Title: BATTERY-POWERED VACUUM CLEANER

Abstract: A battery-powered surface cleaning apparatus (60) has a closed loop recirculation system to re-entrain at least some of the air which is ejected by a clean air outlet (18) positioned in front of a dirty air inlet (64) so that the surface cleaning apparatus recycles the air that exits the surface cleaning apparatus and uses the kinetic energy of the air ejected from the clean air outlet (18) to enhance the performance of a battery-powered vacuum cleaner.
**Title:** BATTERY-POWERED VACUUM CLEANER

**Field of the invention**

[0001] This application relates to a battery-operated vacuum cleaner.

**Background of the invention**

[0002] Various designs for vacuum cleaners are known in the art. Vacuum cleaners require power to drive a suction fan to cause an airflow, which entrains dirt and transports the dirt to a filtration member. Traditionally, vacuum cleaners have been developed which require a substantial amount of power input to the suction fan to provide the desired airflow (e.g. 10 to 13 Amp). In order to provide such amounts of power to a vacuum cleaner, the vacuum cleaner is provided with an electric cord that is plugged into an AC outlet in a building.

[0003] Battery operated vacuum cleaners have been developed. These vacuum cleaners are advantageous as they do not require a cord and therefore provide a consumer with enhanced mobility. Despite this advantage, battery operated vacuum cleaners have had little penetration into the marketplace since they also require a substantial amount of battery power to operate the suction motor and a rotary brush. The capacity of any particular battery (e.g. as expressed in Amp hours) is fixed. The power may be drawn from the battery at a faster rate to increase the power delivered to the suction motor as to produce a higher airflow rate or slower to extend the run time of the vacuum cleaner on a single battery charge. In either case, the cost and weight resulting from providing a sufficient number of batteries to provide a vacuum cleaner with a sufficient run time on a single battery charge (e.g. 20 – 40 minutes) and good cleaning performance, has limited their penetration into the marketplace.

[0004] In order to reduce on board power capacity which is required (e.g. to reduce the number of batteries which are used or enable cheaper batteries having a lower Amp hour rating to be used) without compromising performance or run time, battery operated vacuum cleaners may be designed with reduced back pressure across the airflow passage (i.e. from the dirty air
inlet to the clean air outlet). A reduction in the backpressure enables the same airflow to be produce with a lower power input. The backpressure may be reduced by reducing the number of bends or other flow constrictions in the airflow passage through the vacuum cleaner.

5 [0005] Vacuum cleaners which position the clean air outlet in the surface cleaning head to produce an air flow adjacent the surface being cleaned are also known. Pursuant to such designs, the air after being filtered is returned to the surface cleaning head and conveyed via passages in the surface cleaning head to an air exit.

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Summary of the Invention

[0006] It has been determined that a battery-powered vacuum cleaner or the like have enhanced performance may be produced by using the filtered air to produce an air stream directed at the dirty air inlet. The air stream is directed to assist in producing a flow of air into the dirty air inlet. Therefore, some of the power consumed by the suction motor and fan assembly is utilized to create an air stream that travels across the surface to be cleaned and is directed towards the dirty air inlet. This air stream entrains particulate matter suspended above the surface being cleaned (e.g. by an agitation member such as a beater bar, a rotating brush or any other agitation means known in the vacuum cleaner art). In addition some, or all, of the air stream enters the dirty air inlet where it is accelerated by the vacuum produced by the suction motor. Further, air that does not enter the dirty air inlet imparts momentum to air positioned under the surface cleaning head to produce an airflow directed towards the dirty air inlet. Accordingly, the recycled air, which exits the clean air outlet, works in combination with the suction motor to produce an airflow that enters the dirty air inlet. Surprisingly, it has now been determined that the disadvantage of the backpressure produced by the recycling of the air stream is more than offset by the power saving produced by using the clean air to assist the suction motor in introducing a dirty air stream into the dirty air inlet. This results in improved performance of the
vacuum cleaner which may be used, e.g., to extend the run time of the vacuum cleaner on a single battery charge, to maintain the same cleaning performance and run time while using fewer batteries, to enhance the cleaning performance by increasing the flow rate of the air entering the dirty air inlet while maintaining the same run time, or a combination thereof.

[0007] In accordance with one embodiment of the instant invention, there is provided a surface cleaning apparatus for cleaning a surface comprising a dirty air inlet having an agitation member, a clean air outlet, an air flow passage extending between the dirty air inlet and the clean air outlet, the air flow passage in fluid communication with a filtration member and with a motor and fan assembly which is driven by at least one battery positioned in the vacuum cleaner, the clean air outlet is positioned in front of the dirty air inlet and the agitation member and is configured to produce an airflow to entrain particulate matter which has been positioned above the surface being cleaned by interaction of the agitation member with the surface being cleaned.

[0008] In one embodiment, the air entering the dirty air inlet has a greater velocity due to kinetic energy provided by the airflow produced by the clean air outlet than if the surface cleaning apparatus did not produce the airflow from the clean air outlet.

[0009] In another embodiment, the clean air outlet is configured to direct cleaned air generally parallel to the surface being cleaned.

