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(71) Applicant: **Versuni Holding B.V.**
5656 AE Eindhoven (NL)

(72) Inventors:
- **VAN DER KOOI, Johannes Tseard**
  5656 AE Eindhoven (NL)
- **LEI, Lieuwe Hendrik**
  5656 AE Eindhoven (NL)

(54) **DIRECTION OF ROTATION OF A BRUSH IN A SUCTION HEAD**

(57) In the field of vacuum cleaning, a suction head (1) is provided that comprises a housing (10) and a rotatable brush (20) arranged in the housing (10), wherein the housing (10) has a brush-facing surface (15) that is shaped to encompass the brush (20) along its length and a portion of its periphery. The suction head (1) is configured to be operable in a condition in which a direction of rotation of the brush (20) about its rotation axis (R) is a reverse direction that is opposite to a forward direction associated with a smallest rotation angle (θ_R) from a) an effective surface cleaning area (23) of the brush (20) that is configured to contact the surface (2) to be cleaned towards b) an internal air suction opening (14) provided in the brush-facing surface (15). This is especially beneficial when it comes to effectively removing dirt from a soft surface.

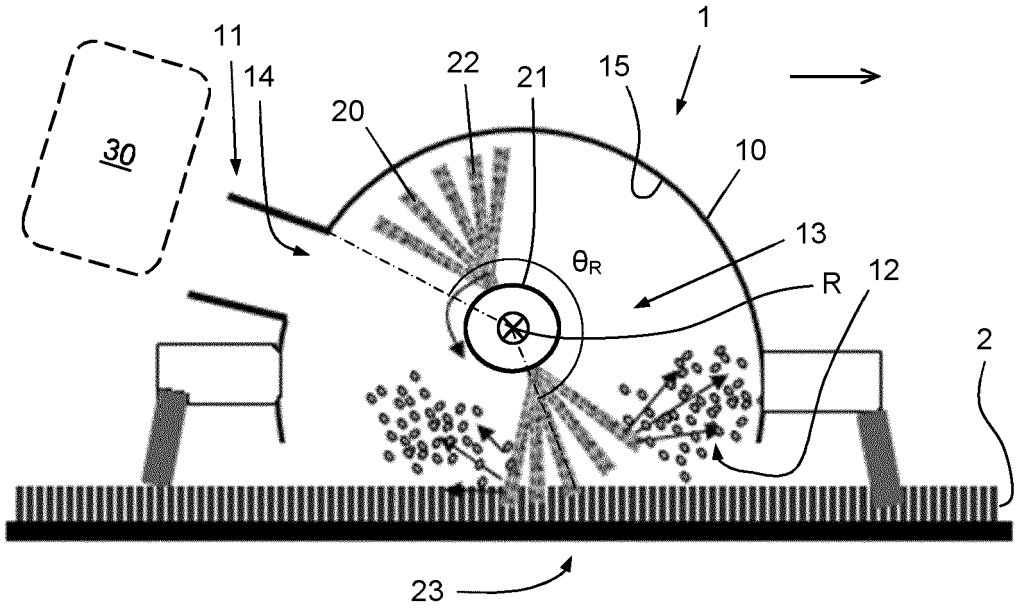

Fig. 2

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Description

FIELD OF THE INVENTION

[0001] The invention relates to a suction head configured to be applied as part of a vacuum cleaner arrangement and to perform a cleaning action on a surface, the suction head comprising: a housing, and a brush arranged in the housing, the brush being rotatable about a rotation axis and being configured to interact with the surface to be cleaned, wherein the housing has an opening through which a bottom portion of the brush including an effective surface-cleaning area that is configured to contact the surface to be cleaned is exposed to outside of the housing, and wherein the housing further has a brush-facing surface that is shaped to encompass the brush along its length and a portion of its periphery, and that is provided with a suction opening that is configured to be in communication with an air suction source configured to invoke a flow of air in a direction away from an area of the housing where the brush is located, through the suction opening.

[0002] Further, the invention relates to a vacuum cleaner arrangement comprising a suction head as mentioned, which vacuum cleaner arrangement may be an arrangement that is commonly referred to as cordless vacuum cleaner and/or stick vacuum cleaner, for example.

BACKGROUND OF THE INVENTION

[0003] Vacuum cleaner arrangements are known for removing dirt from a surface to be cleaned. The term "dirt" as used in the present text is to be understood so as to cover any contamination as may be present on a surface and that can be removed under the influence of a vacuum cleaning action, probably combined with another cleaning action such as mopping. Practical examples in this respect include dust and small particles of any kind, and also wet types of contamination such as spilled drinks. A practical example of the surface to be cleaned is a floor, wherein the floor may be of any kind, such as a wooden floor, a carpet floor, a tile floor, etc. In general, the surface to be cleaned can be classified as being either a soft surface or a hard surface. A carpet floor is an example of a soft surface, whereas a wooden floor and a tile floor are examples of a hard surface.

[0004] Generally, a vacuum cleaner arrangement has a vacuum cleaner head, which is commonly referred to by terms such as suction head, suction nozzle, or nozzle arrangement. In the present text, the first term will be used. The suction head is the part of the vacuum cleaner arrangement where the actual process of removing dirt from a surface to be cleaned is to take place and which is therefore to be put on or at least close to the surface. Further, a vacuum cleaner arrangement normally comprises a body portion including a dirt accumulating area, and an air suction source by means of which it is possible to create a situation in which a suction force is prevailing in the suction head during operation of the vacuum cleaner arrangement, which air suction source may be included in the body portion as well, or may be incorporated in the suction head. The suction force serves to facilitate transport of dirt that is removed from the surface during operation of the vacuum cleaner arrangement towards the dirt accumulating area. The suction force may also have a function in the actual process of loosening the dirt from the surface. Further, the suction head may be equipped with at least one movable component for interacting with the surface in order to loosen the dirt, such as at least one rotatable brush that may serve as an agitator of the dirt (and also of carpet piles if used on a carpet), and that may particularly be configured to help dislodge dirt from the surface, and possibly also to direct the dirt to further inside the suction head.

