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(54) **AUTONOMOUS CLEANER**

(57) The present invention relates to an autonomous cleaner (10) comprising a cleaner body (11) in which a cavity (90) is defined; and a dust container (25) removably fitted in the cavity (90), said dust container (25) comprising an air and debris inlet (27), an air outlet (28) for

admitting an air flow through the dust container (25), said dust container (25) comprises a dust compartment for the debris, wherein the cleaner body has a wider forward (13) than aft end (14).

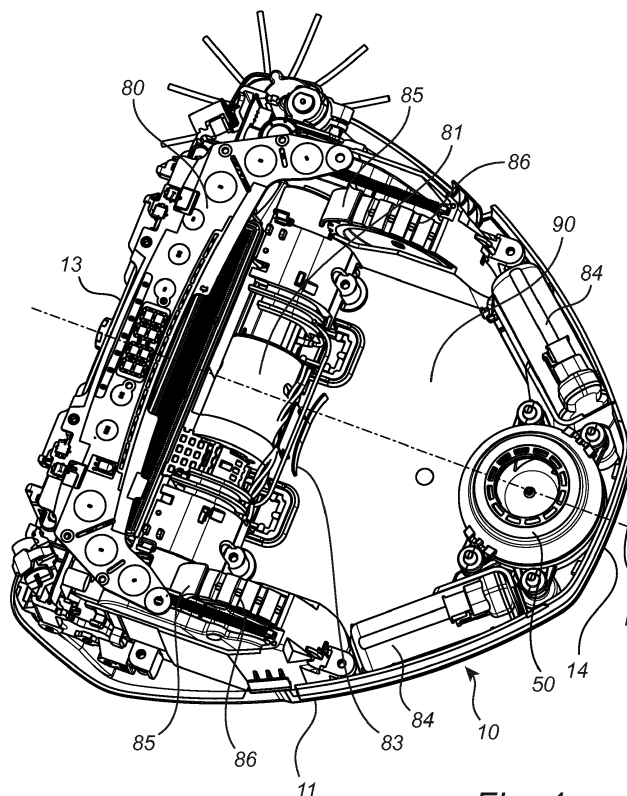


Fig. 4

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DescriptionField of the invention

[0001] The present invention relates to an autonomous cleaner.

Background of the invention

[0002] In order to facilitate the work related to vacuum cleaning of floor areas in different types of building structures, autonomous vacuum cleaners have been available on the market for some time. These autonomous cleaners automatically move in different directions over the floor to clean the floor area without human involvement. The cleaner is either moving randomly or according to a predetermined pattern over the floor until a navigation system detects an obstacle or the cleaner hit some obstacle and turn. Consequently, the size and design of the cleaner is important factors to ensure that the cleaner is able to access as large area as possible of the floor since a cleaner with a limited height and width will be able to access areas under and around furniture, or in close corners more easily.

[0003] Autonomous cleaners have a cleaner body which comprises the different components of the cleaner, and wheels supporting the body to make it possible for the cleaner to move over the floor surface. In the cleaner body electrical motors are arranged together with at least two wheels for powering the cleaner. Particles such as dust, sand etc are collected from the floor surface by a brush roll and lead via a passage adjacent to the roll to a dust container arranged within the body. In order to further improve the cleaning result the roll could be combined with a fan powered by an electric motor to generate a flow of air through the passage to suck the particles into the passage and the dust container.

[0004] In order to make the cleaner work as intended, and ensure a good cleaning result, several components need to be arranged in the cleaner body. This is however contradictable to the desired small outer dimensions of the cleaner body to make it possible for the cleaner to access as large area as possible of the floor surface. The design of each of the components, as well as the interior design of the cleaner is consequently extremely important to ensure the desired function of the different components, the desired limited size of the cleaner body and the possibility to clean as large areas as possible without requiring frequent emptying of the dust container.

[0005] There are a number of autonomous cleaners disclosed in the prior art. One example of a cleaner is illustrated in WO 2013/105431. The disclosed cleaner has a substantially circular cleaner body comprising the different components of the cleaner. As can be seen in the figures a number of different components are fitted within the cleaner body which in combination with the desired small outer size of the cleaner makes the room for the different components limited. The limited space within the cleaner body has some severe drawbacks on the disclosed cleaner. One of them is that the dust container has a very small volume. The small volume results in that the container must be emptied more frequently to ensure the desired cleaning result which is devastating since the container must be emptied manually. Furthermore the removal and fitting of the dust container in the cleaner body is complicated due to the complex design of the dust container and the surrounding structures in the cleaner body.

[0006] There is consequently a need for an improved dust container and an autonomous cleaner design that reduces the drawback described above.

Summary of the invention

[0007] The present invention, defined in the appended claims, relates to an autonomous cleaner that to at least some extent fulfils the needs defined above.

[0008] The autonomous cleaner according to the invention comprises:

- a cleaner body in which a cavity is defined; and
- a dust container removably fitted in the cavity, said dust container comprising an air and debris inlet, an air outlet for admitting an air flow through the dust container, said dust container comprises a dust compartment for the debris, wherein the ratio between the dust compartment volume and the cleaner body volume is within the range 0.1 to 0.2.

[0009] The dust compartment volume is defined as the volume within the dust container usable for particles, debris and dust, and the volume of the cleaner body the volume within the cleaner body with the volume of the dust container included in the cleaner body volume.