[0010] In another embodiment, the clean air outlet is configured to direct cleaned air at an angle of from 0 to 15° below the horizontal.

[0011] In another embodiment, at least a portion of the airflow passage is constructed from metal.

[0012] In another embodiment, at least a sufficient portion of the airflow passage is constructed from metal so as to provide a heat sink to absorb heat produced by the suction motor and fan assembly.

[0013] In accordance with another embodiment of the instant invention, there is also provided a surface cleaning apparatus for cleaning a surface
comprising a dirty air inlet, a clean air outlet, an air flow passage extending between the dirty air inlet and the clean air outlet, the air flow passage in fluid communication with a filtration member and with a motor and fan assembly which is driven by at least one battery positioned in the vacuum cleaner, the clean air outlet is positioned in front of the dirty air inlet and is configured to direct cleaned air towards the dirty air inlet.

[0014] In one embodiment, the clean air outlet is configured produce an airflow that increases the velocity of the air entering the dirty air inlet.

[0015] In another embodiment, the surface cleaning apparatus further comprises an agitation member and the clean air outlet is positioned in front of the agitation member.

[0016] In another embodiment, the clean air outlet is configured to produce an airflow to entrain particulate matter which has been positioned above the surface being cleaned by interaction of the agitation member with the surface being cleaned.

[0017] In another embodiment, the clean air outlet is configured to direct cleaned air generally parallel to the surface being cleaned.

[0018] In another embodiment, the clean air outlet is configured to direct cleaned air at an angle of from 0 to 15° below the horizontal.

[0019] In another embodiment, at least a portion of the airflow passage is constructed from metal.

[0020] In another embodiment, at least a sufficient portion of the airflow passage is constructed from metal so as to provide a heat sink to absorb heat produced by the suction motor and fan assembly.

[0021] In another embodiment, the airflow passage includes a dirty air portion pivotally mounted to a surface cleaning head and extending from the surface cleaning head to a filtration member and a clean air portion pivotally mounted to the surface cleaning head and extending from the filtration
member to the surface cleaning head and at least one of the dirty air portion and the clean air portion are constructed as a heat sink.

[0022] In another embodiment, at least one of the dirty air portion and the clean air portion are constructed from metal.

[0023] In another embodiment, each of the dirty air portion and the clean air portion are constructed from metal.

[0024] In accordance with another embodiment of the instant invention, there is also provided a surface cleaning apparatus for cleaning a surface comprising a dirty air inlet, a clean air outlet, an air flow passage extending between the dirty air inlet and the clean air outlet, the air flow passage in fluid communication with a filtration member and with a motor and fan assembly which is driven by at least one battery positioned in the vacuum cleaner, the clean air outlet is positioned in front of the dirty air inlet and is configured to direct cleaned air towards the dirty air inlet such that at least some of the air that enters the dirty air inlet exited the clean air outlet, wherein at least a sufficient potion of the airflow passage is constructed from metal so as to provide a heat sink to absorb heat produced by the motor and fan assembly.

[0025] In one embodiment, the airflow passage includes a dirty air portion pivotally mounted to a surface cleaning head and extending from the surface cleaning head to a filtration member and a clean air portion pivotally mounted to the surface cleaning head and extending from the filtration member to the surface cleaning head and at least one of the dirty air portion and the clean air portion are constructed as a heat sink.

[0026] In another embodiment, at least one of the dirty air portion and the clean air portion are constructed from metal.

[0027] In another embodiment, each of the dirty air portion and the clean air portion are constructed from metal.

[0028] In another embodiment, the filtration member comprises at least one cyclone. Advantageously, there is generally constant backpressure across a cyclone separator as it is used whereas a physical filter element,
such as a filter bag, has pores which become clogged during use thereby increasing the backpressure across the physical filter element.

**Brief description of the drawings**

[0029] These and other advantages of the instant application may be more clearly and fully understood in accordance with the following description of the preferred embodiments of this invention as illustrated in the following drawings in which:

[0030] Figure 1 is a schematic drawing of a vacuum cleaner according to a first embodiment of this invention;

[0031] Figure 1A is a perspective view of the vacuum cleaner in Figure 1;

[0032] Figure 2 is an alternate view of the vacuum cleaner of Figure 1 with the dirt collection bin removed;

[0033] Figure 3 is a schematic drawing of a vacuum cleaner of Figure 1 wherein the auxiliary above floor cleaning hose has been removed for use in an above the floor cleaning mode;

[0034] Figure 4 is a schematic drawing of a rear view of the vacuum cleaner of Figure 1;

[0035] Figure 5 is a schematic top plan view of the cleaner head of the vacuum cleaner of Figure 1;

[0036] Figure 6 is a cross-section along the line 6-6 in Figure 5 showing a configuration for the air flow pass in the vacuum cleaner head;

[0037] Figure 7 is a cross-section along the line 6-6 of Figure 5 showing an alternate configuration for the air flow pass in the vacuum cleaner head; and,

[0038] Figure 8 is a top plan view of an alternate construction of a vacuum cleaner head shown in Figure 5.

