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(56) Related Art
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US 20080284363 A1
US 4835409 A

ABSTRACT

A portable vacuum cleaner is disclosed. The portable vacuum cleaner includes a rechargeable battery having a nominal battery voltage output at a first voltage level and a DC motor operable at a voltage level substantially equal to the first voltage level. The portable vacuum cleaner further includes a DC power input port for receiving DC power. The DC power input port is adapted to electrically couple the vacuum cleaner alternatively to a first a source of DC power at a first voltage output level substantially equal to the first voltage level and a second source of DC power at a second voltage output level, the second voltage level substantially greater than the first voltage level. The vacuum cleaner still further includes a switching device, such as a two position power switch and a two position car/battery charge switch. The switch may have four output states switchable to selectively cause four operational states. The operational states comprise a first operational state wherein the motor will operate as powered by the battery, a second operational state wherein the motor will not operate, and the battery will not charge if coupled to the first source of DC power and the battery will charge if coupled to the second source of DC power, a third operational state wherein the motor will operate if coupled to the first source of DC power but will not operate if coupled to the second source of DC power and a fourth operational state wherein the motor will not operate and the battery will not recharge.

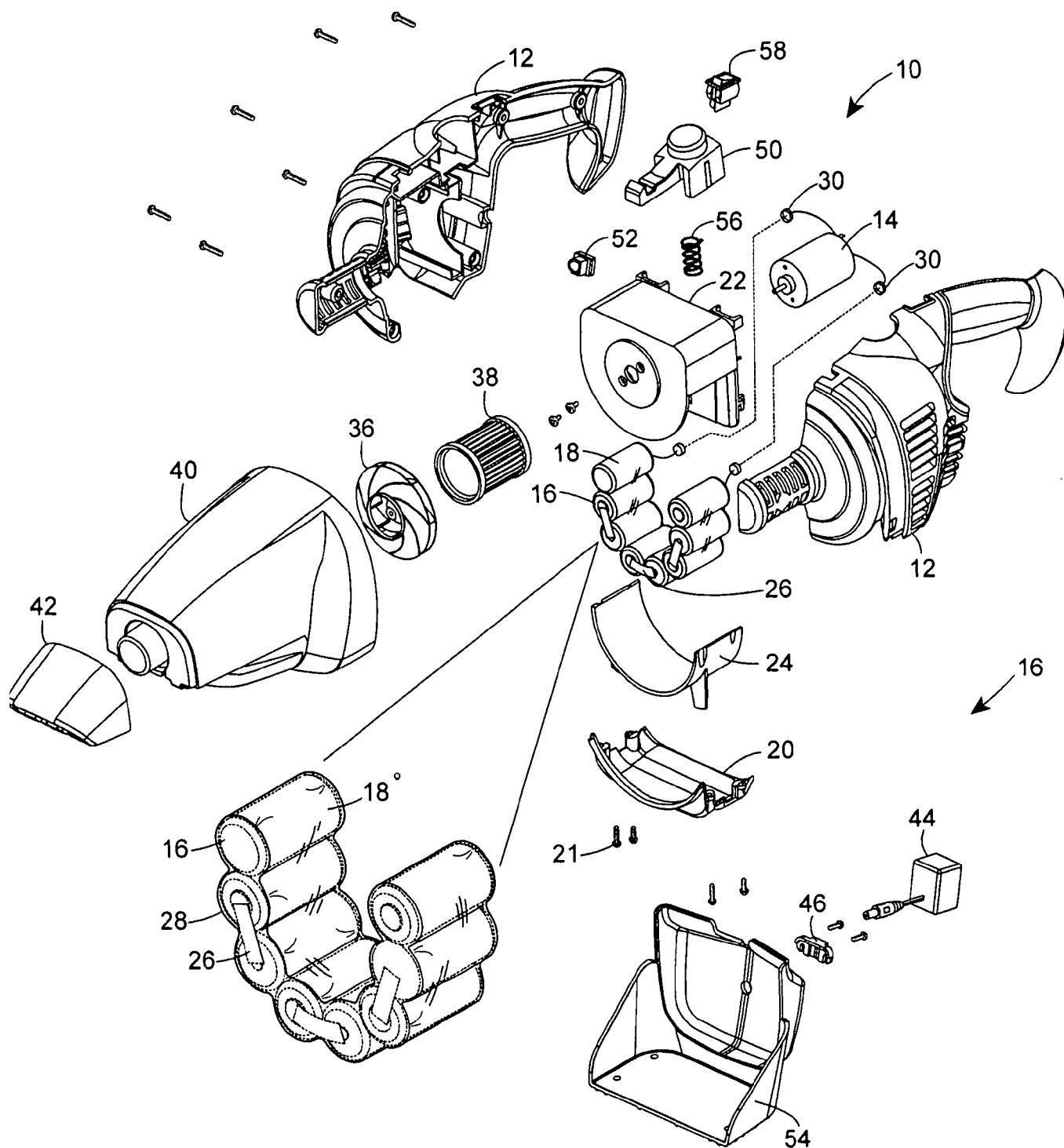


FIG. 2

PORTABLE VACUUM CLEANER
BACKGROUND OF THE DISCLOSURE

[0001] The present application relates to portable vacuum cleaners which may be powered by a rechargeable battery or which may be powered via a conventional source of external DC power, such as vehicle's 12v DC power supply.

[0002] It is to be understood that, if any prior art publication is referred to herein, such reference does not constitute an admission that the publication forms a part of the common general knowledge in the art, in Australia or any other country.

BRIEF SUMMARY

[0003] In accordance with the disclosure, a portable vacuum cleaner is provided. In a first aspect of the disclosure, the portable vacuum cleaner may comprise a rechargeable battery having a nominal battery voltage output at a first voltage level and a DC motor operable at a voltage level substantially equal to the first voltage level. The portable vacuum cleaner may further comprises a DC power input port for receiving DC power. The DC power input port may be adapted to electrically couple the vacuum cleaner alternatively to a first source of DC power at a first voltage output level substantially equal to the first voltage level; and a second source of DC power at a second voltage output level, the second voltage level substantially greater than the first voltage level; and a switch. The switch may have four output states switchable to selectively cause four operational states. The operational states comprising a first operational state wherein the motor may operate as powered by the battery, a second operational state wherein the motor may not operate, and the battery may not charge if coupled to the first source of DC power and the battery may charge if coupled to the second source of DC power, a third operational state wherein the motor may operate if coupled to the first source of DC power but may not operate if coupled to the second source of DC power and a fourth operational state wherein the motor may not operate and the battery may not recharge.