[0005] WO 2015/074769 A1 discloses a nozzle arrangement comprising a brush that is rotatable about a brush axis, said brush being provided with brush element having tip portions for contacting the surface to be cleaned and removing dirt and/or liquid particles from the surface during rotation of the brush, and further comprising a drive means for rotating the brush in a predetermined direction of rotation. The brush is partly surrounded by a brush-facing surface of a nozzle housing. The arrangement of the brush within the nozzle housing is chosen such that the brush partially protrudes from a bottom side of the nozzle housing. During use of a cleaning device including the nozzle arrangement, the bottom side of the nozzle housing faces towards the surface to be cleaned. Dirt and/or liquid particles that have been removed from the surface by the brush are guided from an area of the nozzle housing where the brush is located towards an exhaust channel, wherein the particles are made to pass through a suction opening provided in the brush-facing surface of the nozzle housing.

[0006] In the field of cleaning surfaces, effectiveness of the cleaning action on the surface is a very important characteristic, and there is an ongoing process of trying to realize improvements in this respect. The effectiveness of a suction head is commonly indicated by the so-called DPU level of the suction head, wherein DPU stands for dust pick-up. Use of one or more brushes in a suction head, as described in the foregoing, helps to ensure that particles are freed from surfaces to be cleaned, whereby a higher DPU level can be obtained than if only vacuum would be applied. This is advantageous in the context of vacuum cleaner arrangements in which suction power cannot be very high, as is the case with cordless vacuum cleaners, i.e. battery-operated vacuum cleaners.

SUMMARY OF THE INVENTION

[0007] It is an object of the invention to provide a way of improving the DPU level of a suction head comprising at least one rotatable brush, without increasing complex-

ity of construction, bulkiness of the suction head, or level of suction power and/or energy consumption.

[0008] In view of the foregoing, the invention provides a suction head configured to be applied as part of a vacuum cleaner arrangement and to perform a cleaning action on a surface, the suction head comprising: a housing, and a brush arranged in the housing, the brush being rotatable about a rotation axis and being configured to interact with the surface to be cleaned, wherein the housing has an opening through which a bottom portion of the brush including an effective surface-cleaning area that is configured to contact the surface to be cleaned is exposed to outside of the housing, wherein the housing further has a brush-facing surface that is shaped to encompass the brush along its length and a portion of its periphery, and that is provided with a suction opening that is configured to be in communication with an air suction source configured to invoke a flow of air in a direction away from an area of the housing where the brush is located, through the suction opening, and wherein the suction head is configured to be operable in a condition in which a direction of rotation of the brush about its rotation axis is a reverse direction that is opposite to a forward direction associated with a smallest rotation angle from the effective surface cleaning area of the brush towards the suction opening.

[0009] It follows from the foregoing definition of the suction head according to the invention that the suction head is configured to be operable in a condition in which a direction of rotation of the brush about its rotation axis is a reverse direction that is opposite to a forward direction associated with a smallest rotation angle from the effective surface cleaning area of the brush towards the suction opening. In this respect, it is noted that the forward direction is the conventional direction of rotation of the brush, such as known from WO 2015/074769 A1. Rotating the brush in the forward direction seems to be the most logical thing to do in view of the intended removal of dirt from the surface to be cleaned, wherein it is assumed that rotating the brush in the reverse direction would result in the dirt mostly getting swept away from the suction opening rather than being enabled to reach the suction opening. However, in the context of the invention, it has been found that there is more to the behavior of dust under the influence of the interaction of the brush and the surface, as will now be explained.

[0010] The above-mentioned conventional reasoning that it is best to rotate the brush in the forward direction appears to be valid when it comes to removing dirt from hard surfaces such as wooden floors or tile floors. However, according to insights gained in the context of the invention, matters are more complex when it comes to removing dirt from soft surfaces. In particular, it has been observed that when the brush interacts with a soft surface, two effects take place, on the basis of which dirt is removed from the surface, wherein one effect prevails at one side of the effective surface cleaning area of the brush, and wherein the other effect prevails at the other side of the effective surface cleaning area of the brush. One effect is a sweeping effect, and another effect is a pile flicking effect. The pile flicking effect is obtained as a result of the interaction of the brush with the structure of the soft surface, which causes the structure to first be deformed to some extent and then spring back to its original shape, releasing and flinging away dirt in the process. The occurrence of both the sweeping effect and the pile flicking effect may be promoted by having two types of brush elements in the brush, namely soft, flexible brush elements for causing dislodgement of dirt on the basis of the sweeping effect, and brush elements of less flexibility for causing dislodgement of dirt on the basis of the pile flicking effect.