**Detailed description of the invention**
As shown in the Figures attached hereto, an upright vacuum cleaner 60 has a floor cleaning head 3 and an upper assembly 62 pivotally mounted thereto. It is to be appreciated that the instant invention may be used with any battery operated upright vacuum cleaner, canister vacuum cleaner, backpack vacuum cleaner, stick vacuum cleaner or the like and the battery housing construction is not limited to implementation only in an upright vacuum cleaner. Preferably, the batteries are provided in the surface cleaning head of a vacuum cleaner.

As shown in Figure 1, an upright vacuum cleaner 60 according to the instant invention may comprise a vacuum cleaner head 3 and an upper assembly 62. The vacuum cleaner has a filtration member 11 that is preferably provided in upper assembly 62. In addition, the vacuum cleaner preferably has a rotary brush 1 that is provided in cleaning head 3. In order to provide a low profile for vacuum cleaner head 3, motor and fan assembly 15 is preferably provided as part of upper assembly 62.

The vacuum cleaner may be provided with an on/off switch, which may be provided at any location of the vacuum cleaner. For example, as shown in Figure 1, on/off toggle switch 43 may be provided on upper assembly 62.

Optionally, the filtered air may be used to cool the batteries. For example, as shown in the Figures, the vacuum cleaner is constructed as a closed loop circulation vacuum cleaner. In such a case, air containing entrained dirt may be passed through filtration member 11 to produce a cleaned air stream. Typically, the cleaned air stream in a vacuum cleaner is released to the room. In accordance with the design of Figure 1, the cleaned air stream is recycled through the vacuum cleaner to produce air jets adjacent rotary brush 1 to aid in entraining dirt. In order to assist in battery cooling, some or all of the filtered air may be directed at the batteries to provide forced cooling. For example, batteries 5, 6 may be positioned at least partially in duct 17 so that the filtered air may be used to cool the batteries 5, 6.
In accordance with the instant invention, filtered air is recycled to a position in front of the dirty air inlet to assist in cleaning. Various different configurations of the airflow passages through a vacuum cleaner may be used. For example, referring to Figures 1, 6 and 7, air enters the cleaning head via inlet 64 provided in bottom surface 66 of vacuum cleaner head 3. Dirt from the surface being cleaned is entrained with the assistance of optional rotary brush 1. Suction fan and motor assembly 15 produces an air stream denoted by reference number 4 in Figure 1, which enters duct 2. The dirty air stream passes through inlet duct 2, through up-flow duct 8, through inlet port 10 and into filtration member 11. The filtered air exists filtration member 11 via outlet port 12 through down-flow duct 14, through motor and fan assembly 15 and into duct 17 to produce an air stream for recycling (see Figure 1). These members define the air recirculation loop. It will be appreciated that other configurations of the airflow passage through a vacuum cleaner may be provided to produce an air stream for recycle.

Referring to Figures 6 and 7, duct 17 may consist of a passageway extending through vacuum cleaner head 3 to a position in front of inlet 64. Brush air ejection duct 18 is positioned at the downstream end of duct 17 (see in particular Figures 1 and 8). Preferably, duct 18 distributes the air laterally across the width of vacuum cleaner head 3, preferably along the entire length of rotary brush 1, and produces a stream 19 of cleaned air for recycle that is directed generally parallel to the floor. The jets are angled to direct the air downwardly towards the floor and rearwardly towards brush 1. Preferably, the air is ejected at an angle A to the horizontal of between about 0 and 15° (see Figure 7). It will be appreciated by those skilled in the art that duct 17 may be provided at any desired location in cleaner head 3. For example, as shown in Figure 6, duct 17 is provided adjacent upper surface 68 of cleaner head 3. In the embodiment of Figure 7, duct 17 is provided approximate bottom surface 66 of cleaner head 3.

The air jets produce an air stream, which travels generally parallel to the floor. An advantage to this approach is that the air is generally
directed rearwardly towards the inlet of duct 2 so that a substantial portion, and preferably essentially all, of the air exiting ejection duct 18 enters air duct 2 and is therefore recycled. Accordingly, a substantial portion of air stream 4 entering duct 2 may comprise recycled air. By reducing the amount of air that is exhausted from vacuum cleaner 60, the amount of particulate matter, which is released into the room in which the vacuum cleaner is operated, is also reduced. A further advantage is that the kinetic energy in the exhaust air is used to entrain dirt into air stream 4. As vacuum cleaner 60 is battery powered, then by using the kinetic energy of air stream 19, the number of batteries required to provide a desired operating time for vacuum cleaner 60 on a single cycle of the batteries may be reduced or, if the same number of batteries are used, then air flow rate may be increased without reducing the operating time of a single cycle of the batteries. It is to be appreciated that air ejection duct 18 may be utilized also with a canister vacuum, a back pack vacuum cleaner, a stickvac vacuum cleaner or any other vacuum cleaner in which air is recycled through the vacuum cleaner.

