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(71) Applicant(s): Dyson Technology Limited Tetbury Hill, Malmesbury, Wiltshire, SN16 0RP, United Kingdom	(58) Field of Search: INT CL A47L Other: WPI, EPODOC, Patent Fulltext
(72) Inventor(s): Daniel James Brook Philip Jonathan Stephens	
(74) Agent and/or Address for Service: Dyson Technology Limited Intellectual Property Department, Tetbury Hill, MALMESBURY, Wiltshire, SN16 0RP, United Kingdom	

(54) Title of the Invention: Vacuum cleaner
Abstract Title: Vacuum cleaner

(57) A vacuum cleaner comprises a vacuum motor configured to draw air through the vacuum cleaner, a battery pack configured to supply electricity to the vacuum motor, and a control system configured to switch the vacuum cleaner between a plurality of operating modes upon input from an operator. The control system is further configured to make a determination of a parameter of the battery pack and to change the manner in which the operating modes are presented to the user, based on the determination of the parameter. This could involve changing the order in which the plurality of modes, preferably suction power modes, are presented to the user depending on the capacity of the battery. The controller may be configured to change the manner in which the operating modes are presented to the user by changing the default operating mode which is selected by the vacuum cleaner in the absence of a selection by an operator and the battery pack may include a memory with an indication of the parameter stored thereon, the control system being configured to make the determination of the parameter by reading the indication from the memory.

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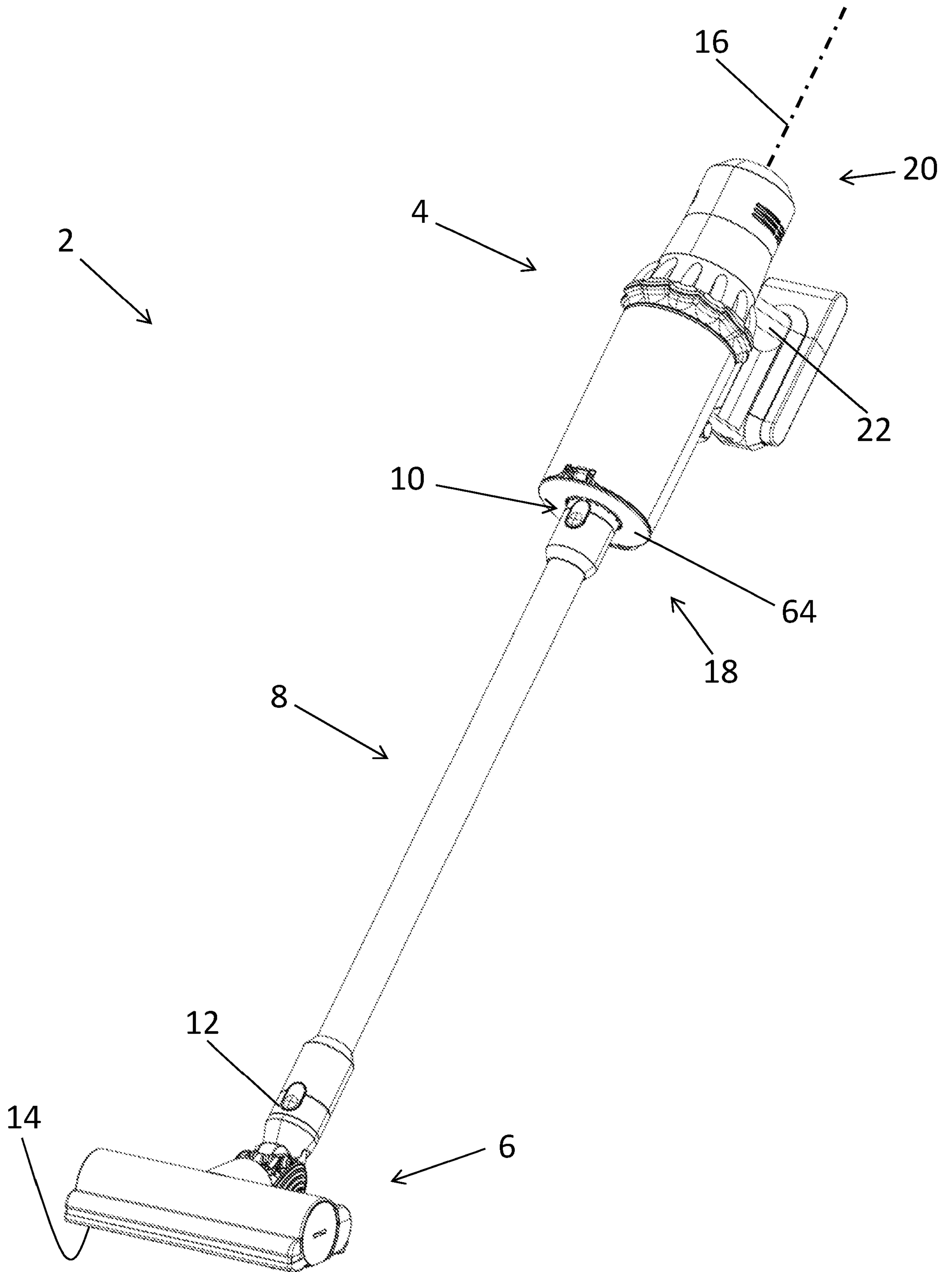


