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(54) **SILENCING AIR DUCT DEVICE, AIR DUCT ASSEMBLY, AND CLEANING ROBOT**

(57) The present disclosure provides a muffling air duct device, an air duct component, and a cleaning robot, and relates to the field of air purification. The airflow channel inside the muffling air duct device is changed by setting the inlet and outlet directions to be at least partially offset from each other, changing the airflow direction inside the airflow channel and reducing the airflow velocity. In the airflow channel, multi-stage diversion components are arranged from the end close to the air inlet to the end close to the air outlet. Each diversion component in the diversion component separates the airflow channel into at least two diversion channels, extending the path length in the airflow channel. Each stage of diversion components can further divert the airflow, indirectly increasing the contact area between the air and each diversion body and the length of the airflow path. This allows sound waves to be more fully absorbed and silenced in the airflow channel, avoiding the situation where the airflow is discharged through the shortest path in the airflow channel, ensuring that the wind resistance parameters in the airflow channel meet the working requirements of cleaning equipment, and improving the noise reduction effect.

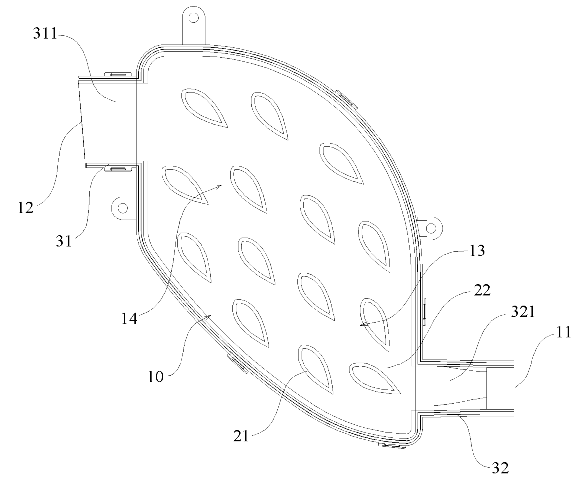

Fig. 4

Description

[0001] The present disclosure claims the priority of a Chinese patent application with the Application No. 202220576584.7 and the title of "MUFFLING AIR DUCT DEVICE, AIR DUCT COMPONENT, AND CLEANING ROBOT", which is filed to CNIPA on March 15, 2022, and the entire contents of the above application are incorporated in the present disclosure by reference.

TECHNIAL FIELD

[0002] The present disclosure relates to the field of air purification, and in particular to a muffling air duct device, an air duct component, and a cleaning robot.

BACKGROUND

[0003] The existing cleaning equipment, such as vacuum cleaners, intelligent cleaning robots, etc., all have functions such as vacuuming and dust removal. The working principle of their vacuuming function is to use an electric motor to drive blades for rotation at high speed, thereby generating negative air pressure inside the sealed housing and sucking up dust from the ground or the required cleaning position.

[0004] However, due to the continuous high-speed rotation of the electric motor during operation, the high-speed airflow generated by the motor will rub against other air and equipment components, resulting in significant noise in the air duct system of the cleaning equipment during suction and dust removal. The noise not only affects the user experience of using the corresponding cleaning equipment products, but also the vibration generated by the friction between the air also affects the stability of the cleaning equipment during use, which to some extent affects the cleaning effect of the equipment.

SUMMARY

[0005] The purpose of the present disclosure is to provide a muffling air duct device, an air duct component, and a cleaning robot that solves a technical problem of excessive noise in a working state of cleaning equipment while ensuring the efficiency of the cleaning equipment.

[0006] In order to solve the above technical problem, the present disclosure adopts the following technical solutions.

[0007] According to a first aspect, a muffling air duct device is provided, which includes:

- an airflow channel equipped with an air inlet and an air outlet connected to external environment at both ends, where the air inlet and the air outlet is configured to restrict an inlet direction and an outlet direction of the airflow channel respectively; and
- multi-stage diversion components located between the air inlet and the air outlet in the airflow channel, where each stage of diversion components separate the airflow channel into several diversion channels, and the diversion channels formed by the separation of each stage of diversion components are communicated with each other;
- the diversion component including at least one diversion body, and each of the diversion bodies separating the airflow channel into at least two diversion channels.

[0008] According to a second aspect, an air duct component is provided, which includes:

- a muffling air duct device mentioned in the first aspect;
- a fan having an exhaust duct, where the exhaust duct is connected to the airflow channel through the air inlet.

[0009] According to a third aspect, a cleaning robot is provided, which includes:

- an air duct component mentioned in the second aspect; and
- a vacuum cleaner, where the vacuum cleaner has a side connected to external environment of the cleaning robot, and the fan further has a suction duct connected to the exhaust duct, another side of the vacuum cleaner is connected to the suction duct.

[0010] The beneficial effects of the present disclosure are: in the muffling air duct device, the inlet direction and the outlet direction of the airflow channel are at least partially offset from each other, thereby extending the length of the airflow path in the airflow channel. During the process of airflow flowing towards the outlet, collisions occur in the airflow channel, causing energy loss and reducing airflow velocity, achieving preliminary muffling effect;

multi-stage diversion components, being installed in the airflow channel, each stage of diversion components dividing the airflow channel into several diversion channels, further extending a path length inside the airflow channel, the diversion body performing diverting processing on the airflow to allow multiple secondary airflows separated from the main airflow to enter each diversion channel separately. In addition, each stage of diversion component can further divert the airflow, indirectly increasing a contact area between the air and each diversion bodies and the length of the airflow path. This allows sound waves to be more fully absorbed and muffled in the airflow channel, and can also avoid the situation where the airflow is discharged through the shortest path in the airflow channel. Without increasing the size of the equipment and air duct, it is ensured that the air resistance parameters in the airflow channel meet working requirements of the cleaning equipment, while improving the muffling effect.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] Hereinafter, the present disclosure will be further explained in details based on the accompanying drawings and embodiments.

Fig. 1 is one schematic diagram of a structure of a muffling air duct device according to an embodiment of the present disclosure.
Fig. 2 is another schematic diagram of the structure of the muffling air duct device according to an embodiment of the present disclosure.
Fig. 3 is one explosion view of the muffling air duct device according to an embodiment of the present disclosure.
Fig. 4 is one schematic diagram of an internal structure of the muffling air duct device according to an embodiment of the present disclosure (omitting a upper cover and a sound-absorbing material).
Fig. 5 is a schematic diagram of a structure of a diversion body according to an embodiment of the present disclosure.
Fig. 6 is a schematic diagram of the division of the airflow channel diversion region according to an embodiment of the present disclosure.
Fig. 7 is a schematic diagram of an airflow direction in an airflow channel according to an embodiment of the present disclosure.
Fig. 8 is another schematic diagram of an internal structure of the muffling air duct device according to an embodiment of the present disclosure.
Fig. 9 is a schematic diagram of an airflow direction inside the muffling duct device according to an embodiment of the present disclosure.
Fig. 10 is a schematic diagram of a relationship between the fluid structure and the inlet direction according to an embodiment of the present disclosure.
Fig. 11 is another exploded view of the muffling air duct device according to an embodiment of the present disclosure.
Fig. 12 is a schematic diagram of an installation manner of a sound-absorbing material according to an embodiment of the present disclosure.
Fig. 13 is a simulation diagram of an airflow channel according to an embodiment of the present disclosure.
Fig. 14 is an assembly view of the air duct component according to an embodiment of the present disclosure.
Fig. 15 is another assembly view of the air duct component according to an embodiment of the present disclosure.
Fig. 16 is a simplified schematic diagram of a cleaning robot according to an embodiment of the present disclosure.

[0012] In the figure: 10. Airflow channel; 11. Air inlet; 12. Air outlet; 13. First channel; 14. Second channel; 20. Diversion component; 21. Diversion body; 211, Air ward part; 2111. First diversion surface; 2112. Second diversion surface; 212. Air guide part; 2121. Air guide surface; 22. Diversion channel; 23. First-stage diversion region; 24. Second-stage diversion region; 25. Third-stage diversion region; 26. Fourth-stage diversion region; 27. Five-stage diversion region; 28. Six-stage diversion region; 30. Air duct housing; 31. Air pipe; 311. Outlet airflow channel; 32. Air duct connecting pipe; 321. Inlet airflow channel; 33. Upper cover; 34. Lower cover; 40. Sound-absorbing material; 50. Fan; 51. Draft duct; 52. Exhaust duct; 53. Shock-absorbing hose; 60. Base body; 70. Dust collection box; 80. Diversion component; 81. Guide channel; 82. Guide surface.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0013] In order to make the technical problem to be solved, the technical solution to be adopted, and the technical effect to be achieved by the present disclosure clearer, the technical solution of the embodiments of the present disclosure will be further described in detail with reference to the accompanying drawings. Obviously, the described embodiments are only a part of the embodiments of the present disclosure, not all thereof. Based on the embodiments in the present disclosure, all other embodiments obtained by those skilled in the art without creative labor are within the scope of protection of the present disclosure.

[0014] In the description of the present disclosure, unless otherwise specified and limited, the terms "connected" and "fixed" should be broadly understood, for example, it may be fixed connections, detachable connections, or integrated; or it may be a mechanical connection or an electrical connection; or it may be directly connected or indirectly connected through an intermediate medium; or it may be a connection within two components or an interaction relationship between two components. For those skilled in the art, the specific meanings of the above terms in the present disclosure may be understood in specific situations.

[0015] In the present disclosure, unless otherwise specified and limited, a first feature "above" or "below" a second feature may include direct contact between the first and second features, or may include contact between the first and second features through another feature between them instead of direct contact. Moreover, the first feature being "above", "over", and "on" the second feature includes the first feature being directly above and diagonally above the second feature, or simply indicating that the first feature is horizontally higher than the second feature. The first feature being "below", "underneath", and "under" includes the first feature being directly below and diagonally below the second feature, or simply indicating that the first feature is horizontally lower than the second feature.

[0016] As shown in Figs. 1-2, the embodiment of the present disclosure provides a muffling air duct device, the muffling air duct device is mainly used in cleaning equipment. The muffling air duct device reduces the exhaust noise of cleaning equipment, such as cleaning robots, by adding multi-stage diversion components 20 in an airflow channel 10. This muffling air duct device is suitable for the characteristics of small installation space and high space utilization required inside cleaning robots.

[0017] As shown in Fig. 16, this embodiment provides a cleaning robot, and the cleaning robot is an intelligent household appliance, also known as an automatic cleaning machine, intelligent vacuum robot, vacuum cleaner, etc. It is a type of intelligent household appliance that may automatically complete cleaning work in its region with certain artificial intelligence. Cleaning robots generally use brushing and vacuum manners to first absorb floor dust into their own dust collection box 70, thereby completing the function of floor cleaning. The cleaning robot is operated remotely using a remote control or through the control panel on the body, which is mainly disc-shaped. Using rechargeable batteries for operation, it is generally possible to set a time to schedule cleaning and self-charge. There are sensors installed in front that may detect obstacles. If encountering walls or other obstacles, they will turn on their own and follow different routes according to different program settings of the system to systematically clean the area. The cleaning robot generates noise during the operation of the fan, which affects the usage of the user and also has a certain impact on the physical health of the user.

[0018] Referring to Fig. 16, it is a schematic diagram of a partial structure of a cleaning robot applied to the muffling air duct device in this embodiment. The cleaning robot generally has an outer shell (not shown in the figure) and a base component arranged inside the outer shell. The base component includes a base body 60, and by setting driving wheels, batteries, air duct components and other components on the base body 60, the cleaning robot described in this embodiment is assembled. The outer shell may play a role in protecting the components in the base assembly of the cleaning robot. A corresponding avoidance space may be opened at an air outlet 12 of the muffling air duct device on the outer shell, providing air blown out from the air outlet 12 to be discharged outside the outer shell.