[0004] In a second aspect of the disclosure, the portable vacuum cleaner may comprise a DC motor, a rechargeable battery, a power switch, a charging switch, a DC power input port, and a circuit. The DC motor is operable at a nominal DC voltage and has a positive motor

terminal and a negative motor terminal. The rechargeable battery has a nominal output voltage substantially equal to the nominal DC voltage of the motor, and the battery has a positive battery terminal and a negative battery terminal. The power switch has a common power switch terminal selectively coupled to a first power switch terminal and a negative power switch terminal. The charging switch has a common charging switch terminal selectively coupled to a first charging switch terminal and a negative charging switch terminal. The DC power input port has a positive input terminal and a negative input terminal. The DC power input port is adapted to alternatively electrically couple to a DC adapter and an AC/DC converter. The DC adapter is adapted to provide a DC voltage substantially equal to the nominal DC voltage of the motor. The AC/DC power converter is adapted to provide DC power at a voltage substantially greater than the nominal DC voltage of the motor. The circuit for selectively coupling the DC power input port to the motor and the battery comprises a power switch, a charging switch, and a first, second, third, fourth and fifth conductor. The power switch has a common power terminal and first and second power terminals. The power switch is switchable between a first power position when the common power terminal is coupled to the first power terminal, and a second power position when the common power terminal is coupled to the second power terminal. The charging switch has a common charging terminal and first and second charging terminals. The charging switch is switchable between a first charging position when the common charging terminal is coupled to the first charging terminal, and a second charging position when the charging terminal is coupled to the second charging terminal. The first conductor couples the positive input power terminal to the first power switch terminal and to the first charger switch terminal. The second conductor couples the common power switch terminal to the common charger switch terminal. The third conductor couples the negative input power terminal to the negative battery terminal and to the negative motor terminal. The fourth conductor couples the second charge switch terminal to the positive battery terminal. The fifth conductor couples the second power switch terminal to the positive motor terminal. The power switch and the charging switch cooperatively provide four selectable output states. The first operational state is when the motor may operate as powered by the battery. The second operational state is when the motor may not operate, and the battery may not charge if coupled to the first source of DC power, however the battery may charge if coupled to the second source of DC power.