Fig. 1

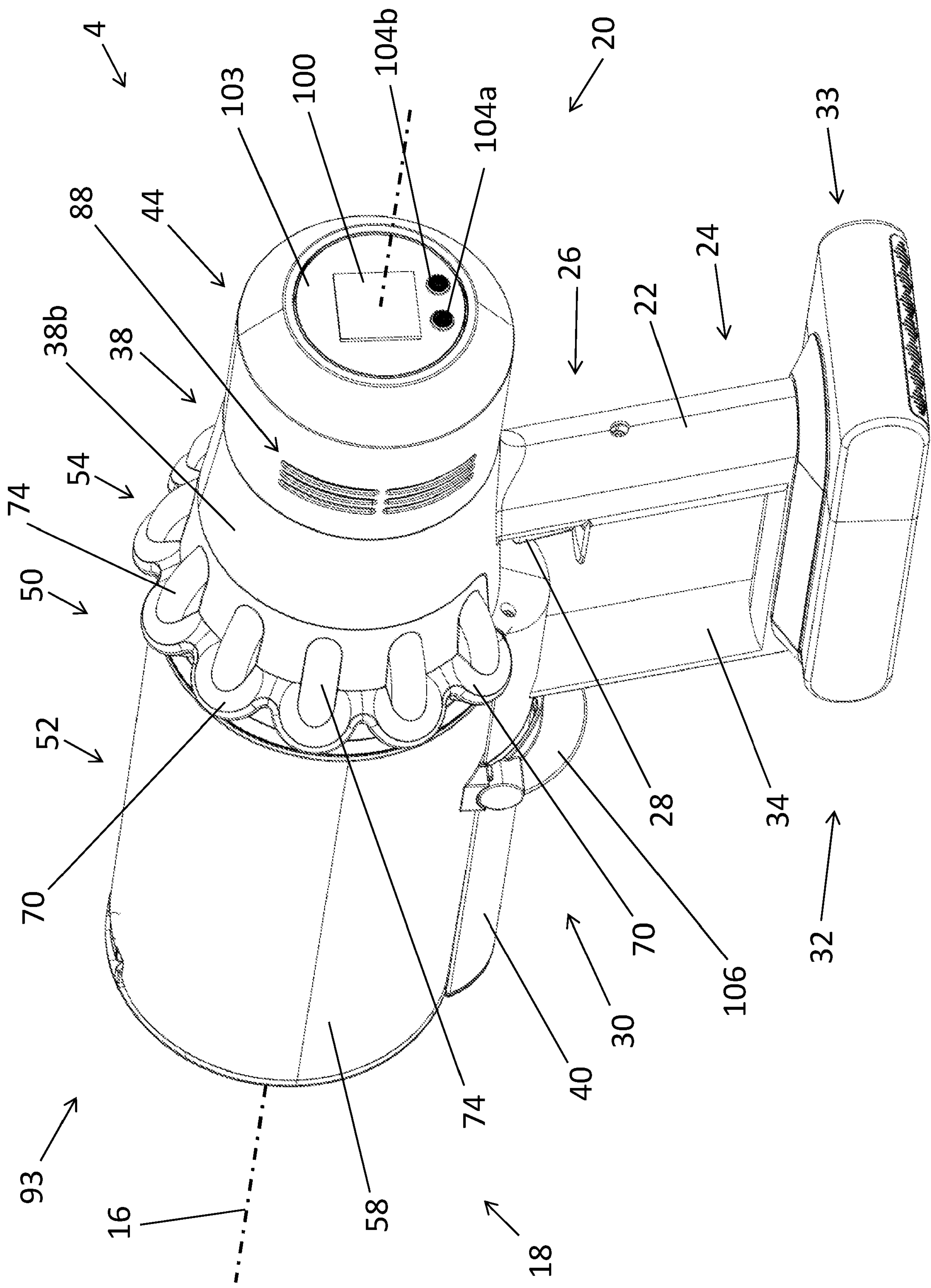


Fig. 2

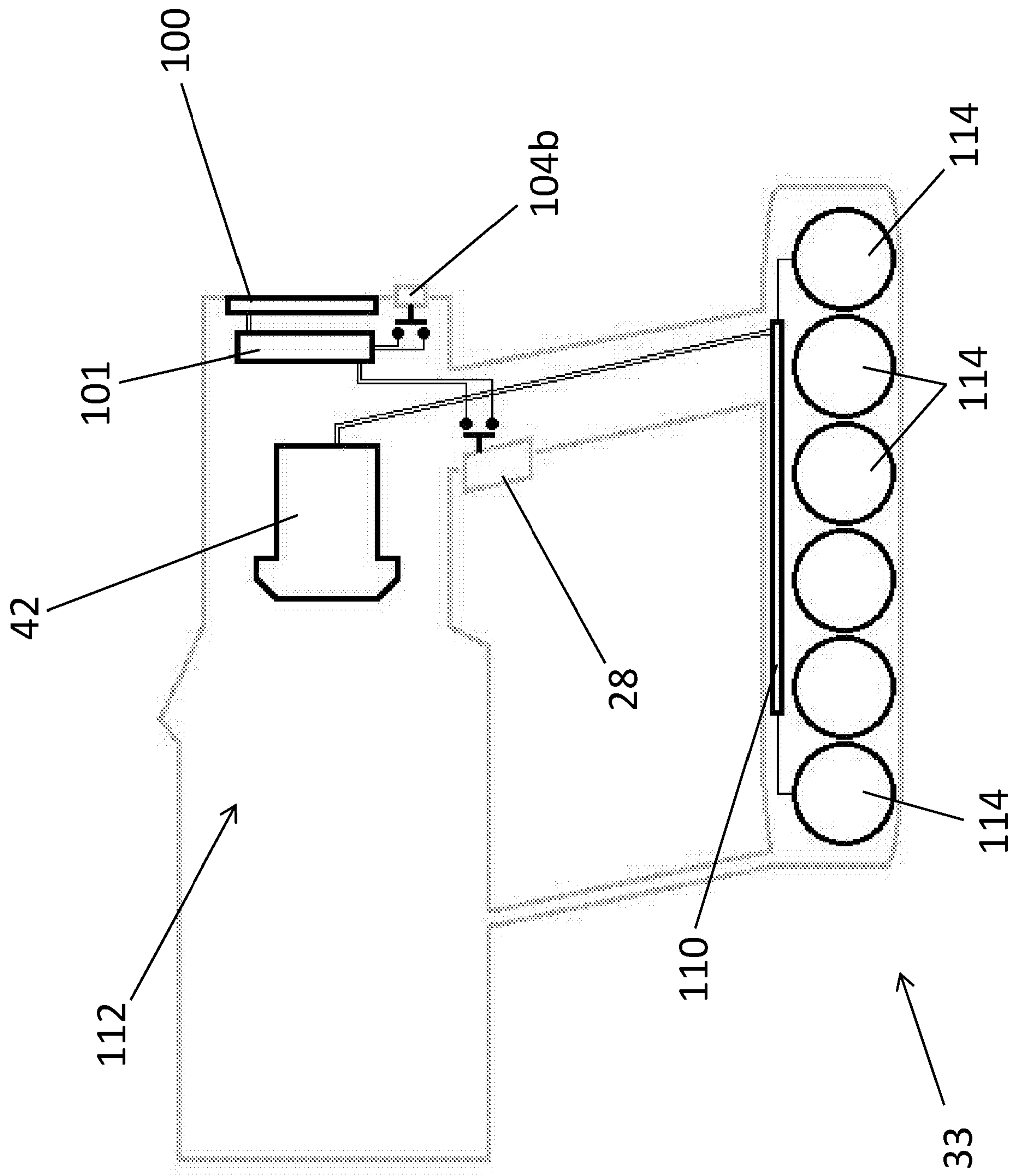


Fig. 4

Vacuum Cleaner

The present invention relates to a vacuum cleaner.

5 Battery-powered vacuum cleaners are often produced with the intention of selling them in many different countries around the world. In some cases minor changes are made to the vacuum cleaner to suit different markets. For example, a particular model of vacuum cleaner may have a smaller capacity battery pack in markets where size and weight are often the primary concern, and a larger capacity battery pack where power
10 is often the primary concern. Further, where such vacuum cleaners have more than one mode, customers in different markets sometimes have preferences for how the different modes are presented to them for selection. If a vacuum cleaner manufacturer is to satisfy these preferences/requirements, it is necessary for them to include steps in the production process to customise a vacuum cleaner for its intended market (which
15 increases production time and cost), and/or to leave the customisation to the end user (whereupon the user may become frustrated at the amount of time needed to set the machine up for their preferences).

It is one object of the present invention to mitigate or obviate at least one of the above
20 disadvantages, and/or to provide an improved or alternative vacuum cleaner.

According to the present invention there is provided a vacuum cleaner comprising:

a vacuum motor configured to draw air through the vacuum cleaner;
a battery pack configured to supply electricity to the vacuum motor; and
25 a control system configured to switch the vacuum cleaner between a plurality of operating modes upon input from an operator,
wherein:

the control system is further configured to make a determination of a parameter of the battery pack; and
30 the control system is configured to change the manner in which the operating modes are presented to the user, based on the determination of the parameter.

The control system changing the manner in which the operating modes are presented to the user, based on the determination of the parameter, can allow the vacuum

cleaner to optimise itself and/or adapt itself to an expected user preference based on the nature of the specific battery pack comprised therein. This may avoid the need for such optimisation or adaptation to be performed as a step in manufacture (thereby increasing the time and thus cost of the production process) or performed by an end user (thereby potentially reducing customer satisfaction due to increased time setting up the machine).

