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(54) Title: ROBOTIC VACUUM CLEANER

(54) Bezeichnung : STAUBSAUGERROBOTER

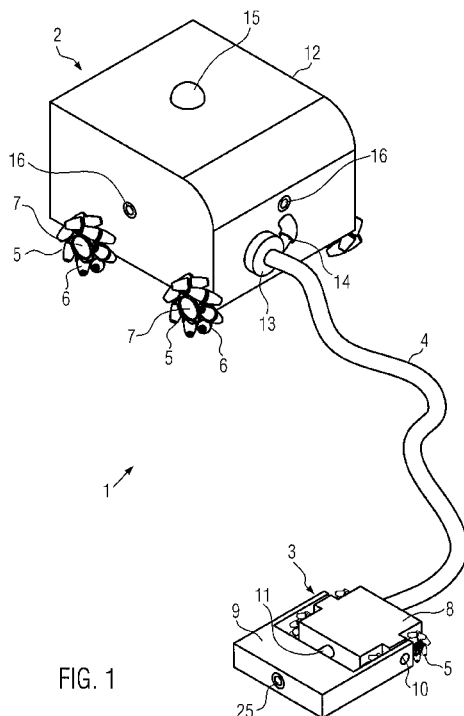


FIG. 1

(57) Abstract: The invention relates to a robotic vacuum cleaner (1) comprising a base (8) mounted on wheels (5), a dust collector and a floor nozzle (9), arranged on the base (8), for taking in a flow of air into the robotic vacuum cleaner (1), the floor nozzle (9) being adjustable in height with respect to the base (8).

(57) Zusammenfassung: Die Erfindung betrifft einen Staubsaugerroboter (1) umfassend eine auf Rädern (5) gelagerte Basis (8), einen Staubabscheider und eine an der Basis (8) angeordnete Bodendüse (9) zum Aufnehmen eines Luftstroms in den Staubsaugerroboter (1), wobei die Bodendüse (9) bezüglich der Basis (8) höhenverstellbar ausgebildet ist.



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ROBOTIC VACUUM CLEANER

BACKGROUND

[0001] The invention relates to a robotic vacuum cleaner.

[0002] Any discussion of the prior art throughout the specification should in no way be considered as an admission that such prior art is widely known or forms part of common general knowledge in the field.

[0003] Conventional vacuum cleaners are operated by a user who moves the vacuum cleaner, and in particular the floor nozzle through which dust is suctioned, across the surface to be cleaned. Conventional floor vacuum cleaners there comprise, for example, a housing which is mounted on rollers and/or runners. A dust collection container is arranged in the housing and contains a filter bag. A floor nozzle is via a suction tube and a suction hose connected to the dust collection chamber. In conventional floor vacuum cleaners, a motorized fan unit is further arranged in the housing and creates a negative pressure in the dust collection container. In the air flow direction, the motorized fan unit is therefore arranged downstream of the floor nozzle, the suction tube, the suction hose, and the dust collection container or the filter bag, respectively. Since cleaned air passes through such motorized fan units, they are sometimes referred to as clean air motors.

[0004] Particularly in former times, there were also vacuum cleaners in which the suctioned dirty air was passed directly through the motor fan and into a dust bag directly attached downstream. Examples thereof are shown in US 2,101,390, US 2,036,056 and US 2,482,337. These forms of vacuum cleaners are nowadays no longer very common.

[0005] Such dirty air or fouled air motor fans are also referred to as a "dirty air motor" or "direct air motor". The use of such dirty air motors is also described in documents GB 554 177, US 4,644,606, US 4,519,112, US 2002/0159897, US 5,573,369, US 2003/0202890 or US 6,171,054.

[0006] In recent years, robotic vacuum cleaners have also gained popularity. Such robotic vacuum cleaners no longer have to be guided by a user over the surface to be cleaned; they instead drive autonomously across the floor. Examples of such robotic vacuum cleaners are known, for example, from EP 2 741 483, DE 10 2013 100 192 and US 2007/0272463.

[0007] The drawback of these known robotic vacuum cleaners is that they have only low dust absorption. This is due to the fact that either the dust absorption is achieved only by the brushing effect of a rotating brush roller, or motorized fan units with very low power are used.

[0008] An alternative robotic vacuum cleaner is described in WO 02/074150. This robotic vacuum cleaner is structured in two parts and comprises a container or fan module and a cleaning module which is connected to the fan module via a hose.

[0009] Conventional robotic vacuum cleaners often have difficulties where the surface to be cleaned is uneven. Such unevenness can be given, for example, by the fact that a carpet is placed on a hard floor (such as parquet) and the robotic vacuum cleaner must change from the hard floor to the carpet. Other unevenness can be given, for example, with door sills. Robotic vacuum cleaners regularly bump into such elevations of the surface to be cleaned and can not move onward because they can not overcome the elevation.

[0010] It is an object of the present invention to overcome or ameliorate at least one of the disadvantages of the prior art, or to provide a useful alternative.

SUMMARY

[0011] According to one aspect of the invention there is provided a robotic vacuum cleaner comprising a base mounted on wheels, a dust collector, and a floor nozzle arranged on said base for collecting an air flow into the robotic vacuum cleaner, said floor nozzle being adjustable in height with respect to said base, wherein said floor nozzle can be positioned at an inclination with respect to said base, wherein said floor nozzle is pivotally hinged to said base wherein the floor nozzle comprises a floor plate with a base surface which, during operation of the robotic vacuum cleaner, faces the surface to be cleaned, wherein the floor plate comprises an air flow channel in the base surface through which air to be cleaned enters the floor nozzle.

[0012] Adjustability in height of the floor nozzle allows the robotic vacuum cleaner to overcome floor unevenness, in particular elevations. If, for example, the robotic vacuum cleaner when coming from a hard floor, with its floor nozzle bumps against a carpet edge, then the floor nozzle can be raised relative to the base so that the robotic vacuum cleaner can then push itself onto the carpet. The base itself can be formed to not be adjustable in height.

