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(54) **COMPACT VACUUM CLEANING DEVICE**

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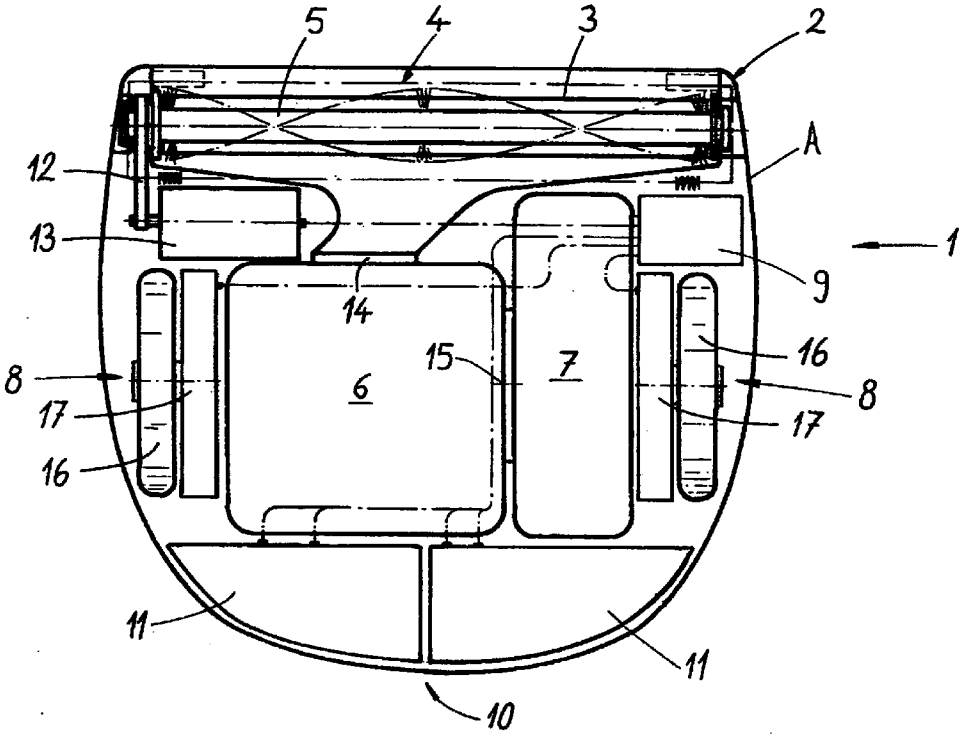
(57) **ABSTRACT**

A compact vacuum cleaning device for automatic cleaning of smooth and textile floor coverings, particularly in the private home sector, has a housing, a suction mouth on the underside of the housing, a cleaning roller disposed in a roller chamber, a dust collection container, a suction fan, an electrical travel drive, control electronics, and a power source. The device height of the vacuum cleaning device is less than 180 mm. The maximal suction air stream that enters through the suction mouth, passes through the dust collection container, and leaves the vacuum cleaning device through the suction fan, is greater than 15 l/s. The maximal suction power is greater than 10 W.