[0046] Up flow duct 8 and down flow duct 14 may be connected to vacuum cleaner head 3 by any means known in the art. Preferably, hollow tubular members, which are in airflow communication with ducts 2 and 17, may be pivotally mounted to vacuum cleaner head 3. Accordingly, ducts 8 and 14 may seat on these hollow tubular members so as to complete the airflow path. For example, up flow duct 8 and down flow duct 14 may be rigid structural members that are themselves pivotally mounted to vacuum cleaner head 3. Alternately, up flow duct 8 and down flow duct 14 may be mounted on a pivotal airflow tube similar to pivotal air flow valves known in the vacuum cleaner art. Alternately, as shown in Figure 1A, up flow duct 8 and down flow duct 14 may be connected in airflow communication with cleaner head 3 via flexible tubes 9 and 16 respectively. In this latter case, upper assembly 62 is mechanically secured to pivotally mounted cross member 170, which does not form part of the airflow path. Pivotal mounted cross member 170 has axle portions 172 at the opposed ends thereof which are pivotally mounted to sidewalls 174 of cleaner head 3.
It will be appreciated by those skilled in the art that filtration member 11 may be any filtration member known in the art. Preferably filtration member 11 comprises at least one cyclone separator. For example, filtration member 11 may be a cylindrical member comprising a cyclone bin or canister whereby inlet port 10 functions to direct the air tangentially into a cyclone bin. It will also be appreciated that filtration member 11 may comprise a plurality of cyclones which may be provided in one or more stages. However, it will also be appreciate that a physical filter element may also be utilized if desired. If filtration member comprises a cyclone bin, then the cyclone bin is preferably transparent.

In conventional vacuum cleaners, the cleaned air is fed past the motor prior to the air exiting the vacuum cleaner. In this way, the cleaned air is used to cool the motor such that the air that exits the vacuum cleaner is heated. If the filtered air is recycled, then the airflow through the vacuum cleaner is preferably used to cool motor 15. Thus, the air in the recirculation air stream exiting duct 17 in cleaner head 3 is heated. The air is therefore preferably cooled as it passes through the vacuum cleaner prior to again encountering motor 15. Accordingly, at least a portion of the airflow passage through the vacuum cleaner is preferably constructed from metal. For example, one or more of duct 2, flexible hose 9, up flow tube 8, down flow tube 14, flexible tube 19, duct 17 and duct 18, as well the housing for motor 15, may be made from metal. Some or all of these surfaces may be provided with pin fins or other heat dissipation members. In addition, one or more fans may be provided to pass cooling air over the ducts to assist in dissipating the heat. Preferably, a substantial number of the components of the airflow path and, most preferably, all or essentially all of the components of the airflow path are made from metal. The metal provides a heat sink for adsorbing heat produced by motor 15. By constructing a substantial portion of the vacuum cleaner from metal, a large heat sink is provided. Further, the surface area available for dissipating the heat to the ambient is also increased.
[0049] Rotary brush 1 may be driven by any means known in the art. For example, as shown in Figure 1, rotary brush 1 is provided with a brush motor 48, which is drivingly connected to gear 49. Similarly, gear 51 is drivingly connected to rotary brush 1. A fan belt 50 extends around gears 49 and 51 so as to drivingly connect brush motor 48 to rotary brush 1. In such an embodiment, rotary brush 1 may be selectively engaged and disengaged by means of an on/off toggle switch 44. Thus, brush 1 may be shut off when it is not required, such as when an extension hose 21 is in use for above floor cleaning.

[0050] In an alternate embodiment (not shown), gear 49 may be driven by an air turbine. Preferably the air turbine is provided in air duct 17. An advantage of this design is that the air turbine would be driven by clean air. Generally, an air turbine comprises a turbine provided within a housing. As clean air would be used to power the turbine, the air gap between the outer end of the blades of the air turbine and the inner wall of the housing may be reduced, thus increasing the amount of power, which may be obtained from an air turbine. In addition, the turbine would be powered by pressurized air (i.e. it is downstream from suction fan and motor assembly 15) as opposed to a negative pressure (e.g. if the air turbine was provided upstream of suction fan and motor assembly 15).

[0051] Optionally, duct 2 may include a portion, such as a trough shaped member, for accumulating material prior to the material being fed with the air stream to filtration member 11. For example, if an area of heavy dirt concentration is encountered, the airflow may not be sufficient to entrain all of the dirt. By providing a storage area, the excess material which is not entrained may be stored for entrainment in the air stream once the concentration of material being entrained in air stream 4 decreases.

[0052] In accordance with the embodiment shown in Figure 1, motor and fan assembly 15 is provided in the clean air stream, e.g. in down flow duct 14. Accordingly, the vacuum cleaner is a clean air system (i.e. the air has already been filtered prior to the air encountering the suction fan). It will be
appreciated that, in accordance with an alternate embodiment, suction fan and motor assembly 15 may be provided in up flow duct 8. In such a case, motor and fan assembly 15 is provided in the dirty air stream, e.g. in up flow duct 8. Accordingly, the vacuum cleaner is a dirty air system (i.e. the air has already been filtered prior to the air encountering the suction fan). In either case, an advantage of such a preferred design is that the motor and fan assembly is provided exterior to cleaning head 3. Typically, the suction motor and fan assembly is the largest element provided in a vacuum cleaner head thus setting the necessary vertical height of a vacuum cleaner head (i.e. the distance from bottom surface 66 to upper surface 68). By removing suction fan and motor assembly 15 from cleaner head 3, the vertical height of cleaner head 3 may be reduced. This reduces the profile of cleaner head 3 enabling it to pass underneath furniture having a lower clearance from the floor.