[0019] The above-mentioned dust collection box 70 is used for temporary storage of dust and garbage collected by the cleaning robot. The dust collection box 70 may be installed on the outer shell of the cleaning robot through a detachable installation manner, or fixed relative to the outer shell. By arranging a dust outlet, users may clean the collected materials inside in a manner of automatic dust exhaust through the workstation or a manner of manual dust exhaust. The dust collection box 70 may be equipped with a dust inlet and an exhaust outlet. The dust inlet may be connected to a dust suction channel (not shown) on the bottom body of the cleaning robot. A dust suction part is formed on the dust suction channel that is connected to the outside of the cleaning robot. When the cleaning robot is in use, the dust suction part is facing the floor to be cleaned by the cleaning robot. The other side of the dust suction part is connected to the inlet airflow channel 321 of the muffling air duct device through the dust suction channel, the dust collection box 70, and an exhaust duct 52 of a fan 50. The exhaust outlet of the dust collection box 70 is used to connect with the draft duct 51 of the fan 50. The fan 50 is a main power output component of the air duct assembly in the cleaning robot. The fan 50 is used to provide power and create negative pressure in the dust suction channel, thereby sucking dust from the ground into the dust collection box 70.

[0020] As shown in Figs. 14-15, this embodiment is applied to the air duct component of the cleaning robot. The fan 50 according to this embodiment is a component that converts input electrical energy into mechanical energy, thereby increasing gas pressure and delivering gas. The fan 50 according to this embodiment has a draft duct 51 and an exhaust duct 52. The draft duct 51 may be arranged at the top or bottom of the fan 50, and the exhaust duct 52 may be arranged at the side of the fan 50. This can effectively utilize the internal space of the cleaning robot, and the fan 50 can also have better air force effect.

[0021] A shock-absorbing hose 53 is arragned between the exhaust duct 52 and the muffling air duct device. The shock-absorbing hose 53 is made of a material with shock-absorbing function, which may be made of soft materials such as soft rubber. The shock-absorbing hose 53 can reduce the noise at the exhaust duct 52 of the fan 50 through shock-absorbing, and also improve the airtightness between the fan 50 and the muffling air duct device, ensuring the stability of air flow and thereby improving the reliability of the air duct component.

[0022] The fan 50 includes a housing and an air supply component arranged inside the housing. A space for air flow is formed between the housing and the air supply component, and the space is connected to the external environment of the housing through the draft duct 51 and the exhaust duct 52, respectively. The housing can protect the air supply components and prevent airflow leakage. The exhaust duct 52 is tangent to the rotation direction of the air supply components, making the airflow inside the fan 50 smoother and increasing the air supply efficiency of the fan 50.

[0023] As shown in Figs. 3-5, the muffling air duct device of this embodiment includes an airflow channel 10, and the airflow channel 10 provides a gas discharge channel space for the cleaning equipment during the dust suction process, thereby restricting the direction of gas flow discharged by the fan 50. The two ends of the airflow channel 10 are respectively equipped with an air inlet 11 and an air outlet 12 that are connected to the external environment. According to the above scheme, in the application of the cleaning robot, the air inlet 11 is used to communicate with the exhaust duct 52 of the fan 50, and the gas discharged from the exhaust duct 52 may be discharged from the air outlet 12 through the airflow channel 10 to the outside of the cleaning robot. The air inlet 11 and the air outlet 12 are respectively used to restrict the inlet and outlet directions of the airflow channel 10. The inlet and outlet directions are at least partially offset from each other, and the offset between the inlet and outlet directions may be understood as the fact that the inlet and outlet directions are at least partially facing in different directions. It may also be understood that even if they are in the same direction, the inlet and outlet directions may be offset on the same horizontal plane or on different horizontal planes. The inlet and outlet directions are also at least partially offset in two positions, so that at least some of the airflow path in the airflow channel 10 may have disturbance structure such as bent, curved, or other ways that may disrupt the flow airflow direction. When the airflow passes through the airflow channel 10, it will collide with a side wall of the airflow channel 10, changing the flow direction and inevitably causing energy loss, forming a simple maze duct structure that reduces the airflow velocity and achieves preliminary muffling.

[0024] In the airflow channel 10, from the end close to the air inlet 11 to the end close to the air outlet 12, that is, in the airflow direction from the air inlet 11 to the air outlet 12 of the airflow channel 10, multi-stage diversion components 20 are sequentially set up. Each stage of diversion components 20 divides the airflow channel 10 into several diversion channels 22. The main airflow entering the airflow channel 10 from the air inlet 11 may be diverted by the diversion channels 22, thus forming a secondary airflow. After respectively entering the corresponding diversion channels 22, the secondary airflow is guided by the diversion channels 22, changing the flow direction and extending the airflow path of the secondary airflow. Each secondary airflow will experience energy loss during the process of changing the flow direction, reducing the flow velocity of each secondary airflow. Corresponding muffling may be arranged in the diversion channels 22. The structure is such that the sound waves of the secondary airflow are buffered and absorbed within the diversion channel 22, The diversion channels 22 formed by each stage of diversion are communicated, allowing each secondary airflow to re-merge near the air outlet 12 and be discharged from the muffling duct device.

[0025] In this embodiment, the structure and muffling design of the diversion channel 22 need to ensure that the air resistance parameters meet the requirements of the cleaning robot during operation, and that the flow of each secondary airflow in the diversion channel 22 is smooth, so that the negative pressure formed at the draft duct 51 of the fan 50 in the application of the cleaning equipment is sufficient to suck in dust at the suction part.

[0026] Specifically, the diversion component 20 includes at least one diversion body 21, each diversion body 21 separating the airflow channel 10 into at least two diversion channels 22, thereby playing a role in diffusing, disturbing, and guiding the airflow with sound waves. When the secondary airflow enters the corresponding diversion channel 22, its sound waves undergo multiple and repeated contact friction with the muffling structure arranged in the diversion channel 22, allowing the sound waves to be absorbed in the diversion channel 22 or resonate with the diversion body 21 when contact friction occurs with the diversion body 21, thereby consuming and absorbing the sound waves of the secondary airflow.

[0027] In an embodiment, in any two adjacent diversion components 20, the later stage of diversion body 21 is arranged at one of the diversion channels 22 separated by the former stage of diversion body 21. It may be understood that the main airflow entering the airflow channel 10 from the air inlet 11 is diverted by the diversion body 21 in the first stage of diversion component 20 closest to the air inlet 11 to form at least two secondary airflows. The secondary airflows flow in the diversion channels 22 separated by the first stage of diversion component 20 and undergo muffling treatment. Each secondary airflow will be guided by the corresponding diversion channel 22 to the later stage of diversion component 20. Subsequently, at least one secondary airflow will be further diverted, disturbed at the second stage of diversion body 21, and further diverted secondary airflow flows into the subsequent diversion channel 22 for further muffling treatment. Thus, multiple levels of branches of diversion channels 22 are formed within the airflow channel 10. The sound waves in the airflow are continuously diverted and disturbed before being subjected to muffling treatment, and then diverted and disturbed again, fully increasing the contact area between each airflow and the diversion body 21 and the muffling structure. The sound waves are buffered by each diversion channel 22, allowing the majority of their energy to be consumed within the diversion channel 22, thereby effectively improving the muffling effect of the muffling air duct device on the sound waves in the airflow.

[0028] In this embodiment, at least one side wall of the diversion channel 22 is formed through the side of the diversion body 21, and the other side wall of the diversion channel 22 may be determined based on the structure located on the side of the diversion body 21.

[0029] In one case, if the number of diversion bodies 21 in the same stage of the diversion component 20 is greater than or equal to two, any two adjacent diversion bodies 21 in the same stage of the diversion component 20 are arranged opposite to each other. On the opposite side of the two diversion bodies 21, two diversion channels 22 are formed from the perspective of airflow, and these two diversion channels 22 will eventually merge. The side walls of these two diversion channels 22 are respectively formed by two adjacent diversion bodies 21.

[0030] In another case, the number of diversion bodies 21 in the same stage of the diversion component 20 is one, and a diversion channel 22 is formed between the side of the diversion body 21 and the inner wall of the muffling duct device; or when the number of diversion bodies 21 in the same level diversion component 20 is greater than or equal to two, a diversion channel 22 is formed between the side of the diversion body 21 closest to the inner wall of the muffling duct device and the inner wall of the muffling duct device.

[0031] According to the above situation, each secondary airflow may be guided to flow between the inner wall of the muffling duct device and the diversion body 21, as well as in the diversion channel 22 formed between each diversion body 21.

[0032] In another embodiment, a partition may be arranged between any two adjacent diversion bodies 21 of the same stage of diversion component 20, and a partition may be arranged between the diversion bodies 21 and the inner wall of the muffling air duct device, forming a diversion channel 22 through the partition and the side of the diversion bodies 21.

[0033] As shown in Fig. 6, taking the schematic diagram of the internal structure of the airflow channel 10 as an example, in this embodiment, the first stage of diversion component 20 closest to the air inlet 11 includes a diversion body 21, and the second stage of diversion component 20 after the first stage of diversion component 20 includes two diversion bodies 21. The diversion bodies 21 in the second stage of diversion component 20 are respectively arranged on the paths of two diversion channels 22 formed by the diversion body 21 of the first stage of diversion component 20. In this way, the main airflow entering from the air inlet 11 will be separated by the diversion body 21 located in the first stage of diversion component 20 to form two secondary airflows. The two secondary airflows will flow along the diversion channels 22 formed on both sides of the first stage of diversion body 21, respectively, towards the two diversion bodies 21 located in the second stage of diversion component 20. Subsequently, when the secondary airflows respectively come into contact with the second stage of diversion body 21, they will be separated into two secondary airflows, ultimately forming at least four secondary airflows. When the airflows are not separated once, their flow direction, velocity, and flow rate will change, thereby improving the contact area between each diversion channel 22 and its internal gas, effectively enhancing the sound wave muffling effect.

[0034] It should be noted that the first stage of diversion component 20, which is the diversion component 20 in the first stage of diversion region in this embodiment, is the diversion component 20 arranged closest to the air inlet 11, the last stage of diversion component 20, which is the diversion component 20 in the sixth stage of diversion region in this embodiment, is the diversion component 20 arranged closest to the air outlet 12, the second stage of diversion component 20, the third stage of diversion component 20, and the subsequent stage of diversion components 20 are the diversion components 20 arranged in sequence along the airflow direction of the airflow channel 10 in each stage of diversion region. The former stage diversion component 20 refers to the diversion component 20 that is relatively located in the diversion region close to the air inlet 11, while the second stage of diversion component 20 refers to the diversion component 20 that is relatively located in the diversion region close to the air outlet 12.

[0035] Here, the principle of noise generated by the exhaust duct 52 of fan 50 will be described. Due to the small diameter of exhaust duct 52, the air supply component generates a large air pressure inside the housing of the fan 50 during rotation. Therefore, when high-pressure air is discharged from exhaust duct 52, it will cause impact vibration on the external air, resulting in noise. Therefore, the faster the speed of the air supply component and the higher the air pressure inside exhaust duct 52, the greater the noise generated by the fan 50 during the exhaust process. In order to fully reduce the airflow noise discharged from the exhaust duct 52 and improve the muffling effect of sound waves, the size of the airflow channel 10 needs to be larger than that of the exhaust duct 52, providing sufficient buffer space for the discharged airflow, so that the noise can be buffered and absorbed in the muffling duct device.

[0036] In order to further improve the muffling effect on sound waves within the limited installation space of the muffling duct device adapted to the cleaning robot, the diversion body 21 includes an air ward part 211 and an air guide part 212. It should be noted that the air ward part 211 and the air guide part 212 may be integrated into a single molding structure to reduce the processing and installation difficulties of the diversion body 21. The air ward part 211 and the air guide part 212 may also be two independent components that are coupled to each other in the air path structure formed by them, and are arranged in the airflow channel 10 through independent processing, installation, and other manners.

[0037] In the same diversion body 21, the air ward part 211 is arranged at an end of the diversion body 21 close to the air inlet 11, used to separate the airflow channel 10 into at least two alternating diversion channels 22. When the airflow flows towards the diversion body 21, the air ward part 211 is a part where the diversion body 21 first comes into contact with the airflow. The air ward part 211 will block the airflow, change the airflow direction, and divide the airflow into at least two channels, each of divided airflow will flow into the corresponding diversion channel 22. There are at least two air guide parts 212, each of air guide parts 212 is arranged on opposite sides of the diversion body 21. Each of air guide parts 212 forms one side wall of its corresponding diversion channel 22, and the air guide part 212 is used to guide the airflow direction in its corresponding diversion channel 22. The airflow path formed by the separation of each air guide part 212 and the air ward part 211 is consistent, so that all the airflow diverted by the air ward part 211 can be guided by the air guide part 212, and the buffering and absorption effect of noise and sound waves in the airflow can also be improved.