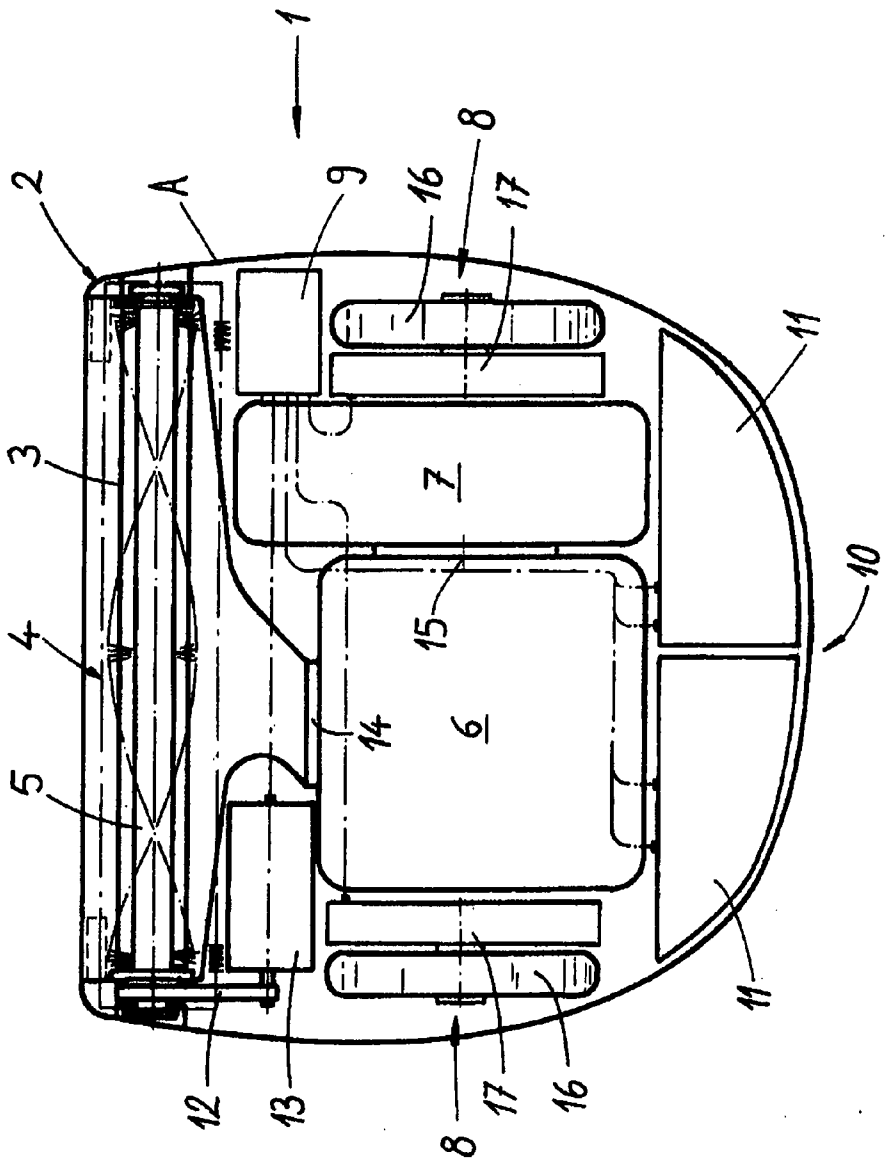


Fig.1

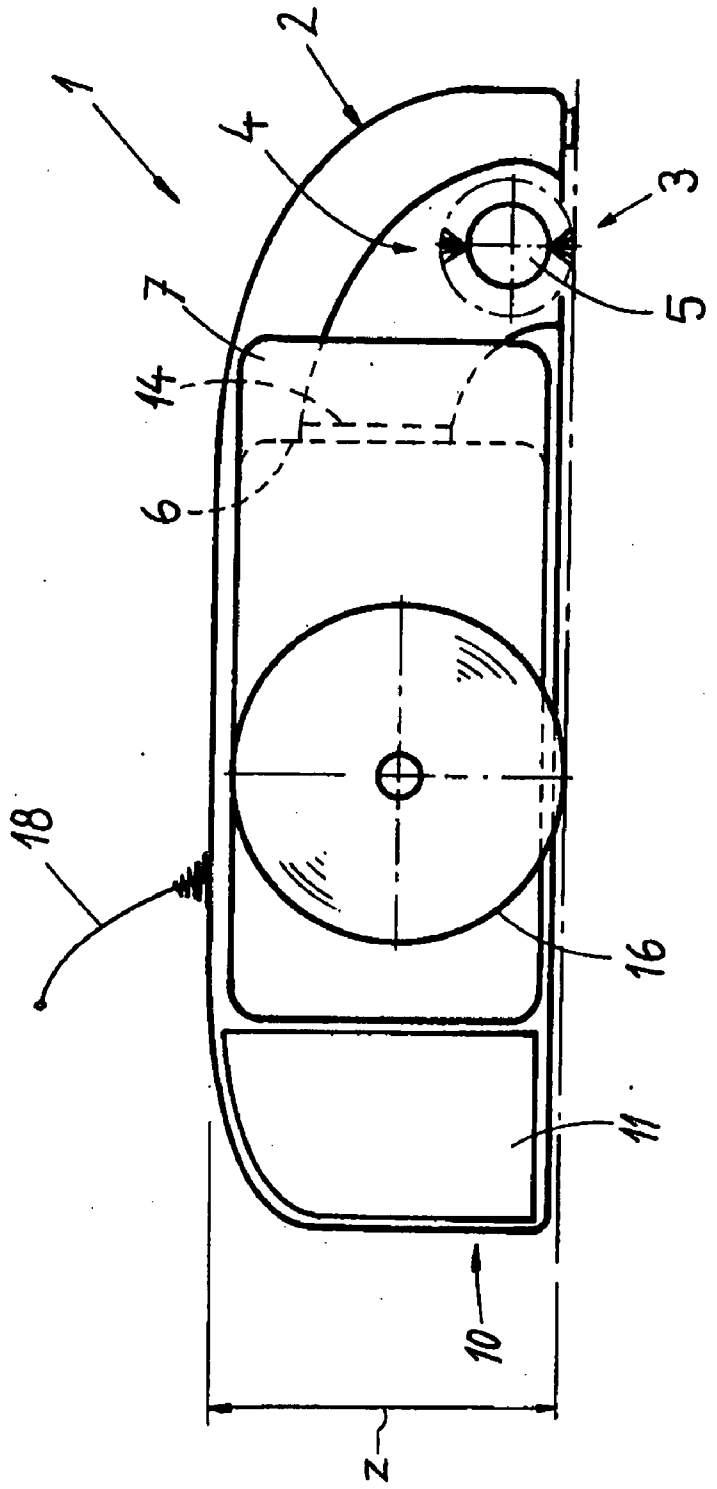


Fig.2

COMPACT VACUUM CLEANING DEVICE

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The invention relates to a compact vacuum cleaning device for automatic cleaning of smooth and textile floor coverings, particularly in the private home sector. The device has a housing, a suction mouth on the underside of the housing, a cleaning roller disposed in a roller chamber, a dust collection container, a suction fan, an electrical travel drive, control electronics, and a power source. The height of the vacuum cleaning device is less than 180 mm. The height results from the distance above the floor that is predetermined by the travel drive, and from the dimensions of the housing that accommodates the dust collection container, the suction fan, the travel drive, the cleaning roller, the control electronics, and the power source. Antennas and any projecting fins that are intended to prevent the device from going under low pieces of furniture are not taken into consideration in determining the device height. Vacuum cleaning devices having the characteristics described are also referred to as vacuum cleaning robots.

[0003] 2. The Prior Art

[0004] Compact vacuum cleaning devices having the characteristics described above are described in European Patent No. EP 0 803 224 B1 and corresponding U.S. Pat. No. 5,781,960 and are shown in various known embodiments. The known embodiments have a rechargeable battery as the power source, which is charged in a charging station, manually or automatically, during breaks in operation. The vacuum cleaning devices that function in automatic manner are controlled, during the cleaning operation, by control electronics that act on the electronic travel drive. Various contact sensors or sensors that work without