[0013] The floor nozzle is fluidically connected to the base and/or to the dust collector, for example via a hose and/or tube connection. The air flow (for example, suctioned in) flows through the floor nozzle into the robotic vacuum cleaner and therefore subsequently into the dust collector connected fluidically to the floor nozzle.

[0014] Height adjustment of the floor nozzle attached to the base can be effected in different ways. The floor nozzle can in particular be positioned at an inclination with respect to the base. The base can be oriented parallel to the surface to be cleaned. The inclined position can be such that the distance between the floor nozzle and a surface to be cleaned increases starting from the base.

[0015] Due to the inclined or slanted position, the robotic vacuum cleaner can push itself onto an elevation. If the floor nozzle there at least partly rests on the floor (the elevation), then the base can by a (forward) motion of the robotic vacuum cleaner also be raised.

[0016] The floor nozzle can be arranged on or attached to the base in different ways. For example, the floor nozzle can be pivotally hinged on the base. In this case, height adjustment of the floor nozzle is effected by pivoting about a pivot axis. This makes it possible to bring the floor nozzle into a position that is inclined relative to the base. In an initial position, the floor nozzle can be oriented parallel to the base and/or parallel to a surface to be cleaned.

[0017] The floor nozzle can be arranged on one side of the base. It can in particular be arranged in front of the base (in the direction of the intended direction of movement). The base can comprise a housing. In this case, the floor nozzle can be arranged on or attached to the housing. It can, for example, be pivotally hinged to the housing of the base. The floor nozzle can be arranged on one side of the housing, in particular in front of the housing (viewed in the direction of the intended direction of movement).

[0018] In the above-described robotic vacuum cleaners, the floor nozzle can be lockable in a fixed position or a plurality of fixed positions with respect to the base. The floor nozzle can thereby be fixed in a desired position relative to the base, which allows for the adjustment of desired pressure conditions at, under and/or in the floor nozzle as well as for pushing the robotic vacuum cleaner onto an unevenness or floor elevation. In the case of a pivotal arrangement, this can be, in particular, one or several pivoting or angular positions. Alternatively or additionally, the floor nozzle can be arranged freely movable with respect to the base.

[0019] The robotic vacuum cleaners described above can comprise a distance and/or obstacle sensor. The distance and/or obstacle sensor can be an optical sensor or a pressure sensor. The distance and/or obstacle sensor can be arranged on the base or on the floor nozzle. A distance sensor or obstacle sensor is used to detect unevenness, in particular elevations.

[0020] The robotic vacuum cleaners described above can comprise a stepping motor or a servo motor for height adjustment of the floor nozzle with respect to the base. With such a stepping motor or a servo motor, for example, the floor nozzle can be moved (rotated) about a pivot axis.

[0021] The above-described robotic vacuum cleaners can comprise a brush roller arranged in or on the floor nozzle. The brush roller (sometimes referred to as a beating and/or rotation brush) can be driven electro-motorically.

[0022] The floor nozzle can comprise a floor plate with a base surface which, during operation of the robotic vacuum cleaner, faces the surface to be cleaned, where the floor plate comprises an air flow channel in the base surface through which air to be cleaned enters the floor nozzle. The floor plate is also referred to as a nozzle sole. The air flow channel is also referred to as a suction slot, nozzle opening, suction mouth or suction channel.

[0023] The floor plate can with its base surface during operation of the robotic vacuum cleaner rest in an initial position on the surface to be cleaned (the floor) or be spaced apart therefrom. The base surface can in particular be arranged parallel to the surface to be cleaned. The floor nozzle can comprise a bristle strip with which, in the event of a spacing, the air flow through the slot between the surface to be cleaned and the floor plate can be adjusted. The air flow channel can parallel to the base surface have a straight, i.e. not curved, or a curved shape. It can have two parallel transverse sides, formed in particular to be rectilinear. In particular, it can have a rectangular shape or base surface.

[0024] The longitudinal direction is meant to be the direction in which the air flow channel has its minimal extension parallel to the base surface of the floor nozzle; The transverse direction is perpendicular thereto (i.e., in the direction of maximum extension of the air flow channel) and also parallel to the base surface. The longitudinal sides are therefore the sides along or parallel to the direction of minimum extension, and the transverse sides are the sides along the direction of maximum extension in the plane of the base surface.

[0025] The floor nozzle can also comprise several air flow channels. In the case of several air flow channels, they can have the same shape or different shapes.

[0026] The floor nozzle can comprise a drive device in order to drive at least one of the wheels. The wheels can be designed for direct contact with the floor. Alternatively, they can be designed as drive wheels for a crawler chain. In the latter case, the crawler chain will during operation of the robotic vacuum cleaner directly contact the ground for moving the robotic vacuum cleaner.

[0027] One of the wheels, several or all wheels can be omnidirectional wheels. This is particularly useful with direct contact of the wheels to the floor during operation of the robotic vacuum cleaner.

[0028] The use of one or several omnidirectional wheels allows for very flexible and versatile movement of the robotic vacuum cleaner, whereby the latter can reliably reach and also again leave spaces that are difficult to access.

[0029] The floor nozzle can comprise a rotation device for rotating the air flow channel about an axis perpendicular to the base surface. Such a rotation device allows for advantageously aligning the air flow channel through which dirt and dust to be absorbed enters the floor nozzle. This increases the suction efficiency of the robotic vacuum cleaner since, in particular, the floor surface processed by the floor nozzle is optimized due to the air flow channel. The rotation device can in particular be designed in the manner described in European patent application No. 15 151 741.4.

[0030] Each omnidirectional wheel can on its circumference comprise a plurality of rotatably mounted rollers or roller bodies, respectively, these axes of which do not extend parallel to the wheel axis (of the omnidirectional wheel). The axes of the rollers can in particular run or be oriented at an angle or transverse with respect to the wheel axis. An example of an omnidirectional wheel is a Mecanum wheel, which is described, inter alia, in US 3,876,255.