[0010] The cleaner according to the invention provides an efficient autonomous cleaner that is able to cover large floor areas without requiring emptying of the dust container since the volume of the dust container in relation to the volume within the cleaner body is larger than in known cleaners. The increased dust container volume is a result of extensive work to optimize the different components arranged in the cleaner body and the internal configuration and layout of the

different components required to ensure that the autonomous cleaner work as intended.

[0011] In one embodiment of the autonomous cleaner, the dust container furthermore comprises a container wall and a filter arranged in the dust container, wherein the dust compartment within the dust container is defined by the container wall and the filter. The filter, together with the container wall, defines the dust compartment, i.e. the dust compartment usable for debris received in the dust container.

[0012] In one embodiment of the autonomous cleaner, the cleaner body is surrounded by a casing and the volume of the cleaner body defined by the casing is within the range 4 to 6 litres. The casing protects the different components arranged in the cleaner body and the specified volume ensures a cleaner body with limited outer dimensions which makes it easier for the cleaner to clean areas that otherwise would have been difficult to access.

[0013] In one embodiment of the autonomous cleaner, the dust container comprises a surface arranged to constitute a part of the cleaner casing to reduce the number of different components and/or different constructional elements within the cleaner body and thereby make it possible to increase the dust container volume within the cleaner body.

[0014] In one embodiment of the autonomous cleaner, the inlet is arranged in a first side and the outlet is arranged in a second side of the dust container, said filter is arranged to extend across the entire dust container between the inlet and the outlet and the volume of the dust compartment on the inlet side of the filter is at least 0,6 liters. The defined container design with the filter in the dust container is favourable since the flow of air through the dust container will extend through the filter. This embodiment furthermore makes it possible to arrange a filter with large filter area such that the flow of air must pass through the filter.

[0015] In one embodiment of the autonomous cleaner, the cleaner body has a lower side intended to be arranged towards a floor surface, an upper side in which the cavity is defined and a forward and an aft end.

[0016] In one embodiment of the autonomous cleaner, an elongated brush roll with a first and a second end is arranged in a recess in the lower side of the cleaner body, said brush roll is extending substantially transverse to a longitudinal direction of the cleaner.

[0017] One embodiment of the autonomous cleaner furthermore comprises a brush roll engine adapted rotate the brush roll, the engine is arranged close to the longitudinal axis behind the brush roll and an elongated drive shaft extending from the engine towards one end of the brush roll where a drive transmission is arranged. The defined position and design of the brush roll engine and the drive shaft makes it possible to arrange the engine in a position within the cleaner body that makes it possible to increase the volume of the dust container since the engine is arranged in front of the dust container close to the bottom structure of the cleaner body.

[0018] One embodiment of the autonomous cleaner comprises two drive units each comprising a wheel and an engine powering the wheel, said drive units are arranged behind the brush roll adjacent to the first and second end of the brush roll and said brush engine is arranged between the first and second drive unit. The use of two separately arranged drive units facilitates the installation since each wheel has its dedicated small electrical engine arranged in direct relation to respective wheel.

[0019] In one embodiment of the autonomous cleaner, the engines of the drive units are electrical engines powered by at least two battery packs arranged separately within the cleaner body. Electrical engines are small, reliable and efficient. Furthermore, the use of two battery packs reduces the overall size of each battery pack which makes it easier to fit the battery packs within the cleaner body and ensures a reliable powering of the cleaner since each battery pack will be able to power the cleaner individually for a period of time.

[0020] In one embodiment of the autonomous cleaner, the drive units furthermore comprise a wheel suspension extending in forward direction from the wheel shaft. The wheel suspension makes it easier for the cleaner to access areas where the floor structure is rough and obstacles are arranged on the floor surface.

[0021] In one embodiment of the autonomous cleaner, the cleaner body has a substantially triangular shape with a wider forward than aft end. The brush roll is arranged in the forward end and the dust container in the centre of the cleaner body. The triangular shape improves the possibilities for the cleaner to access areas that otherwise would have been difficult to reach.

[0022] The different embodiment described above may of course be combined and modified in different ways without departing from the scope of the invention that will be described more in detail in the detailed description.

Brief description of the drawings

[0023] One embodiment of the dust container and an autonomous cleaner are illustrated in the appended figures.

Figure 1 discloses a perspective view of an autonomous cleaner.

Figure 2 discloses the autonomous cleaner in a cross sectional view through the longitudinal direction of the autonomous cleaner.

Figure 3 discloses a perspective view of the dust container

Figure 4 discloses a perspective view of the interior of an autonomous cleaner from above.

Figure 5 illustrates an exploded view of different components of the autonomous cleaner.

Detailed description

[0024] An autonomous cleaner 10 is illustrated in perspective in figure 1. The cleaner has a cleaner body 11 in which all cleaner components are arranged. The cleaner body is enclosed by a cleaner casing 12 that surrounds the different components arranged within the cleaner body. The cleaner casing 12 is designed to both make room for the required components enclosed by the casing, and to give the cleaner the desired attractive appearance. The shape and colour could be modified in several different ways.

[0025] The illustrated cleaner 10 has a forward end 13 and an aft end 14, and a longitudinal axis L extending through the centre of the cleaner body. The cleaner casing 12 has a front side 15 that is slightly curved while the width of the cleaner is reduced towards the rounded aft end 14 resulting in a substantially triangular shape with rounded corners. The shape of the cleaner, with rounded corners, is important to ensure that the cleaner can access and turn in narrow passages or floor areas.