[0038] Specifically, in the same diversion body 21, the distance between any two adjacent air guide parts 212 is greater than or equal to that of the air ward parts 211, thereby forming a diffusive structure of diversion channels 22, providing sufficient installation space for the later stage of diversion body 21 and sufficient flow space for the air in the first stage.

[0039] This embodiment takes the example of being able to separate two airflows from each diversion body 21. The air ward part 211 includes a first diversion surface 2111 and a second diversion surface 2112 arranged at an angle. The first diversion surface 2111 and the second diversion surface 2112 are used to separate the airflow channel 10 to form a diversion channel 22. An end of the first diversion surface 2111 is connected with that of the second diversion surface 2112, and the first diversion surface 2111 and the second diversion surface 2112 may gradually extend in the direction away from each other and towards the air outlet 12. It may be understood that, as shown in Fig. 7, when a main airflow L1 comes into contact with the air ward part 211, the airflow will be separated into two secondary airflows by the end of the first air ward surface in contact with the second air ward surface. The two separated branch airflows L2 flow in the directions guided by the first and second diversion surfaces 2111 and 2112 respectively, and flow towards the corresponding air guide part 212.

[0040] Continuing from the above, in the case where two branch airflows L2 may be separated by the air ward part 211, there are two air guide parts 212, each of air guide parts 212 includes an air guide surface 2121. An end of the air guide surface 2121 is connected to the first diversion surface 2111 or the second diversion surface 2112, and the other end of the air guide surface 2121 extends along the airflow direction of the corresponding diversion channel 22. It may be understood that in the same diversion body 21, taking the air guide part 212 being two as an example, the air guide surface 2121 includes a first guide surface and a second guide surface. An end of the first guide surface is connected to the first diversion surface 2111, and an end of the second guide surface is connected to the second diversion surface 2112. The other ends of the first guide surface and the second guide surface are facing away from each other and extend towards the direction of the air outlet 12. It should be noted that the airflow path formed by the first diversion surface 2111 is coupled with the airflow path of the first guide surface, and the airflow path formed by the second diversion surface 2112 is coupled with the airflow path of the second guide surface.

[0041] The space between each air guide surface 2121 gradually increases from the end close to the air ward part 211 to the end far away from the air ward part 211. In the case where there are two air guide parts 212, as the two air guide surfaces 2121 extend in the direction away from each other, the space between them gradually increases to form a diffusive structure, providing sufficient installation space for the later stage of diversion body 21 and sufficient airflow space for the later stage of diversion channel 22.

[0042] It may be understood that the peripheral shape of the diversion body 21 includes but is not limited to a combination of one or more of droplet shape, circle, diamond shape, and rectangle.

[0043] The above description of the structure of the diversion body 21 is applicable to cases where the periphery of the diversion body 21 has irregular shapes such as water droplets, diamonds, rectangles, etc. In this embodiment, the shape of the periphery of the diversion body 21 adopts a water droplet structure.

[0044] The air ward part 211 may also be a plane, as long as it may achieve the effect of diverting airflow.

[0045] There are connected first channel 13 and second channel 14 formed in the airflow channel 10. The air inlet 11 is correspondingly connected to the first channel 13, and the air outlet 12 is correspondingly connected to the second channel 14. The number of diversion components 20 is greater than 2. The number of diversion bodies 21 of each stage of diversion components 20 in the first channel 13 increases stage by stage in the airflow direction, and the number of diversion bodies 21 of each stage of diversion components 20 in the second channel 14 decreases stage by stage in the airflow direction. Thus, the main airflow is separated into multiple secondary airflows after entering the airflow channel 10, and the multiple secondary airflows may merge into one airflow and be discharged from the air outlet 12 when approaching the air outlet 12. Through the internal structure of the air duct, the muffling requirements of the air duct device are met, and the volume of the air duct device gradually increases from the air inlet 11 to the air outlet 12 and then gradually decreases, minimizing the overall volume of the air duct device and meeting the installation needs of the cleaning robot.

[0046] As shown in Figs. 6-7, the airflow channel 10 is sequentially equipped with multi-stage diversion regions along the airflow direction, and each of the diversion regions is equipped with the diversion component 20; the number of diversion channels 22 separated by any two adjacent diversion regions gradually increases or decreases in the airflow direction. For example, the airflow channel 10 is sequentially provided with six diversion regions in the airflow direction, with the first stage of diversion region closest to the air inlet 11, namely the first-stage diversion region 23, including a diversion body 21. The air ward part 211 of the diversion body 21 located in the first-stage diversion region 23 is arranged towards the air inlet 11. The main airflow L1 entering from the air inlet 11 is separated into two branch airflows L2 under the diversion of the first-stage diversion region 23, and the two secondary airflows flow along the separated diversion channels 22. The diversion component 20 in the subsequent second-stage diversion region 24 includes two diversion bodies 21. The two diversion bodies 21 located in the second-stage diversion region 24 are respectively arranged on the path of the two diversion channels 22 separated by the first-stage diversion region 23. The air ward part 211 of the diversion body 21 in the second-stage diversion region 24 faces the air ward direction of the respective diversion channels 22, and diverts the two branch airflows L2 into four branch airflows L3-1. The branch airflows L3-1 between two adjacent diversion bodies 21 merge to form a merging L3-2 after flowing along the diversion channels 22 for a certain distance. The diversion component 20 of the third-stage diversion region 25 includes three diversion bodies 21, and the three diversion bodies 21 are respectively arranged on the diversion channels 22 formed by the separation of the second-stage regions. One diversion body 21 located in the third-stage diversion region 25 is arranged on the merging channel to divert the merging L3-2, while the diversion bodies 21 located on both sides divert the branch airflow L3-1 on both sides of the second-stage diversion region 24, forming six secondary airflows L4-1. The secondary airflows L4-1 between two adjacent diversion bodies 21 merge to form the merging L4-2 after flowing for a certain distance. The diversion section of the fourth-stage diversion region 26 includes four diversion bodies 21, which follow the same diversion principle as the third-stage diversion region 25. The four diversion bodies 21 correspond to the secondary airflow L4-1 and the two merging L4-2 on both sides of the third-stage diversion body 21 for diversion. The diversion body 21 in the fifth-stage diversion region 27 and the sixth-stage diversion region 28 gradually decreases, ultimately allowing each secondary airflow and merging to converge and be discharged from the air outlet 12. During this process, the main airflow may be separated into multiple secondary airflows with relatively lower flow rates than the main airflow, in order to gradually perturb, buffer, and absorb each secondary airflow. Finally, the airflow with absorbed noise and sound waves can be re merged and discharged from the air outlet 12.

[0047] As shown in Figs. 8-9, the muffling air duct device further includes a diversion component 80, and the diversion component 80 may be arranged between the air inlet 11 and the diversion component 20. For example, the diversion component 80 may be arranged between the air inlet 11 and the first-stage diversion region 23, so that the airflow flowing into the airflow channel 10 through the air inlet 11 may all pass through the diversion component 80. It should be noted that the diversion component 80 is used to separate the airflow channel 10 into multiple guide channels 81, similar to the arrangement of the diversion body 21 in the airflow channel 10. Each guide channel 81 is arranged side by side in the airflow channel 10, and multiple diversion bodies 21 are arranged in the first-stage diversion region 23 to form multiple diversion channels 22. At that time, the diversion channel 22 of the first-stage diversion region 23 and the guide channel 81 are alternately arranged and connected to each other. For example, as shown in Fig. 9, the main airflow L1 flowing into the airflow channel 10 through the air inlet 11 may be divided into multiple corresponding branch airflow L2 flowing into each guide channel 81 under the action of the diversion component 80. The branch airflow L2 flows in the direction of the first-stage diversion region 23 under the guidance of the diversion component 80 and ultimately acts on the first-stage diversion region 23. Under the action of the first-stage diversion region 23, each branch airflow L2 flows into the corresponding diversion channel 22 formed by the first-stage diversion region 23, ultimately implementing the above-mentioned muffling and vibration reduction of the airflow.

[0048] By implementing the above scheme, the main airflow L1 may relatively uniformly flow into each guide channel 81 under the action of the diversion component 80 to form a branch airflow L2, and uniformly diffuse into each diversion channel 22 formed by the first-stage diversion region 23 under the guidance of each guide channel 81 to form a branch airflow L3. In this way, the branch airflow L3 flowing into each diversion channel 22 of the first-stage diversion region 23 is relatively uniform, improving the efficiency of the interaction between the airflow in the airflow channel 10 and the first-stage diversion region 23. To a certain extent, it ensures that each diversion body 21 in the first-stage diversion region 23 may have the same noise and vibration reduction effect on the second stage diversion, avoiding the situation where the airflow is discharged through the shortest path in the airflow channel 10.

[0049] It should be noted that the main function of the diversion component 80 is to separate the main airflow into multiple branch airflows L2, and evenly spread the branch airflows L2 to the first-stage diversion region 23. Therefore, the diversion component 80 should ensure the relative smoothness of the first stage diversion in the guide channel 81, avoiding excessive deceleration or disturbance of the airflow in the guide channel 81, which may affect the effect of the subsequent branch airflows L2 being disturbed by the first-stage diversion region 23.

[0050] In an embodiment, the guide channel 81 may be formed between any two adjacent diversion components 80, or may be formed by the diversion component 80 cooperating with the channel side wall of the airflow channel 10.

[0051] Referring to Figs. 8-9, the diversion component 80 is formed with a guide surface 82 that guides the airflow from the air inlet 11 to the first-stage diversion region 23. The guide surface 82 extends from an end close to the air inlet 11 towards the first-stage diversion region 23, so that the main airflow L1 enters the guide channel 81 and forms a branch airflow L2, and is guided to the corresponding position of the first-stage diversion region 23 according to the extension direction of the guide surface 82.

[0052] As an example, the diversion component 80 may be one of other irregular structures such as a plate-like structure, a block structure, etc., and at least two guide surfaces 82 may be provided on the diversion component 80. Taking the diversion body as a plate-like structure with two guide surfaces 82 as an example, the two guide surfaces 82 are respectively formed on the opposite side surfaces of the diversion body. The guide channel 81 may be formed between any guide surface 82 and the channel side wall of the airflow channel 10, or between any two adjacent and opposite guide surfaces 82 when multiple diversion bodies are arranged.

[0053] In order to reduce the influence of the guide surface 82 on the airflow velocity and other airflow parameters, and ensure that the first stage diversion can be quickly diverted into the first stage diversion by the diversion component 80 and then flow into the first-stage diversion region 23, the guide surface 82 may be arranged as a curved surface or a flat surface.

[0054] Sequentially referring to Figs. 8-10, the guide surface 82 of this embodiment is arranged as a curved surface that gradually bends towards the first-stage diversion region 23 close to the air inlet 11. In this way, the airflow in the guide channel 81 may be guided by the curved structure of the diversion surface, allowing it to flow more smoothly towards the first-stage diversion region 23 for turbulence treatment.

[0055] In an embodiment, the end of the guide surface 82 close to the air inlet 11 is tangent to the direction of the air inlet, so that the flow velocity and direction of the main airflow entering the corresponding guide channel 81 are not greatly disturbed. Moreover, an angle α between the straight line L5 formed by connecting the opposite ends of the guide surface 82 and the extension line of the inlet direction L6 of the air inlet 11 is 0°-70°. For example, the opposite ends of the diversion component 80 in the airflow direction are respectively formed with a first end close to the air inlet 11 and a second end far away from the air inlet 11. The straight line L5 may also be understood as the straight line formed by connecting the first end of the diversion component 80 with its second end. And the inlet direction L6 may be understood as the airflow direction at the position of the first end of the diversion component 80. In practical applications, there will be multiple airflows entering the airflow channel 10 through the air inlet 11. When multiple airflows flow towards the corresponding diversion component 80 along the airflow direction, each airflow will be cut and divided by the corresponding diversion component 80. At this time, the airflow direction corresponding to the first end of the diversion component 80 is defined as the inlet direction L5. It may be understood that the channel structure between the air inlet 11 and the diversion component 80 may be a straight channel, an arc-shaped channel, etc., but regardless of the channel structure between the diversion component 80 and the air inlet 11, the airflow direction ultimately in contact with the position of the first end of the corresponding diversion component 80 is the inlet direction L6. Arranging the guide surface 82 in the above-mentioned structural form between the air inlet 11 and the first-stage diversion region 23 can ensure that the guide surface 82 can guide the corresponding first diversion to the position corresponding to the first-stage diversion region 23, and the first diversion is not easily affected by the guide surface 82, avoiding the situation where the first diversion generates additional turbulence at the end of the guide surface 82 close to the first-stage diversion region 23.