The parameter may be a maximum capacity of the battery pack.

10 Battery capacity is a key variable in vacuum cleaner design, in view of different customer preferences for battery capacity in view of the trade-off between capacity and size/weight. Accordingly, a vacuum cleaner which can optimise or adapt itself to different battery capacities may have particular benefit.

15 As an alternative, the parameter may be a battery pack age (e.g. absolute age or number of charge/discharge cycles experienced by the battery in its lifetime), battery pack maximum voltage or maximum allowable current draw.

The plurality of modes may include a plurality of suction power modes.

20

The suction power provided by a particular vacuum cleaner depends largely on the amount of electrical power delivered to the vacuum motor, with higher suction power requiring higher electrical power. Accordingly, suction power is inextricably linked to the supply of electrical power from the battery pack. Self-optimisation and/or self-adaptation of the suction power modes of a vacuum cleaner based on the parameter of the battery pack can therefore be of particular benefit. For instance, where the parameter is battery capacity the control system may vary the manner in which the suction power modes are presented to the user such that the vacuum cleaner favours lower power modes when the battery pack is of a smaller capacity.

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Alternatively or in addition, the plurality of modes may include a plurality of cleaner head brush bar modes (e.g. brush bar on or off, or a plurality of brush bar speed settings), and/or a plurality of cleaner head headlight modes (e.g. lights on or off, or a plurality of brightnesses).

The control system may be configured to change the manner in which the operating modes are presented to the user by changing the default operating mode which is selected by the vacuum cleaner in the absence of a selection by an operator.

5

The default mode of the vacuum cleaner is more likely to be the mode that a new owner will experience first (unless they adjust the settings of the vacuum cleaner straight away). Accordingly, the default mode being dependent on the parameter of the battery pack can allow a new owner's first impression of the vacuum cleaner to be aligned to their likely preference. For example, Asian consumers generally prefer lighter machines which therefore tend to have smaller capacity batteries, and also generally prefer vacuum cleaners to start in their lowest power mode. In contrast, North American consumers generally prefer more powerful vacuum cleaners which therefore tend to have larger capacity batteries (so as to provide sufficient run-time). The control system changing the default mode based on determined battery capacity can therefore allow machines destined for Asian markets, fitted with smaller battery packs, to automatically adapt themselves by selecting low mode as the default mode. Similarly, machines destined for North American markets, fitted with larger battery packs, can automatically adapt themselves by selecting a more powerful mode.

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The default operating mode may be the mode that the vacuum cleaner starts in whenever it is powered on. Alternatively, the vacuum cleaner may have a memory which stores the last mode used so that when the vacuum cleaner is powered on it starts operation in the mode that it was in when it was last powered off. In the latter case, the default mode may be the mode the vacuum cleaner starts in when it is powered on for the first time after manufacture.

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The control system may be configured to switch the vacuum cleaner between at least three operating modes upon input from the operator.

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The control system may be configured to cycle through said operating modes, and the control system may be configured to change the order in which the operating modes are cycled through based on the determination of the parameter.

For example, the control system may change the operation mode which appears first in the cycle (whereupon the control system may also be considered to change the default operating mode, as discussed above). As an alternative, where there are three or more operation modes the first mode in sequence may remain the same, and the control system may change the order of the remaining operation modes.

The control system may change the order of the operation modes by rearranging the sequence of operating modes, and/or by making one or more operating modes unavailable altogether (for instance where the operation modes are suction power modes and the parameter of the battery pack is its capacity, the control system may make the highest suction power mode unavailable upon determining that the battery pack's capacity is relatively small).

Optionally, the control system is configured to:

cycle sequentially and repeatedly through the power modes, switching from low to mid, mid to high, high to low and so on;

cycle through the suction power modes starting with the low suction power mode if it determines that the capacity of the battery pack is below a threshold; and

cycle through the suction power modes starting with the mid suction power mode if it determines that the capacity of the battery pack is above the threshold.

The battery pack may be removably mountable to the vacuum cleaner.

This can allow an operator to use the vacuum cleaner with different battery packs (for instance battery packs with different parameters).

Alternatively, that battery pack may be permanently attached to the vacuum cleaner during manufacture.

The battery pack may comprise a memory with an indication of the parameter stored thereon, the control system being configured to make the determination of the parameter by reading the indication from the memory.

This may reduce processing time and/or allow a cheaper control system to be utilised in comparison to a vacuum cleaner where the control system makes the determination by measuring the parameter directly.

- 5 Where the parameter is a maximum capacity, the indication may be a data 'flag' indicating that the battery pack is of a particular size (for instance a 0 to indicate a small capacity battery pack and a 1 to indicate a large capacity battery pack; or an 00 to indicate a small capacity battery pack, an 01 to indicate a medium capacity battery pack and a 10 to indicate a large capacity battery pack). As an alternative, the
10 indication may be an integer corresponding to the maximum capacity of the battery pack (in mAh, for instance).