[0026] In the front side 15 of the cleaner 10, means 16 for navigation of the cleaner are arranged. Furthermore, the forward part of the cleaner casing 12 is formed as a front section 17 structurally separated from the rest of the cleaner casing. The front section 17 is designed as a bumper with detecting means that indicate if the cleaner hit an obstacle. The means 16 for navigation, and the detection means are connected to a control unit arranged within the cleaner body 11. The control unit, in the illustrated embodiment of the cleaner the control unit comprises a printed circuit board 80 extending substantially horizontally in the forward end of the cleaner body in order to process information, control the manoeuvring of the autonomous cleaner and the different functions of the cleaner. The casing 12 furthermore comprises a substantially flat top side 18.

[0027] In figure 2 a cross sectional view through the longitudinal axis L of the cleaner 10 is illustrated and in figure 4 a sections of the casing has been excluded to more clearly illustrate the interior of the autonomous cleaner and the different components fitted in the cleaner body. Figure 5 illustrates an exploded view of the autonomous cleaner. In the forward end 13 of the cleaner body, an elongated brush roll 19 is arranged in a corresponding recess in the lower side of the autonomous cleaner. The brush roll 19 has a substantially circular cross section and extends across substantially the entire forward end of the cleaner perpendicular to the longitudinal axis L to cover as wide floor area as possible when the cleaner is moving over the floor surface. The brush roll is provided with at least one brush 20 and / or elastic rib 21 that extend along the roll 22 either substantially straight along the brush roll, or helically around the brush roll. The brush roll in the forward end of the cleaner body is intended to lift and collect particles from the floor surface and transports them via a dust passage 24 to a dust container 25 arranged in the centre of the cleaner body 11. Behind the brush roll 19 an engine 81 for rotating the brush roll is arranged. The engine is arranged close to the longitudinal axis L with the drive shaft 82 extending substantially parallel to the brush roll 19. The drive shaft 82 is extending all the way to one of the brush roll ends where the drive shaft via a drive transmission rotates the brush roll 19. The engine is arranged close to the bottom structure 83 of the cleaner free space within the cleaner body behind and above the engine. The engine is preferably an electrical engine powered by two battery packs 84 arranged close to the inner surface of the cleaner casing 12 in the aft of the cleaner body. Two small battery packs are more easily fitted within the cleaner body than one larger battery and the position of the battery packs in the aft increases the space in the centre of the cleaner body for the dust container 25.

[0028] Immediately behind the brush roll 19 and adjacent to each end of the brush roll a drive unit 85 is arranged. Each drive unit 85 comprises an individually controlled and powered wheel 86 for supporting the cleaner on the floor surface, an electrical engine 87 for transmission and steering of the cleaner and a wheel suspension 88 in order to make it possible for the cleaner to move over rough floor structures. The cleaner is furthermore supported on the floor surface by a third aft wheel 89.

[0029] In the centre of the cleaner body, behind the brush roll, the brush roll engine and the drive units the cavity 90 for the dust container is formed. The cavity is open towards the top surface 18 of the cleaner casing to facilitate both the fitting and removal of the dust container 25 from the cleaner body 11.

[0030] The autonomous cleaner furthermore comprises a side brush unit 91 arranged close to one of the brush roll ends. The side brush unit comprises a side brush 92 rotating around a substantially vertical axis to sweep dust and particles towards the brush roll 19 and improve the cleaning in close corners or close to for example a wall structure or furniture. The side brush is rotated by a small electrical engine 93 arranged above the vertical shaft.

[0031] The dust passage 24 is arranged to direct air and debris from the brush roll to the dust container and has a width corresponding to the length of the brush roll and a forward opening 23 arranged adjacent to the brush roll such that the collected particles could enter the opening 23 easily. The passage 24 is slightly curved and ended by an aft opening 26 arranged in contact with a corresponding inlet opening 27 of the dust container 25 to lead the particles from the brush roll backwards to the dust container 25. The container 25 is illustrated separately in figure 3 and will be described in detail further down this description.

[0032] In the aft end of the cleaner 10, a fan 50 and an electrical engine 51 for powering the fan are arranged to create a flow of air through the cleaner 10. The air is sucked into the forward opening 23 of the dust passage 24 and continues via the dust passage 24 to the dust container 25 to assist the brush roll by sucking dust and particles from the floor surface and the brush roll and lead the dust and particles to the dust container 25. The air continues via a dust compartment 32 through a filter 30 arranged in the dust container 25 above the inlet opening to ensure that dust and particles remain in the dust container before the air continues to an outlet opening 28 in the aft end of the dust container 25 and exits the cleaner via an outlet passage 31 in the aft end 14 of the cleaner casing. The air flow through the cleaner 10 is illustrated in figure 2 by a number of small arrows A.

[0033] The dust container 25 comprises a container wall 31 formed of for example a plastic material. The container wall 31 encloses a dust compartment 32 for collected dust and particles formed in the centre of the dust container 25. The dust compartment 32 is defined by the surrounding dust container wall 31 and the filter extending within the dust container across the entire path from the inlet to the outlet to ensure a large filter area and that all air pass the filter. In the illustrated embodiment of the autonomous cleaner the dust compartment has a volume within the range of 0.6 to 0.8 litres. The dust container 25 comprises a first side 33 arranged in the forward end of the container and intended to be arranged substantially parallel to the aft end of the dust passage 24 and the brush roll. In the illustrated embodiment the first side 33 is slightly angled to correspond to the aft end of the dust passage. However, modifications are possible as long as the aft end of the dust passage 24 and the first side 33 of the dust container 25 have corresponding shapes and fit together. In the first side the inlet opening 27 to the dust chamber 32 is formed. The inlet opening 27 is elongated to provide a large inlet area and facilitate the flow of air, particles and dust into the dust chamber.