contact can be provided for recognizing impeding objects and walls. It is also known to store the traveled path in the control electronics in the form of a card, thereby making it possible to achieve cleaning that covers the entire area in the shortest possible period of time.

[0005] The use of a self-propelled vacuum cleaning device that works automatically is supposed to make manual cleaning with a conventional vacuum cleaner superfluous. In order to meet this requirement and offer the user an actual added value however, the vacuum cleaner must have a sufficient cleaning effect not only on large areas of a hard floor but also, in particular, on textile floor coverings. Furthermore, dust and dirt can collect under pieces of furniture that stand on legs. In order to avoid having to remove this dust and dirt manually, the vacuum cleaning devices must have a low height that enables them to pass underneath such pieces of furniture.

[0006] With automatic, self-propelled vacuum cleaning devices, the available electrical power is limited due to the integrated power source. In order to keep the power consumption low, the cleaning effect is determined to a decisive extent by the cleaning roller, which is typically configured as a brush roller with the known vacuum cleaning devices. The air stream that flows through the suction mouth is low and merely guarantees that dirt and dust picked up or loosened by the cleaning roller will be vacuumed up during cleaning operation. While known vacuum cleaning devices are suitable for removing coarse, loose particles such as crumbs and fuzz from smooth floor coverings, the cleaning effect on textile floor coverings, on the other hand, is insufficient. In many cases, additional, undesirable manual cleaning of textile floor coverings with a conventional vacuum cleaner therefore becomes necessary.

