

Floor cleaning device

The invention relates in first instance to a floor cleaning device, in particular a cleaning robot, with
5 electromotive drive and with displacement wheels and/or a driven brush, a floor identification being carried out.

In the case of floor cleaning devices, it is known to
10 use a floor identification to determine the floor that is to be cleaned. Therefore, depending on the floor covering that is determined, for example, different cleaning characteristics can be chosen. In the case of a floor cleaning device which is formed as an
15 attachment for a customary, hand-guided domestic vacuum cleaner, such floor identification may be used according to choice for switching on/off a brush roller driven by electric motor, for raising or lowering screening means delimiting a suction space of the
20 attachment or for varying the power of the vacuum cleaner's suction blower. In the case of cleaning robots which, operating autonomously, clean floor coverings over a large area, such floor identifications are used to change the cleaning characteristics or to
25 avoid specific regions. Known in this respect are solutions in which the floor covering is ascertained by using ultrasound which is emitted by a transceiver and reflected by the floor. In this case, the reflection is greater on hard floors than on carpeted floors,
30 which dampen the sound more. This known solution proves to be problematical to the extent that different floors, determined on the basis of the reflection, can only be classified with difficulty. For instance, there are hard floors, such as cork for example, which
35 deflect the ultrasound very weakly. As a result, the circuitry may make a false evaluation. Highly damping carpets may also prevent reflection, so that an exact evaluation is not possible. Further known solutions

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provide a reflection light barrier, for the detection of differences in height on the floor, whereby edges of a carpet can be detected. However, these reflection light barriers cannot be used to distinguish between
5 the floors in their nature as carpets or hard floors.

With regard to the prior art described above, a technical problem for the invention is seen as that of configuring, in improved manner, a floor cleaning
10 device of the type in question in such a way that, with a simple construction, a reliable identification of the floor covering is made possible.

This problem is solved first and foremost by the
15 subject matter of claim 1, it being provided that the floor identification is carried out by means of sensing a slippage and/or a resistance to displacement. As a result of the configuration, reliable identification of the floor covering is achieved, which can be used in
20 particular in the case of cleaning robots but additionally also in the case of attachments for customary domestic vacuum cleaners. The floor is reliably identified independently of reflection characteristics. Since the resistance to displacement
25 of the device's displacement wheels and the slippage with respect to the floor are greater on a carpet than on a hard floor, the rotational speed of the displacement wheels of the floor cleaning device is lower on carpets. This also applies to a brush of the
30 floor cleaning device that is provided, which is driven by electric motor and the rotational speed of which is reduced on carpets in comparison with hard floors. The slippage is determined by means of a comparison between distance covered and revolutions of a driven
35 displacement wheel and/or a driven brush. Moreover, the resistance to displacement is determined on the basis of the power consumption of the drive motor of the displacement wheel and/or of the brush. For

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instance, the power consumption of the displacement wheel drive motor increases on carpets, this being caused by the greater resistance. It is also the case with a brush driven by electric motor which works the floor to be cleaned that the resistance is increased on carpets, which leads to an increase in the power consumption of the respective drive motor.

For sensing the distance covered, the floor cleaning device has a sensor, which is configured by way of example as a slave wheel. If the distance measured by means of the sensor is set in relation to the time elapsed since the last measurement, the speed of the floor cleaning device, in particular the cleaning robot, can be ascertained. The floor cleaning device has an electronic memory, in which comparison values for slippage and/or resistance to displacement of different floor coverings are stored. Setpoint values for a reference floor, for example a hard floor or carpet, are therefore stored. For the processor-aided identification of the floor that is traveled over, the floor cleaning device has a computer unit, which compares the measured values with the stored values and derives from this a signal for the navigation and/or a drive power of the brush or displacement wheels and/or a signal for setting the brushes and/or the device's elements that influence the resistance to displacement. For example, in the case of a cleaning robot, a floor identification according to the invention can be used to maneuver it appropriately to avoid traveling over specified floor coverings. The drive power of the brush may also be adapted in the case of such a cleaning robot, but also in the case of a floor cleaning device in the form of a vacuum cleaner attachment, for instance to provide gentle working by brush of the floor covering determined. Apart from changing the rotational speed of the brush, the projecting position of the brushes can also be changed

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in dependence on the floor covering determined. A further measure that is dependent on the floor covering is for example that of raising or lowering screening means delimiting a suction space, for example in the
5 form of brush strips.