The memory may be part of a battery management system of the battery pack.

- 15 Embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 is a perspective view of a stick vacuum cleaner according to an embodiment of the present invention;

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Figure 2 is a perspective view of a handheld vacuum cleaner of the stick vacuum cleaner of Figure 1;

- Figure 3 is a schematic cross-sectional view through the handheld vacuum cleaner of
25 Figure 2; and

Figure 4 is a schematic diagram of a control system of the vacuum cleaner.

- Throughout the description and drawings, corresponding reference numerals denote
30 corresponding features.

Figure 1 shows a stick vacuum cleaner 2 according to an embodiment of the invention. The stick vacuum cleaner 2 comprises a handheld vacuum cleaner 4 which is connected to a floor tool 6 in the form of a cleaner head by an elongate rigid wand 8. In

this case the wand is attachable to an air inlet 10 of the handheld vacuum cleaner, and to a rear duct 12 of the cleaner head 6. The wand 8 is generally tubular, the space inside forming a suction path which extends from the cleaner head 6 to the air inlet 10 of the handheld vacuum cleaner 4.

5

The cleaner head 6 has a sole plate 14 which is configured to engage a floor surface, and which has a suction opening (not visible) through which dirty air (i.e. air with entrained dirt) from the floor surface can be sucked into the cleaner head 6. In use, a vacuum motor (not visible) housed in the handheld vacuum cleaner 4 generates suction at the air inlet 10. Dirty air from a floor surface is drawn into the cleaner head 6 through the suction opening (not visible) in the sole plate 14, then runs along the inside of the wand 8 and into the air inlet 10 of the handheld vacuum cleaner.

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The wand 8 is releasably attachable to the handheld vacuum cleaner 4, so that the handheld vacuum cleaner can be used on its own (or with a tool attached to the air inlet 10). The wand 8 is also releasably attachable to the cleaner head 6, so that different floor tools can be fitted to the wand. Furthermore, the rear duct 12 of the cleaner head 6 can be attached directly to the air inlet 10 of the handheld vacuum cleaner so that the cleaner head 6 can be used in conjunction with the handheld vacuum cleaner 4 rather than being limited to use as part of the stick vacuum cleaner 2.

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The handheld vacuum cleaner 4 defines a longitudinal axis 16 which runs from a front end 18 of the handheld vacuum cleaner to a rear end 20. The longitudinal axis 16 intersects the air inlet 10. When it is attached to the handheld vacuum cleaner 4, the wand 8 is parallel to (and in this case collinear with) the longitudinal axis 16. The handheld vacuum cleaner further comprises a pistol grip 22 which is positioned transverse to the longitudinal axis 16. The pistol grip 22 is positioned rearward of the air inlet 10, i.e. the axial position of the pistol grip is further towards the rear end 20 than the air inlet. In other words, the air inlet 10 is positioned forward of the pistol grip 22 (in that the axial position of the air inlet is further towards the front end 18 than the pistol grip).

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Figures 2 and 3 show the handheld vacuum cleaner 4 in isolation. The handheld vacuum cleaner 4 will now be described further with reference to these figures in conjunction with Figure 1.

5 As noted above, the pistol grip 22 is positioned transverse to the longitudinal axis 16. In this case, the pistol grip 22 is positioned at an angle of around 75 degrees to the longitudinal axis 16. As shown in Figures 1-3, with the handheld vacuum cleaner 4 positioned with the longitudinal axis 16 horizontal, the pistol grip 22 can positioned in a generally vertical orientation, running from a lower end 24 to an upper end 26. The
10 upper end 26 has a trigger 28 which forms the on/off switch for the handheld vacuum cleaner 4, as described in more detail later.

The handheld vacuum 4 cleaner comprises a first housing 30 positioned at the upper end 26 of the pistol grip 22, and a second housing 32 positioned at the lower end 24 of
15 the pistol grip 22. The first and second housings 30, 32 are attached to one another by the pistol grip 22, and by a support strut 34 which in this case runs generally parallel to the pistol grip 22.

The handheld vacuum cleaner 4 is battery powered. An array of cells (not visible) and
20 a battery management system (BMS) on a PCB (not visible) are provided in the second housing 32. The cells, BMS and second housing 32 form a battery pack 33. In some embodiments the battery pack 33 may be removable, but in this case it is permanently attached. In this embodiment the batteries are rechargeable. They can be charged in situ by plugging a charging cable into a charging port (not shown) of the handheld
25 vacuum cleaner 4.

The first housing 30 comprises a motor housing 38 and a separator support 40. The motor housing 38 is generally elongate and defines a longitudinal axis which is collinear with the longitudinal axis 16. The motor housing 38 houses a vacuum motor
30 42 and supports a filter assembly 44. The vacuum motor 42 comprises an electric motor 46 and an impeller 48. The electric motor 46 is configured to receive power from the batteries (not visible) so as to drive the impeller 48 to rotate about a motor axis which in this case is collinear with the longitudinal axis 16. Rotation of the impeller 48

creates a flow of air through the handheld vacuum cleaner 4 (as discussed in more detail below) and thereby generates suction at the air inlet 10.