[0011] When the brush is used on a soft surface and rotated in the forward direction, the sweeping effect takes place at the side of the effective surface cleaning area of the brush that is closest to the suction opening, which is where the brush elements leave the surface to be cleaned. Thus, dirt particles getting airborne as a result of the sweeping effect are enabled to directly reach the suction opening without hindrance. At the other side of the effective surface cleaning area of the brush, which is where the brush elements approach the surface to be cleaned, the pile flicking effect takes place. It appears that the dirt particles getting airborne as a result of the pile flicking effect are smashed back into the structure of the soft surface under the influence of approaching brush elements, wherein the fact that the path towards the suction opening is long at the side where the pile flicking effect occurs is a relevant factor in the process. According to a notable insight of the invention, the pile flicking effect is therefore not used to an optimal extent and the DPU level of the suction head can be improved when the direction of rotation of the brush relative to the position of the suction opening in the suction head is chosen to be the reverse direction, opposite to what is known from the prior art. When the invention is put to practice, it is achieved that the dirt particles getting airborne as a result of the pile flicking effect are enabled to directly reach the suction opening without hindrance, and that the dirt particles getting airborne as a result of the sweeping effect are enabled to also reach the suction opening, following the longest path towards the suction opening and moving along the brush-facing surface of the housing. With the direction of rotation of the brush being the reverse direction, the longest path towards the suction opening is in the direction of rotation of the brush so that the dirt particles are not hindered in following this path. It appears that on the basis of the measure according to the invention, it is possible to achieve an improvement of the DPU level of as much as 3% to 6% when a comparison is made to the achievements of state-of-the-art suction heads of good quality.

[0012] In the context of the invention, the following practical options are applicable to the design of the suction head: a) the brush-facing surface of the housing is shaped to encompass the brush along its length and a

portion of its periphery at close range, b) the suction opening has an elongated shape and extends substantially parallel to the rotation axis of the brush, c) the suction opening is located at a level that is between a level of the rotation axis of the brush and a level of the effective surface cleaning area of the brush, d) the brush comprises a core and brush elements arranged on the core, wherein, as seen in a direction about the rotation axis of the brush, at least one area of the core is free from brush elements, e) the brush comprises at least two types of brush elements which are different at least as far as their flexibility is concerned, and f) the brush elements comprise filaments which are arranged on the core in tufts. In respect of option d), it is noted that having bare portions on the core contributes to enabling dirt that is loosened from a soft surface on the basis of the pile flicking effect when the brush is rotated in the reverse direction to actually reach the suction opening without being hindered by approaching brush elements. In respect of option e), it is noted that having the at least two types of brush elements may help in realizing both the sweeping effect and the pile flicking effect when the suction head is used on a soft surface, as explained earlier. However, it is to be noted that it is also very well possible to only have a single type of brush elements. When two different types of brush elements are used, it is practical if the most flexible brush elements are at least as long as the less flexible brush elements, preferably longer than the less flexible brush elements, because this helps in ensuring that hard surfaces are contacted by the most flexible brush elements while a scratching effect from contact to the less flexible brush elements can be avoided. In that case, when the brush is used on a soft surface, it is still possible to have optimal agitating effect from the less flexible brush elements, because the brush sinks further into the surface due to wheels, sliding surfaces or the like of the suction head sinking between the carpet piles.

[0013] In a basic embodiment of the suction head according to the invention, the suction head is especially designed for use on soft surfaces by allowing rotation of the brush in the reverse direction. In another embodiment of the suction head according to the invention, the suction head is designed for use on hard surfaces and soft surfaces by allowing rotation of the brush in two different directions. For example, it may be so that the suction head comprises a drive system that is configured to bring about rotation of the brush about its rotation axis, and that the drive system is configured to be operable in two different conditions, namely a condition in which the drive system is configured to bring about rotation of the brush in the forward direction and a condition in which the drive system is configured to bring about rotation of the brush in the reverse direction, wherein the suction head further comprises a drive control system configured to set the condition of the drive system in relation to at least one discrimination parameter. Another way of achieving this involves equipping the suction head with an opening positioning system configured to vary the position of the suction opening in the brush-facing surface of the housing, and an opening control system configured to control the opening positioning system in relation to at least one discrimination parameter. In the latter case, it may be so that either a) at least one portion of the housing is movable in the suction head and the opening positioning system is configured to vary the position of the suction opening in the brush-facing surface of the housing by bringing about movement of the at least one portion of the housing or b) the brush-facing surface of the housing is provided with two openable and closable suction openings and the opening positioning system is configured to vary the position of the suction opening in the brush-facing surface of the housing by opening and closing the respective suction openings.

[0014] In any case, the at least one discrimination parameter can be a parameter that is representative of a presence status of at least one removably arranged component of the suction head. In view of the fact that it is intended to rotate the brush in the reverse direction when the suction head is used on a soft surface, a practical example of the at least one removably arranged component of the suction head is a component that is especially used for cleaning such a type of surface, i.e. a soft surface accessory.

[0015] Additionally or alternatively, the at least one discrimination parameter can be a parameter that is representative of the type of the surface to be cleaned. In conformity with what has been explained in the foregoing, it is advantageous if the suction head is configured to be operable in a condition in which the direction of rotation of the brush is the forward direction when the at least one discrimination parameter is representative of a hard type of surface to be cleaned, and to be operable in a condition in which the direction of rotation of the brush is the reverse direction when the at least one discrimination parameter is representative of a soft type of surface to be cleaned.