[0034] The dust container 25 furthermore comprises a second side 34 arranged opposite to the first side 33 and arranged substantially parallel to the first side. The second side 34 is arranged in the aft end of the dust container 25 and is substantially flat and intended to be arranged substantially transverse to the longitudinal axis L of the cleaner 10. The outlet opening 28 is formed in the second side 34 of the container 25.

[0035] The first and second side of the container are connected by side surfaces 35 extending between the first and second side to enclose the dust chamber 32, and a substantially flat bottom surface 40. The side surfaces 35 have a slightly curved shape but could be modified in several ways as long as the dust container fit in the provided space within the cleaner body.

[0036] The illustrated dust container has a shape corresponding to the shape of the cleaner body, i.e. a wide forward end and a narrower aft end to provide as large dust container volume as possible. In order to facilitate the removal of dust and particles collected in the dust container, the dust container 25 is divided in an upper 36 and a lower section 37. The upper section 37 serves as a lid that is used to open and close the dust container. The upper and lower section is turnably connected to each other by for example one or more hinges 38 arranged along one of the corresponding sides of the upper and lower section. The upper section of the container wall comprises a substantially flat top surface 41 facing upwards and intended to constitute an outside upper surface section of the cleaner casing when the dust container is correctly fitted in the cleaner. Letting the top side 41 of the dust container constitute a section of the cleaner casing saves space and simplifies the structure of the cleaner body and the cleaner casing which makes it possible to increase the dust container volume further which is very favourable since the time between required emptying of the dust container is increased.

[0037] The inlet opening 27 is arranged in the lower section 37 while the outlet opening is arranged in the upper section 36. The dust container 25 furthermore comprises releasable securing means 39 arranged on the upper and / or lower section to maintain the upper and lower section in the closed position. In the illustrated embodiment the securing means 39 are embodied as a resilient hook 42 arranged on the upper section and intended to grip a not illustrated recess in the lower section thereby securing the two sections together. The securing means are released by pressing the resilient hook 42 to disengage the recess. The resilient hook is accessible via an opening in the top side of the cleaner casing.

[0038] Within the dust container 25 the filter 30 is arranged. The filter 30 is arranged in the upper section 36 of the dust container and is intended to move together with the upper section when the dust container is opened. The filter divides the space within the dust container in a dust compartment on one side of the filter and an outlet compartment on the opposite side of the filter. The volume of the dust compartment in relation to the overall volume within the dust container should preferably be as large as possible to extend the time between emptying of the dust container. The filter is arranged slightly angled in relation to a horizontal plane in the upper section between the inlet opening 27 and the outlet opening 28 such that the flow of air must pass through the filter 30. The filter 30 has a shape corresponding to the shape of the dust container in the intended filter position and extends across the entire cross section of the dust chamber to maximise the filter area. The filter could be made of any known filter material, soft or stiff, as long as the desired filter characteristics are achieved. However, the filter material is preferably washable and possible to reuse to reduce waste material.

[0039] The illustrated filter arrangement comprises a frame 43 surrounding a filter area 44 of filter material. The filter material of the filter area must be replaced or cleaned regularly and could be removed from the frame 43 without efforts. The frame 43 is designed to fit within the upper section of the dust container during use of the cleaner. The filter is

arranged between the outlet opening and a surrounding edge 45 of the upper section that is facing the lower section. The filter frame is movably secured in the upper section 36 of the dust container by at least one hinge in order to be movable between a secured position within the upper section, i.e. the intended filter position during use of the autonomous cleaner, and an open position where the space inside the filter adjacent to the outlet opening is accessible to make it possible to replace the filter material within the frame or the entire filter alternatively clean the filter and the space within the upper section normally closed by the filter 30.

[0040] The dust container 25 or the container body furthermore comprises means for securing the dust container in the autonomous cleaner, not illustrated in the appended figures. The means for securing the dust container are fitted in the container wall on the outside surface of the container wall and / or in the cleaner body. The dust container is secured in the correct position within the cleaner body by the securing means but could be released by a release button 47 accessible from the outside of the cleaner casing. The release button 47 is positioned on the top side of the cleaner casing adjacent to the first side of the container in the forward end of the cleaner. The dust container is released by pressing the release button.

EXAMPLE

[0041] As described in the summary of the invention, the dust compartment volume is defined as the volume within the dust container usable for particles, debris and dust and the volume of the cleaner body the volume within the cleaner body with the volume of the dust container included in the cleaner body volume.

[0042] For the autonomous cleaner illustrated in the appended figures the following numbers have been determined:

Cleaner body volume	5.15 Liters
Dust compartment volume	0.7 Liters

$$\text{Ratio} = \text{Dust compartment volume} / \text{Cleaner body volume} = 0.7/5.15 = 0.136$$

[0043] The dust compartment volume as well as the cleaner body volume will however change if the design of the autonomous cleaner is modified but in order to ensure that the desired extended time period between the required emptying of the dust container and the limited overall size of the autonomous cleaner the ration between the dust compartment volume and the cleaner body volume should be within the range 0.1 to 0.2.

[0044] Furthermore the dust compartment preferably has a volume exceeding 0.6 liters to ensure the desired extended time period between the required emptying of the dust container, and preferably the cleaner body volume does not exceed 7 liters to keep the overall dimensions of the cleaner body small which is essential to make it possible for the autonomous cleaner to turn and access narrow passages or floor areas.