[0007] Furthermore, a compact vacuum cleaning device having a housing, a cleaning roller disposed in a roller chamber, a dust collection container, a fan, an electrical travel drive, control electronics, and a power source is described in International Application No. WO 2006/089 307 A2. During cleaning operation, a cleaning fluid is dispensed from a cleaning agent tank within the housing, on the underside of the vacuum cleaning device, so that damp cleaning of the floor covering takes place, to support the vacuum cleaning. The cleaning fluid that is dispensed in this way can be vacuumed up through a separate suction opening on the underside of the vacuum cleaning device. A good cleaning result can be achieved on smooth floors with this combined cleaning. However, the vacuum cleaning device described is not suitable for cleaning textile floor coverings, and is complicated in design.

SUMMARY OF THE INVENTION

[0008] It is therefore an object of the invention to provide a self-propelled vacuum cleaning device that functions in an automatic manner, and cleans textile floor coverings better, while having a compact structure.

[0009] This object is accomplished, according to the invention, in that the maximal suction air stream q_{max} that enters through the suction mouth, is passed through the dust collection container, and leaves the vacuum cleaning device through the suction fan, is greater than 15 l/s (liters per second), and that the maximal suction power $P_{2,max}$ is greater than 10 W. The suction air stream in the sense of the invention refers to the volume of the suction air that enters through the suction mouth per second, is passed through the dust collection container, and leaves the vacuum cleaning device through the suction fan. The dust collection container can be equipped with a bag or a filter. The "maximal suction air stream" q_{max} is defined as that air stream that occurs during operation of the vacuum cleaning device with a freely exposed suction mouth, for example when the vacuum cleaning device is lifted off a floor to be cleaned. It is presupposed that the dust collection container is not contaminated and is equipped with a factory-new dust bag, if applicable, as well as a factory-new filter. The testing conditions that must be adhered to in the determination of the air stream q, in liters per second, as well as the testing conditions for determining the other air data of the vacuum cleaning tool, are contained in the European standard "EN 60312: 1998+A1: 2000."

[0010] The vacuum cleaning device is preferably designed in such a manner that a maximal pressure drop of more than 2 kPa (kilopascal), preferably a maximal pressure drop of at least 4 kPa, occurs at the suction mouth. The "maximal pressure drop" (maximal partial vacuum) is determined while the suction mouth is completely closed. The test apparatuses are also described in the European standard "EN 60312: 1998+A1: 2000."

[0011] The maximal air stream q_{max} and the maximal pressure drop h_{max} represent the limit values of the possible suction parameters. In the case of usual operation of the vacuum cleaning device, a value occurs for the air stream q and a related value occurs for the partial vacuum h, as a function of the floor covering and of the degree of fullness of the dust collection container. Both a large air stream, for transporting the dirt particles, and as great a partial vacuum as possible, for guaranteeing a good depth effect, are aimed at. In this con-

nection, the suction capacity can be determined using the suction power P_2 as the product of air stream q and partial vacuum h, for different operating parameters. Within the framework of the invention, the term suction power refers, in agreement with the European standard "EN 60312: 1998+A1: 2000, " to the power of the flowing suction air, and is therefore also referred to as air power, in practice. The value pair of suction air stream and pressure drop at which the suction power is maximal can be determined by varying the operating parameters. According to the invention, the maximal suction power $P_{2,max}$ is greater than 10 watts, preferably greater than 15 watts.

[0012] In order to be able to use the vacuum cleaning device well in the private home sector, a low device height and, at the same time, a small base area are aimed at. Preferably, the vacuum cleaning device has a base area between 1000 cm^2 and 1500 cm^2. Within the framework of the invention, the base area is the area that is covered by the vacuum cleaning device in the case of a vertical projection. If the base area is small, particularly if the base area lies in the range indicated, it is possible for the vacuum cleaning device to reach nooks as well, making it possible to achieve complete cleaning even in regions where access is difficult. For the purpose of good maneuverability, it is practical if the base area is configured to be round or oval.

[0013] It is practical if the vacuum cleaning device has a volume of 15 to 25 liters, and a range of 17 to 20 liters is preferred. The volume is defined as the space enclosed by the housing bottom and an upper housing part of the housing, including the roller chamber.