[0056] On the basis of the above-mentioned structure of the diversion component 80, the end of the diversion component 80 close to the air inlet 11 may be arranged as a circular arc structure, and the two sides of the circular arc structure are respectively tangent to the guide surfaces 82 placed on opposite sides of the diversion component 80. In this way, when the main airflow L1 comes into contact with the diversion component 80 for the first time, the main airflow L1 will act on the circular arc structure at the end of the diversion component 80. The circular arc structure may divide the main airflow into two first stage diversions and guide them to the corresponding guide channels 81 on both sides, minimizing the turbulence caused by the main airflow when it impacts the end of the diversion component 80.

[0057] In other embodiments, the end of the diversion component 80 close to the air inlet 11 may also be designed as a conical structure.

[0058] Sequentially referring to Figs. 8-10, the first-stage diversion region 23 of this embodiment includes at least two separated and parallel diversion bodies 21. The diversion bodies 21 of the first-stage diversion region 23 are used to divide the airflow channel 10 into at least two diversion channels 22, thereby playing the roles of diffusion, turbulence, and acoustic guidance of the airflow as described above. When there is airflow flowing in the diversion channel 22 of the first-stage diversion region 23, the sound waves in the airflow undergo multiple and repeated contact frictions with the first-stage diversion region 23 and the muffling structure arranged in the first-stage diversion body 21, so that the sound waves are absorbed to a certain extent in the diversion channel 22 formed by the first-stage diversion region 23. Moreover, when there is contact friction between the airflow and the diversion body 21, resonance occurs between the airflow and the diversion body 21, thereby consuming and absorbing the sound waves of the first stage diversion.

[0059] In order to ensure that the branch airflow L2 can interact with each diversion body 21 in the first-stage diversion region 23, the diversion bodies 21 in the first-stage diversion region 23 are alternately arranged with the diversion component 80. This setting method may be understood as:

[0060] an end of the diversion component 80 close to the first-stage diversion region 23 is directly facing the diversion channel 22 of the first-stage diversion region 23; as well as

[0061] the diversion body 21 of the first-stage diversion region 23 is arranged facing the guide channel 81.

[0062] Through the above arrangement, it can be ensured that the branch airflow L2 flowing out through the guide channel 81 can act on the corresponding diversion body 21 of the guide channel 81, and be fully utilized by each diversion body 21 in the first-stage diversion region 23 to achieve diversion and diffusion into the corresponding diversion channel 22 in the first-stage diversion region 23.

[0063] In an embodiment, in order to ensure that the branch airflow L2 can act on each diversion body 21 in the corresponding position of the first-stage diversion region 23, this embodiment sets the number of diversion channels 22 in the first-stage diversion region 23 to n, where n ≥ 3, and the corresponding number of guide channels 81 is (n-1). As shown in Fig. 9, when the number of diversion channels 22 arranged in the first-stage diversion region 23 is 5, the corresponding guide channels 81 are 4.

[0064] In other embodiments, the number of diversion channels 22 in the first-stage diversion region 23 does not correspond to the number of guide channels 81. For example, if the number of diversion channels 22 in the first-stage diversion region 23 is set to 5, the corresponding guide channels 81 may also be set to 2, 3, etc.

[0065] In this way, the branch airflow L2 may evenly enter the first-stage diversion region 23, so that the branch airflow L3 in each diversion channel 22 within the first-stage diversion region 23 is more uniform, facilitating further muffling and shock absorption processing in the second-stage diversion region 24, third-stage diversion region 25, etc.

[0066] In this embodiment, referring to Figs. 11-12, in order to further improve the muffling effect, a sound-absorbing material 40 is installed inside the airflow channel 10.

[0067] In an embodiment, the sound-absorbing material 40 may be fitted around the periphery of each diversion body 21;

[0068] as an implementation that may be independently or jointly implemented with the above embodiments, the sound-absorbing material 40 may be arranged around the inner wall of the air duct housing 30;

[0069] in this embodiment, the sound-absorbing material 40 may be filled in the airflow channel 10, specifically, the sound-absorbing material 40 is filled in each diversion channel 22. In order to reduce the impact on the airflow during the diversion process, the sound-absorbing material 40 is not provided in the guide channel 81, that is, the sound-absorbing material 40 is provided between the diversion component 80 and the air outlet 12.

[0070] According to the technical solution provided above, referring to Fig. 13, Fig. 13is a simulation diagram of the airflow channel 10 of the muffling air duct device in this embodiment. It may be seen that under the action of the diversion component 80, the high-speed main airflow (the lighter colored part near the air inlet 11) may be evenly diverted and flow towards the first-stage diversion region 23. As the airflow passes through the first-stage diversion region 23, the second stage diversion region 24, the third-stage diversion region 25 in sequence, the airflow gradually becomes stable (the color gradually becomes uniform), so that the airflow may be smoothly discharged at the air outlet 12, achieving the effect of muffling and vibration reduction.

[0071] As shown in Fig. 4, the muffling air duct device further includes an air duct housing 30, which is hollow inside to form an airflow channel 10. The air inlet 11 and the air outlet 12 are both arranged in the air duct housing 30. Each diversion body 21 is arranged inside the air duct housing 30, so that each diversion channel 22 is formed inside the air duct housing 30. An avoidance space is opened on the surface of the air duct housing 30, which is opposite to the air inlet 11 and the air outlet 12. The air duct housing 30 may be equipped with an air guide pipe 31 extending from the air duct housing 30 at the air outlet, and an outlet airflow channel 311 is formed inside the air guide pipe 31 to restrict the flow direction of the gas discharged from the muffling air duct device. The air duct housing 30 may be equipped with an air duct connecting pipe 32 extending from the air duct housing 30 at the air inlet 11, and an air inlet channel 321 is formed inside the air duct connecting pipe 32 to restrict the flow direction of the gas entering the muffling air duct device and facilitate the connection between the muffling air duct device and the fan 50.

[0072] Specifically, the cross-sectional shapes of the inlet airflow channel 321 and the outlet airflow channel 311 may have various shapes, such as but not limited to: circular, square, trumpet shaped, and other irregular shapes.

[0073] Following the formation of the above-mentioned diversion channel 22, when the number of diversion bodies 21 in the same stage diversion component 20 is greater than or equal to two, the diversion bodies 21 arranged on opposite sides of the diversion component 20, and the side walls of the diversion bodies 21, that is, between the guide part and the inner wall of the air duct housing 30, the diversion channel 22 is formed.

[0074] In another scenario, when the number of diversion bodies 21 in the same stage of the diversion component 20 is one, a diversion channel 22 is formed between the side of the diversion body 21, namely the guide part, and the inner wall of the air duct housing 30.

[0075] As shown in Fig. 3, in order to facilitate the production, assembly, and subsequent replacement and maintenance of components, the air duct housing 30 includes an upper cover 33 and a lower cover 34 that cover each other. The airflow channel 10 may be formed by the assembly of the upper and lower housings, and the diversion body 21 may be arranged on the upper or lower housings, which can improve the processing efficiency through integrated molding during the processing. The upper and lower housings described in this embodiment are specifically the two housings of the muffling air duct device that are relatively close to and far away from the cleaning robot when installed in the cleaning robot. The housing that is relatively close to the cleaning robot is defined as the lower housing, and the housing that is relatively far away from the cleaning robot side is defined as the upper housing. The upper cover 33 and the lower cover 34 may be detachably connected by buckles or fixedly connected by threaded connections.

[0076] Optionally, the materials of the air guide part 212, upper cover 33, and lower cover 34 mentioned above include but are not limited to a combination of one or more of resin materials, plastic materials, and metal materials.

[0077] It may be understood that in order to fully contact the air in the airflow channel 10 and allow the airflow flowing through the diversion body 21 in the airflow channel 10 to be diverted and diffused, an end of the diversion body 21 is arranged on the lower cover 34. After the upper cover 33 and the lower cover 34 are closed, the other end of the diversion body 21 may be pressed against the upper cover 33, so that the diversion body 21 is horizontally placed between the upper cover 33 and the lower cover 34.

[0078] In order to improve the muffling effect, the sound-absorbing material 40 is installed inside the airflow channel 10.

[0079] As one of the implementation methods, the diversion body 21 includes a diversion main body integrally formed on the air duct housing 30 and the sound-absorbing material 40 fitted around the periphery of the diversion main body. Compared with the scheme of processing the diversion main body separately from the air duct housing 30 and then assembling and connecting them later, the diversion main body integrally formed on the air duct housing 30 does not need to have assembly structures or reserved installation positions between the air duct housing 30 and the diversion main body, which is more conducive to the production and processing of the device.

[0080] As another implementation, the sound-absorbing material 40 is arranged around the inner wall of the air duct housing 30.

[0081] It may be understood that the sound-absorbing material 40 is different from the material of the diversion body. Through the above settings, the diversion body 21 may divert the airflow while allowing the air to come into contact with the sound-absorbing material 40 as much as possible. After the airflow is diverted into at least two channels by the diversion body 21, each airflow may come into contact with the sound-absorbing material 40. Compared with simply using the sound-absorbing material 40 to come into contact with the airflow, the diversion treatment can reduce the airflow velocity, increase the contact area between the air and the sound-absorbing material 40, and improve the sound-absorbing effect of the sound-absorbing duct device.

[0082] The upper and lower sides of the upper and lower shells used to enclose the airflow channel 10 may further be equipped with sound-absorbing materials 40, but there should be a certain gap between the sound-absorbing materials 40 located on the upper and lower housings to ensure that gas can smoothly pass through the diversion channel 22.

[0083] Specifically, the sound-absorbing material 40 may be in the form of a sheet or block structure. When the sound-absorbing material 40 is in the form of a sheet, the sound-absorbing material 40 may be attached or clamped to the inner wall of the air duct housing 30 or the periphery of each diversion body 21. When the sound-absorbing material 40 is a block structure, the sound-absorbing material 40 may be arranged by filling the ventilation space.

[0084] The sound-absorbing material 40 according to this embodiment is a sheet-like structure, which is attached to the outer peripheral wall of each diversion body 21 and the inner wall of the air duct housing 30.

[0085] It should be noted that the specific function of the sound-absorbing material 40 is to reduce the noise generated by the exhaust of the fan 50 during the operation of the cleaning robot. When selecting sound-absorbing material 40, some necessary conditions should be met. For example, the sound-absorbing material 40 needs to be a breathable component, or may be said that the air resistance of sound-absorbing material 40 should not be too high, so that sound-absorbing material 40 can reduce noise in the airflow without affecting the normal operation of the fan 50. The sound-absorbing material 40 needs to be a component with good muffling effect, so as to minimize noise and enhance the user experience.

[0086] In this embodiment, the sound-absorbing material 40 is sound-absorbing cotton, and the material of sound-absorbing cotton is not limited to fiber cotton, polyurethane sound-absorbing cotton, sponge, pearl cotton, etc. Its thickness is not limited. It may be understood that the internal structure of the sound-absorbing cotton is mesh shaped. When noise enters the surface of the sound-absorbing cotton, a part of the noise will be reflected by the sound-absorbing cotton, and the reflected noise will cancel out the subsequent noise transmitted to the direction of the sound-absorbing cotton, achieving an once-sound-absorbing effect. Part of the noise will pass through the sound-absorbing cotton and be absorbed by the sound-absorbing cotton, and another part of the noise will be lost when it rubs against the surrounding medium due to its own vibration propagation, ultimately achieving the sound-absorbing effect.

[0087] In an embodiment, the sound-absorbing cotton is a material made of single or multiple different fibers processed through various processes, among which polyester sound-absorbing cotton has a better sound-absorbing effect. Polyester sound-absorbing cotton is composed of 100% polyester fibers that have undergone high-tech hot pressing and are formed in the shape of cocoon cotton, which has good air permeability. At the same time, the sound absorption coefficient of polyester sound-absorbing cotton reaches 0.94 in the noise range of 125-4000HZ, which can maximize the absorption of the noise generated by the exhausts of the fan 50.