The separator support 40 supports a dirt separator 50 which is configured to remove dirt from the air that is drawn into the handheld vacuum cleaner 4 through the air inlet 10. The dirt separator 50 of this embodiment comprises a first separation stage 52 and a second separation stage 54. The first separation stage 52 has a single cyclone chamber 56 formed by an upper portion of a transparent bin 58, a porous cylindrical shroud 60, and a first dirt receptacle 62 which is formed by a lower portion of the bin 58 and an openable lid 64 which is pivotable about a hinge (not visible). The bin 58 takes the form of a cylindrical outer wall which is concentrically positioned around the longitudinal axis 16. With the bin 58 being concentrically positioned, the rotational axis of the first separation stage 52 (i.e. the rotational axis of the cyclone which forms inside the cyclone chamber 56) is collinear with the longitudinal axis.

Behind the shroud 60 is an air passage 66 which surrounds an inner wall 68 and leads to the second separation stage 54. The second separation stage 54 has a plurality of cyclone chambers 70 arranged in parallel. The cyclone chambers 70 have respective tangential inlets 72 which branch off from the air passage 66, open ends 74 configured as dirt outlets, and air outlets in the form of vortex finders 76. The second separation stage 54 also has a second dirt receptacle 78 which is defined between the inner wall 68 and a duct 80 of the air inlet 10. The duct 80 is generally elongate, defining an inlet axis which is parallel to, and in this case collinear with, the longitudinal axis 16.

The filter assembly 44 comprises a casing 82, a pre-motor filter member 84 and a post-motor filter member 86. The casing 82 defines a pair of grid-like air outlets 88 through which clean air (i.e. air from which at least some of the entrained dirt had been separated therefrom) is exhausted from the handheld vacuum cleaner 4. The pre-motor filter member 84 is positioned upstream of the vacuum motor 42 and downstream of the dirt separator 50, and is configured to filter out small dirt particles which were not removed by the dirt separator 50 before they can reach the vacuum motor 42. The pre-motor filter member 84 comprises a layered wad of porous felt which in this case including a layer of an electrostatic felt such as is sold under the name 'Technostat'. The post-motor filter member 86 is positioned downstream of the

vacuum motor 42 and upstream of the air outlets 88. The post-motor filter member 86 is configured to filter any dirt particles which may be released by the electric motor 46 (for instance debris from carbon brushes of the electric motor 46). In this case the post-motor filter member 86 is a pleated glass fibre HEPA filter. The filter members 84, 86 are annular in shape and share a common axis, which in this embodiment is collinear with the longitudinal axis 16. Indeed, the entire filter assembly 44 is annular, and is positioned substantially concentrically around the longitudinal axis 16.

The handheld vacuum cleaner 4 comprises a screen 100, more particularly a planar, full colour, backlit TFT screen mounted on a rear face of the motor bucket 38a, which faces rearwards. On the reverse of the screen is a controller 101 in the form of a PCB, which will be discussed in more detail later.

The screen 100 faces substantially exactly rearwards (i.e. is substantially normal to the longitudinal axis). It is positioned on the first housing 30 (more particularly on the motor bucket 38a, behind the vacuum motor 42), and is therefore situated radially above the pistol grip 22 for ease of visibility. As well as being above it, the screen 100 lies axially behind the pistol grip 22. Indeed, the screen 100 is positioned on a rearmost surface 103 of the handheld vacuum cleaner so that it cannot be obscured by components of the handheld vacuum cleaner positioned behind it. The screen 100 is located such that it is intersected by the longitudinal axis 16.

The screen 100 is visible through an aperture 102 in the filter assembly 44 which takes the form of a circular through-hole in the casing 82 of the filter assembly 44. In this case the screen 100 is recessed slightly with respect to the casing 82 such that the screen is viewed by looking through the aperture 102. In other cases, however, the core 38 of the motor housing 30 may extend slightly further rearwards such that the screen 100 projects through the aperture 102 and stands proud of the casing 82.

Positioned beneath the screen 100 (in the vertical direction defined by the pistol grip 22) are a pair of control members 104a, 104b, each of which is positioned adjacent to the screen 100 and is configured to receive a control input from the user. In this case each control member 104a, 104b takes the form of a push-button. Like the screen 100, each control member 104a, 104b faces rearwards. The control members 104a, 104b

are pressed by pushing them forwards in a direction parallel to the longitudinal axis 16. In this embodiment, the buttons 104a, 104b are used to change the suction power level of the vacuum cleaner 4.