[0014] In order to achieve a further improvement in the suction behavior within the framework of an advantageous embodiment of the invention, seals are provided between the individual components, along the path of the air stream, in the vacuum cleaning device. The proportion of useless air that is drawn in not through the suction mouth but rather through cracks and openings between the components can be minimized by such seals. The flow cross-sections and flow transitions along the path of the suction air can also be optimized, in terms of flow technology, in order to avoid pressure losses.

[0015] The cleaning roller provided according to the invention is disposed in an assigned roller chamber, and the suction mouth can be disposed on the underside of the housing, at a distance from the roller. However, in a preferred embodiment of the invention, the suction mouth is disposed on the underside of the roller chamber, and the suction air is guided from the roller chamber to the dust collection container. The cleaning roller can be driven electrically or by an air turbine, and contributes to cleaning by direct contact of the roller surface with the floor covering. In order to guarantee contact between cleaning roller and floor covering on different floor coverings, and to avoid increased friction between floor covering and cleaning roller, the cleaning roller is preferably mounted in the housing so that it is resilient in the vertical direction. Alternatively, the roller chamber, with suction mouth and cleaning roller, can be mounted in the housing, as a whole, to be resilient in the vertical direction. The roller chamber can rest on the floor, in sections, with its underside or with rollers and/or slide surfaces. Both in the case of a resiliently mounted cleaning roller and in the case of a resiliently mounted roller chamber, the optimal contact pressure of the cleaning pressure, and a distance between the suction mouth and the surface to be cleaned that is advantageous from a flow-technology point of view can be achieved by a corresponding spring force of the resilient mounting. For example, the cleaning roller can be configured as a lamella roller having soft, resilient lamellae made of plastic, or as a brush roller. Preferably, soft bristles are provided, which lead to low friction between cleaning roller and floor covering.

[0016] The vacuum cleaning device according to the invention cleans different floor coverings well, and is suitable for picking up large amounts of dirt in a short time, also because of the large air stream. In order to match the improved suction properties, the volume of the dust collection container is greater than 1 liter. Such a configuration can be implemented even in combination with the compact construction described above, by means of effective utilization of the available volume.

[0017] In order to achieve a compact construction, the dust collection container and the suction fan can be disposed next to one another, seen in the longitudinal direction, for example, at approximately the same height. The suction fan is connected to the dust collection container at the side. In order to avoid dead volumes within the housing, the shape of the power source, for example in the form of rechargeable batteries, can also be adapted to the outside contour of the housing. Furthermore, the components of the vacuum cleaning device are preferably coordinated with one another in terms of their shape, and disposed packed as close together as possible. Drive motors for the travel drive or the cleaning roller, as well as the control electronics, can be disposed in narrow interstices between the other components.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] Other objects and features of the present invention will become apparent from the following detailed description considered in connection with the accompanying drawings. It is to be understood, however, that the drawings are designed as an illustration only and not as a definition of the limits of the invention.

[0019] In the drawings, wherein similar reference characters denote similar elements throughout the several views:

[0020] FIG. **1** shows a schematic representation of the components of a vacuum cleaning device according to one embodiment of the invention; and

[0021] FIG. **2** shows a schematic side view of a vacuum cleaning device according to an embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0022] Referring now in detail to the drawings, FIG. **1** shows a compact vacuum cleaning device **1** for automatic cleaning of smooth and textile floor coverings, particularly in the private home sector, having a housing **2**, a suction mouth **3** that is disposed on the underside of a roller chamber **4**, a cleaning roller **5** disposed in the roller chamber **4**, a dust collection container **6**, a suction fan **7**, an electrical travel drive **8**, control electronics **9**, and a power source **10** in the form of two rechargeable batteries **11**. Dust collection container **6** can be equipped with an air-permeable bag, and with a filter on the outlet side. The various components are disposed packed closely together in housing **2**, for optimal utilization of space. Roller chamber **4** is mounted resiliently in housing **2**, and cleaning roller **5**, which is disposed in roller chamber **4** and configured as a brush roller, is driven by an electric motor **13**, by way of a drive belt **12**. From roller chamber **4**, the air stream that enters through suction mouth **3**