The third operational state is when the motor may operate if coupled to the first source of DC power but may not operate if coupled to the second source of DC power. The fourth operational state is when the motor may not operate and the battery may not recharge.

[0005] In a third aspect is disclosed a portable vacuum cleaner comprising a DC motor operable at a first voltage level, a rechargeable battery and a DC power input port. The rechargeable battery has nominal voltage output at the first voltage level. The DC power input port has a positive input terminal and a negative input terminal. The DC power input port is adapted to alternatively receive a first power cable for coupling a source of external DC power substantially at the first voltage level to the DC power input port and a second power cable for coupling a source of external AC power to the DC power input port. The second power cable includes an AC/DC converter adapted to convert AC power from the AC power source to DC power at a second voltage level. The second voltage level is greater than the first voltage level. A circuit is coupled to the DC power input port, the battery and the motor. The circuit includes a power switch and a charge switch for selectively blocking current flow or directing current flow to operate the motor or recharge the battery, depending upon the relative positions of the power switch and the charge switch and the DC power received at the DC power input port.

[0006] In some embodiments of the disclosure, the first source of DC power may be a DC adapter, such as one configured to plug into a conventional power, or cigarette, outlet of a vehicle. The second source of DC power may be an AC/DC converter, such as one configured to plug into a conventional AC power outlet.

[0007] In some embodiments of the disclosure, the vacuum cleaner may still further comprise a switching device, such as a two position power switch cooperating with a two position car/battery charge switch.

[0008] In some embodiments of the disclosure, the nominal voltage of the battery and the motor may be 12v DC.

[0009] In some embodiments of the disclosure, the AC/DC converter may provide an output voltage in the range of 14.5-14.8v DC and a trickle charge of approximately 300 mA.

[0010] Other features and advantages of the disclosure may be apparent from the following specification taken in conjunction with the following drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] Fig. 1 is a side view of a first embodiment of a battery powered vacuum cleaner in accordance with the present disclosure;

[0012] Fig. 2 is an exploded view of the vacuum cleaner of Fig. 1;

[0013] Fig. 3 is a sectional view of the vacuum cleaner of Fig. 1, taken along line 3-3 of Fig. 1;

[0014] Fig. 4 is a perspective view of a second embodiment of a battery powered vacuum cleaner in accordance with the present disclosure;

[0015] Fig. 5 is an exploded view of the vacuum cleaner of Fig. 4;

[0016] Fig. 6 is a sectional view of the vacuum cleaner of Fig. 4, taken along line 6-6 of Fig. 4;

[0017] Figs. 7a-7d are schematic views of wiring of a modified version of the battery powered vacuum cleaner of Fig. 4, in accordance with the present disclosure, each of the Figures 7a-7b illustrating particular current paths; and

[0018] Fig. 8 is a plan view of the modified version of the battery powered vacuum cleaner of Figs. 4 and 5, illustrating the actually wiring.

DETAILED DESCRIPTION OF THE DISCLOSURE

[0019] While this disclosure is susceptible of embodiments in many different forms, there is shown in the drawings and may herein be described in detail, preferred embodiments of the disclosure with the understanding that the present disclosure is to be considered as an exemplification of the principles of the disclosure and is not intended to limit the broad aspect of the disclosure to the embodiments illustrated.