[0031] The robotic vacuum cleaners described above can comprise a control device for controlling height adjustment of the floor nozzle with respect to the base. The control device can in particular be designed to automatically control height adjustment of the floor nozzle with respect to the base. For example, the control device can be configured to control a pivotal motion of the floor nozzle about a pivot axis.

[0032] The control device can be adapted to control the above-mentioned stepping motor or the above-mentioned servo motor. The control device can be designed to control height adjustment in dependence of or as a function of signals or data from a distance and/or an obstacle sensor. If, for example, a distance and/or obstacle sensor detects unevenness or an elevation, then the control device can cause the floor nozzle to be raised with respect to the base. In an analogous manner, the control device can cause the floor nozzle to be lowered when a depression is detected.

[0033] The robotic vacuum cleaners described above can comprise a pressure and/or airflow sensor for determining the pressure and/or the speed of the air suctioned in. The control device can be configured to control height adjustment of the floor nozzle in dependence of or as a function of data or signals from a pressure and/or air flow sensor. In this way, the suction and/or air flow conditions can be set in a desired manner in order to achieve an optimized suctioning result.

[0034] The robotic vacuum cleaners described above can comprise a motorized fan unit for suctioning in an airflow through the floor nozzle. The motorized fan unit can be a dirty air motor or a clean air motor.

[0035] The motorized fan unit can have in particular single stage radial fan. The use of a motorized fan unit leads to particularly good cleaning or suctioning results. With a radial fan, the air is suctioned in parallel or axially relative to the drive axis of the fan wheel and deflected by the rotation of the fan wheel, in particular by approximately 90°, and blown out radially.

[0036] The floor nozzle comprises a suction opening for producing a fluidic connection to the motorized fan unit. This suction opening is in fluidic communication with the air flow channel.

[0037] The motorized fan unit can be arranged between the floor nozzle and the dust collector unit such that an air flow suctioned in through the floor nozzle flows through the motorized fan unit into the dust collector assembly.

[0038] A dirty air motor or direct air motor is thereby advantageously used in a robotic vacuum cleaner. Even with low motor power, a high volumetric flow can be obtained with the robotic vacuum cleaner according to the invention.

[0039] According to one alternative, the motorized fan unit can also be arranged fluidically downstream of the dust collector such that an air flow suctioned in through the floor nozzle flows through the dust collector into the motorized fan unit. In this alternative, in particular a clean air motor is used.

[0040] The robotic vacuum cleaners described above can comprise a floor nozzle module and a power supply module, where the floor nozzle module comprises the base mounted on wheels and the floor nozzle connected to the base. The power supply module is mounted on wheels and comprises a drive device for driving at least one of the wheels of the power supply module. The power supply module is connected to the floor nozzle module via a power supply cable in order to supply the floor nozzle module with power.

[0041] Due to the structure of the robotic vacuum cleaner with a floor nozzle module on the one hand and a power supply module on the other hand, a versatile robotic vacuum cleaner is obtained. The power supply for the floor nozzle module is provided by the (autonomously movable) power supply module. Therefore, the floor nozzle module need not comprise its own rechargeable batteries and can therefore be formed to be compact and have less weight. This improves movability of the floor nozzle module. The floor nozzle module can reach the surfaces to be suctioned even in confined conditions.

[0042] The floor nozzle module and the power supply module are in this embodiment designed as individual or (spatially) separate units; they are each mounted separately on their own wheels. The floor nozzle module and the power supply modules are movable independently of one another. In particular, they can be connected to one another only by way of the power supply cable.

[0043] The dust collector can be arranged on or in the floor nozzle module. Alternatively, the dust collector can be arranged on or in the power supply module. In the latter case, the floor nozzle module and the power supply module are connected to one another by way of a suction hose. Air suctioned in through this suction hose can be passed through the floor nozzle into the dust collector.

[0044] The motorized fan unit can be arranged on or in the floor nozzle module. Alternatively, the motorized fan unit can be arranged on or in the power supply module.

[0045] In any case, when the dust collector is arranged on or in the power supply module and the motorized fan unit on or in the floor nozzle module, the motorized fan unit comprises a dirty air motor.

[0046] When providing a power supply module, one, several, or all the wheels of the power supply module can be omnidirectional wheels.

[0047] Alternatively to the embodiment with two modules, the robotic vacuum cleaner can also comprise only one module. For example, the dust collector and/or a power supply device can then be arranged on or in the wheel-mounted base. In this case, no separate power supply module is provided.

[0048] The robotic vacuum cleaner can be a bag-type vacuum cleaner. A bag vacuum cleaner is a vacuum cleaner in which the suctioned dust is separated and collected in a vacuum cleaner filter bag. The robotic vacuum cleaner can in particular be a bag vacuum cleaner for disposable bags.

[0049] In the robotic vacuum cleaners described, the dust collector can comprise a vacuum cleaner filter bag, in particular with an area of at most 2000 cm², in particular at most 1500 cm². The dust collector can in particular consist of such a vacuum cleaner filter bag.

[0050] The filter area of a vacuum cleaner filter bag designates the entire area of the filter material which is located between or within the edge seams (for example welding or adhesive seams). Any possibly side or surface folds that may be present also need to be considered. The area of the bag filling opening or inlet opening (including a seam surrounding this opening) is not part of the filter area.

[0051] The vacuum cleaner filter bag can be a flat bag or have a block bottom shape. A flat bag is formed by two side walls made of filter material which are joined together (for example welded or glued) along their peripheral edges. The bag filling opening or inlet opening can be provided in one of the two side walls. The side faces or walls can each have a rectangular basic shape. Each side wall can comprise one or more layers of nonwoven and/or nonwoven fabric.

[0052] The robotic vacuum cleaner in the form of a bag-type vacuum cleaner can comprise a vacuum cleaner filter bag, where the vacuum cleaner filter bag is designed in the form of a flat bag and/or a disposable bag.

[0053] The bag wall of the vacuum cleaner filter bag can comprise one or more layers of a nonwoven and/or one or more layers of nonwoven fabric. It can in particular comprise a laminate of one or more layers of nonwoven and/or one or more layers of nonwoven fabric. Such a laminate is described, for example, in WO 2007/068444.