is guided into dust collection container **6** by way of a short connection **14**. Suction fan **7** is connected with dust collection container **6** by way of a side opening **15**, and suction fan **7** draws the suction air in axially, and blows it out radially, for example at a slant towards the top. Travel drive **8** has drive wheels **16**, each having an assigned drive motor **17**, controlled by control electronics **9**, whereby precise travel movements are possible even in the tightest space by separate control of drive motors **17**. Despite the compact construction of vacuum cleaning device **1**, with a base area A between 1,000 cm^2 and 1,500 cm^2, the vacuum cleaning device is characterized by a very good cleaning effect. The fact that the maximal air stream q_{max}, when suction mouth **3** lies free, amounts to more than 15 l/s, contributes to the invention in an essential manner. The maximal partial vacuum h_{max}, when suction mouth **3** is closed, is greater than 2 kPa, and preferably amounts to at least 4 kPa. The maximal suction power $P_{2,max}$ is always greater than 10 W, and preferably lies in the range of 15 to 25 W or more.

[0023] FIG. **2** shows a compact vacuum cleaning device **1** according to the invention in a side view. Device height z is less than 180 mm, preferably less than 150 mm. Device height z results from the distance from the floor predetermined by the travel drive, and the dimensions of housing **2** that accommodates dust collection container **6**, suction fan **7**, travel drive **8**, cleaning roller **5**, control electronics **9**, and power source **10**. Additional structures on the top or to the side, such as a sensor or an antenna **18**, which are resilient or can bend away in resilient manner when the device moves under an impeding object, are not taken into consideration in the determination of device height z. Furthermore, projecting fins can be disposed on the top of the housing, which prevent it from traveling underneath low pieces of furniture, whose distance from the floor is not, or only slightly, greater than the device height of the vacuum cleaning device. Such fins are also not taken into consideration in determining the device height. Dust collection container **6** and suction fan **7** are disposed next to one another and extend almost over the device height of the vacuum cleaning device **1**, thereby making it possible to achieve optimal space utilization. Despite the compact dimensions, dust collection container **6** can be configured to be larger than 1 liter, preferably larger than 1.5 liters.

[0024] The vacuum cleaning device has a volume between 15 and 25 liters, whereby a range of 17 to 20 liters is preferred. The volume is defined as the space enclosed by the housing bottom and an upper housing part, including the roller chamber.

[0025] Accordingly, while only a few embodiments of the present invention have been shown and described, it is obvious that many changes and modifications may be made thereunto without departing from the spirit and scope of the invention.

What is claimed is:

1. A compact vacuum cleaning device for automatic cleaning of smooth and textile floor coverings, comprising:

a housing;

a suction mouth disposed on an underside of the housing;

a cleaning roller disposed in a roller chamber in the housing;

a dust collection container in the housing;

a suction fan in the housing;

an electrical travel drive in the housing;

control electronics in the housing; and

a power source in the housing,

wherein a height of the device is less than 180 mm, wherein a maximal suction air stream q_{max} that enters through the suction mouth, passes through the dust collection container and leaves the vacuum cleaning device through the suction fan, is greater than 15 l/s (liters per second), and wherein a maximal suction power $P_{2,max}$ is greater than 10 watts.

2. A vacuum cleaning device according to claim **1**, wherein the height of the device is less than 150 mm.

3. A vacuum cleaning device according to claim **1**, wherein a maximal partial vacuum h_{max} is greater than 2 kPa (kilopascal).

4. A vacuum cleaning device according to claim **1**, wherein the maximal suction power $P_{2,\ max}$ is greater than 15 W.

5. A vacuum cleaning device according to claim **1**, wherein a base area (A) of the vacuum cleaning device amounts to 1000 cm^2 to 1500 cm^2.

6. A vacuum cleaning device according to claim **1**, wherein the device has a volume of 15 to 25 liters.

7. A vacuum cleaning device according to claim **1**, wherein the suction mouth is disposed on an underside of the roller chamber.

8. A vacuum cleaning device according to claim **1**, wherein a volume of the dust collection container is greater than 1 liter.

9. A compact vacuum cleaning device according to claim **1**, wherein the dust collection container and the suction fan are disposed next to one another when viewed in a longitudinal direction.

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