[0020] A first embodiment of a battery powered vacuum cleaner, generally designated 10, is illustrated in Figs. 1-3. The vacuum cleaner 10 may be a hand held portable vacuum cleaner.

[0021] The vacuum cleaner 10 may comprise a two-piece vacuum cleaner housing 12, a motor 14, such as a conventional 9.8v. motor, disposed within the housing 12, and a battery, such as a battery pack 16 comprising eight rechargeable battery cells 18 arranged in a generally horseshoe configuration. The motor 14 has an axis of rotation, and the battery cells 18 are arranged substantially coaxial with the axis of rotation of the motor 14. The actual number of battery cells, and thus the overall voltage of the battery pack 16, may vary, depending upon the voltage required by the particular motor.

[0022] The battery pack 16 may be wrapped about the motor 14 within the vacuum cleaner housing 12. The battery pack 16 may directly engage the motor 14. The vacuum cleaner 10 may further include a removable battery door 20, secured to the housing 12, such as by conventional screws 21. The battery door 20 may provide access to the battery pack 16 and may be adapted to permit relatively easy removal of the battery pack 16 from the vacuum cleaner housing 12. Permitting removal of the battery pack 16 permits one to remove the battery pack 16, such as to permit replacement of the battery pack 16 or to permit environmentally friendly disposal of the battery pack 16 separate from disposal of the vacuum cleaner 10 itself. The motor 14 and battery pack 16 may also be contained within a motor housing 22 and battery cover 24, which may be collectively contained within the vacuum cleaner housing 12.

[0023] The battery pack 16 may include conductive tabs 26 electrically coupling the battery cells 18 in series. The conductive tabs 26 may structurally interconnect the battery cells 18. The battery cells 18 of the battery pack 16 may also be flexibly enclosed in a unitary shrink-wrap covering 28. The battery pack 16 may be electrically coupled to the motor 14 by separable connectors 30, to permit easy separation/reattachment of the battery pack 16 from/to the motor 14.

[0024] The vacuum cleaner 10 may also include conventional vacuum cleaner components, including an impeller 36 driven by the motor 14, a filter cartridge 38, a dust housing 40 and a snout 42. The vacuum cleaner may further include a charger 44, a jacket 46, a latch 50, a recharge socket 52, a wall mounting bracket 54, a spring 56 and a motor actuating switch 58.

[0025] The charger 44 may have a charger cable 44a for insertion into a DC power input port 52. The AC/DC converter may be an AC/DC converter.

[0026] A second embodiment of a battery powered vacuum cleaner 10' is illustrated in FIGS. 4-6. The vacuum cleaner 10' may be what is commonly referred to as a wet/dry vacuum cleaner. Components of the vacuum cleaner 10' which are functionally similar to the components of the first embodiment of the vacuum cleaner 10 are identified with the same reference numbers.

[0027] The vacuum cleaner 10' may comprise a vacuum cleaner housing 12, a motor 14, such as a conventional 9.8v. motor, disposed within the housing 12 and a battery pack 16 comprising twelve rechargeable battery cells 18 arranged in a generally horseshoe configuration. The actual number of the battery cells 18, and thus the overall voltage of the battery pack 16, may vary, depending upon the voltage required by the particular motor.

[0028] The battery pack 16 may be wrapped about the motor 14 within the vacuum cleaner housing 12. The battery pack 16 may directly engage the motor 14. The motor 14 has an axis of rotation, and the battery cells 18 are arranged substantially perpendicular to the axis of rotation of the motor 14. The vacuum cleaner 10 may further include a removable battery door 20, secured to the housing 12 such as by a conventional screw 21. The battery door 20 may provide access to the battery pack 16 and may be adapted to permit relatively easy removal of the battery pack 16 from the vacuum cleaner housing 12. As with the first embodiment, permitting removal of the battery pack 16 permits one to remove the battery pack 16, such as to permit replacement of the battery pack 16 or to permit environmentally friendly disposal of the battery pack 16 separate from disposal of the vacuum cleaner 10' itself. The motor 14 and battery pack 16 may also be contained within a motor housing 22 which may be contained within the vacuum cleaner housing 12.