[0088] Due to the length of the ventilation space, the noise frequency band will not continuously decay with distance and time as the airflow passes through each diversion channel 22. Therefore, as the noise flows through each diversion channel 22 in the airflow direction, its frequency band will also decrease. In order to improve the muffling effect of different frequency bands, the preset energy absorption frequency band of the sound-absorbing material 40 close to the air inlet 11 is higher than that of the sound-absorbing material 40 close to the air outlet 12, so that the sound-absorbing frequency band of the sound-absorbing duct device covers a wider range of frequency bands and improves the applicability of the sound-absorbing duct device.

[0089] Finally, it should be noted that the muffling duct device in this embodiment does not have a completely silent effect on the fan 50 and the airflow discharged by the fan 50. It only reduces the noise, allowing users to almost ignore the reduced noise when applying the muffling duct device to the corresponding cleaning equipment.

[0090] In the description of this specification, the reference terms such as "embodiment", "example", etc. means that specific features, structures, materials, or characteristics described in conjunction with the embodiment or example are included in at least one embodiment or example of the present disclosure. In this description, the illustrative expressions of the above terms may not necessarily refer to the same embodiments or examples.

[0091] In addition, it should be understood that although this description is described according to the embodiments, not each embodiment only contains an independent technical solution. This description in the description is only for clarity, and those skilled in the art should consider the description as a whole. The technical solutions in each embodiment may also be appropriately combined to form other embodiments that those skilled in the art can understand.

[0092] The technical principle of the present disclosure has been described above in conjunction with specific embodiments. These descriptions are only intended to explain the principles of the present disclosure and cannot be interpreted in any way as limiting the scope of protection of the present disclosure. Based on the explanation here, those skilled in the art do not need to exert creative labor to associate with other specific embodiments of the present disclosure, which will fall within the scope of protection of the present disclosure.

Claims

1. A muffling air duct device, comprising:

an airflow channel equipped with an air inlet and an air outlet connected to external environment at both ends, wherein the air inlet and the air outlet are configured to restrict an inlet direction and an outlet direction of the airflow channel respectively; and

multi-stage diversion components located between the air inlet and the air outlet in the airflow channel, wherein each stage of diversion components separate the airflow channel into several diversion channels, and the diversion channels formed by the separation of each stage of diversion component are communicated with each other;

wherein the diversion component includes at least one diversion body, and each of the diversion bodies separates the airflow channel into at least two diversion channels.

2. The muffling air duct device of claim 1, wherein in any two adjacent diversion components, the diversion body of the later stage of diversion component is arranged at one of the diversion channels separated by the diversion body of the former stage of diversion component.

3. The muffling air duct device of claim 2, wherein the diversion body comprises:

an air ward part arranged at an end of the diversion body close to the air inlet, and configured to separate the airflow channel into at least two alternating diversion channels; and

at least two air guide parts arranged on sides of the diversion body, and configured to form side walls of corresponding diversion channels and guide the airflow direction in the corresponding diversion channel.

4. The muffling air duct device of claim 3, wherein the distance between any two adjacent air guide parts is greater than or equal to that of the air ward parts.

5. The muffling air duct device of claim 3, wherein the air ward part includes a first diversion surface and a second diversion surface arranged at an angle, the first diversion surface and the second diversion surface are used to separate the airflow channel to form a diversion channel;

the air guide part includes an air guide surface, an end of the air guide surface is connected to the first diversion surface or the second diversion surface, and the other end of the air guide surface extends along the airflow direction of the corresponding diversion channel.

6. The muffling air duct device of claim 5, wherein on the same diversion body, the space between each air guide surface gradually increases from the end close to the air ward part to the end far away from the air ward part.

7. The muffling air duct device of claim 1, wherein the shape of the periphery of the diversion body is a combination of one or more of a water-droplet shape, a diamond shape, a rectangle.

8. The muffling air duct device of any one of claims 1-7, wherein the airflow channel is sequentially equipped with multi-stage diversion regions along the airflow direction, and each of the diversion regions is equipped with the diversion component;
the number of diversion channels separated by any two adjacent diversion regions gradually increases or decreases in the airflow direction.

9. The muffling air duct device of any one of claims 1-7, wherein a first channel and a second channel are formed in the airflow channel and are communicated with each other, the air inlet is correspondingly connected to the first channel, and the air outlet is correspondingly connected to the second channel;

the number of diversion components is greater than 2;
the number of diversion bodies of each stage of diversion components in the first channel increases stage by stage in the airflow direction, and the number of diversion bodies of each stage of diversion components in the second channel decreases stage by stage in the airflow direction.

10. The muffling air duct device of any one of claims 1-7, further comprising:
a diversion component arranged between the air inlet and the diversion component, and configured to separate the airflow channel into multiple guide channels, wherein the guide channel is used to guide the airflow to the diversion body.

11. The muffling air duct device of claim 10, wherein the diversion component is formed with a guide surface that guides the airflow from the air inlet to the diversion body, the guide surface extends from an end close to the air inlet towards the diversion body; and the guide surface is a curved surface or a flat surface.

12. The muffling air duct device of claim 11, wherein an angle between the straight line formed by connecting the opposite ends of the guide surface and the extension line of the inlet direction of the air inlet is 0°-70°.

13. The muffling air duct device of any one of claims 1-7, further comprising:
an air duct housing, wherein the air duct housing is hollow inside to form an airflow channel, and the air inlet and the air outlet are both arranged in the air duct housing.

14. The muffling air duct device of claim 13, wherein a sound-absorbing material is arranged in the airflow channel.

15. The muffling air duct device of claim 14, wherein the diversion body includes a diversion main body integrally formed on the air duct housing and the sound-absorbing material fitted around the periphery of the diversion main body.

16. The muffling air duct device of claim 14, wherein the sound-absorbing material is arranged around the inner wall of the air duct housing.

17. The muffling air duct device of claim 14, wherein a preset energy absorption frequency band of the sound-absorbing material close to the air inlet is higher than that of the sound-absorbing material close to the air outlet.

18. The muffling air duct device of claim 1, wherein two ends of the airflow channel are provided with an inlet airflow channel and an outlet airflow channel, and the inlet airflow channel and the outlet airflow channel are connected through the airflow channel, the air inlet is correspondingly connected to the inlet airflow channel, and the air outlet is correspondingly connected to the outlet airflow channel;
the inlet airflow channel is at least partially staggered with the outlet airflow channel to form at least one air ward position within the airflow channel.

19. The muffling air duct device of claim 18, wherein the cross-sectional area of the inlet airflow channel is smaller than that of the outlet airflow channel.

20. The muffling air duct device of claim 1, 18 or 19, wherein the area of the air outlet is larger than that of the air inlet.

21. The muffling air duct device of claim 1, wherein the inlet direction and the outlet direction are at least partially offset from each other.

22. An air duct component, comprising:

a muffling air duct device of any one of claims 1-21;
a fan having an exhaust duct, wherein the exhaust duct is connected to the airflow channel through the air inlet.

23. The air duct component of claim 22, wherein a shock-absorbing hose is arranged between the exhaust duct and the muffling air duct device.

24. A cleaning robot, comprising:

an air duct component of claim 22 or 23; and
a vacuum cleaner, wherein the vacuum cleaner has a side connected to external environment of the cleaning robot, and the fan further has a

suction duct connected to the exhaust duct, another side of the vacuum cleaner is connected to the suction duct.