[0016] Information about the type of surface to be cleaned may be obtained in any suitable way. For example, the invention covers a possibility of the suction head being equipped with a user interface configured to enable a user of the suction head to input information that is representative of the type of the surface to the drive control system or the opening control system. According to an additional or another possibility, the suction head comprises a detector system configured to detect the at least one discrimination parameter. Such a detector system may be configured to obtain images from the surface to be cleaned and/or to measure at least one actual value of an operational parameter of at least one component of the suction head, for example. In the latter case, assuming that the suction head comprises the drive system mentioned in the foregoing and the drive system includes a motor and an output shaft of the motor, it may be so that the at least one component of the suction head comprises the motor. In general, it takes an increased level of motor power to rotate the brush on a soft surface than on a hard surface, and this fact can be used to detect the

type of surface. In respect of the motor, it is noted that when the working principle of the invention involves the drive system being configured to be operable in two different conditions, it is practical if the motor is configured to allow for rotation of its output shaft in the two possible different directions.

[0017] The invention further relates to a vacuum cleaner arrangement comprising a suction head as mentioned, which vacuum cleaner arrangement may particularly be an arrangement that is commonly referred to as cordless vacuum cleaner and/or stick vacuum cleaner. As is known per se in the relevant field, a vacuum cleaner arrangement normally comprises a body portion to which the suction head is connectable, wherein the body portion usually includes a dirt accumulating area, and further comprises an air suction source by means of which it is possible to create a situation in which a suction force is prevailing in the suction head during operation of the vacuum cleaner arrangement, which air suction source may be included in the body portion as well, or may be incorporated in the suction head. In general, the invention relates to any type of vacuum cleaner arrangement, and the vacuum cleaner arrangement according to the invention may be an arrangement that is commonly referred to as a cordless vacuum cleaner and/or a stick vacuum cleaner, as mentioned earlier. Other feasible options in respect of the vacuum cleaner arrangement according to the invention include an arrangement that is commonly referred to as canister vacuum cleaner, an arrangement that is commonly referred to as upright vacuum cleaner, an arrangement that is commonly referred to as robotic vacuum cleaner, and an arrangement that is commonly referred to as sweeper.

[0018] The above-described and other aspects of the invention will be apparent from and elucidated with reference to the following detailed description of a practical embodiment of the suction head as defined and described in the foregoing.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] The invention will now be explained in greater detail with reference to the figures, in which equal or similar parts are indicated by the same reference signs, and in which:

Figures 1 and 2 diagrammatically show a cross-sectional view of a suction head according to the invention as used on a carpet floor, wherein figure 1 illustrates how dirt is loosened from the carpet in case a brush of the suction head is rotated in a forward direction, and wherein figure 2 illustrates how dirt is loosened from the carpet in case the brush is rotated in a reverse direction, and

Figure 3 diagrammatically shows a front view of the suction head according to the invention.

DETAILED DESCRIPTION OF EMBODIMENTS

[0020] Figures 1-3 relate to a suction head 1 according to an embodiment of the invention. It is to be noted that the embodiment illustrated in the figures is a practical one out of various possibilities covered by the invention, and that aspects of the embodiment as will be discussed in the following are in no way to be understood so as to represent limitations to the invention as defined in the attached claims.

[0021] The suction head 1 is configured to be applied as part of a vacuum cleaner arrangement, and comprises a housing 10 that includes a coupling area 11 configured to enable coupling of the housing 10 to another portion of the vacuum cleaner arrangement, such as a body portion or a hose/duct. At the side at which the housing 10 is to face a surface 2 to be cleaned, the housing 10 is provided with an opening 12. Further, the suction head 1 comprises a brush 20 that is configured to interact with the surface 2 and arranged in a brush area 13 of the housing 10. At the position of the opening 12 in the housing 10, a bottom portion of the brush 20 is exposed to the surface 2. The brush 20 is rotatable about a rotation axis R, and may be of any suitable type, such as the type comprising a core 21 and brush elements 22 extending from the core 21, wherein free end portions of the brush elements 22 are configured to contact the surface 2 and to thereby agitate dirt as may be present on the surface 2. In figure 3, the outline of the brush 20 is represented by a dashed rectangle, to thereby clarify the position of the brush 20 in the suction head 1. Similarly, the outline of the suction opening 14 is represented by a dashed rectangle, to thereby clarify the position of the suction opening 14 in the suction head 1 and relative to the brush 20. A line A-A in figure 3 is representative of a line along which a cross-section as shown in figures 1 and 2 can be obtained.

[0022] When the suction head 1 is actually installed as part of the vacuum cleaner arrangement and the vacuum cleaner arrangement is operated to clean the surface 2, the brush 20 is driven so as to rotate, and an air suction source 30 that is configured to invoke a flow of air in a direction away from the brush area 13, through a suction opening 14 that is an internal opening of the housing 10, is in an active state. As a result, dirt as may be present on the surface 2 is removed from the surface 2 and displaced to inside the housing 10 of the suction head 1. The dirt is made to move further downstream in the housing 10, from the brush area 13 towards the coupling area 11, wherein the dirt passes the suction opening 14. The suction opening 14 can have an elongated shape and extend substantially parallel to the rotation axis R of the brush 20, as illustrated in figure 3. In figures 1 and 2, airborne dirt particles in the brush area 13 are represented by small dots.

[0023] The above-mentioned air suction source 30 is also part of the vacuum cleaner arrangement and is located at a suitable position in the vacuum cleaner ar-

rangement, which may be a position in the suction head 1 or a position outside of the suction head 1, particularly in the other portion of the vacuum cleaner arrangement to which the suction head 1 is coupled. In figures 1 and 2, the air suction source 30 is shown in a schematic fashion at a position outside of the suction head 1. The suction opening 14 is provided in a brush-facing surface 15 of the housing 10 that is shaped to encompass the brush 20 along its length and a portion of its periphery, and is configured to be in communication with the air suction source 30 so that during operation of the vacuum cleaner arrangement, air is continuously sucked from the brush area 13. It is practical if the brush-facing surface 15 of the housing 10 encompasses the brush 20 at close range, as illustrated in figures 1 and 2.