[0045] The embodiments described above could be combined and modified in different ways without departing from the scope of the invention that is defined by the appended claims.

Claims

1. Autonomous cleaner (10) comprising:

a cleaner body (11) in which a cavity (90) is defined; and
a dust container (25) removably fitted in the cavity (90), said dust container (25) comprising an air and debris inlet (27), an air outlet (28) for admitting an air flow through the dust container (25), said dust container (25) comprises a dust compartment for the debris,
wherein the cleaner body has a wider forward (13) than aft end (14).

2. Autonomous cleaner (10) according to claim 1, wherein the cleaner (10) has a substantially triangular shape.

3. Autonomous cleaner (10) according to claim 1, wherein the cavity (90) is formed in the centre of the cleaner body (11).

4. Autonomous cleaner (10) according to any of claims 1 - 3, wherein the cleaner body is enclosed by a cleaner casing (12), the cleaner casing has a front side (15) in the forward end (13) wherein the means for navigation (16) is arranged in the front side (15) of the cleaner.

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5. Autonomous cleaner (10) according to claim 4, wherein the means for navigation (16) is connected to a control unit (80) such as a printed circuit board, the control unit extending substantially horizontally in the forward end (13) in the cleaner body.
- 5 6. Autonomous cleaner (10) according to claim any of claims 1 - 5, wherein an elongated brush roll (19) is arranged in the forward end (13) of the cleaner casing.
7. Autonomous cleaner (10) according to claim 6, wherein the brush roll (19) is arranged in (connection with) a forward opening (23) in the lower side of the cleaner body.
- 10 8. Autonomous cleaner (10) according to claim 6 or 7, wherein the cleaner comprises a side brush unit (91) arranged close to one end of the brush roll (19).
- 15 9. Autonomous cleaner (10) according to any of claims 1 - 8, wherein a fan (50) and an electrical engine (51) for powering the fan are arranged in the aft end (14) of the cleaner to create a flow of air through the cleaner (10).
10. Autonomous cleaner (10) according to claim 9, wherein the air flow through the cleaner exits the cleaner via an outlet passage (31) in the aft end (14) of the cleaner casing (12).
- 20 11. Autonomous cleaner (10) according to any of claims 1 -10, wherein the top side (41) of the dust container (25) constitute a section cleaner casing (12).
12. Autonomous cleaner (10) according to any of claims 1 -11, wherein the dust container (25) has a wide forward end and a narrower aft end.