[0053] Preferably, suction motor and fan assembly 15 are axial aligned (i.e. the fan is mounted on an axle that extends outwardly from the suction motor and rotates about that axle such that the air passes sequentially through the suction motor and the fan). By positioning suction fan and motor assembly 15 so that its longitudinal direction (i.e. the direction defined by the axle upon which the suction fan is mounted for rotation) is in line with ducts 8 and 14, the profile of upper assembly 62 may be reduced thus creating a low profile for upper assembly 62. When it is desired to vacuum underneath furniture, upper assembly 62 may be lowered so as to extend rearwardly behind cleaner head 3. In this configuration, the extent to which cleaner head 3 may extend underneath furniture is limited by the extent that upper assembly 62 extends vertically above the surface being cleaned. By positioning suction fan and motor assembly 15 in one of ducts 8 and 14 and aligning the axle of the motor and fan assembly with the longitudinal axis of the duct, the vertical extent of upper assembly 62 when in this configuration is minimized thus increasing the ability of the vacuum cleaner to clean underneath furniture. Also, such an arrangement also reduces the backpressure through the vacuum cleaner, by reducing the number of bends
in the air flow passage, and therefore reduces the power required to obtain the same air flow rate through the vacuum cleaner.

[0054] The batteries to operate the vacuum cleaner 60 may be provided at any location. Batteries 5, 6 are preferably mounted in cleaner head 3 so as to reduce hand weight of the handle of the vacuum cleaner. For example, referring to Figure 1, two battery sticks 5, 6 are provided in cleaner head 3. The batteries may be individually mounted in vacuum cleaner 60 or they may be provided in one or more battery sticks as is known in the battery art. The number of batteries will depend upon a number of factors including the operational time of vacuum cleaner 60 on a single charge and the airflow rate produced by motor 15.

[0055] Optionally, the batteries are provided with an airflow stream to cool the batteries during charging and/or discharging. The cooling air is preferably provided by one or more cooling fans 26, 27 that are positioned to blow cooling air over the batteries 5 and 6. Preferably a fan is provided for each battery stick. As shown in Figure 1, the cooling fans 5, 6 are preferably positioned to blow air longitudinally along the length of a plurality of batteries or a battery stick.

[0056] The batteries may be removable. Accordingly, they may be provided in a removable battery pack as is known in the art. Alternately, the batteries may be mounted in the vacuum cleaner for charging in situ. If the batteries are charged while in the vacuum cleaner, the vacuum cleaner may be provided with a power cord 45 and a battery charging control circuit. Any charging circuit known in the battery art may be used. In one embodiment, the vacuum cleaner may be configured to also operate on AC power, e.g., when the batteries are discharged. Accordingly, power cord 45 may be any cord known in the vacuum cleaner art. However, if vacuum cleaner 60 is not designed to operate on AC power (i.e. it only operates on batteries 5, 6), then power cord may be relatively short (e.g. from 1 to 10 feet long, preferably from about 1 to 6 feet long and most preferably about 3 feet long). If the vacuum cleaner includes the power control system for charging the batteries (e.g. if
may be a part of electronic control board 7), and if the vacuum cleaner operates only on batteries, then power cord 45 may be of a thinner gauge. In such a case, the power cord may be 16 – 18 gauge. Thus, a relatively lightweight cord may be used. Advantageously, this requires a smaller volume to store the cable and a lighter spring may be used on an automatic cord rewind mechanism.

[0057] The power cord may be secured in position when it is not in use to charge the batteries by, e.g., a holder 46 provided on one of ducts 8, 14. A battery life indicator 47 may be provided, such as on electronics board 7. Battery life indicator is preferably a read out, and more preferably a digital readout, showing the operating time remaining in the battery cycle.

[0058] Batteries 5, 6 are preferably removed prior to the disposal of the vacuum cleaner. Thus, an optional openable panel 34 is preferably provided in cleaner head 3 so as to permit access to the compartment in which batteries 5, 6 are placed. For example, panel 34 may be pivotally mounted to permit it to be opened or it may be removable mounted the vacuum cleaner. Preferably, as shown in Figures 1 and 8, cover 34 is provided in upper surface of cleaner head 3 with the batteries positioned immediately under cover 34. Cover 34 is preferably transparent so as to permit the batteries to be visible to the user. This facilitates the user locating the batteries when they are to be replaced (e.g., the batteries have been subjected to the recommended number of charging cycles) or removed for disposal. Cover 34 may be secured to cleaner head 3 by any means known in the art. For example, cover 34 may be secured by male and female engagement members. Alternately, a plurality of screws 35, 36, 37 and 38 may be provided around the perimeter of cover 34 to secure cover 34 to cleaner head 3.