[0024] In the context of the invention, embodiments of the suction head 1 which are configured for autonomous movement are feasible. In the shown example, the suction head 1 is configured to be moved forward and backward in an advancement direction of the suction head 1 over the surface 2 under the influence of user action, particularly under the influence of a pushing force and a pulling force, respectively, exerted by a user. In figures 1 and 2, a forward movement is indicated by means of a horizontal arrow. For the purpose of performing a cleaning action, the user takes hold of an appropriate portion of the vacuum cleaner arrangement to which the suction head 1 is coupled, which may be a handle on a body portion of the vacuum cleaner arrangement in case the vacuum cleaner arrangement is an arrangement that is commonly referred to as stick vacuum cleaner or a grip portion on a hose of the vacuum cleaner arrangement in case the vacuum cleaner arrangement is an arrangement that is commonly referred to as canister vacuum cleaner, and manipulates this portion so that the movement of the suction head 1 on the surface 2 as desired is realized.

[0025] The brush 20 may be of any suitable type, such as the type in which at least some of the brush elements 22 are arranged on the core 21 in a number of rows, wherein each row may be arranged so as to spiral about the core 21 along at least a portion of the periphery of the core 21, and wherein the core 21 can be bare at the areas outside of the areas where the brush elements 22 are present. In any case, the fact is that during a cleaning action on the surface 2, the brush 20 interacts with the surface 2 at the position of an effective surface-cleaning area 23. For the sake of completeness, it is noted that as the brush 20 rotates, which ones of the brush elements 22 are involved in the effective surface cleaning area 23 continuously changes. Further, for the sake of completeness, it is noted that the effective surface cleaning area 23 may be made up by a single area where brush elements 22 are present or at least two of such areas arranged at a distance from each other as seen along the length of the brush 20, depending on the design of the brush 20 and/or the angular position of the brush 20.

[0026] Figures 1 and 2 illustrate how the suction head 10 can be used on a soft surface, particularly a carpet floor.

[0027] Figure 1 illustrates how dirt is loosened from the carpet in case the brush 20 is rotated in a forward direction, which is the conventional way of rotating the brush 20. The term "forward direction" as used in this context is to be understood so as to indicate a direction that is associated with a rotation angle θ_R from the effective surface cleaning area 23 of the brush 20 towards the suction opening 14 that is the smallest one of the two possibilities that exist when it comes to choosing a direction about the rotation axis R. In figure 1, the forward direction is clockwise about the rotation axis R, as indicated by a curved arrow in the figure. Two different principal ways in which dirt is loosened from the carpet can be distinguished. In the first place, a sweeping effect occurs as the brush 20 is rotated, at a position that is in front of the brush 20 as seen in the direction of rotation of the brush 20, i.e. at a position that is at the left side of the brush 20 as seen in figure 1. Sweeping is pulling dirt particles as present on the carpet along with the brush 20 in the effective surface cleaning area 23. As seen from the perspective on a tip portion of a brush element 22, the brush element 22 is made to advance the carpet, dirt adheres to the brush element 22 when the brush element 22 is in a position of contacting the carpet, the brush element 22 is made to leave the carpet, and the dirt is flung from the brush element 22 when the brush element 22 is totally free from the carpet. In the second place, a pile flicking effect occurs as the brush 20 is rotated, at a position that is behind the brush 20 as seen in the direction of rotation of the brush 20, i.e. at a position that is at the right side of the brush 20 as seen in figure 1. Pile flicking is releasing dirt from the carpet as a result of movement/deformation of the carpet piles caused by interaction with the brush elements 22. At the position where the brush elements 22 contact the carpet piles, the carpet piles are folded open. The carpet piles act like a spring, and when they are released by the moving brush elements 22, dirt particles are shot out from the carpet.

[0028] Figure 2 illustrates how dirt is loosened from the carpet in case the brush 20 is rotated in a reverse direction, as proposed by the invention, at least when it comes to using the suction head 1 on a soft surface. The reverse direction is opposite to the forward direction. In view thereof, the reverse direction can be typified as a direction that is associated with a largest rotation angle θ_R from the effective surface cleaning area 23 of the brush 20 towards the suction opening 14, i.e. a rotation angle that is the largest one of the two possibilities that exist when it comes to choosing a direction about the rotation axis R. In figure 2, the forward direction is counterclockwise about the rotation axis R, as indicated by a curved arrow in the figure. When the brush 20 is rotated in the reverse direction, the sweeping effect still occurs at a position that is in front of the brush 20 as seen in the direction of rotation of the brush 20, i.e. at a position that is at the right side of the brush 20 as seen in figure 2, and the pile flicking effect still occurs at a position that is behind the

brush 20 as seen in the direction of rotation of the brush 20, i.e. at a position that is at the left side of the brush 20 as seen in figure 2.

[0029] According to an insight of the invention, the capability of the brush 20 to remove dirt from a soft surface is increased when the brush 20 is rotated in the reverse direction. A reason is that the dirt that is removed on the basis of the pile flicking effect is present at the side of the brush 20 where the dirt particles can move directly towards the suction opening 14. In the conventional situation of the brush 20 being rotated in the forward direction, the dirt that is removed from the carpet on the basis of the pile flicking effect needs to move along a long path before it can finally reach the suction opening 14 and is smashed back into the carpet again by approaching brush elements 22. When the brush 20 is rotated in the reverse direction, the dirt that is removed from the carpet on the basis of the pile flicking effect is enabled to reach the suction opening 14 in time without encountering approaching brush elements. Meanwhile, the sweeping effect is not compromised in view of the fact that the direction of the rotation of the brush 20 is from the position where the sweeping effect occurs towards the suction opening 14.