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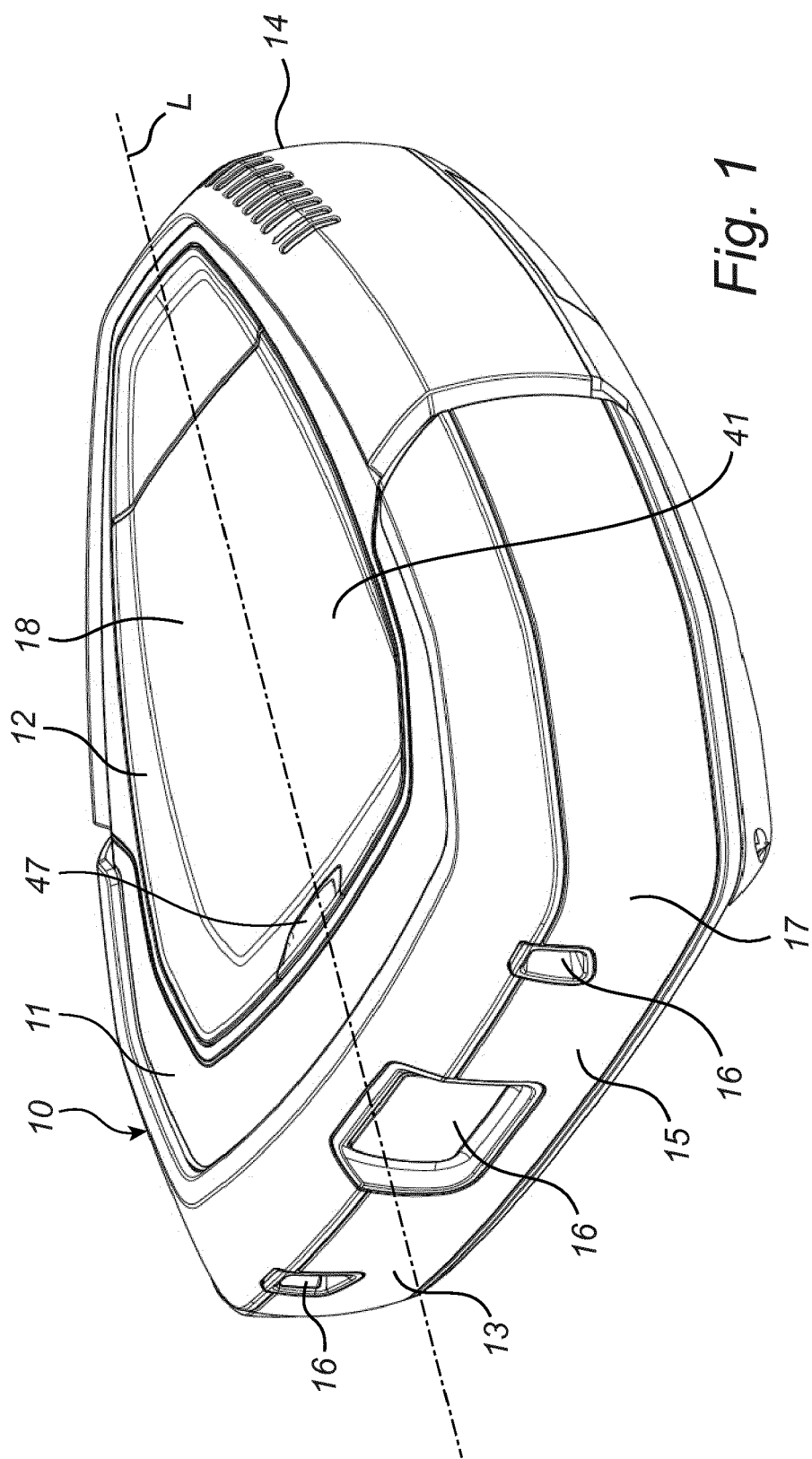
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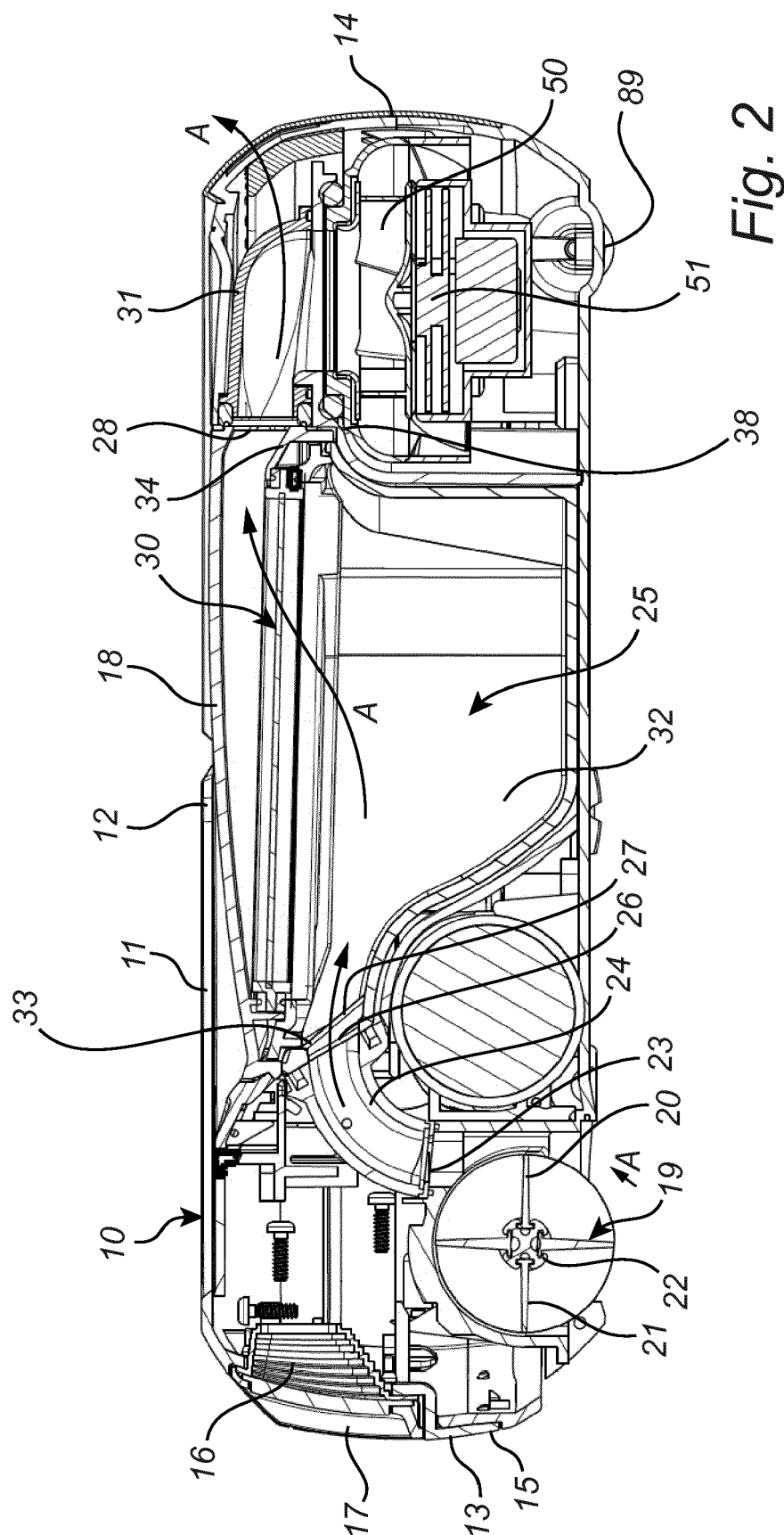