[0054] The term nonwoven fabric is used within the meaning of standard DIN EN ISO 9092:2010. In particular, film and paper structures, in particular filter paper, are there not regarded as being nonwoven fabric. "Nonwoven" is a structure made of fibers and/or continuous filaments or short fiber yarns shaped into a surface structure by some method (except interlacing of yarns such as woven fabric, knitwear, lace, or tufted fabric) but not bonded by some method. With a bonding process, a nonwoven turns into nonwoven fabric. The nonwoven or nonwoven fabric can be dry laid, wet laid or extruded.

[0055] The suction devices described can comprise a holder for a vacuum cleaner filter bag. Such a holder can be arranged on, at or in the base and/or a housing of the robotic vacuum cleaner.

[0056] Instead of a bag-type vacuum cleaner, the robotic vacuum cleaner can be a bagless vacuum cleaner, in particular with a blow-out filter with a filter area of at least 800 cm². A bagless vacuum cleaner is a vacuum cleaner in which the suctioned dust is separated and collected without a vacuum cleaner filter bag. In this case, the dust collector can comprise an impact separator or a centrifugal separator or a cyclone separator, respectively.

[0057] The robotic vacuum cleaners described above can comprise a navigation device for autonomously driving the robotic vacuum cleaner. The navigation device can be coupled to a control device for controlling height adjustment of the floor nozzle with respect to the base. In this way, height adjustment can also be controlled in dependence of or as a function of data or signals from the navigation device.

[0058] The robotic vacuum cleaners described can comprise one or more devices for determining the location or position. The devices for determining the location can be, in particular, cameras, displacement sensors and/or distance sensors. The distance sensors can be based, for example, on sound waves or electromagnetic waves.

[0059] The navigation device can be coupled to one or several devices for determining the location. In particular navigation or autonomous driving can be performed in dependence of or as a function of data or signals from one or several devices for determining the location.

[0060] Unless the context clearly requires otherwise, throughout the description and the claims, the words "comprise", "comprising", and the like are to be construed in an inclusive sense as opposed to an exclusive or exhaustive sense; that is to say, in the sense of "including, but not limited to".

BRIEF DESCRIPTION OF DRAWINGS

[0061] A preferred embodiment of the invention will now be described, by way of example only, with reference to the accompanying drawings in which:

[0062] Figure 1 schematically shows a robotic vacuum cleaner composed of two modules;

[0063] Figure 2 schematically shows a block circuit diagram of a robotic vacuum cleaner composed of two modules,

[0064] Figure 3 schematically shows an embodiment of a robotic vacuum cleaner composed of one module.

DETAILED DESCRIPTION

[0065] Figure 1 is a schematic representation of a first embodiment of a robotic vacuum cleaner 1. Robotic vacuum cleaner 1 illustrated comprises a power supply module 2 and a floor nozzle module 3 which is connected to power supply module 2 by way of a flexible suction hose 4. Robotic vacuum cleaner 1 is in this embodiment therefore structured having two modules, where power supply module 2 and floor nozzle module 3 are separate units which are connected to one another only by way of suction hose 4.

[0066] Power supply module 2 is mounted on four wheels 5, where each of these wheels is in the example shown designed as an omnidirectional wheel. In principle, however, conventional wheels can also be used instead of the omnidirectional wheels. Each omnidirectional wheel 5 has a plurality of rotatably mounted rollers 6 on its circumference. The rotational axes of rollers 6 are all not parallel to the wheel axis 7 of the respective omnidirectional wheel. For example, the rotational axes of the rollers can assume an angle of

45° relative to the respective wheel axis. The surfaces of the rollers or roller bodies are curved or bent.

[0067] Examples of such omnidirectional wheels are described in US 3,876,255, US 2013/0292918, DE 10 2008 019 976 or DE 20 2013 008 870.

[0068] Power supply module 2 comprises a drive device for driving wheels 5 of the power supply module. The drive device can comprise a separate drive unit, for example, in the form of an electric motor, for each wheel 5 so that each wheel 5 can be driven independently of the other wheels. Rollers 6 are rotatably mounted without a drive.

[0069] By suitably driving individual or all wheels 5, power supply module 2 can be moved in any direction. If, for example, all four wheels 5 are moved at the same speed in the same direction of rotation, then the power supply module moves straight ahead. With a counter-rotating movement of the wheels on one side, a lateral movement or displacement can be achieved.

[0070] In principle, not all wheels need to be drivable; Individual wheels can also be provided without their own drive. In addition, it is also possible that individual wheels are not driven for certain movements, even if they are basically drivable.

[0071] In alternative embodiments, the power supply module can also comprise fewer or more than four wheels. Not all wheels there need to be designed as omnidirectional wheels. An example with three omnidirectional wheels is described in US 2007/0272463.

[0072] Floor nozzle module 3 comprises a base 8 and a floor nozzle 9 arranged on this base 8. Base 8 (and therefore also the entire floor nozzle module 3) is in the example shown mounted on four omnidirectional wheels 5. These wheels are in the embodiment sized to be smaller than the wheels of power supply module 2. In analogous form, floor nozzle 3 also comprises a drive device for wheels 5. Here as well, the drive device for each wheel comprises a single drive unit, for example, in the form of electric motors, in order to drive each wheel separately and independently of the other wheels. In this way, the floor nozzle can also be moved in any direction by suitably driving the wheels. In principle, conventional wheels can also be used instead of the omnidirectional wheels.

[0073] Instead of wheels which, as in the embodiment illustrated, directly contact the floor and cause movement of the robotic vacuum cleaner due to this contact, the wheels can also

be designed as drive wheels for a crawler chain so that the robotic vacuum cleaner is moved by a track drive.

[0074] Floor nozzle 9 is pivotally hinged on base 8 via a pivot joint 10. Due to this pivotal mounting, floor nozzle 9 is designed to be adjustable in height with respect to base 8, it can be tilted upwardly.