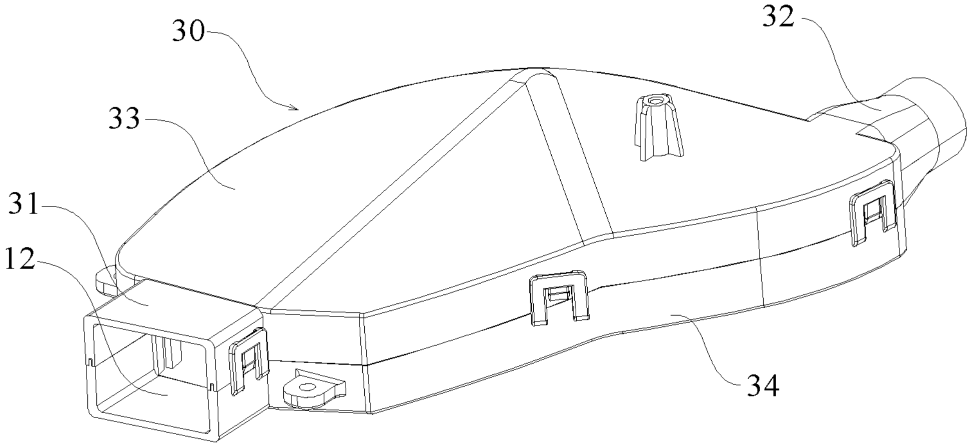

Fig. 1

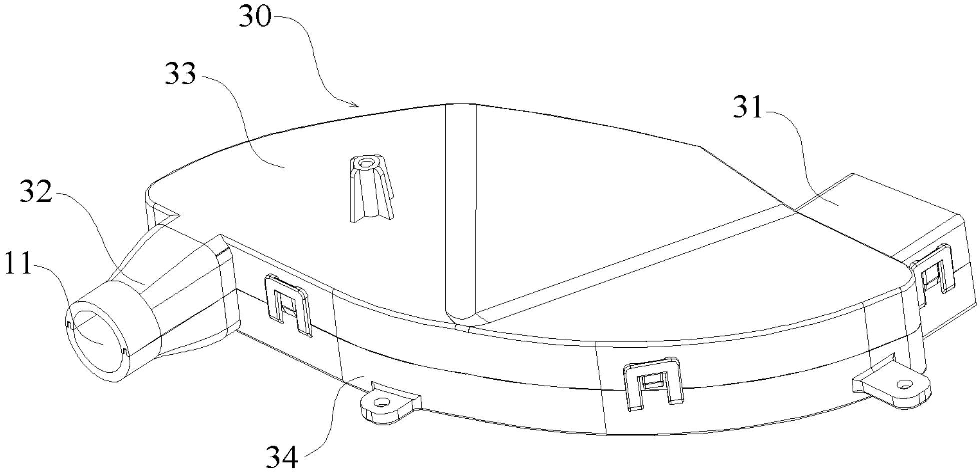

Fig. 2

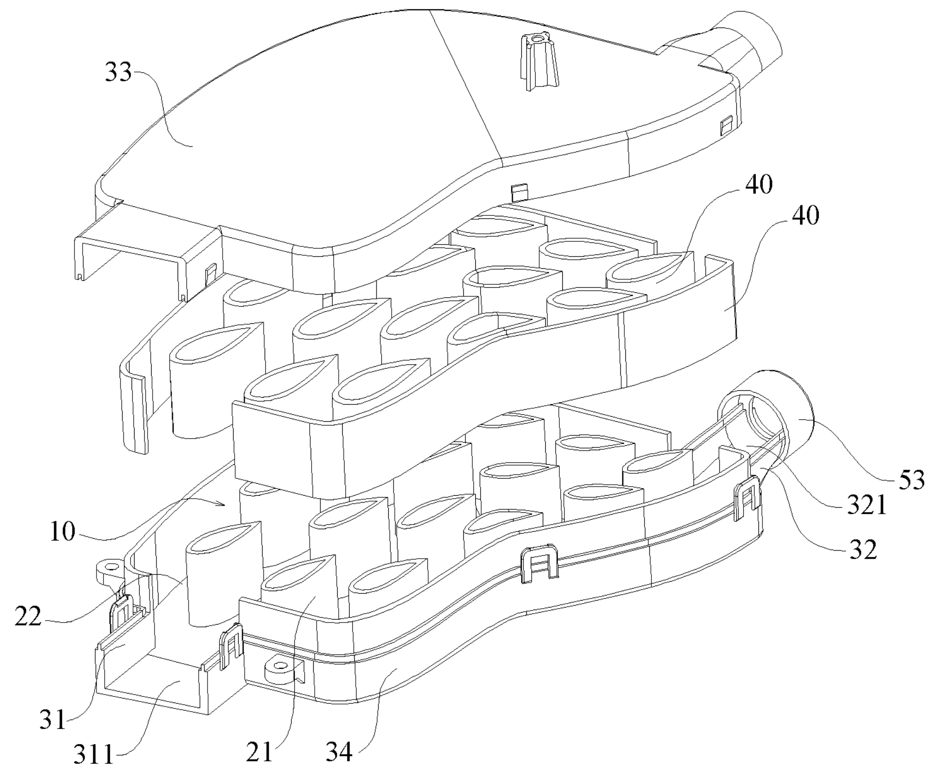
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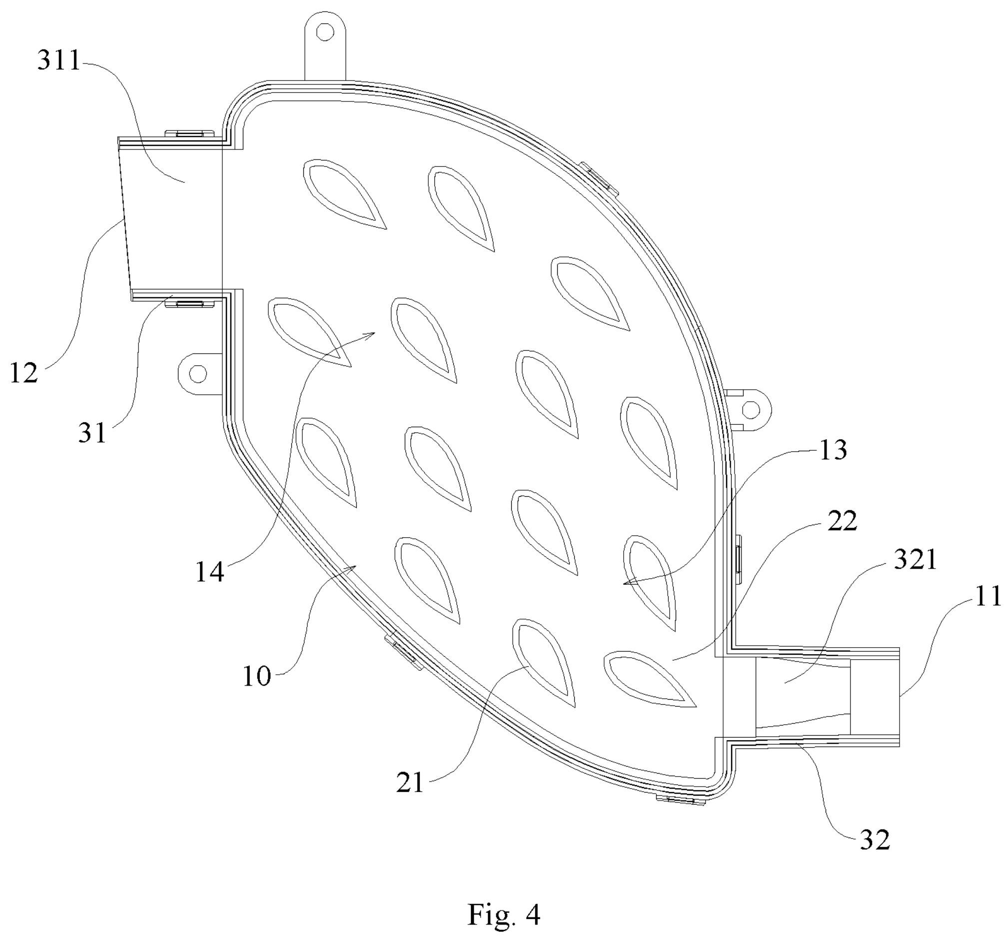
Fig. 3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32