The invention also relates to a floor cleaning device, in particular a cleaning robot, with a driven brush and a receptacle for dirt, the receptacle having not only
10 an intake opening but optionally also a discharge opening and the intake opening and optionally the discharge opening having closure means, which close the respective opening in any case when the device is switched off. Floor cleaning devices of the type in
15 question are known, reference being made for example to DE 44 14 683 A1, from which there is known a carpet cleaning device, in particular a sweeping machine or carpet sweeping machine, with a receptacle for swept-up dirt and a discharge opening in the receptacle, via
20 which discharge opening the dirt collected can be removed by suction by means of a vacuum cleaner after completion of the sweeping work. This discharge opening of the receptacle can be closed for example by means of a shutter. In order to improve a floor
25 cleaning device of the type in question, the term floor cleaning devices being used for the purposes of the invention to refer not only to cleaning robots but also to attachments for customary domestic vacuum cleaners, in such a way that, with a construction that is as
30 simple as possible, advantageous and, in particular, hygienic handling is achieved, it is proposed that the closure means come into action automatically in dependence on a transmission state of the device. This provides a floor cleaning device which has a closure
35 mechanism for the receptacle which in cleaning mode opens the path to the receptacle, but when it is at a standstill or being transported seals it - optionally in addition to a discharge opening. This ensures that,

once it has been picked up, dirt cannot come into contact with the ambient air and cannot fall out of the device. The opening and closing of the receptacle corresponds to the operating states. For instance, there is a customary operating state, in which the closure means are kept in an open position by the floor cleaning device, with the brush rotating, standing on the floor to be cleaned or moving over it. The closure means may also be automatically actuated in dependence on an operating state of the device, for instance be actively displaced into the closed position or from this into the open position by means of closing mechanisms. According to the invention, it is provided that actuation takes place by lifting of the device. As a result of this configuration according to the invention, any escape of dirt collected in the receptacle, for example when the floor cleaning device is being transported, is counteracted. It is also conceivable that a carriage which can be made to extend when lifting occurs brings about a lever-actuated closure of the opening. The carriage, which is for example made to extend under the action of a spring when the device is lifted, closes the closure means of the receptacle for example by means of a coupled mechanism. A counter-torque of an electric drive motor may also be used for the actuation of the closure means, the counter-torque of the drive motor of the brush and/or of that serving for the traveling movement preferably being used. This may also be combined with a dependence on the lifting of the device, this lifting being detected by clearance sensors known per se, whereby the drive motor remains at a standstill, accordingly the counter-torque ceases and a mechanism coupled with the motor displaces the closure means into the closed position. The general stopping of the drive motor for the brush and/or for the traveling movement also leads to the same reaction, by closing of the preferably spring-biased or gravity-operated closure

means. In a development of the idea of the invention, it is provided that a separate actuating means acts on the closure means in dependence on the device being at a standstill and/or lifting of the device, it being
5 further preferred for the separate actuating means to be an electric motor or an actuator of some other form. It is also proposed that the receptacle is mounted in such a way that it is vertically movably in the device and is displaced vertically downward under its own
10 weight when the device is lifted, the opening moving into the closed position in relation to a closure means in the course of this displacement. The closure means here is preferably a wall of the device housing or the like, which pushes the receptacle in front of the
15 opening in a closing manner when the device is lifted. Finally, it is proposed that a separate fan is associated with the receptacle, a path of movement of the fan blades coinciding with the opening and a fan blade closing the opening when it is at a standstill.