[0075] Floor nozzle 9 comprises a floor plate with a base surface which, during operation of the robotic vacuum cleaner faces the floor, i.e. the surface to be suctioned. In the floor plate, an air flow channel is incorporated parallel to the base surface through which the dirty air is suctioned in and via a flexible hose connection 11 passed into base 8, from where it is passed through suction hose 4 to a dust collector in power supply module 2.

[0076] The floor nozzle can comprise a rotation device for rotating the air flow channel about an axis perpendicular to the base surface.

[0077] In the examples shown, power supply module 2 comprises a housing 12 on which a motorized fan unit 13 is arranged. A tube member 14 leads from motorized fan unit 13 into the interior of housing 12 to a vacuum cleaner filter bag disposed within the housing and forming a dust collector. The vacuum cleaner filter bag can be removably attached in the interior of housing 12 in a conventional manner, for example, by way of a holding plate.

[0078] In the arrangement shown, a continuous fluidic connection to the dust collector is therefore established by floor nozzle 3, hose member 11, base 8, suction hose 4, motorized fan unit 13 and tube member 14. Motorized fan unit 13 is there arranged between suction hose 4 and the dust collector so that dirty air suctioned in through the floor nozzle flows through motorized fan unit 13 (in particular via tube member 14) into the vacuum cleaner filter bag arranged in the interior of housing 12.

[0079] Motorized fan unit 13 is therefore a dirty air motor. This is in particular a motorized fan unit comprising a radial fan.

[0080] The motorized fan unit has a volumetric flow of more than 30 l/s (determined according to DIN EN 60312-1: 2014-01, with an aperture of 8) at an electrical input power of less than 450 W, a volumetric flow rate of more than 25 l/s at an electrical input power of less than 250, and a volumetric flow of more than 10 l/s at an electrical input power of less than 100 W.

[0081] The fan diameter can be 60 mm to 160 mm. A motorized fan unit can be used, which is also used in Soniclean Upright vacuum cleaners (e.g. SONICLEAN VT PLUS).

[0082] The motorized fan unit of the SONICLEAN VT PLUS was characterized according to DIN EN 60312-1: 2014-01 as explained above. The motorized fan unit was measured without the vacuum cleaner housing. For possibly necessary adapters for connecting to the measuring chamber, the descriptions in section 7.3.7.1 apply. The table shows that high volumetric flows are obtained at low rotational speeds and low input power.

"Dirty air" (fan wheel diameter 82 mm) with aperture 8 (40 mm)				
Input power	voltage	rotational speed	negative pressure box	volumetric flow
[W]	[V]	[RPM]	[kPa]	[l/s]
200	77	15,700	0.98	30.2
250	87	17,200	1.17	32.9
300	95	18,400	1.34	35.2
350	103	19,500	1.52	37.5
400	111	20,600	1.68	39.4
450	117	21,400	1.82	41.0

[0083] Instead of a dirty air motor, power supply module 2 can also comprise a conventional clean air motor which is in the direction of air flow arranged downstream of the dust collector. In this case, the dirty air suctioned in would pass through suction hose 4 to power supply module 2, enter its housing 12 and be passed into the dust collector, for example, in the form of a vacuum cleaner filter bag.

[0084] Robotic vacuum cleaner 1 comprises a navigation device for driving power supply module 2 and floor nozzle module 3 in an autonomous manner. For this purpose, a correspondingly programmed microcontroller is arranged in housing 12 of power supply module 2. The navigation device is connected to devices for determining the location. They include cameras 15 as well as distance sensors 16. The distance sensors can be, for example, laser sensors.

[0085] Navigation of the robotic vacuum cleaner occurs in a known manner, as described, for example, in WO 02/074150. The navigation device arranged in housing 12 controls both the drive unit of power supply module 2 as well as the drive unit of floor nozzle module 3.

[0086] A device is provided for the latter for transmitting control signals from the navigation device in housing 12 of power supply module 2 to floor nozzle module 3, in particular to the drive device of the floor nozzle module. For this purpose, wireless transmitters/receivers can respectively be arranged on the side of power supply module 2 and floor nozzle module 3. Alternatively, a wired connection for transmitting control signals can also be provided along the suction hose.

[0087] Floor nozzle module 3 can in a supporting manner also comprise one or more devices for determining the location. For example, path sensors and/or distance sensors can be provided on the floor nozzle module. In order to use the corresponding information for control and navigation, respective signals are transmitted from the floor nozzle module to the navigation device.

[0088] The power supply for the robotic vacuum cleaner can be effected in a cabled or wireless manner. In particular, power supply module 2 can comprise rechargeable batteries which can be charged, for example, in a cabled or wireless (inductive) manner. For charging the rechargeable batteries, robotic vacuum cleaner 1 can move, for example, autonomously to a charging station.

[0089] Power supply for the floor nozzle module, in particular its drive device, can be effected by way of a power supply cable in or along suction hose 4. If the power supply to the drive device of the floor nozzle module is not exclusively effected by a power connection via suction hose 4, then floor nozzle module 3 itself can also comprise rechargeable batteries.

[0090] Figure 2 is a schematic block diagram of a robotic vacuum cleaner 1 with a power supply module 2 and a floor nozzle module 3. The drive device for wheels 5 of power supply unit 2 comprises, firstly, four drive units 17 in the form of electric motors and, secondly, a microcontroller 18 for controlling the electric motors.

[0091] Provided in power supply module 2 is further a navigation device 19 which serves to autonomously drive the power supply module and the floor nozzle module. Navigation device 19 comprising a microcontroller is connected both to microcontroller 18 of the drive device as well as to a further microcontroller 20 which is part of the devices for determining the location. Data signals from different sensors and/or cameras are processed in microcontroller 20 and made available to navigation device 19.

[0092] Navigation device 19 is also connected to motorized fan unit 13 in order to control it.

[0093] In the example illustrated, power supply or voltage supply is effected by way of a rechargeable battery 21, which can be charged wirelessly or in a cabled manner. For the sake of clarity, not all power supply connections are shown in the figure.