- 5 To use the stick vacuum cleaner 2, the user grips the handheld vacuum cleaner 4 by the pistol grip 22, with their index finger and middle finger gripping the upper end 26 and their ring finger and little finger gripping the lower end 24. This positions the longitudinal axis 16 substantially in line with the user's forearm when their wrist is straight. The user can then point longitudinal axis 16 of the handheld vacuum cleaner 4
10 towards an area of floor to be cleaned (by moving their forearm and/or wrist), thereby pointing the air inlet 10, wand 8 and cleaner head 6 towards that area.

In use, electricity from the batteries is delivered to the electric motor 46 of the vacuum motor by wires (not visible), as discussed in more detail below, and the electric motor
15 46 rotates the impeller 48. The impeller 48 creates a flow of air through the vacuum cleaner, drawing air into the air inlet 10 and exhausting it out of the air outlets 88. This creates suction at the air inlet 10 which draws an air flow into the stick vacuum cleaner 2. The air flow runs through an air flow passage that extends from the suction opening (not visible) of the sole plate 14 to the air outlets 88 of the filter assembly 44, through
20 the cleaner head 6, wand 8 and handheld vacuum cleaner 4.

Dirty air which has entered the air inlet 10 from the cleaner head 6 via the wand 8 passes along the duct 80, an end section 94 of which turns the air flow radially outwards and then directs it to enter the cyclone chamber 56 of the first separation
25 stage 52 tangentially. The air then spirals around the cyclone chamber 56, where coarse dirt is separated therefrom by centrifugal action and is deposited into the first dirt receptacle 62. Air from which coarse dirt has been separated then passes through the shroud 60, through the air passage 66 and into the second separation stage 54. The air then splits into a series of streams, each of which enters one of the cyclone
30 chambers 70 through its inlet 72 and forms a cyclone therein. Finer dirt is separated by centrifugal action and ejected out of the open end 74 of the cyclone chamber 70 into the second dirt receptacle 78, while air from which the finer dirt has been removed exits the cyclone chamber 70 through its vortex finder 76. From the vortex finders 76, the separate streams are then directed into the filter assembly 44. The air is then directed

generally radially inwards, through the pre-motor filter member 84, through the apertures 90 and into the electric motor 46. It then passes out axially of the electric motor 46, through the impeller 48, through the apertures 92 and through the post-motor filter member 86. The clean air then runs out of the handheld vacuum cleaner 4 through the air outlets 88.

Referring now to Figure 4 in combination with Figures 1-3, the trigger 28, BMS 110, screen 100, controller 101 and control members 104a, 104b are linked together by wiring, and together form a control system 112 of the vacuum cleaner 4.

The control system 112 controls the supply of electricity from the cells 114 of the battery pack 33 to the vacuum motor 42. In this embodiment, the control system 112 controls the timing of when electricity is delivered to the vacuum motor 42, as well as switching the power level at which electricity is delivered (i.e. switching the power mode of the vacuum cleaner), as outlined below.

The controller 101 is wired to the trigger 28 and to the BMS 110, and the BMS is wired to the cells 110 and the vacuum motor 42. When the trigger is pulled by an operator, the controller 101 senses this and signals the BMS 110. The BMS 110 then allows electricity to flow from the batteries to the vacuum motor 42 at a particular power level, whereby the electric motor 46 rotates the impeller to draw air through the vacuum cleaner 4 at a particular suction power.

The vacuum cleaner 4 has three different operating modes, in this case three power modes in which electricity is delivered to the vacuum motor 42 at different power levels – a high power mode in which electricity is supplied to the vacuum motor 42 at a power level of 600W; a mid power mode in which electricity is supplied to the vacuum motor 42 at a power level of between 200W and 400W; and a low power mode in which electricity is supplied to the vacuum motor at a power level of 100W. The precise power level at which electricity is delivered to the vacuum motor 42 when the vacuum cleaner 4 is in the second power mode varies with time according to the surface being cleaned by the vacuum cleaner 4, in a manner which is not material to the present invention.

The control system 112 is configured to switch the vacuum cleaner 4 between the three power modes upon input from an operator. In this case, an operator can cycle through the three power modes using control member 104b, which is wired to the controller 101. When the operator presses that control member 104b, the controller detects this and signals the BMS to change the power level at which electricity will be supplied to the vacuum motor 42 next time the trigger 28 is pulled. More particularly, when the user presses the control member 104b then the controller 101 signals the BMS 110 to advance one step in a repeating cycle of increasing power level. For instance if the vacuum cleaner 4 is in low mode then pressing the control member 104b will change it to mid mode, if the vacuum cleaner is in mid mode then pressing the control member 104b will change it to high mode, if the vacuum cleaner is in high mode then pressing the control member 104b will change it back to low mode, and so on.

When during assembly of the vacuum cleaner the battery pack 33 is first connected to the controller 101, the control system 112 makes a determination of a parameter of the battery pack. In this case, the control system 112 makes a determination of the maximum capacity of the battery pack 33. Some models of the vacuum cleaner 4 are sold with smaller capacity battery packs and some are sold with larger battery packs, and by determining the capacity of the battery pack the control system 112 determines which particular model that machine is.