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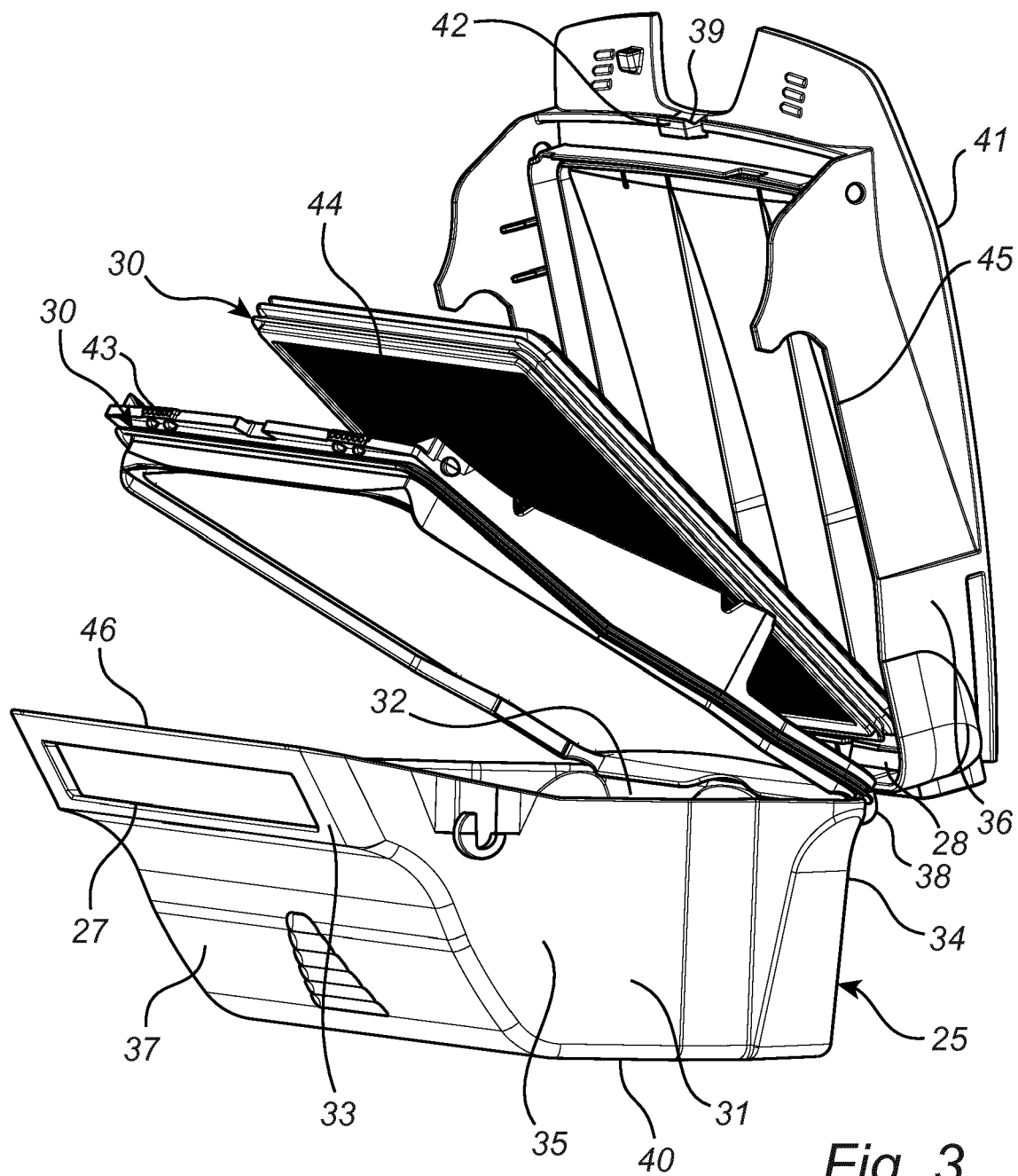
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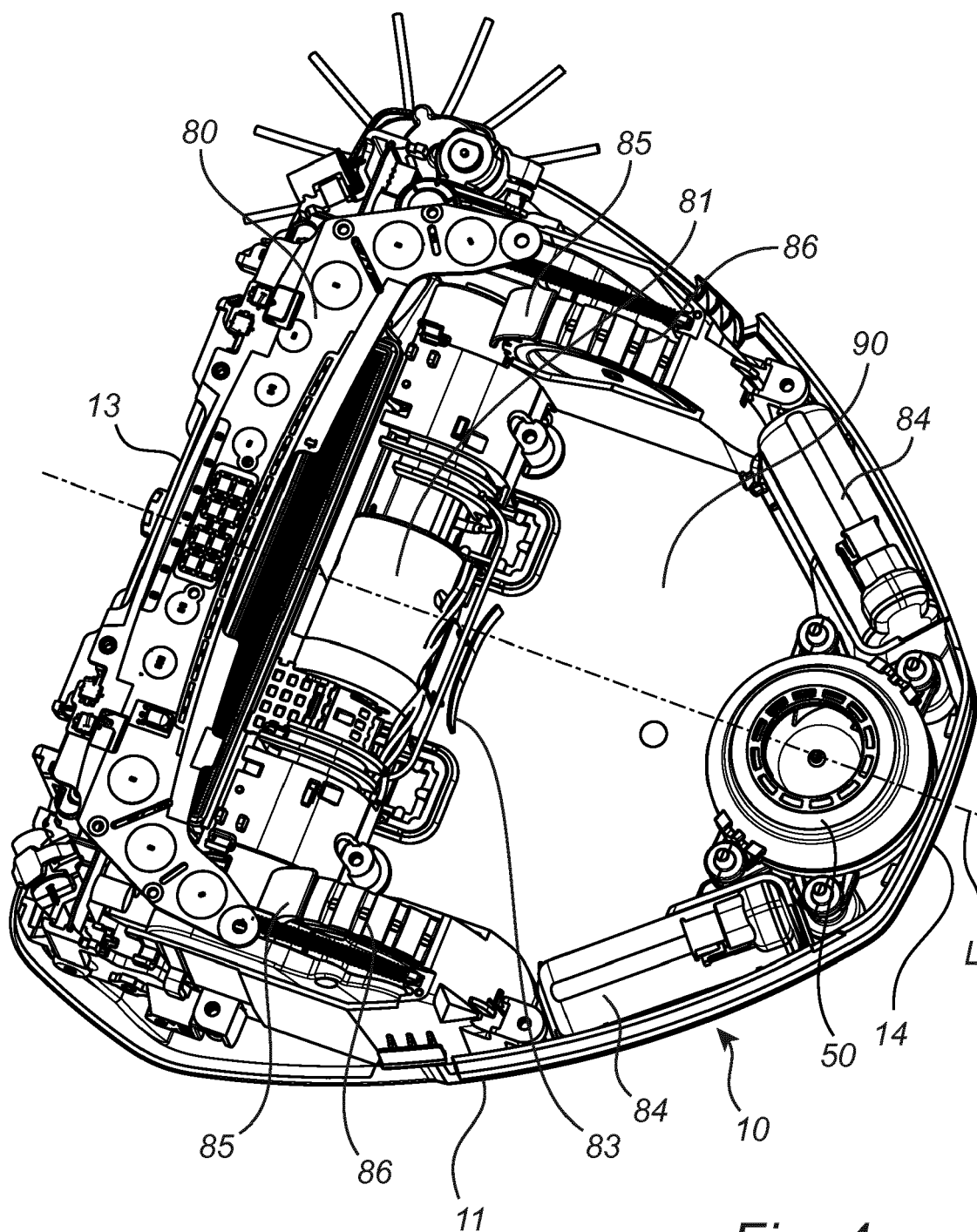