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The invention is explained in more detail below on the basis of the accompanying drawings, which merely represent several exemplary embodiments and in which:

25 Figure 1 shows in perspective representation a floor cleaning device according to the invention in the form of a cleaning robot;

Figure 2 shows the floor cleaning device in a
30 perspective view from below;

Figure 3 shows a schematic representation in side view of the floor cleaning device with a brush driven by electric motor and also a
35 displacement wheel and means for floor identification;

Figure 4 shows a schematic partial representation of a floor cleaning device with a receptacle for dirt and a carriage spring-mounted with respect to the device housing, for an open position of the receptacle;

Figure 5 shows a representation corresponding to Figure 4, but for the closed position of the receptacle opening after lifting of the device;

Figure 6 shows a further schematic partial representation of a floor cleaning device in a further embodiment with the receptacle opened;

Figure 7 shows a representation according to Figure 6, but for the closed position of the receptacle opening after lifting of the device;

Figure 8 shows a schematic partial representation of the floor cleaning device in a further embodiment, for the operating position with the receptacle opened;

Figure 9 shows a representation corresponding to Figure 8, but after switching off an electric drive for a brush and accompanying closure of the receptacle;

Figure 10 shows a schematic partial representation of a floor cleaning device in a further embodiment, for the operating position;

Figure 11 shows a representation according to Figure 10, but for the closed position of the receptacle;

Figure 12 shows in a further embodiment a schematic partial representation of the floor cleaning device in an opened position of the receptacle;

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Figure 13 shows a representation corresponding to Figure 12, but with the receptacle opening closed after lifting of the device.

10 Represented and described is a floor cleaning device 1 in the form of a cleaning robot with a chassis 2, which carries on the underside, facing the floor 10 to be treated, displacement wheels 3 driven by electric motor and also a brush 5, which is likewise driven by
15 electric motor and protrudes beyond the lower edge of the chassis base 4. Engaging over the chassis 2 is a device hood 6, the floor cleaning device 1 having a circular outline.

20 The displacement wheels 3 are disposed behind the brush 5 in the customary direction of displacement r of the floor cleaning device 1, a dirt ramp 7 that is similar to a sweeping plate and via which the brushed-up dirt is thrown into a container-like receptacle 8 also being
25 disposed behind the brush 5.

Positioned in front of the brush 5 in the customary direction of displacement r is a supporting wheel in the form of a slave wheel 9, as a result of which a
30 three-point support of the floor cleaning device 1 on the floor 10 to be treated is achieved.

In particular in the case of a cleaning robot, there is the need to adapt its behavior to the characteristics
35 of the floor 10 that is traveled over. For this purpose, a floor identification is provided, which by means of sensing any slippage and/or resistance to displacement, in particular of the displacement wheels

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3 but also alternatively or in combination with the brush 5.

The slippage is determined here by means of a comparison between the distance covered by the floor cleaning device 1 and the revolutions of the displacement wheel 3, driven by means of the electric motor 11, and/or of the brush 5, driven by means of the electric motor 12. In order to make allowance for possible slippage between electric motor and driven means (displacement wheel 3 or brush 5), such as for example in the case of a belt drive, the determination of the revolutions may preferably take place directly at the displacement wheel 3 or at the brush 5, alternatively at the displacement wheel 3 and at the brush 5.

As an alternative or in combination with floor identification by means of sensing any slippage, the floor identification may also be carried out by determining the resistance to displacement, the power consumption of the electric motor 11 of the displacement wheel 3 and/or the power consumption of the motor 12 of the brush 5 being sensed when there is transmission without any slippage, for example via a toothed belt between the drive motor and the driven means.

The slave wheel 9, disposed at the front, serves for sensing the distance covered and has a sensor 13, the values of which are recorded by a processor 14 integrated in the floor cleaning device 1. The determined numbers of revolutions of the displacement wheel 3 and/or of the brush 5, and alternatively or in combination with this the values of the power consumption of the displacement-wheel electric motor 11 and/or the brush electric motor 12, are also transmitted to said processor.

Also associated with the processor 14 is an electronic memory 15, in which comparison values for slippage and/or resistance to displacement of different floor coverings are stored. The processor compares the measured values such as slippage and/or resistance to displacement of the displacement wheel 3 or of the displacement-wheel electric motor 11 and/or of the brush 5 or of the brush electric motor 12 with the values stored in the memory 15 and derives from this a signal for controlling the floor cleaning device 1.