[0030] In view of the foregoing, a notable feature of the invention resides in the suction head 1 being configured to be operable in a condition in which a direction of rotation of the brush 20 about its rotation axis R is the reverse direction. In the framework of this feature, various options exist, including an option of the suction head 1 being designed such as to only allow rotation of the brush 20 about its rotation axis R in the reverse direction while the position of the suction opening 14 in the suction head 1 is fixed, in which case the suction head 1 is particularly suitable for use on soft surfaces. According to another option, the suction head 1 is designed such as to allow rotation of the brush 20 about its rotation axis R in both possible directions while the position of the suction opening 14 in the suction head 1 is fixed. In that case, it is possible to use the suction head 1 on all kinds of surfaces 2 and to set the direction of rotation of the brush 20 about its rotation axis R so as to be appropriate under the circumstances. In the process, use may be made of one or more sensors, for example. Additionally or alternatively, the value of one or more parameters of operation of the suction head 1, particularly one or more parameters which are known to be influenced by the type of surface 2, may be monitored and used as a basis for determining which direction of rotation of the brush 20 is to be realized. Other control options are covered by the invention as well, including options of manual setting. The same versatile and optimal use of the suction head 1 is possible if the suction opening 14 has a variable position in the suction head 1, in which case the brush 20 can always be rotated in the same direction while the position of the suction opening 14 can be chosen so as to be optimal in view of actual circumstances. Varying the position of the suction opening 14 can be achieved in various practical ways, including having a design of the suction head 1 in which two suction openings 14 are present at different sides of the housing 10, and in which the open/closed state of the suction openings 14 can be regulated. In any case, generally speaking, it is appropriate to realize a situation of the direction of rotation of the brush 20 being the forward direction when the surface 2 to be cleaned is a hard surface, and to realize a situation of the direction of rotation of the brush 20 being the reverse direction when the surface 2 to be cleaned is a soft surface. In that way, dirt removal from the surface 2 can be optimal under all circumstances, wherein the potential of the pile flicking effect is optimally employed when the surface 2 is a soft surface.

[0031] It will be clear to a person skilled in the art that the scope of the invention is not limited to the examples discussed in the foregoing, but that several amendments and modifications thereof are possible without deviating from the scope of the invention as defined in the attached claims. It is intended that the invention be construed as including all such amendments and modifications insofar they come within the scope of the claims or the equivalents thereof. While the invention has been illustrated and described in detail in the figures and the description, such illustration and description are to be considered illustrative or exemplary only, and not restrictive. The invention is not limited to the disclosed embodiments. The drawings are schematic, wherein details which are not required for understanding the invention may have been omitted, and not necessarily to scale.

[0032] Variations to the disclosed embodiments can be understood and effected by a person skilled in the art in practicing the claimed invention, from a study of the figures, the description and the attached claims. In the claims, the word "comprising" does not exclude other steps or elements, and the indefinite article "a" or "an" does not exclude a plurality. Any reference signs in the claims should not be construed as limiting the scope of the invention.

[0033] Elements and aspects discussed for or in relation with a particular embodiment may be suitably combined with elements and aspects of other embodiments, unless explicitly stated otherwise. Thus, the mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage.

[0034] The terms "comprise" and "include" as used in the present text will be understood by a person skilled in the art as covering the term "consist of'. Hence, the term "comprise" or "include" may in respect of an embodiment mean "consist of', but may in another embodiment mean "contain/have/be equipped with at least the defined species and optionally one or more other species".

[0035] The term "brush" as used in the present text is to be understood in a broad sense, and particularly to be interchangeable with the term "agitator". In respect of the term "suction opening" as used in the present text, it is

to be noted that this term is to be understood so as to cover various options, particularly both an option of the suction opening 14 being provided as a single hole in the brush-facing surface 15 of the housing 10 and an option of the suction opening 14 being provided as a collection of holes in the brush-facing surface 15 of the housing 10.

[0036] Notable aspects of the invention are summarized as follows. In the field of vacuum cleaning, a suction head 1 is provided that is configured to be applied as part of a vacuum cleaner arrangement and to perform a cleaning action on a surface 2. The suction head 1 comprises a housing 10 and a brush 20 that is arranged in the housing 10, that is rotatable about a rotation axis R, and that is configured to interact with the surface 2 to be cleaned. The housing 10 has an opening 12 through which a bottom portion of the brush 20 including an effective surface-cleaning area 23 that is configured to contact the surface 2 to be cleaned is exposed to outside of the housing 10, and further has a brush-facing surface 15 that is shaped to encompass the brush 20 along its length and a portion of its periphery, and that is provided with a suction opening 14 that is configured to be in communication with an air suction source 30 configured to invoke a flow of air in a direction away from an area 13 of the housing 10 where the brush 20 is located, through the suction opening 14. The suction head 1 is configured to be operable in a condition in which a direction of rotation of the brush 20 about its rotation axis R is a reverse direction that is opposite to a forward direction associated with a smallest rotation angle θ_R from the effective surface cleaning area 23 of the brush 20 towards the suction opening 14. This is especially beneficial when it comes to effectively removing dirt from a soft surface.