[0059] The vacuum cleaner may include an electronic control board 7, which regulates the power to suction fan and motor assembly 15. Alternately, or in addition, board 7 may also perform other functions. If vacuum cleaner 60 contains optional board 7, then board 7 is preferably provided in cleaner head 3 so that it is visible to the user. To this end, board 7 may be provided under
transparent openable cover 34 or under a separate transparent cover (not shown).

[0060] It will be appreciated that board 7 and batteries 5, 6 may be provided in a variety of configurations. For example, as shown in Figure 1, board 7 may be provided to the rear of batteries 5, 6. Alternately, as shown in Figure 8, board 7 may be provided in front of batteries 5, 6. In an alternate embodiment, which is not shown, board 7 may be provided between batteries 5, 6.

[0061] In order to cool board 7, a fan 28 may be provided to direct cooling air over board 7. Alternately, or in addition, one or both of battery cooling fans 26 and 27 could be utilized to provide cooling air to board 7, depending upon the position of board 7 and the direction of the air flow which is produced by fans 26, 27.

[0062] Optionally, vacuum cleaner 60 is provided with at least one LED and preferably a plurality of LED's, which are directed so as to function as headlights for the vacuum cleaner. Preferably, each headlight comprises at least 2 LEDs and more preferably from 2 to 8 LEDs and most preferably from 2 to 4 LEDs. Thus a vacuum cleaner may have 2 headlights each of which has, for example, 2 to 4 LEDs.

[0063] The LEDs may have a light intensity of at least 500 minicandella (mcd). Preferably, the LED's are super bright LED's. Generally, super bright LEDs are considered in industry to be any LED having a light intensity of at least about 1,000 mcd and may have a light intensity of up to 13,000 mcd or more. Preferably super bright LEDs which are used in a vacuum cleaner as disclosed herein have a light intensity from 1,000 to 10,000 mcd, more preferably from 2,000 to 8,000 mcd and most preferably from 2,000 to 4,000 mcd. Accordingly a headlight having 2 LEDs may have a light intensity of from 4,000 to 16,000 mcd.

[0064] Preferably, the LED's are provided directly on board 7 to minimize wiring of the lights. For example, as shown in Figure 1, LED's 41
and 42 are provided as headlights. The LED's may be provided with or without a reflector to concentrate and direct the light produced by the LED's.

[0065] Optionally, filtration member 11 comprises a transparent cyclone bin, such as is known in the art. In such an embodiment, vacuum cleaner 60 preferably includes at least one, and preferably a plurality of LED's (for example LED's 39 and 40), which are angled so as to illuminate the transparent cyclone bin. The LED's may be angled so as to illuminate the cyclone bin only when the vacuum cleaner is being used to clean a carpet (the normal carpet cleaning position wherein upper assembly 62 is angled rearwardly behind cleaner head 3), when the vacuum cleaner is in the upright or storage position (e.g. upper assembly 62 extends generally vertically upwardly from cleaner head 3) or when in both positions. The LED's may provide constant illumination or they may be strobed to illuminate the motion of dirt within a transparent cyclone bin. Preferably the LED's are super bright LED's. In this embodiment, board 7 is preferably positioned so that the LED's may shine upwardly onto the cyclone bin. Accordingly, it is preferred to position board 7 towards the rear of cleaner head 3, (e.g. as shown in Figure 5). To aid in construction, a transparent cover is preferably provided over the portion of board 7 on which LEDs 39, 40 are positioned so that the light from the LEDs is directed at filtration member 11. This is preferably cover 34. If a transparent cover is not provided, then an opening may be provided in upper surface 68 of cleaner head 3. Alternately, the LEDs may be mounted on an exterior surface of the vacuum cleaner.

[0066] In another embodiment, the vacuum cleaner preferably has an extendible stretch hose 21 for use in above the floor cleaning. In such an embodiment, a valve 20 is provided to connect flexible hose 21 in airflow communication with suction fan and motor assembly 15. As shown in Figure 1, valve 20 may be provided in up flow duct 8. Valve 20 may be any valve known in the art. An advantage of providing valve 20 in duct 8 is that the construction of vacuum cleaner head 3 is simplified. In particular, a valve structure need not be incorporated into the pivotal connection of the upper
assembly 62 to cleaner head 3 but may be provided in cleaner head 3 as is common in the industry.

[0067] In another embodiment, the optional extension wand for the above floor cleaning hose 21 preferably also functions as the handle for the vacuum cleaner. As shown in Figure 2, according to this alternate embodiment, hose 21 is provided with a rigid tube 22. When mounted on the vacuum cleaner, tube 22 functions as the handle for the vacuum cleaner. When removed from the vacuum cleaner, tube 22 functions as an extension wand so that the dirty air travels through wand 22 into hose 21 and then into up flow duct 8 via valve 20. An advantage of this construction is that tube 22 may be used both as the handle for the vacuum cleaner as well as an extension for hose 21.