Fig. 4

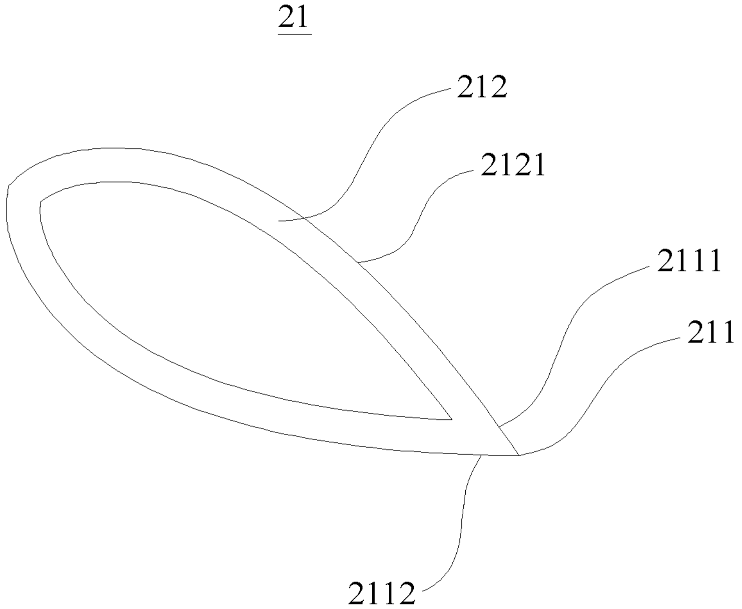

Fig. 5

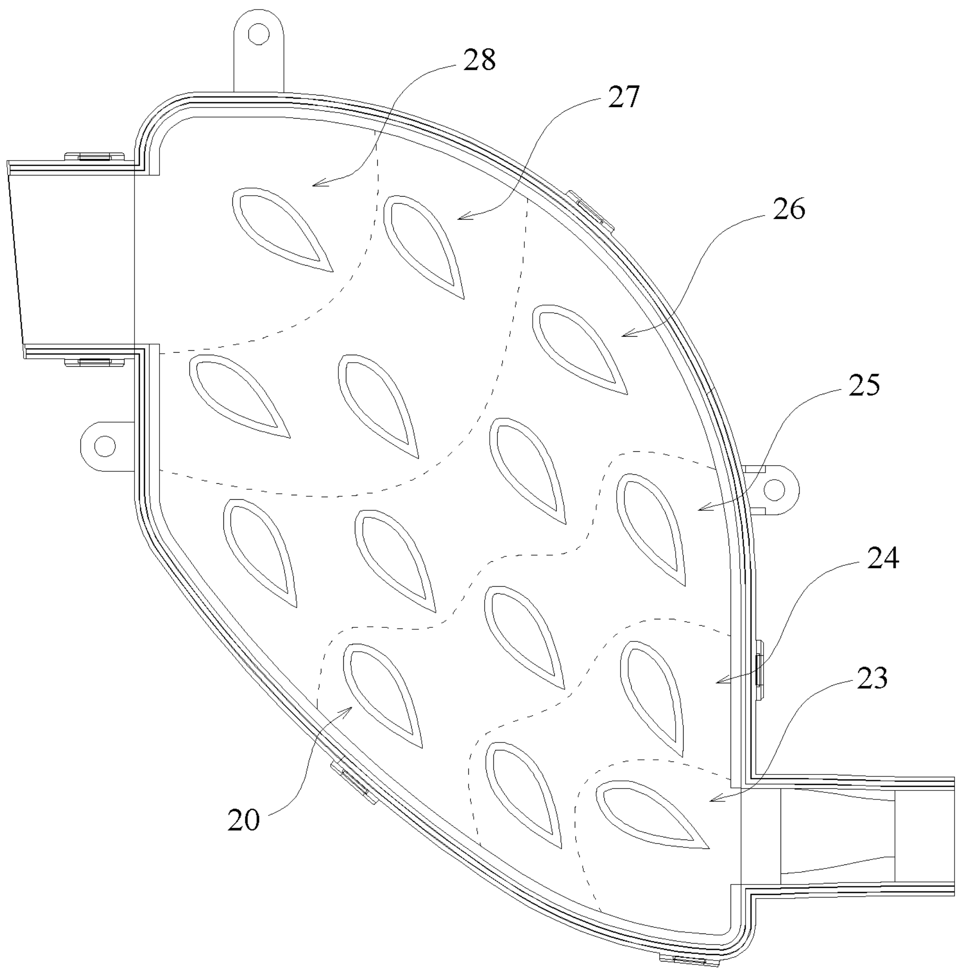

Fig. 6

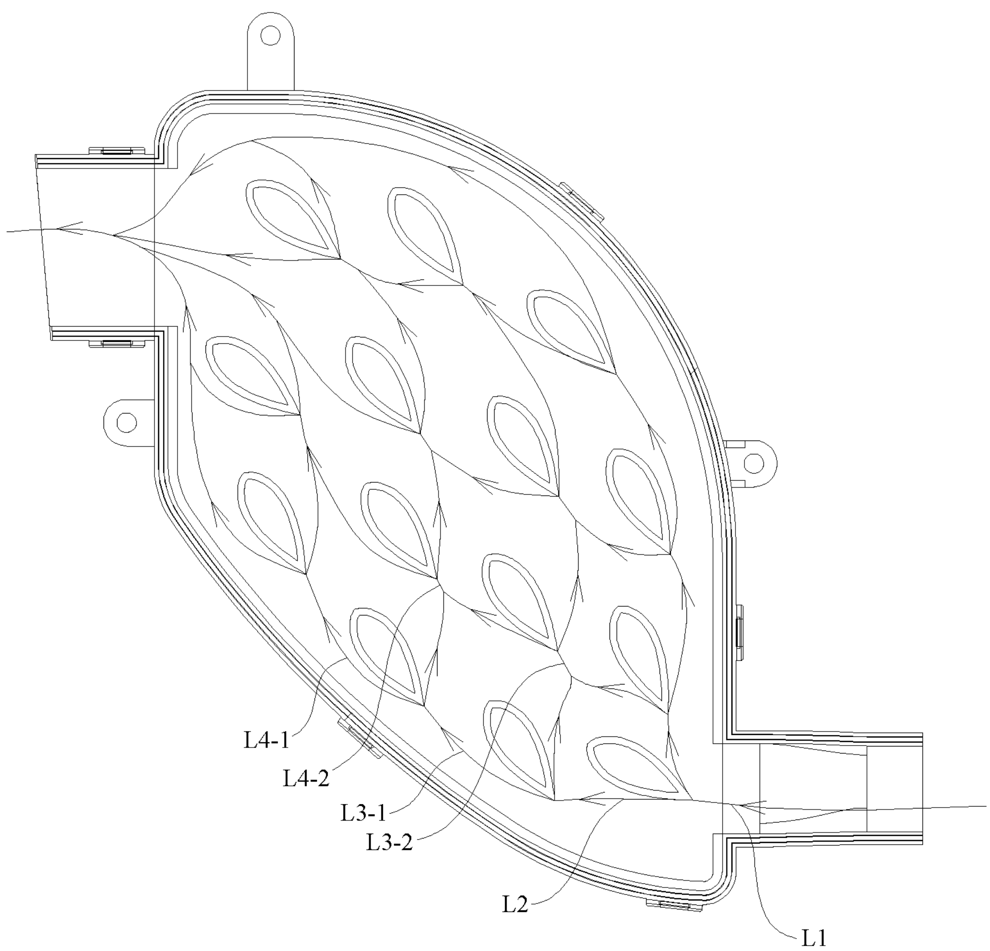

Fig. 7

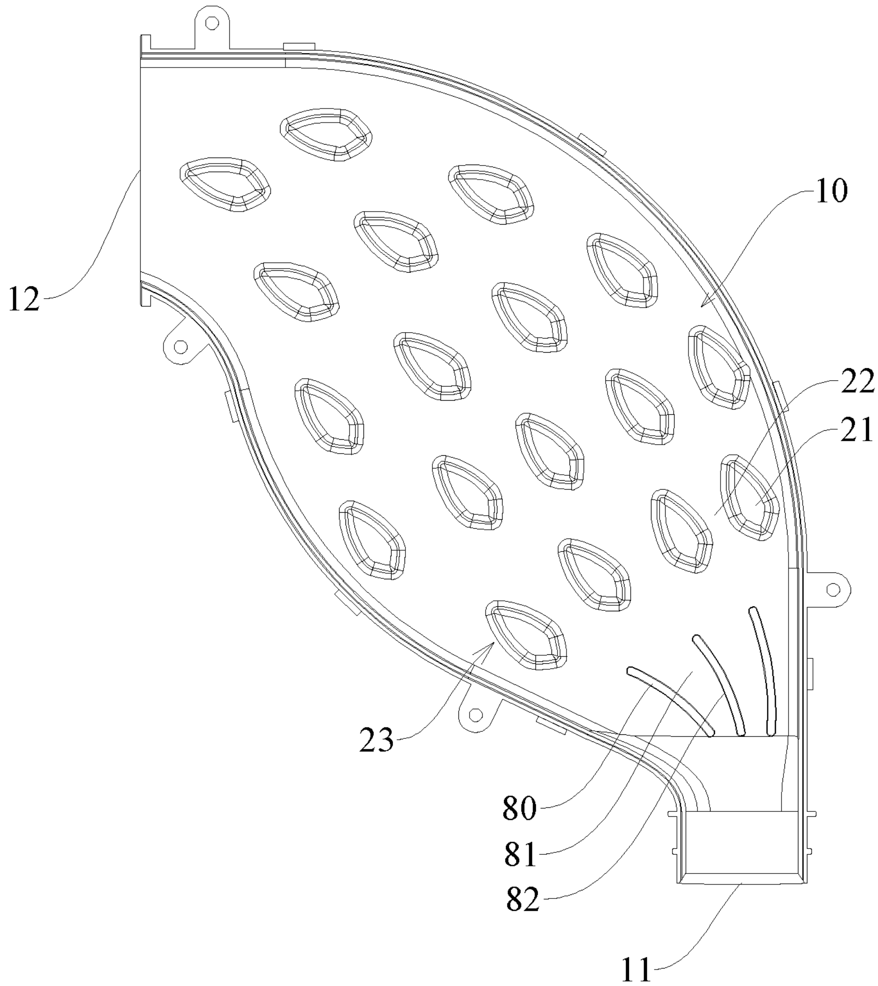

Fig. 8

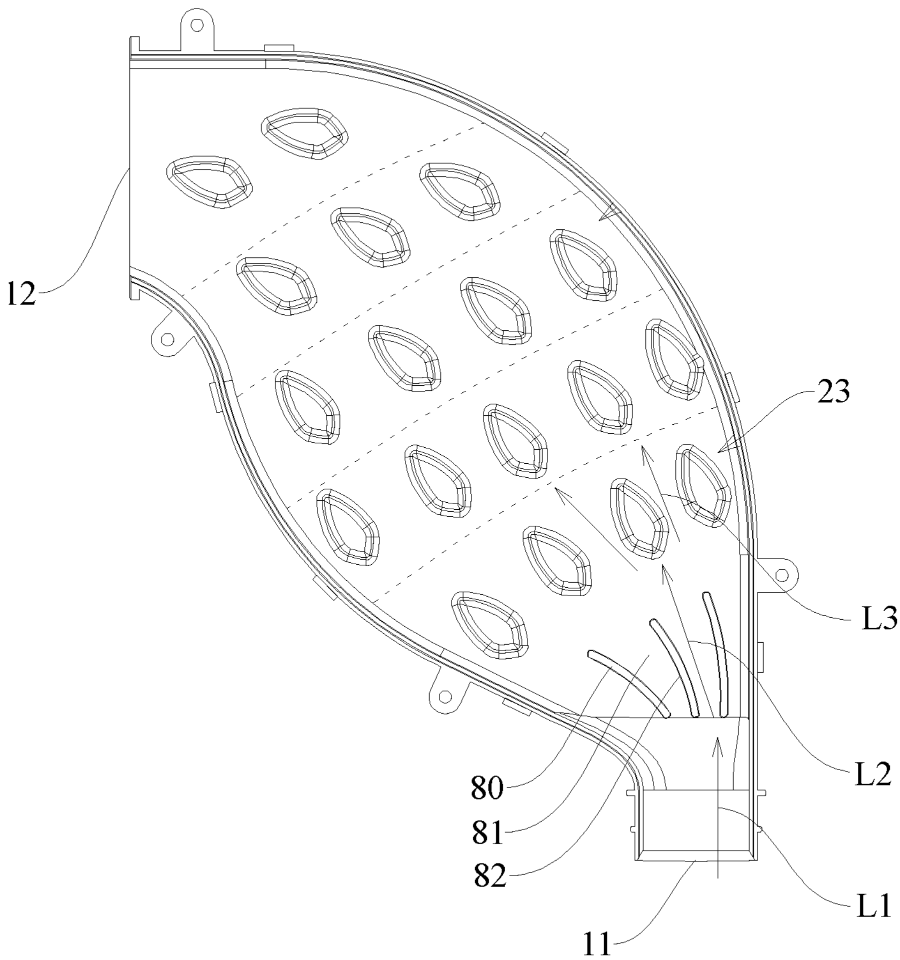

Fig. 9

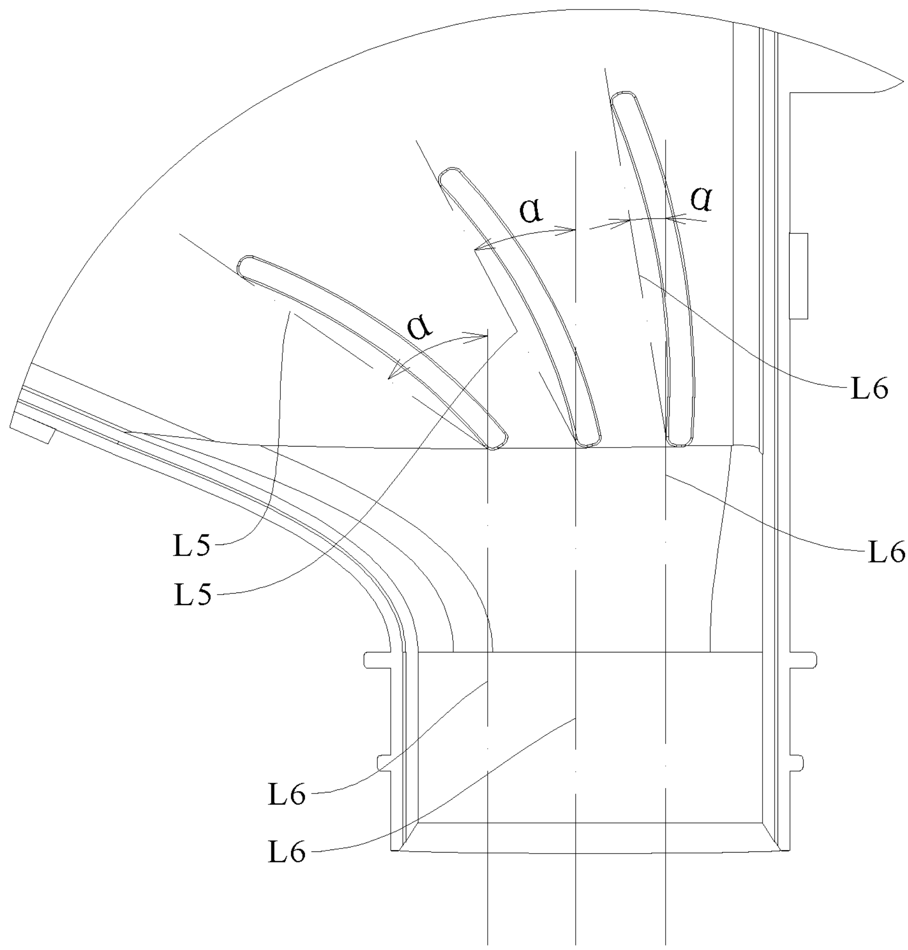

Fig. 10

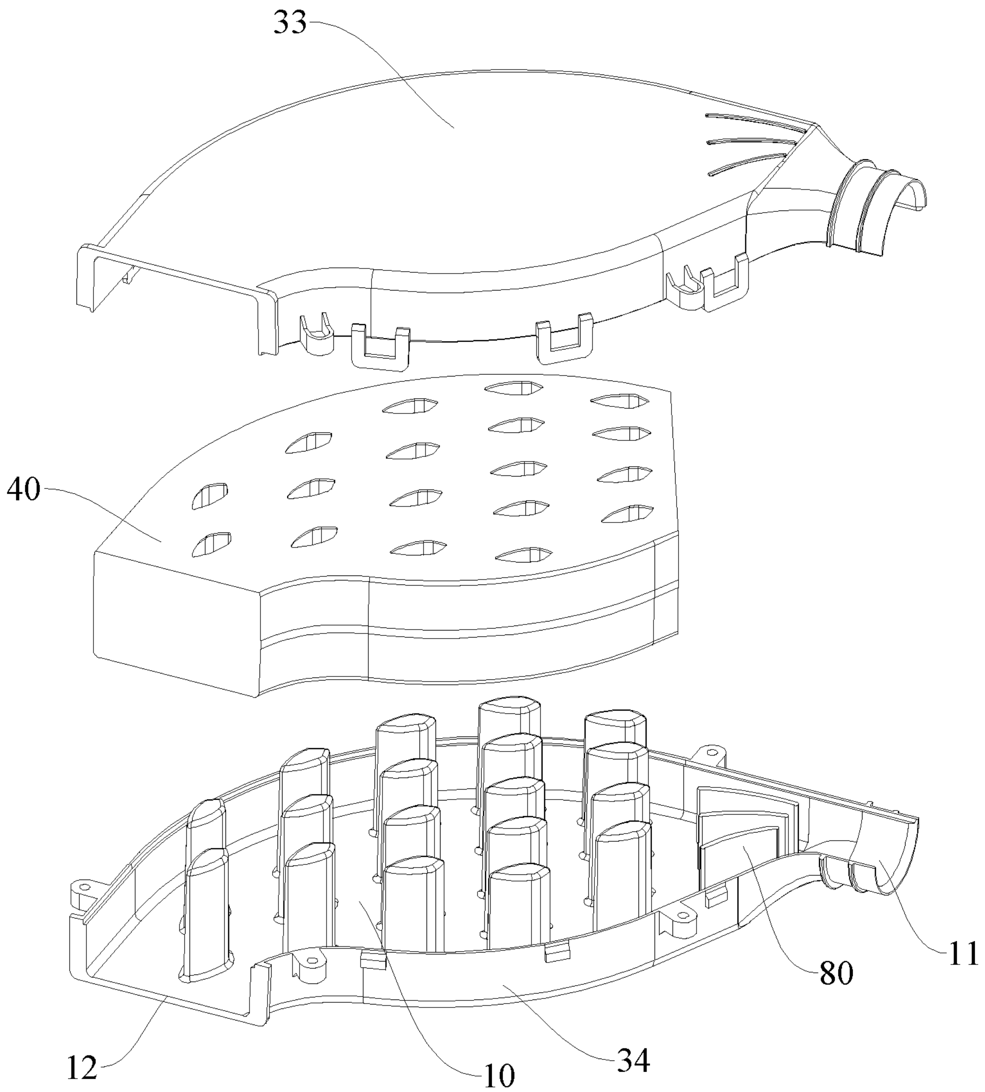

Fig. 11

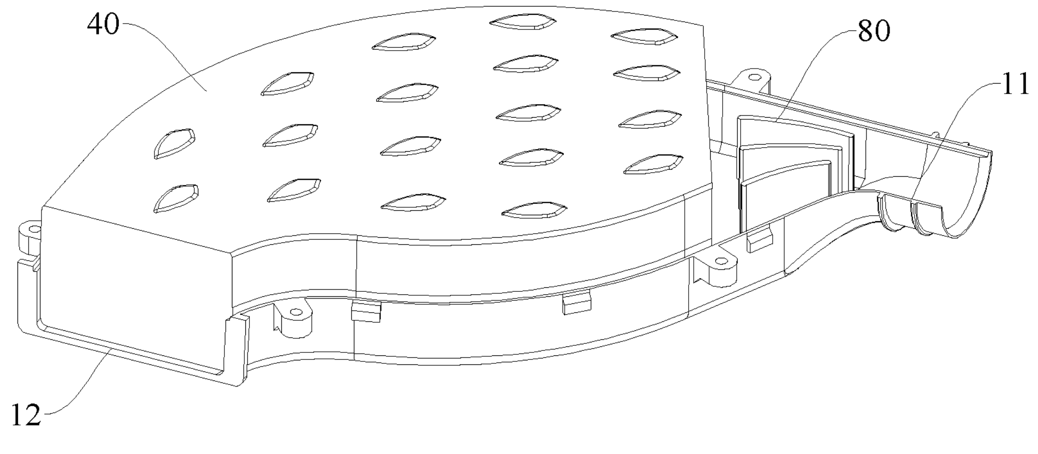

Fig. 12

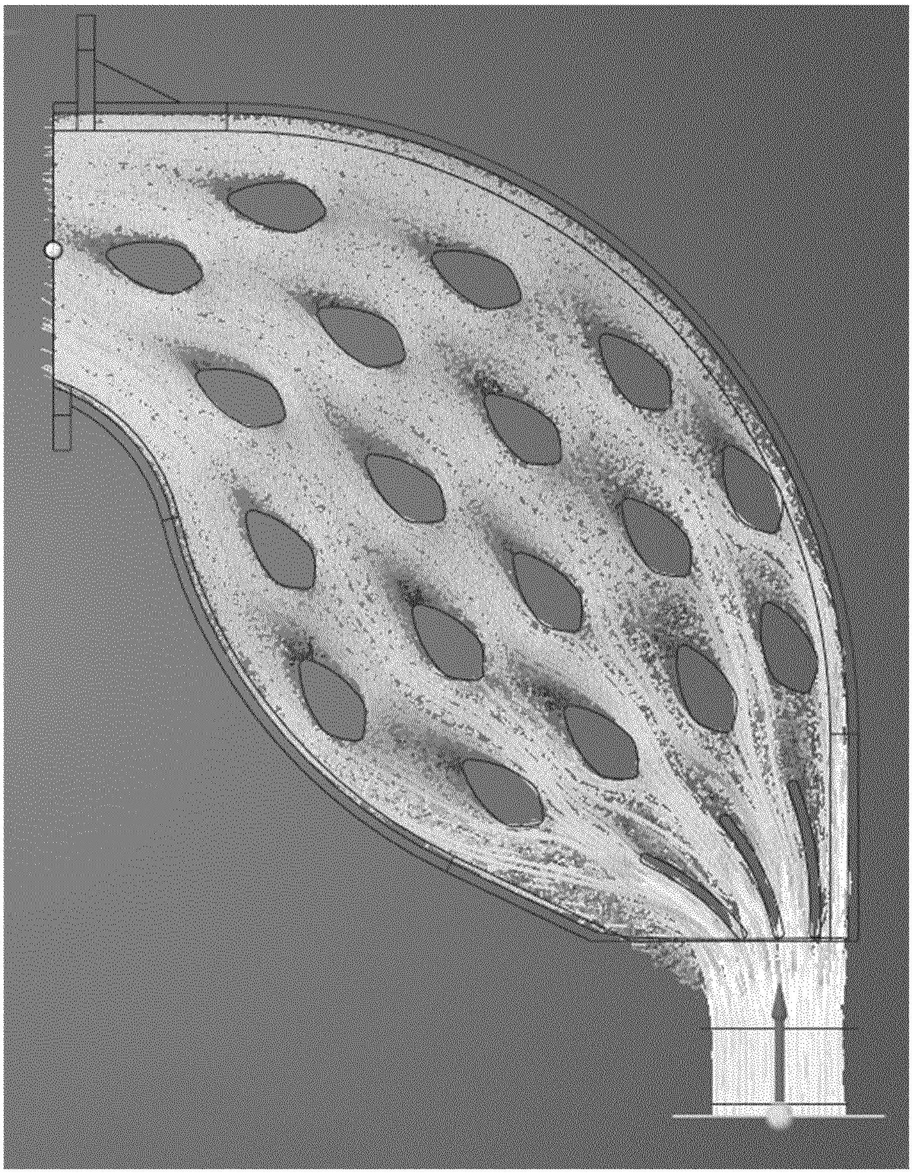

Fig. 13

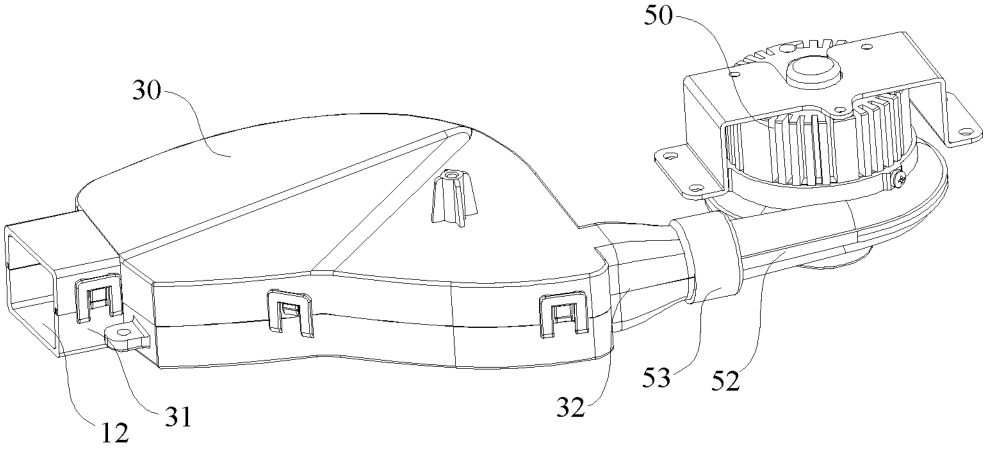

Fig. 14

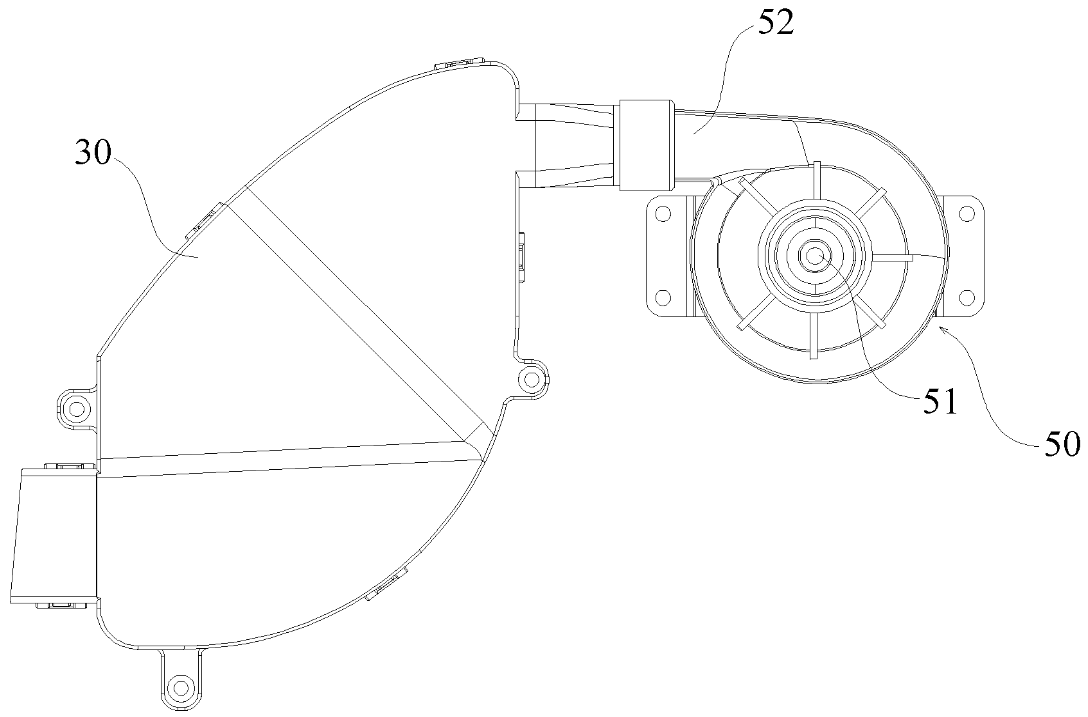

Fig. 15

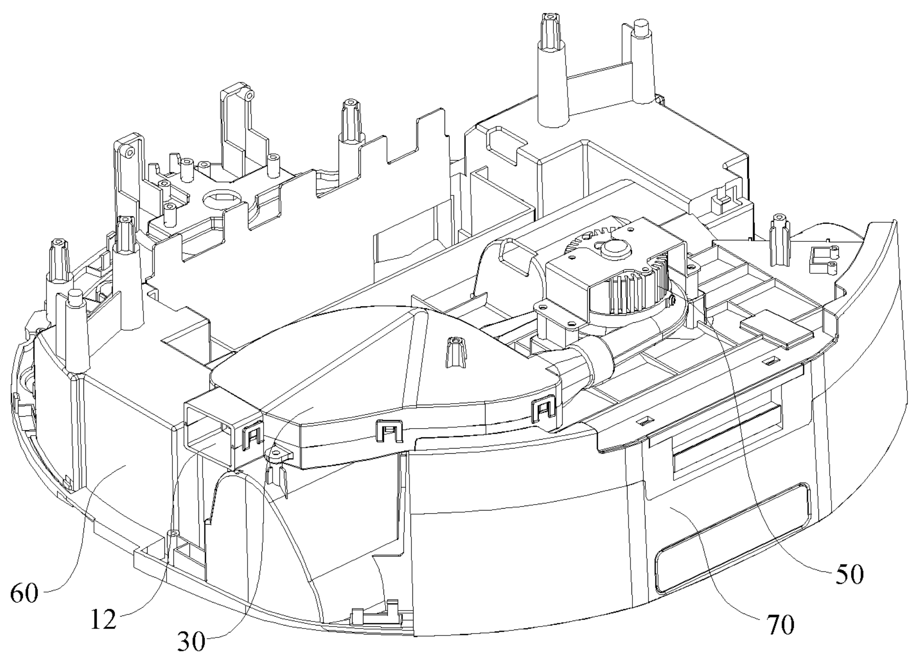

Fig. 16

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2023/081642

A. CLASSIFICATION OF SUBJECT MATTER

A47L9/00(2006.01)i；A47L5/22(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)

IPC：A47L

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: 气道, 风道, 气流通道, 消声, 消音, 降噪, 减噪, 导流, 分流, 多级, 分级, air duct, air passage, air channel, air flow, noise, sound, abatement, muffling, divers+, mulitistage

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 212538221 U (QINGDAO HAIER AIR CONDITIONER ELECTRIC CO., LTD. et al.) 12 February 2021 (2021-02-12) description, paragraphs 26-52, and figures 1-4	1-24
X	CN 213901431 U (GUANGDONG MIDEA DOMESTIC ELECTRICAL APPLIANCE MANUFACTURING CO., LTD.) 06 August 2021 (2021-08-06) description, paragraphs 73-84, and figures 4-5	1-24
X	CN 204750174 U (CSR QINGDAO SIFANG CO., LTD.) 11 November 2015 (2015-11-11) description, paragraphs 26-49, and figures 1-5	1-24
A	CN 211299813 U (GUANGDONG MIDEA WHITE HOME APPLIANCE TECHNOLOGY INNOVATION CENTER CO., LTD. et al.) 21 August 2020 (2020-08-21) entire document	1-24