Fig. 4

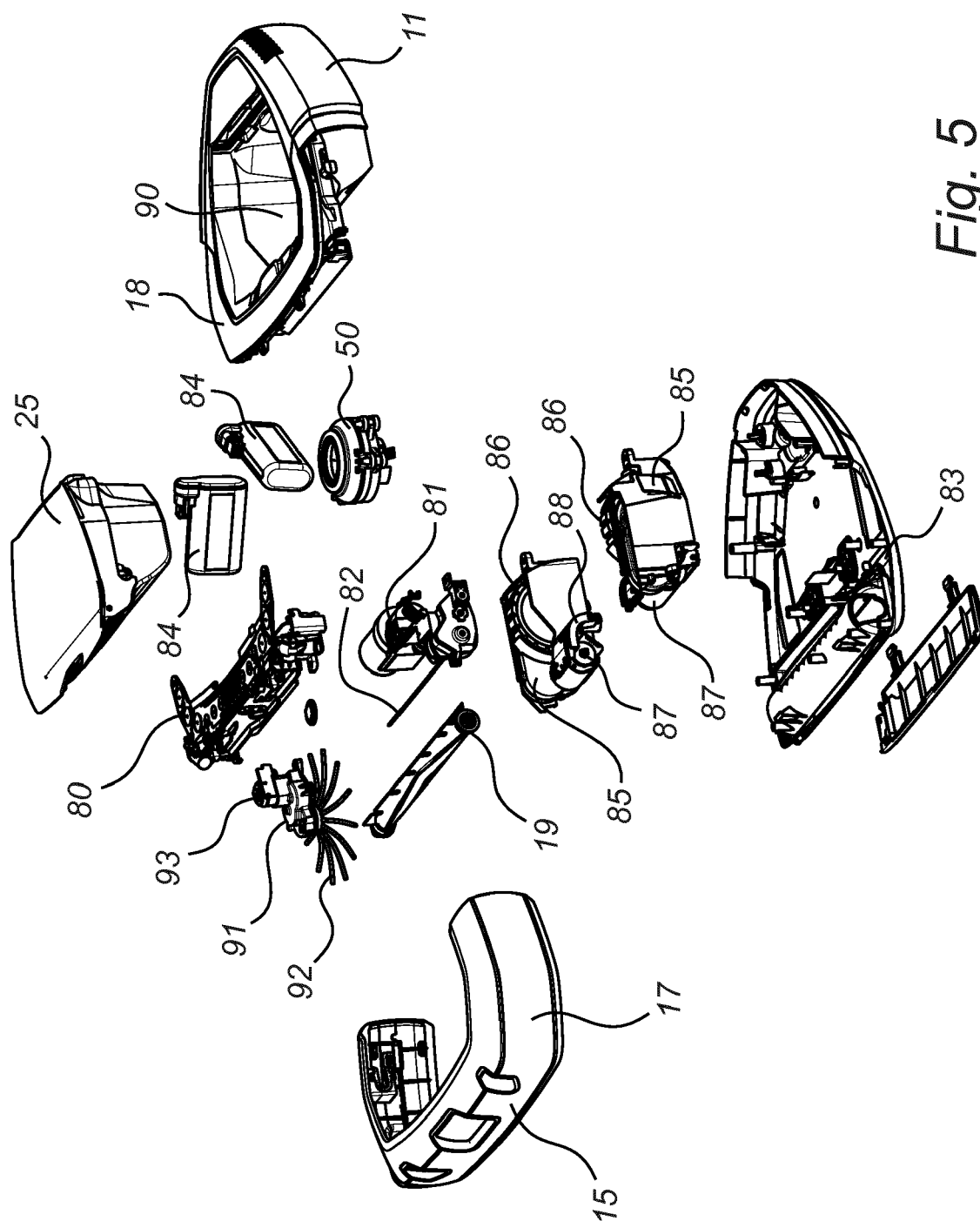


Fig. 5

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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