[0094] Floor nozzle module 3 also comprises a drive device for its four wheels 5, where the drive device, like in the case of power supply module 2, comprises a microcontroller 15 and four electric motors 14. The control signals for the drive device of floor nozzle module 3 originate from navigation device 19 which is arranged in power supply module 2. The signals are transmitted via a communication line 22 which can be arranged, for example, in the wall of the suction hose. Alternatively, however, this signal transmission could also be effected wirelessly.

[0095] Floor nozzle module 3 comprises a base 8 on which floor nozzle 9 is rotatably mounted by way of pivot joints 10. A schematically indicated air flow channel 24 is arranged on the side of floor nozzle 9 facing the surface to be cleaned. Dirty air is suctioned in through air flow channel 24 and is via base 8 and suction hose 4 passed into the power supply module, more precisely its dust collector.

[0096] In a first position (initial position), floor nozzle 9 is aligned parallel to the base and to the (level) surface to be cleaned. The floor nozzle can in particular be locked in this position.

[0097] As can also be seen in particular in Figure 1, a distance or obstacle sensor 25 is arranged on floor nozzle 9. If, for example, unevenness, such as an elevation, is by way of this distance sensor or obstacle sensor 25 determined in the surface to be cleaned, then floor nozzle 9 can be adjusted in height relative to the surface to be cleaned or relative to base 8, respectively. The unevenness can be, for example, a carpet edge or a door sill.

[0098] Height adjustment of floor nozzle 9 is effected, for example, by pivoting the floor nozzle about the pivot joint with which floor nozzle 9 is connected to base 8. For this purpose, rotational axes 10 can be designed as shafts which are each coupled to a stepping motor or a servo motor 26.

[0099] A control device 27 for controlling height adjustment of floor nozzle 9 relative to base 8 is provided in floor nozzle module 3. The control device comprises a programmed microcontroller and is connected to sensor 25. If an obstacle in the form of, for example, an

elevation is detected by distance or obstacle sensor 25, then a corresponding signal is sent to control device 27 which then drives electric motors 26 in such a way that the floor nozzle by way of a rotation pivots by a certain angle and is thereby raised. In this new position, the floor nozzle can then be locked by stopping (or blocking) electric motors 26.

[0100] It can by way of distance or obstacle sensor 25 be verified whether or not an obstacle exists for this (new) height adjustment or angular position of floor nozzle 9. Furthermore, if an obstacle is detected, then floor nozzle 9 can be raised further.

[0101] Due to the raised floor nozzle 9, floor nozzle module 3 is no longer blocked by the elevation because the latter fits underneath floor nozzle 9.

[0102] If floor nozzle 9 in the course of the advance motion rests on or impacts such an elevation, then base 8 is due to the inclined position of floor nozzle 9 also lifted upwardly when the floor nozzle module is further advanced. In this way, floor nozzle module 3 pushes itself completely onto and over the elevation.

[0103] Floor nozzle 9 can also be provided with a distance sensor on its underside, i.e. on the side facing the surface to be cleaned. This distance sensor can, for example, be arranged in the floor plate of floor nozzle 9. With this distance sensor, the distance can be determined between the floor nozzle (its underside) and the surface to be cleaned. It can via the changes in the detected distance be ascertained whether or not the surface to be cleaned exhibits any unevenness.

[0104] If a depression in the surface to be cleaned is in this way detected (for example, the transition from a carpet to a hard floor), then the floor nozzle can again be lowered. In an analogous manner, it can be detected via a decreasing distance between the base surface of the floor nozzle and the surface to be cleaned whether an elevation is present and a corresponding upwardly motion of the floor nozzle can be initiated.

[0105] Floor nozzle module 3, in particular floor nozzle 9, can comprise an active (electro-motorically driven) brush roller or a passive (not electro-motorically driven) brush roller.

[0106] Instead of the embodiment illustrated in Figures 1 and 2, in which the fan unit is arranged on the side of the power supply module, the fan unit can also be arranged on, at or in the floor nozzle module. In this case, the dust collector can also be provided on the side of the floor nozzle module. A suction hose connection between the floor nozzle module and the

power supply module is thereby rendered obsolete. In this case, only a power cable must be provided between the power supply module and the floor nozzle module. Alternatively, however, the dust collector can also be provided on the side of the power supply module.

[0107] Instead of a two-module design as schematically illustrated in Figures 1 and 2, the robotic vacuum cleaner can also consist merely of one module, as shown schematically in Figure 3.

[0108] In this case, floor nozzle 9 is via a rotational axis or shaft 10 likewise hinged to a base 8 which in this case comprises housing 12. In this embodiment as well, floor nozzle 9 can be adjusted in height relative to base 8 by way of pivoting about rotational axis 10. In an initial position, floor nozzle 9 can be aligned parallel to a planar surface to be cleaned. Pivoting the floor nozzle leads to an oblique position.