According to the invention, the distance covered is accordingly recorded by the slave wheel 9, which measured distance is set in relation to the time elapsed since the last measurement. From this, the speed of the floor cleaning device 1 can be definitively ascertained. Since the resistance to displacement and the slippage with respect to the floor is greater on a carpet than on a hard floor, the speed of the floor cleaning device 1 is lower on a carpet. In addition, owing to the greater resistance, the current of the electric motor 11 of the displacement wheel 3 increases. This also applies moreover to the brush 5 of the floor cleaning device 1, the mechanical resistance of which increases on carpets, which results in an increase in the power consumption. Likewise, the rotational speed of the brush 5 also falls.

The values recorded by the processor 14 are compared with the stored setpoint values for a reference floor. The signal derived from this may serve for example for the navigation of the floor cleaning device 1, for instance in particular in the case of floor cleaning devices 1, in particular cleaning robots, that are not to travel over specific floor coverings. The drive power of the brush 5 or of the displacement wheels 3

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may also be adapted appropriately for the floor covering determined. In addition, a signal for setting the brushes 5, in particular the projecting position of the brush 5 beyond the chassis base 4, may also be
5 derived, so that, for example for the more gentle working of carpets by brush, the brush 5 is raised by means of a rocker assembly known per se.

The receptacle 8, schematically represented in one
10 embodiment in Figures 4 and 5, can be closed in dependence on an operating state of the floor cleaning device 1. It is therefore provided that, when the floor cleaning device 1 is lifted from the floor 10 to be treated and/or when the floor cleaning device 1 is
15 switched off, in particular when the electric motors 11 and/or 12 of the displacement wheels 3 and/or of the brush 5 are switched off, the receptacle 8 is closed, so that dust or dirt already collected in the receptacle 8 cannot escape again from it in an
20 uncontrolled manner.

For this purpose, the receptacle 8 may have an activatable closure means 16 in the form of a closure flap 17, which, on the basis of the operating state,
25 closes at any rate an intake opening 18 of the receptacle.

In the embodiment according to the representations in Figures 4 and 5, the closure flap 17 is hinged on the
30 upper side of an intake opening 18. The free end of the closure flap 17 is in connection with an axle of a displacement wheel 3, which is part of an extendable carriage 20, by means of a lever 19 running to the side of the receptacle 8.

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In the customary operating position according to the representation in Figure 4, the chassis 2 (not represented any more specifically here) of the floor

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cleaning device 1 is supported on the carriage 19, for example in the region of an axle 21, by means of a supporting surface 20, which is for example shell-like. Said axle is loaded in the direction of the supporting
5 shell 20 by means of a tension spring 22.

The dirt ramp 7, already mentioned at the beginning, is pivotally articulated in the region of the lower marginal edge of the intake opening 18, i.e. in the
10 region opposite the hinged region of the closure flap 17.

Lifting of the floor cleaning device 1, schematically represented in Figure 5, leads to spring extension by
15 the carriage 19, by means of which carriage and via the lever 23 the displacement of the closure flap 17 into the closed position of the intake opening is brought about.

20 As an alternative to this closing mechanism coupled with the carriage 19, lifting of the floor cleaning device 1 may also be detected by clearance sensors 24 (cf. Figure 2), a corresponding logic deriving a signal for closing the intake opening 18. An actuator for
25 example, as a further example a servo motor, may bring the closure flap 17 into the closed position. By means of such an actuator, the closed position can also be achieved when the floor cleaning device 1 is at a standstill, sensed by a sensor.

30 Figures 6 and 7 show a further alternative configuration for the automatic closing of the receptacle intake opening 18. Here, the receptacle is mounted in a floating manner in the floor cleaning
35 device 1 or in the chassis 2, so that the floor cleaning device 1 is movable in the vertical direction in relation to the receptacle 8.

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In the customary operating position (represented in Figure 6), the chassis 2 is supported on the receptacle 8, for which purpose furthermore the chassis 2 has a pocket-like depression 25 for the receptacle 8. When the floor cleaning device 8 is displaced, by this means the receptacle 8 is taken along to collect the swept-up or sucked-up dirt, which receptacle 8 slides over the floor 10 on skid-like spacers 33.