Claims

1. Suction head (1) configured to be applied as part of a vacuum cleaner arrangement and to perform a cleaning action on a surface (2), the suction head (1) comprising:

   a housing (10), and
   a brush (20) arranged in the housing (10), the brush (20) being rotatable about a rotation axis (R) and being configured to interact with the surface (2) to be cleaned,
   wherein the housing (10) has an opening (12) through which a bottom portion of the brush (20) including an effective surface-cleaning area (23) that is configured to contact the surface (2) to be cleaned is exposed to outside of the housing (10),
   wherein the housing (10) further has a brush-facing surface (15) that is shaped to encompass the brush (20) along its length and a portion of its periphery, and that is provided with a suction opening (14) that is configured to be in communication with an air suction source (30) configured to invoke a flow of air in a direction away from an area (13) of the housing (10) where the brush (20) is located, through the suction opening (14), and
   wherein the suction head (1) is configured to be operable in a condition in which a direction of rotation of the brush (20) about its rotation axis (R) is a reverse direction that is opposite to a forward direction associated with a smallest rotation angle (θ_R) from the effective surface cleaning area (23) of the brush (20) towards the suction opening (14).

2. Suction head (1) according to claim 1, wherein the suction opening (14) has an elongated shape and extends substantially parallel to the rotation axis (R) of the brush (20).

3. Suction head (1) according to claim 1 or 2, wherein the suction opening (14) is located at a level that is between a level of the rotation axis (R) of the brush (20) and a level of the effective surface cleaning area (23) of the brush (20).

4. Suction head (1) according to any of claims 1-3, wherein the brush (20) comprises a core (21) and brush elements (22) arranged on the core (21), and wherein, as seen in a direction about the rotation axis (R) of the brush (20), at least one area of the core (21) is free from brush elements (22).

5. Suction head (1) according to claim 4, wherein the brush (20) comprises at least two types of brush elements (22) which are different at least as far as their flexibility is concerned.

6. Suction head (1) according to any of claims 1-5, comprising a drive system configured to bring about rotation of the brush (20) about its rotation axis (R), wherein the drive system is configured to be operable in two different conditions, namely a condition in which the drive system is configured to bring about rotation of the brush (20) in the forward direction and a condition in which the drive system is configured to bring about rotation of the brush (20) in the reverse direction, and wherein the suction head (1) further comprises a drive control system configured to set the condition of the drive system in relation to at least one discrimination parameter.

7. Suction head (1) according to any of claims 1-5, comprising an opening positioning system configured to vary the position of the suction opening (14) in the brush-facing surface (15) of the housing (10), and an opening control system configured to control the opening positioning system in relation to at least one discrimination parameter.

8. Suction head (1) according to claim 7, wherein either a) at least one portion of the housing (10) is movable in the suction head (1) and the opening positioning system is configured to vary the position of the suction opening (14) in the brush-facing surface (15) of the housing (10) by bringing about movement of the at least one portion of the housing (10) or b) the brush-facing surface (15) of the housing (10) is provided with two openable and closable suction openings (14) and the opening positioning system is configured to vary the position of the suction opening (14) in the brush-facing surface (15) of the housing (10) by opening and closing the respective suction openings (14).

9. Suction head (1) according to any of claims 6-8, wherein the at least one discrimination parameter is representative of a presence status of at least one removably arranged component of the suction head (1).

10. Suction head (1) according to any of claims 6-9, wherein the at least one discrimination parameter is representative of the type of the surface (2) to be cleaned.

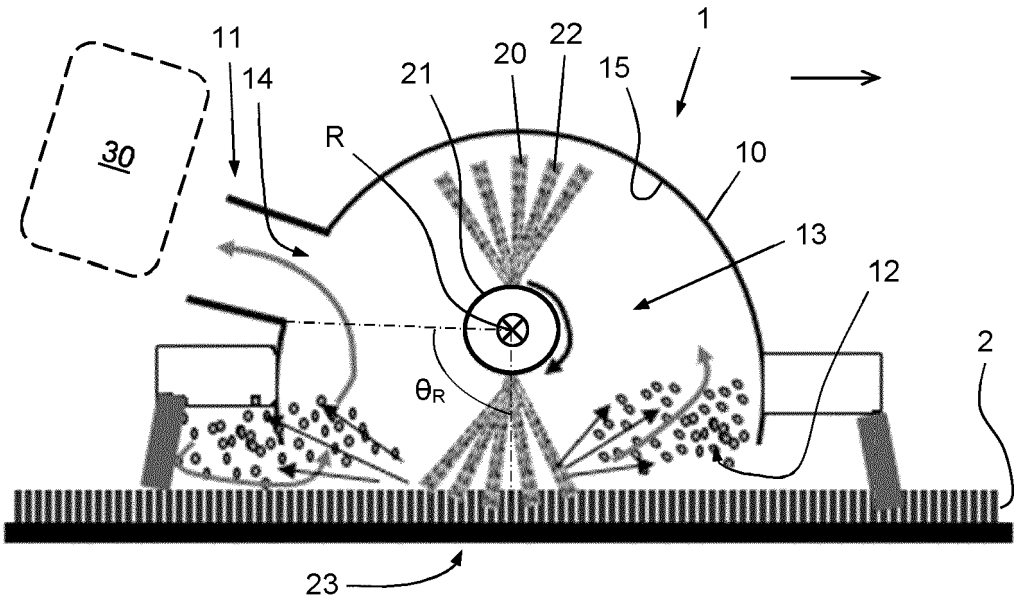
11. Suction head (1) according to claim 10, wherein the suction head (1) is configured to be operable in a condition in which the direction of rotation of the brush (20) is the forward direction when the at least one discrimination parameter is representative of a hard type of surface (2) to be cleaned, and to be operable in a condition in which the direction of rotation of the brush (20) is the reverse direction when the at least one discrimination parameter is representative of a soft type of surface (2) to be cleaned.