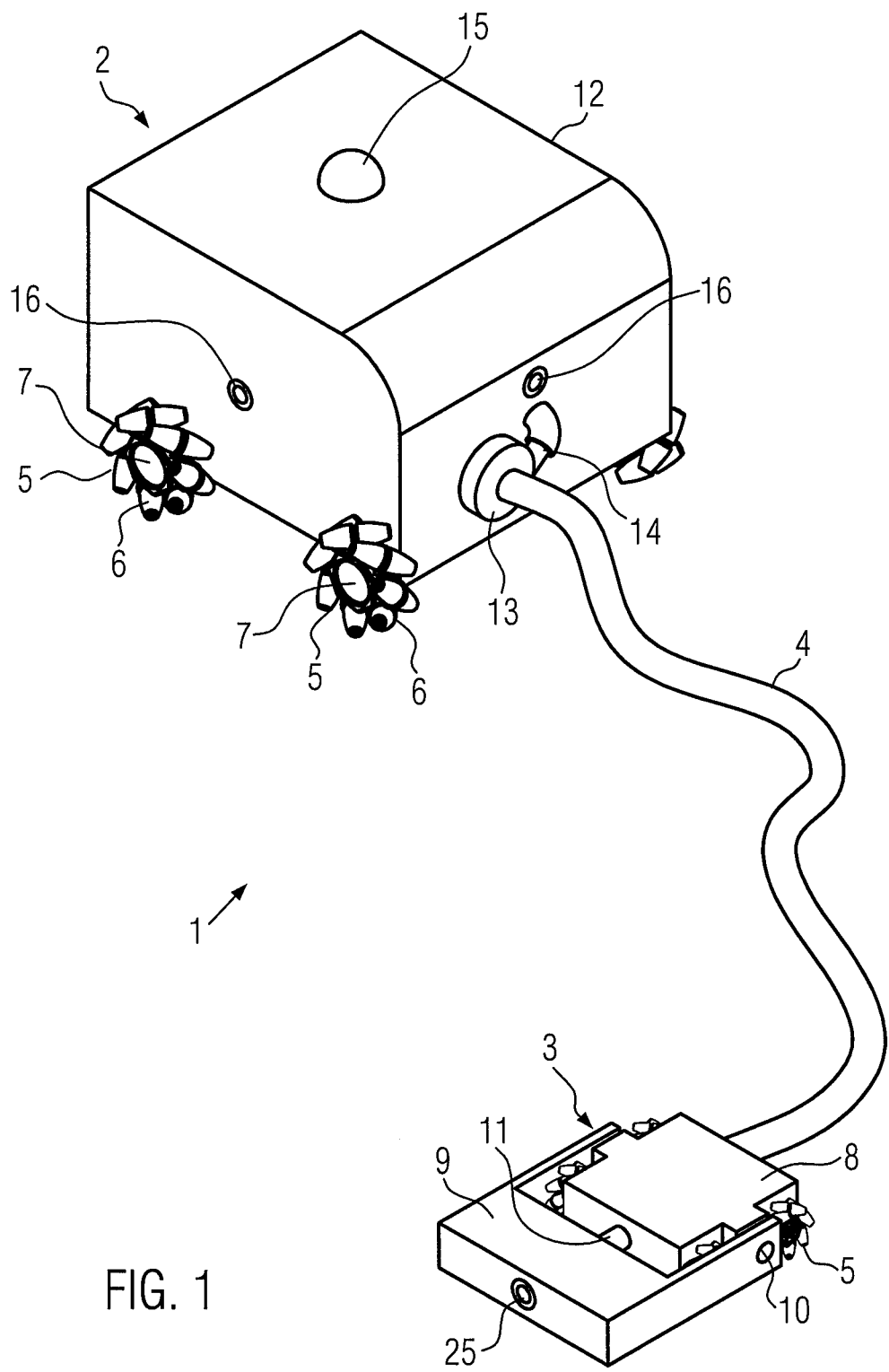
[0109] Floor nozzle 9 also in this embodiment on its underside (the side facing the surface to be cleaned) comprises an air flow channel through which dirty air is suctioned in and via a hose member 11 passed into housing 12 of base 8, in the interior of which the dust collector is arranged, for example in the form of a vacuum cleaner filter bag or an impact separator.

CLAIMS

1. Robotic vacuum cleaner comprising a base mounted on wheels, a dust collector, and a floor nozzle arranged on said base for collecting an air flow into said robotic vacuum cleaner, said floor nozzle being adjustable in height with respect to said base,
wherein said floor nozzle can be positioned at an inclination with respect to said base,
wherein said floor nozzle is pivotally hinged to said base,
wherein the floor nozzle comprises a floor plate with a base surface which, during operation of the robotic vacuum cleaner, faces the surface to be cleaned, where the floor plate comprises an air flow channel in the base surface through which air to be cleaned enters the floor nozzle.
2. Robotic vacuum cleaner according to claim 1, wherein said floor nozzle is arranged on one side of said base.
3. Robotic vacuum cleaner according to claim 2 wherein said floor nozzle is arranged in front of said base.
4. Robotic vacuum cleaner according to any one of the preceding claims, wherein said floor nozzle is lockable with respect to said base in a fixed position or a plurality of fixed positions.
5. Robotic vacuum cleaner according to any one of the preceding claims, comprising a distance and/or obstacle sensor.
6. Robotic vacuum cleaner according to any one of the preceding claims, comprising a stepping motor or a servo motor for height adjustment of said floor nozzle with respect to said base.
7. Robotic vacuum cleaner according to any one of the preceding claims, comprising a brush roller arranged in or on said floor nozzle.
8. Robotic vacuum cleaner according to any one of the preceding claims, comprising a control device for controlling height adjustment of said floor nozzle with respect to said base.

9. Robotic vacuum cleaner according to claim 8 wherein said control device automatically controls said height adjustment.
10. Robotic vacuum cleaner according to any one of the preceding claims, comprising a pressure and/or air flow sensor for determining the pressure and/or the speed of the air suctioned in.
11. Robotic vacuum cleaner according to any one of the preceding claims, comprising a motorized fan unit for suctioning an air flow in through said floor nozzle.
12. Robotic vacuum cleaner according to any one of the preceding claims, wherein said robotic vacuum cleaner is a bag-type vacuum cleaner or a bagless vacuum cleaner.
13. Robotic vacuum cleaner according to any one of the preceding claims, comprising a navigation device for autonomously driving said robotic vacuum cleaner.
14. Robotic vacuum cleaner according to any one of the preceding claims, comprising one or several devices for determining the location.