10 If the floor cleaning device 1 is lifted, this involves a vertical relative displacement of the chassis 2 with respect to the receptacle 8, the latter remaining on the floor 10. This relative displacement of the chassis 2 has the effect that a chassis wall 26, forming the closure means 16, moves in a blocking manner in front of the intake opening 18 of the receptacle 8, whereby the latter is closed.

Not represented, but advantageous from a handling viewpoint, is a configuration in which the relative vertical displaceability of the floor cleaning device 1 or of the chassis 2 with respect to the receptacle 8 is stop-limited, so that further lifting from the position shown in Figure 7 has the effect that the receptacle 8 is taken along.

The closure of the receptacle intake opening 18 may also be coupled to the operating state of the brush 5, driven by means of the electric motor 12, and/or of the displacement wheels, driven by means of the electric motor 11. Therefore, mechanical closing of the intake opening 18 may be achieved by means of these electric motors 11, 12 being switched off by the user or else, as already indicated, by means of a sensor system for clearance detection when the floor cleaning device 1 is lifted. Figures 8 and 9 show an exemplary embodiment of this. Here, too, the closure means 16 is formed as a closure flap 17 that is hinged in the upper marginal

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region of the intake opening 18. The free end of this closure flap 17 is coupled with the motor - in the representations the electric motor 12 for the brush 5 - by means of a toggle lever mechanism 27, a tension spring 29 that is fixed to the chassis in the region of the toggle joint 28, biasing the mechanism 27 into a closed position of the closure flap 17.

Figure 8 shows the operating situation with the electric motor 12 for the brush 5 switched on, in which situation the toggle lever mechanism 27 is actuated against the spring force of the tension spring 29 by the motor counter-torque in such a way that the closure flap 17 is kept in the open position by means of this mechanism. When the electric motor is switched off - by user intervention and/or by a sensor sensing when the device is lifted - the counter-torque subsides, so that the toggle lever mechanism 27 is brought back into its basic position, represented in Figure 9, on account of the spring force of the tension spring 29, which brings about a pivoting of the closure flap 17 into the closed position of the intake opening by means of the mechanism.

When the toggle lever mechanism 27 interacts with the electric motor 11 for the displacement wheels 3, means which keep the closure flap 17 open during reverse travel, i.e. when traveling counter to the customary direction of displacement r , are provided.

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A fan 30, serving for providing a stream of air to assist the transportation of the dirt into the receptacle 8, may also be provided for closing the receptacle 8. This fan is driven by electric motor and is mounted directly in the region of the intake opening 18 in such a way that the fan blades 31 extend in a blocking manner in front of the intake opening 18 in a standstill position of the fan 18 according to the

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representation in Figure 11, this closed position of the fan 30 being defined by engagement of at least one fan blade 31 with a marginal portion of the intake opening 18.

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When the device is switched off by the user, or the floor cleaning device 1 is lifted, sensed by clearance sensors 24, the fan 30 is brought by the electric motor into the closed position and is switched off after this position is reached, it being possible for the reaching of the closed position to be monitored for example by a light barrier.

According to the representations in Figures 12 and 13, a closure flap 17 that is hinged on the receptacle 8 may also be coupled by means of a lever 23 with a cleaning unit 32 disposed in a floating or pivotable manner, which cleaning unit substantially comprises the electric motor 12 and the brush 5 driven by it, which are mounted pivotably about a horizontal axis on a common pivot arm (not represented any more specifically). In the customary operation of the floor cleaning device 1, this cleaning unit 32 rests with the brush 5 on the floor 10 that is to be cleaned, in a known gravity-dependent manner. Lifting of the floor cleaning device 1 off the floor 10 has the effect of pivoting the cleaning unit 32 away about its pivot axis in a downward direction, which by means of the articulated lever 23 results in the displacement of the closure flap 17 into the closed position of the intake opening. The pivoting away of the cleaning unit 32 is stop-limited.

All disclosed features are (in themselves) pertinent to the invention. The disclosure content of the associated/accompanying priority documents (copy of the prior application) is also hereby incorporated in full in the disclosure of the application, including for the

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purpose of incorporating features of these documents in claims of the present application.