[0068] Tube 22 may be removably mounted to upper assembly 62 by any means known in the art. In accordance with an alternate embodiment, the mount for releasable receiving tube 22 preferably also functions as a carry handle for the vacuum cleaner such as, for example, mount 24 (see Figure 4). In this embodiment, mount 24 comprises a first portion for releasable receiving tube 22 and a second portion for securing the first portion to upper assembly 62. The first portion may comprise a dovetail receiver 29 which is configured for receiving dovetail 23 which is provided on tube 22. The second portion may comprise one or more rigid rods 52 which extend outwardly from filtration member 11 to provide a securing point for dove tail receiver 29 and to permit a user to pick up vacuum cleaner 60 using mount 24. It will be appreciate that other releasable engagement means may be utilized. An advantage of this construction is that when tube 22 is detached from the vacuum cleaner as shown in Figures 3 and 4, mount 24 provides a user with a handle which may be used to move vacuum cleaner 60. Accordingly, a rigid handle is always accessible to the user to facilitate moving the vacuum cleaner regardless of whether tube 22 is in the above floor cleaning position.

[0069] Upper assembly 62 may comprise a space frame. In particular, referring to Figure 2, upper assembly 62 comprises up flow duct 8, down flow
duct 14 and one or more cross members to dynamically stabilize ducts 8 and 14. For example, referring to Figure 2, cross-members 30 and 31 are provided to limit and, preferably, prevent any relative motion of duct 8 with respect to duct 14. Preferably, support member 30, 31 dimensionally stabilize ducts 8 and 14 in two dimensions (i.e. to prevent ducts 8 and 14 bending forward or backwards relative to each other or to prevent side to side motion of ducts 8, 14). For example, support members 30, 31 may be ovals thus cross-stabilizing ducts 8, 14. Preferably, ducts 8, 14 and supports 30, 31 are made from metal (e.g. aluminum). This provides a rigid, lightweight construction which may weigh less than conventional plastic cover casings which are manufactured for vacuum cleaners.

[0070] Preferably, upper assembly 62 includes upper cover assembly 25 (see Figure 2). Upper cover assembly 25 of filtration member 11 incorporates inlet port 10 and outlet port 12. Upper cover assembly 25 may accordingly provide the lid for filtration member 11 (e.g. if filtration member 11 is a cyclone bin, then upper cover assembly 25 may comprise the lid of the cyclone bin). Inlet port 10 and outlet port 12 are preferably removably mounted on ducts 8, 14 thereby permitting filtration member 11 to be removed from vacuum cleaner 60 for emptying merely by lifting filtration member 11 and cover 25 upwardly off of ducts 8, 14. In this way, filtration member 11 may be transported while still sealed to a garbage can or refuse container for emptying. Preferably, filtration member 11 is emptied by removing cover 25 and inverting filtration member 11 so the contents empty into a garbage can or refuse container by means of gravity. An advantage of this design is that a user need not bend over to remove filtration member 11 or to empty a cyclone bin.

[0071] A supplemental filtration media 13 may be provided in down flow duct 14 (see Figures 1 and 2). In accordance with this embodiment, as the cleaned air exits filtration member 11, the air travels through outlet port 12 and then through filtration member 13 as the air travels downwardly through duct 14. Filtration member 13 may be removed for cleaning or replacement
whenever cover 25 is removed from upper assembly 62. When cover 25 has been removed from upper assembly 62, filtration member 13 may merely be lifted upwardly out of duct 14 thereby permitting filter media 13 to be cleaned or replaced. An advantage of this design is that the interior volume of an airflow duct is utilized to house a supplemental filtration member thereby reducing the overall profile of vacuum cleaner 60.

[0072] Upper cover 25 may be secured to upper assembly 62 by any means known in the art. In one preferred embodiment, cover assembly 25 is secured in position by at least one magnet and, preferably, a plurality of magnets. For example, referring to Figure 2, duct 8 is provided with a magnet 33. The upper face of magnet 33 may have any desired polarity (i.e. north or south). A magnet 32 is provided in housing of inlet tube 10 so as to be aligned with magnet 33 when upper cover 25 is mounted on upper assembly 62. The lower or bottom face of magnet 32 has the opposite polarity of the upper or top face of magnet 33. Accordingly, when duct 8 is in airflow communication with inlet port 10, magnets 32 and 33 assist in securing, or secure, cover 25 on duct 8. A similar pair of mating magnets may be provided on duct 14 and the housing of outlet port 12. It will be appreciated by those skilled in the art that other securing means which utilize the physical engagement of a male and female member may be utilized.

[0073] It will be appreciated by a person skilled in the art that a battery-operated vacuum cleaner may use one or more of the different embodiments disclosed herein and the different embodiment may be combined in any combination of features to provide a unique vacuum cleaner.
Claims:

1. A surface cleaning apparatus for cleaning a surface comprising a dirty air inlet having an agitation member, a clean air outlet, an air flow passage extending between the dirty air inlet and the clean air outlet, the air flow passage in fluid communication with a filtration member and with a motor and fan assembly which is driven by at least one battery positioned in the vacuum cleaner, the clean air outlet is positioned in front of the dirty air inlet and the agitation member and is configured to produce an airflow to entrain particulate matter which has been positioned above the surface being cleaned by interaction of the agitation member with the surface being cleaned.