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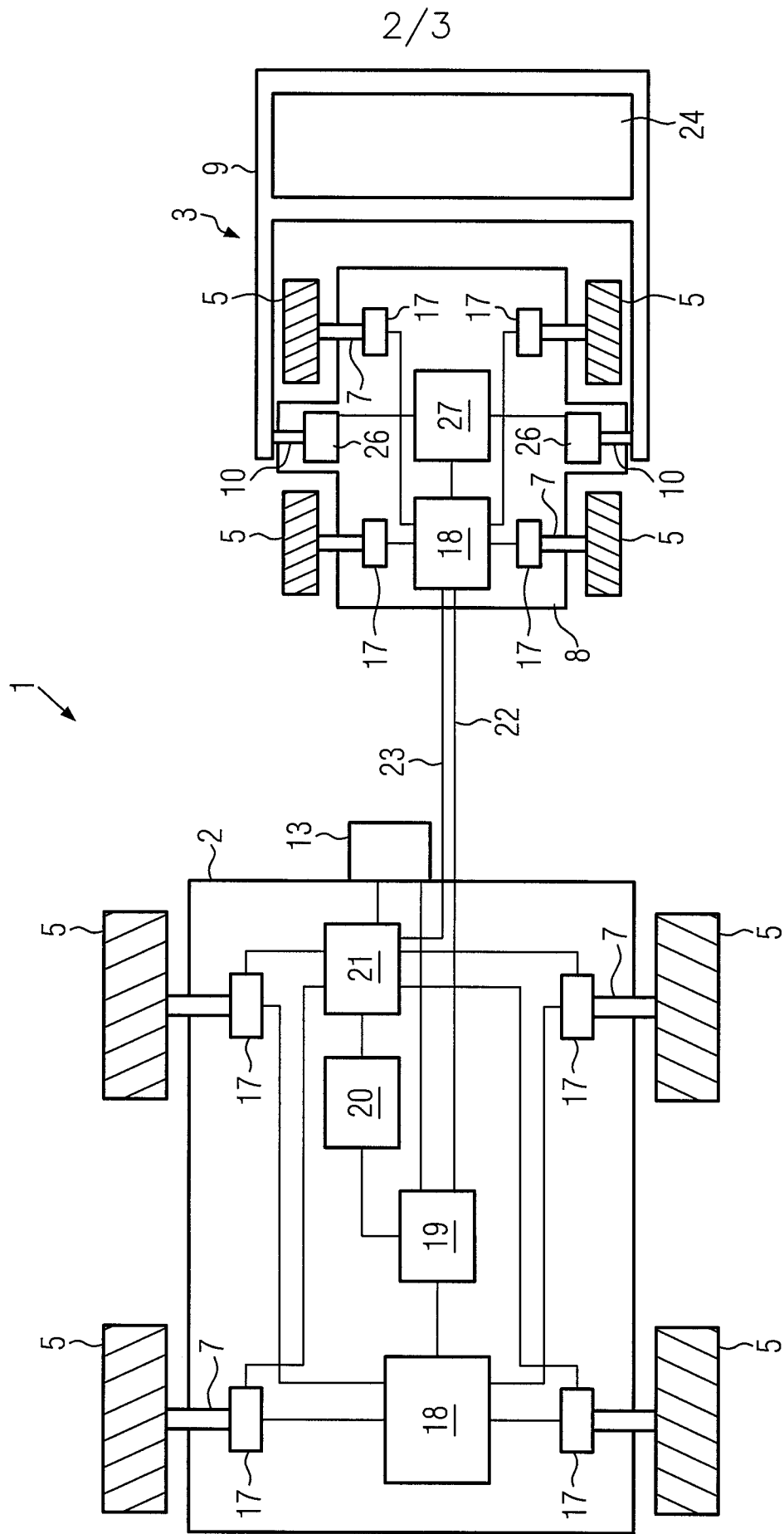


FIG. 2

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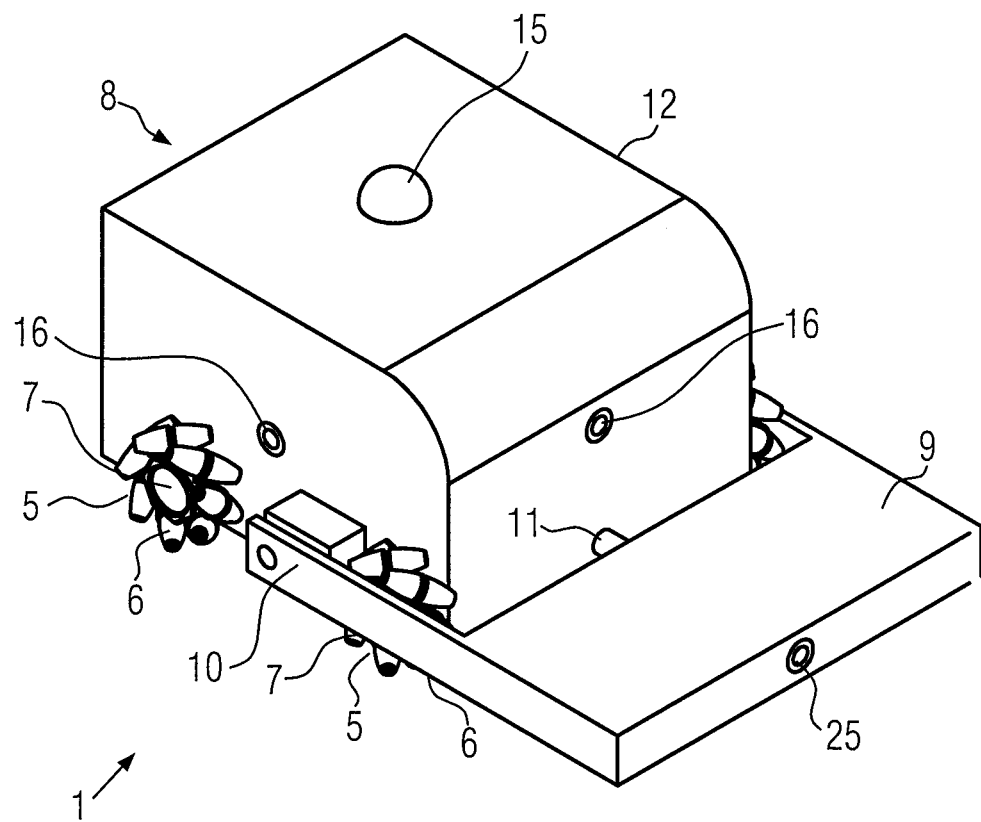


FIG. 3