In this embodiment, the BMS 110 of the battery pack 33 comprises a memory which contains a data flag that indicates whether the battery pack is of the smaller capacity or larger capacity type. When the BMS 110 and controller 101 are first connected together the BMS sends a data stream to the controller 101, one digit of which is a '1' if the battery pack 33 is of the larger capacity and a '0' if the battery pack 33 is of a smaller capacity. The determination of the battery capacity by the control system 112 therefore merely involves reading that data stream.

As discussed above, the control system 112 switches the power mode of the vacuum cleaner in a repeating cycle from low to mid, mid to high and high to low. However, the control system 112 changes the manner in which the modes are presented to the user based on the determination of the battery pack 33. More particularly, it changes the order in which the modes are presented to the user, in this case by changing the

default mode which is selected by the vacuum cleaner 4 in the absence of an input from the user.

If the control system 112 determines that the battery pack 33 has the smaller of the two possible capacities, the control system 112 will select low mode as the default mode. Accordingly, the first time the trigger 28 is pulled after assembly of the vacuum cleaner 4, the vacuum cleaner will come on in low mode, then pressing the control member 104b will cycle from low to mid mode, then from mid to high mode, then from high to low mode, and so on. In this embodiment the controller 101 has a memory which stores the mode that the vacuum cleaner was in last time the trigger 28 was pulled, therefore from that point onwards the sequence of modes will be presented to the user starting from the last one they used the vacuum cleaner 4 in.

Similarly, if the control system 112 determines that the battery pack 33 has the larger of the two possible capacities, the control system will select mid mode as the default mode. Accordingly, the first time the trigger 28 is pulled after assembly of the vacuum cleaner 4, the vacuum cleaner will come on in mid mode, then pressing the control member 104b will cycle from mid to high mode, from high to low mode, from low to mid mode, and so on.

It will be appreciated that numerous modifications to the above described embodiments may be made without departing from the scope of invention as defined in the appended claims. For instance, whilst in the above embodiment the mode of the vacuum cleaner 4 switching of the power mode (using control member 104b) and selective delivery of electricity to the vacuum motor 42 (using the trigger 28) can be performed independently, in other embodiments this may not be the case. For instance, a single button may control both functions (for instance by cycling from off, to low mode, to mid mode, to high mode then to off again with consecutive presses).

For the avoidance of doubt, the optional and/or preferred features described above may be utilised in any suitable combinations, and in particular in the combinations set out in the appended claims.

CLAIMS

1. A vacuum cleaner comprising:

a vacuum motor configured to draw air through the vacuum cleaner;

5 a battery pack configured to supply electricity to the vacuum motor; and

a control system configured to switch the vacuum cleaner between a plurality of operating modes upon input from an operator,

wherein:

10 the control system is further configured to make a determination of a parameter of the battery pack; and

the control system is configured to change the manner in which the operating modes are presented to the user, based on the determination of the parameter.

15 2. A vacuum cleaner according to claim 1 wherein the parameter is a maximum capacity of the battery pack.

3. A vacuum cleaner according to claim 1 or 2 wherein the plurality of modes includes a plurality of suction power modes.

20 4. A vacuum cleaner according to any preceding claim wherein the control system is configured to change the manner in which the operating modes are presented to the user by changing the default operating mode which is selected by the vacuum cleaner in the absence of a selection by an operator.

25 5. A vacuum cleaner according to any preceding claim wherein the control system is configured to switch the vacuum cleaner between at least three operating modes upon input from the operator.

30 6. A vacuum cleaner according to any preceding claim wherein the control system is configured to cycle through said operating modes, and the control system is configured to change the order in which the operating modes are cycled through, based on the determination of the parameter.

7. A vacuum cleaner according to claim 6, incorporating each one of claims 2 to 5, wherein the control system is configured to:

cycle sequentially and repeatedly through the power modes, switching from low to mid, mid to high, high to low and so on;

5 cycle through the suction power modes starting with the low suction power mode if it determines that the capacity of the battery pack is below a threshold: and

cycle through the suction power modes starting with the mid suction power mode if it determines that the capacity of the battery pack is above the threshold.

10 8. A vacuum cleaner according to any preceding claim wherein the battery pack is removably mountable to the vacuum cleaner.

9. A vacuum cleaner according to any preceding claim wherein the battery pack comprises a memory with an indication of the parameter stored thereon, the control
15 system being configured to make the determination of the parameter by reading the indication from the memory.



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Examiner: Mr Rhodri Evans

Claims searched: 1-9

Date of search: 18 September 2019

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
A	-	WO 2017/157891 A1 (Vorwerk)
A	-	EP 3000373 A1 (LG)
A	-	GB 2442033 A (Dyson)
A	-	WO 2015/077588 A1 (Techtronic)

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^X :

Worldwide search of patent documents classified in the following areas of the IPC

A47L

The following online and other databases have been used in the preparation of this search report

WPI, EPODOC, Patent Fulltext

International Classification:

Subclass	Subgroup	Valid From
A47L	0009/28	01/01/2006