A	CN 214231212 U (ANKOBOT (SHENZHEN) INTELLIGENT TECHNOLOGY CO., LTD. et al.) 21 September 2021 (2021-09-21) entire document	1-24

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

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- "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
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- "&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 June 2023	**20 June 2023**

Name and mailing address of the ISA/CN	Authorized officer
China National Intellectual Property Administration (ISA/CN) **China No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088**	 Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2023/081642

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 211933902 U (GUANGZHOU COAYU ROBOT CO., LTD.) 17 November 2020 (2020-11-17) entire document	1-24
A	CN 211460047 U (GUANGDONG MIDEA WHITE HOME APPLIANCE TECHNOLOGY INNOVATION CENTER CO., LTD. et al.) 11 September 2020 (2020-09-11) entire document	1-24
A	JP 2009089561 A (RAILWAY TECHNICAL RESEARCH INSTITUTE) 23 April 2009 (2009-04-23) entire document	1-24
PX	CN 217696390 U (GUANGZHOU CVTE ELECTRONIC TECHNOLOGY COMPANY LIMITED et al.) 01 November 2022 (2022-11-01) entire document	1-24

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2023/081642

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
CN 212538221 U	12 February 2021	None	
CN 213901431 U	06 August 2021	None	
CN 204750174 U	11 November 2015	None	
CN 211299813 U	21 August 2020	None	
CN 214231212 U	21 September 2021	None	
CN 211933902 U	17 November 2020	None	
CN 211460047 U	11 September 2020	None	
JP 2009089561 A	23 April 2009	JP 5305372 B2	02 October 2013
CN 217696390 U	01 November 2022	None	

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- CN 202220576584 **[0001]**