2. The surface cleaning apparatus as claimed in claim 1 wherein the air entering the dirty air inlet has a greater velocity due to kinetic energy provided by the airflow produced by the clean air outlet than if the surface cleaning apparatus did not produce the airflow from the clean air outlet.

3. The surface cleaning apparatus as claimed in claim 1 wherein the clean air outlet is configured to direct cleaned air generally parallel to the surface being cleaned.

4. The surface cleaning apparatus as claimed in claim 3 wherein the clean air outlet is configured to direct cleaned air at an angle of from 0 to 15° below the horizontal.

5. The surface cleaning apparatus as claimed in claim 1 wherein at least a portion of the airflow passage is constructed from metal.

6. The surface cleaning apparatus as claimed in claim 1 wherein at least a sufficient portion of the airflow passage is constructed from metal so as to provide a heat sink to absorb heat produced by the suction motor and fan assembly.
7. The surface cleaning apparatus as claimed in claim 1 wherein the filtration member comprises at least one cyclone.

8. A surface cleaning apparatus for cleaning a surface comprising a dirty air inlet, a clean air outlet, an air flow passage extending between the dirty air inlet and the clean air outlet, the air flow passage in fluid communication with a filtration member and with a motor and fan assembly which is driven by at least one battery positioned in the vacuum cleaner, the clean air outlet is positioned in front of the dirty air inlet and is configured to direct cleaned air towards the dirty air inlet.

9. The surface cleaning apparatus as claimed in claim 8 wherein the clean air outlet is configured produce an airflow that increases the velocity of the air entering the dirty air inlet.

10. The surface cleaning apparatus as claimed in claim 8 further comprising an agitation member and the clean air outlet is positioned in front of the agitation member.

11. The surface cleaning apparatus as claimed in claim 10 wherein the clean air outlet is configured to produce an airflow to entrain particulate matter which has been positioned above the surface being cleaned by interaction of the agitation member with the surface being cleaned.

12. The surface cleaning apparatus as claimed in claim 8 wherein the clean air outlet is configured to direct cleaned air generally parallel to the surface being cleaned.

13. The surface cleaning apparatus as claimed in claim 8 wherein the clean air outlet is configured to direct cleaned air at an angle of from 0 to 15° below the horizontal.

14. The surface cleaning apparatus as claimed in claim 8 wherein at least a potion of the airflow passage is constructed from metal.

15. The surface cleaning apparatus as claimed in claim 8 wherein at least a sufficient portion of the airflow passage is constructed from metal so
as to provide a heat sink to absorb heat produced by the suction motor and fan assembly.

16. The surface cleaning apparatus as claimed in claim 8 wherein the airflow passage includes a dirty air portion pivotally mounted to a surface cleaning head and extending from the surface cleaning head to a filtration member and a clean air portion pivotally mounted to the surface cleaning head and extending from the filtration member to the surface cleaning head and at least one of the dirty air portion and the clean air portion are constructed as a heat sink.

17. The surface cleaning apparatus as claimed in claim 16 wherein at least one of the dirty air portion and the clean air portion are constructed from metal.

18. The surface cleaning apparatus as claimed in claim 16 wherein each of the dirty air portion and the clean air portion are constructed from metal.

19. The surface cleaning apparatus as claimed in claim 8 wherein the filtration member comprises at least one cyclone.

20. A surface cleaning apparatus for cleaning a surface comprising a dirty air inlet, a clean air outlet, an air flow passage extending between the dirty air inlet and the clean air outlet, the air flow passage in fluid communication with a filtration member and with a motor and fan assembly which is driven by at least one battery positioned in the vacuum cleaner, the clean air outlet is positioned in front of the dirty air inlet and is configured to direct cleaned air towards the dirty air inlet such that at least some of the air that enters the dirty air inlet exited the clean air outlet, wherein at least a sufficient portion of the airflow passage is constructed from metal so as to provide a heat sink to absorb heat produced by the motor and fan assembly.

21. The surface cleaning apparatus as claimed in claim 20 wherein the airflow passage includes a dirty air portion pivotally mounted to a
surface cleaning head and extending from the surface cleaning head to a filtration member and a clean air portion pivotally mounted to the surface cleaning head and extending from the filtration member to the surface cleaning head and at least one of the dirty air portion and the clean air portion are constructed as a heat sink.

22. The surface cleaning apparatus as claimed in claim 21 wherein at least one of the dirty air portion and the clean air portion are constructed from metal.

23. The surface cleaning apparatus as claimed in claim 19 wherein each of the dirty air portion and the clean air portion are constructed from metal.

24. The surface cleaning apparatus as claimed in claim 20 wherein the filtration member comprises at least one cyclone.
Figure 5
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER


According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 A47L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

Date of the actual completion of the international search: 31 March 2004

Date of mailing of the international search report: 07/04/2004

Name and mailing address of the ISA

European Patent Office, P.B. 5816 Patentlaan 2 NL - 2280 HV Rijswijk
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Authorized officer

Cabra Matos, A
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## INTERNATIONAL SEARCH REPORT

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