12. Suction head (1) according to claim 10 or 11, comprising a detector system configured to detect the at least one discrimination parameter.

13. Suction head (1) according to claim 12, wherein the detector system is configured to obtain images from the surface (2) to be cleaned and/or to measure at least one actual value of an operational parameter of at least one component of the suction head (1).

14. Suction head (1) according to claim 13 insofar as dependent on claim 6, wherein the drive system includes a motor and an output shaft of the motor, and wherein the at least one component of the suction head (1) comprises the motor.

15. Vacuum cleaner arrangement, comprising a suction head (1) according to any of claims 1-14.


11
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R
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2
θR
23

Fig. 1

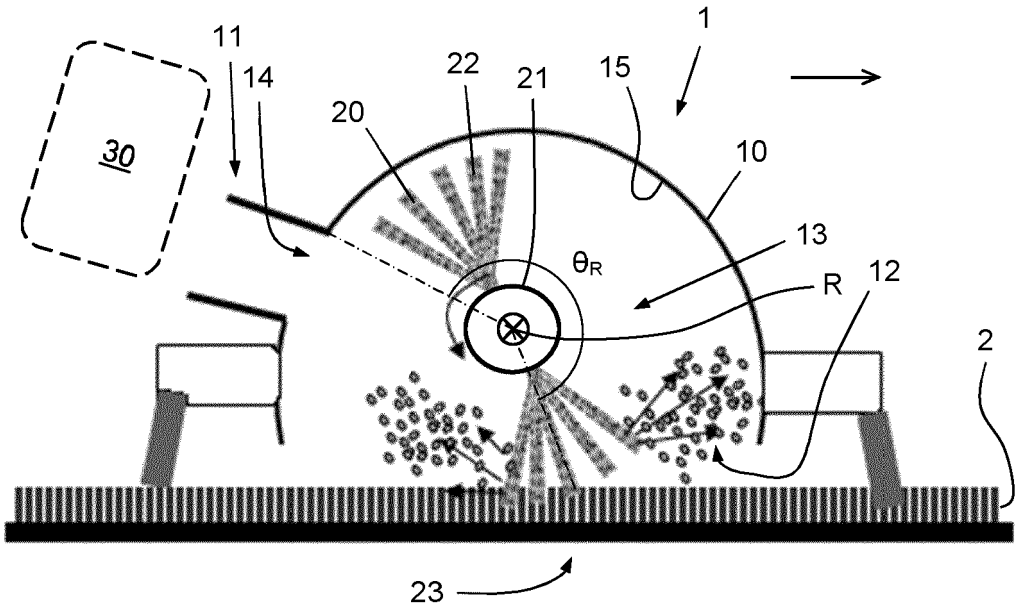
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Fig. 2

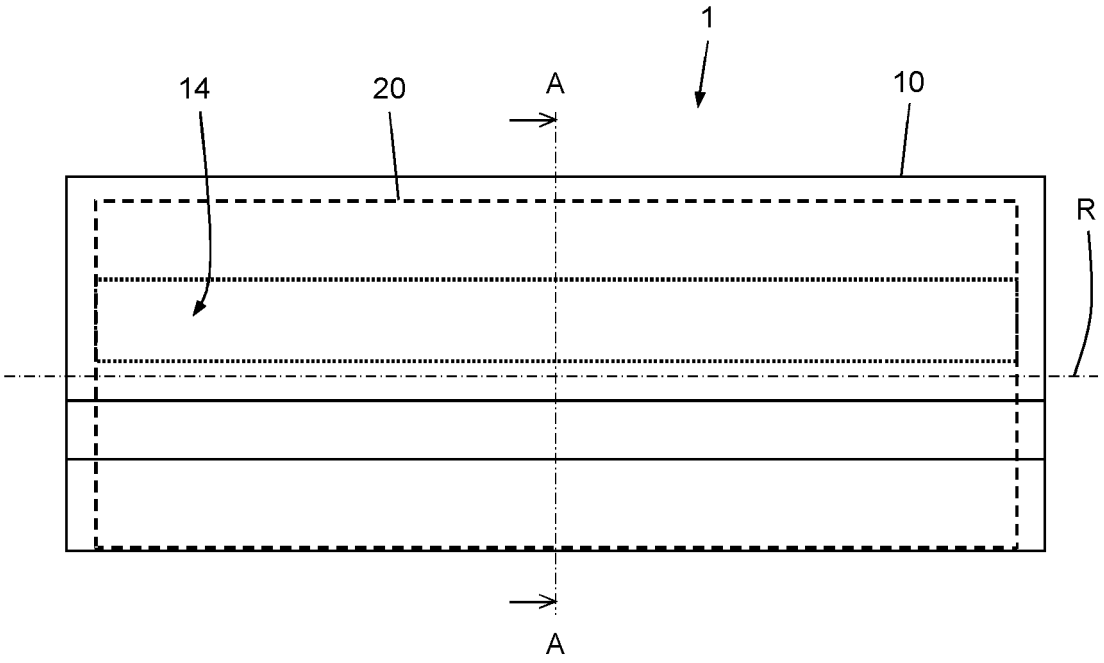

Fig. 3

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EUROPEAN SEARCH REPORT

Application Number
EP 21 20 1170

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	2 March 2022	Jezierski, Krzysztof

CATEGORY OF CITED DOCUMENTS

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