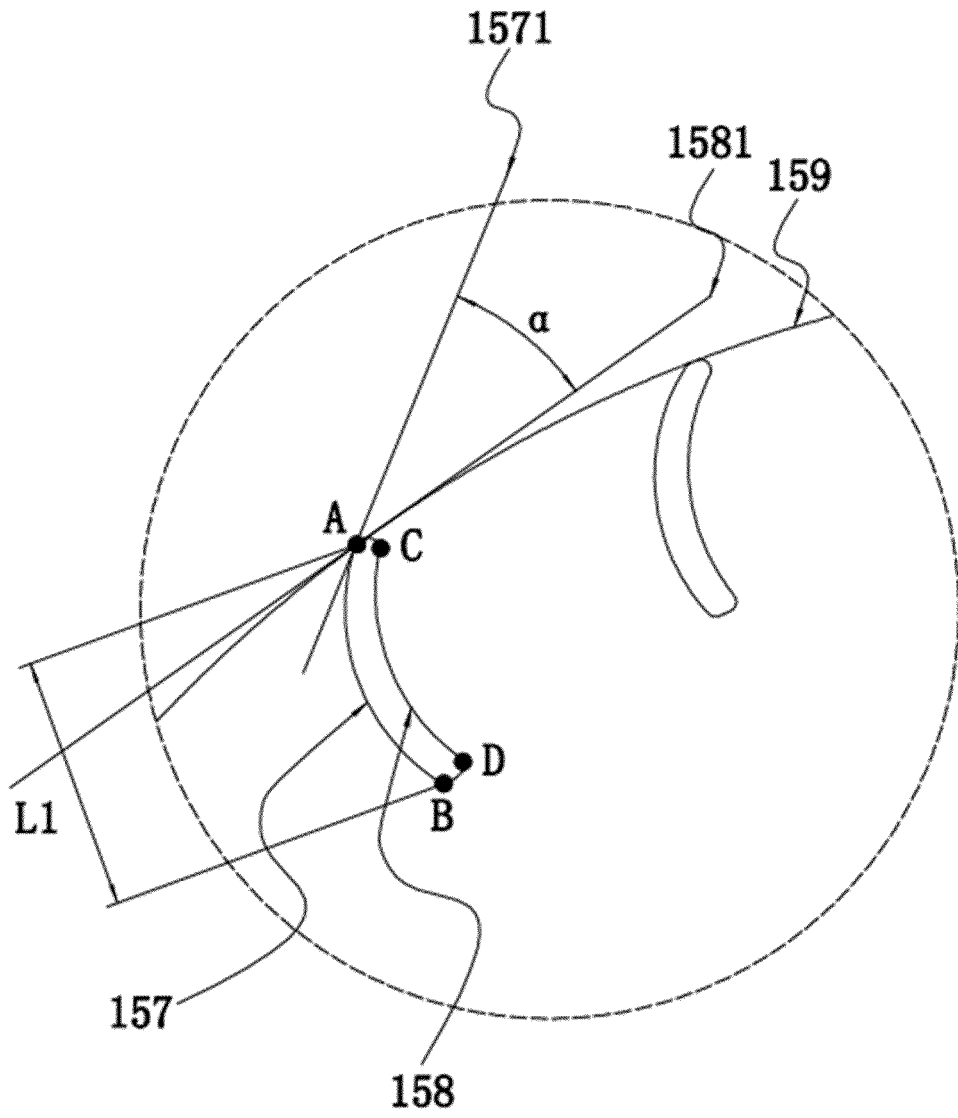


FIG. 12

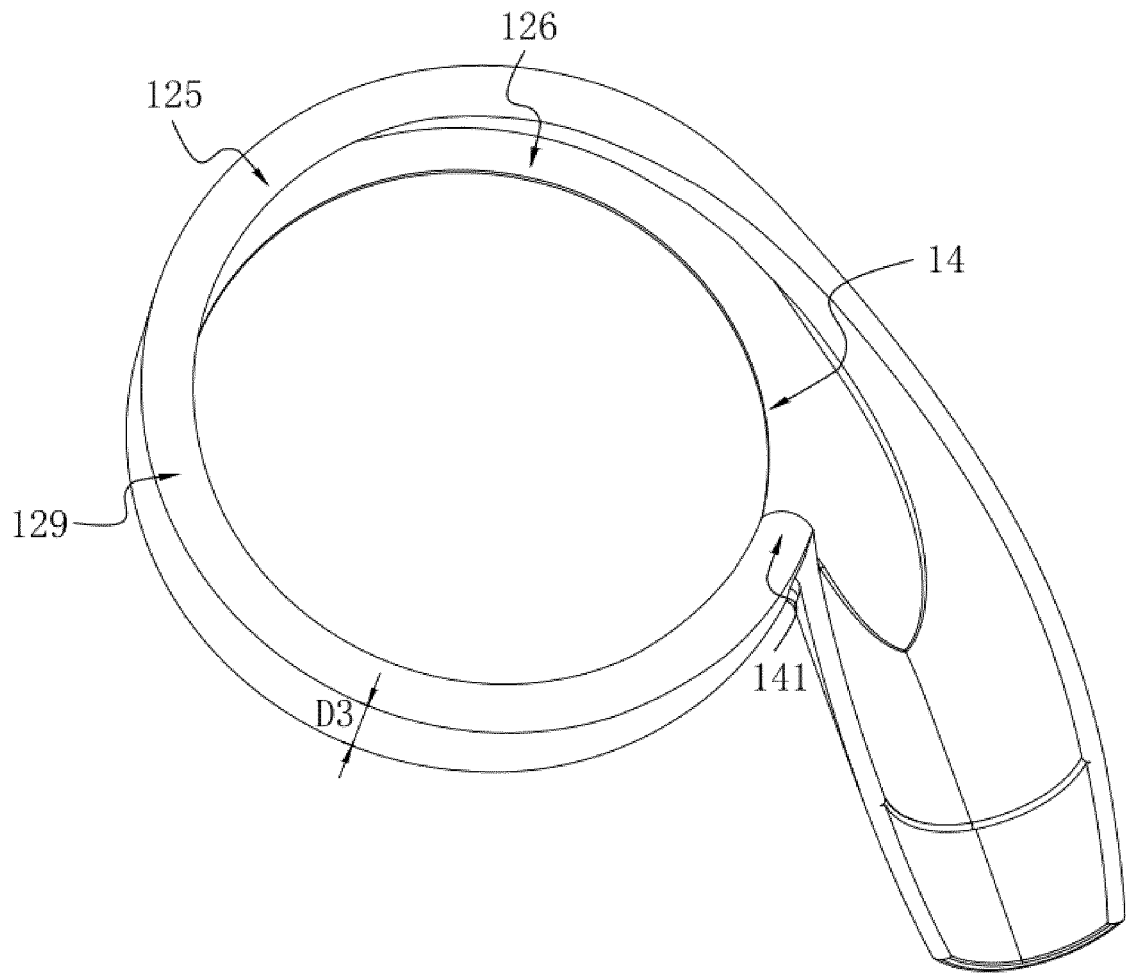


FIG. 13

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2022/118810

A. CLASSIFICATION OF SUBJECT MATTER		
B24B 55/06(2006.01)i; B24B 23/02(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)		
B24B		
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, VEN, ENTXT, CJFD: 砂光机, 电池, 风扇, 盖, 壳体, 电机, 集尘, 通道, sander, battery, fan, cover, housing, motor, collect+, dust, passage		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	CN 207971792 U (STANLEY BLACK & DECKER INC.) 16 October 2018 (2018-10-16) description, paragraphs 49-60, and figures 1-15	11
Y	DE 3607106 A1 (FABRITIUS HANS JOSEF) 10 September 1987 (1987-09-10) description, column 4, line 47 to column 6, line 37, and figures 1-3	11
A	CN 108527092 A (NANJING CHERVON INDUSTRY CO., LTD.) 14 September 2018 (2018-09-14) entire document	1-15
A	CN 103862351 A (POSITEC POWER TOOLS (SUZHOU) CO., LTD.) 18 June 2014 (2014-06-18) entire document	1-15
A	CN 107030608 A (NANJING CHERVON INDUSTRY CO., LTD.) 11 August 2017 (2017-08-11) entire document	1-15
A	CN 214124010 U (CHANGZHOU CREATE APPLIANCE CO., LTD.) 03 September 2021 (2021-09-03) entire document	1-15
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "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
12 October 2022		28 October 2022
Name and mailing address of the ISA/CN		Authorized officer
China National Intellectual Property Administration (ISA/CN) 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/CN2022/118810

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Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

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- [1] Invention 1: claims 1-10 relate to a first type sander;
- [2] invention 2: claims 11-14 relate to a second type sander;
- [3] invention 3: claim 15 relates to a third type sander.

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1. As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

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2. As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

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4. No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

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Remark on Protest The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

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No protest accompanied the payment of additional search fees.

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2022/118810

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Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
CN	207971792	U	16 October 2018	US	2018056473	A1	01 March 2018
				EP	3315264	A1	02 May 2018
				US	2020223026	A1	16 July 2020
DE	3607106	A1	10 September 1987	None			
CN	108527092	A	14 September 2018	US	2018250789	A1	06 September 2018
				DE	202018100760	U1	26 February 2018
CN	103862351	A	18 June 2014	None			
CN	107030608	A	11 August 2017	None			
CN	214124010	U	03 September 2021	None			

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- CN 202111192829 [0001]