CLAIMS

1. Floor cleaning device (1), in particular a cleaning robot, with an electromotive drive and with displacement wheels (3) and/or a driven brush (5),
5 a floor identification being carried out, characterized in that the floor identification is carried out by means of sensing a slippage and/or a resistance to displacement.
- 10 2. Floor cleaning device according to Claim 1 or in particular according thereto, characterized in that the slippage is determined by means of a comparison between distance covered and revolutions of a
15 driven displacement wheel (3) and/or a driven brush (5).
3. Floor cleaning device according to one or more of the preceding claims or in particular according
20 thereto, characterized in that the resistance to displacement is determined on the basis of the power consumption of the drive motor (11, 12) of the displacement wheel (3) and/or of the brush (5).
- 25 4. Floor cleaning device according to one or more of the preceding claims or in particular according thereto, characterized in that the floor cleaning device (1) has a sensor (13) for sensing the distance covered.
- 30 5. Floor cleaning device according to one or more of the preceding claims or in particular according thereto, characterized in that the sensor (13) is a slave wheel (9).
- 35 6. Floor cleaning device according to one or more of the preceding claims or in particular according thereto, characterized in that the floor cleaning

device (1) has an electronic memory (15), in which comparison values for slippage and/or resistance to displacement of different floor coverings are stored.

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7. Floor cleaning device according to one or more of the preceding claims or in particular according thereto, characterized in that the floor cleaning device has a computer unit, which compares the measured values with the stored values and derives from this a signal for the navigation and/or a drive power of the brush (5) or displacement wheels (3) and/or a signal for setting the brushes (5) and/or the device's elements that influence the resistance to displacement.

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8. Floor cleaning device (1), in particular a cleaning robot, with a driven brush (5) and a receptacle (8) for dirt, the receptacle (8) having not only an intake opening (18) but optionally also a discharge opening and the intake opening (18) and optionally the discharge opening having closure means (16), which close the respective opening (18) in any case when the device is switched off (1), characterized in that the closure means (16) come into action automatically in dependence on an operating state of the device (1).

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9. Floor cleaning device according to Claim 8 or in particular according thereto, characterized in that the closure means (16) are automatically actuated in dependence on an operating state of the device (1).

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10. Floor cleaning device according to one or either of Claims 8 and 9 or in particular according thereto, characterized in that actuation takes place by lifting of the device (1).

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11. Floor cleaning device according to one or more of
Claims 8 to 10 or in particular according thereto,
characterized in that a carriage (19) which can be
made to extend when lifting occurs brings about a
lever-actuated closure of the opening (18).
12. Floor cleaning device according to one or more of
Claims 8 to 11 or in particular according thereto,
characterized in that a counter-torque of an
electric drive motor (11, 12) is used for the
actuation of the closure means (16).
13. Floor cleaning device according to one or more of
Claims 8 to 12 or in particular according thereto,
characterized in that the counter-torque of the
drive motor (11, 12) of the brush (5) and/or of
that serving for the traveling movement is used.
14. Floor cleaning device according to one or more of
Claims 8 to 13 or in particular according thereto,
characterized in that the closure means (16) is
biased into the closed position by means of a
spring (29).
15. Floor cleaning device according to one or more of
Claims 8 to 14 or in particular according thereto,
characterized in that a separate actuating means
acts on the closure means (16) in dependence on the
device being at a standstill and/or lifting of the
device (1).
16. Floor cleaning device according to one or more of
Claims 8 to 15 or in particular according thereto,
characterized in that the separate actuating means
is an electric motor.

17. Floor cleaning device according to one or more of Claims 8 to 16 or in particular according thereto, in that the receptacle (8) is mounted in such a way that it is vertically movably in the device (1) and is displaced vertically downward under its own weight when the device (1) is lifted, the opening (18) moving into the closed position in relation to a closure means (16) in the course of this displacement.
18. Floor cleaning device according to one or more of Claims 8 to 17 or in particular according thereto, characterized in that a separate fan (30) is associated with the receptacle (8), a path of movement of the fan blades (31) coinciding with the opening (18) and a fan blade (31) closing the opening (18) when it is at a standstill.