[0029] The battery pack 16 may include conductive tabs 26 electrically coupling the battery cells 18 in series. The conductive tabs 26 may structurally interconnect the battery cells 18. The battery cells 18 of the battery pack 16 may also be flexibly enclosed in a unitary shrink-wrap covering 28. The battery pack 16 may be electrically coupled to the motor 14 by separable connectors 30, to permit easy separation/reattachment of the battery pack 16 from/to the motor 14.

[0030] The vacuum cleaner 10' may also include conventional vacuum cleaner components, including an impeller 36 driven by the motor 14 and a conventional filter cartridge (not shown). The vacuum cleaner may further include a conventional charger (not shown), a conventional recharge socket 52, and a motor actuating switch 58.

[0031] The vacuum cleaner 10' may further include a tank 63, a foam sleeve 64, a float cup 66 and a cage 68 disposed between the foam sleeve 64 and the float cup 66. The vacuum cleaner 10' may still further include a lid 70, a baffle 72 and a handle 74.

[0032] A modified version of the vacuum cleaner, discussed above and hereinafter referred to as the modified vacuum cleaner 10'', is illustrated in Figs. 7a-7d and Fig. 8. The modified vacuum cleaner 10'' may be powered by a rechargeable DC battery pack 16'', such as a 12v DC battery pack.

[0033] The battery pack 16'' may be recharged by an AC/DC charger 44'', having an AC/DC charger cable 44a. The AC/DC charger 44'' may convert AC power, such as conventional 110-120v AC, to DC power, such as 14.5-14.8v DC, at 300mA. The charger 44'' may provide the DC power, such as the 14.5-14.8v DC power at 300mA, until the voltage across the battery pack 16'' reaches the output voltage of the AC/DC charger 44, at which time the charger 44'' may shut off, until such time as the voltage across the battery pack 16 dissipates below this amount.

[0034] Alternatively the modified vacuum cleaner 10'' may be powered by a DC power adapter 80, such as power adapter providing a 12v DC power output, having an output power adapter cable 80a. The power adapter 80 may be adapted to be plugged in to a conventional DC power supply, such as a conventional 12v DC cigarette lighter (not shown) of a vehicle, to provide a 12 DC voltage to the modified vacuum cleaner 10''.

[0035] Referring in particular to Figs. 7a-7d and 8, the modified vacuum cleaner 10'' may include a DC motor 14'', such as a 12v DC motor, having a positive motor terminal 14a and a negative motor terminal 14b. The modified vacuum cleaner 10'' may further include a rechargeable DC battery pack 16'', such as a 12v DC battery pack, having a positive battery terminal 16a and a negative battery terminal 16b. The modified vacuum cleaner 10'' may still further include the two position power switch 58 having a common power switch terminal 58a selectively coupled to a first power switch terminal 58b and to a second power switch

terminal 58c. When the common power switch terminal 58a is coupled to the first power switch terminal 58b, the power switch 58 is in the “off” position and when the common power switch terminal 58a is coupled to the second power switch terminal 58c, the power switch 58 is in the “on” position.

[0036] The modified vacuum cleaner 10” may further include a two position car/charge switch 82 having a common car/charge switch terminal 82a selectively coupled to a first car/charge switch terminal 82b and a second car/charge switch terminal 82c. When the common car/charger switch terminal 82a is coupled to the first car/charge switch terminal 82b, the car/charge switch is in “car” position and when the common car/charge switch terminal 82a is coupled to the second car/charge switch terminal 82c, the car/charge switch 82 is in the “battery/charge” position.

[0037] The present disclosure describes two, two-position switches, 58, 82, which collectively provide four output states. It is to be understood that the switches 58, 82 may be in the form of a single switching device that selectively provides at least four output states.

[0038] The modified vacuum cleaner 10” may still further include a DC power input port 52’ having a positive input terminal 52a’ and a negative input terminal 52b’ . The DC power input port 52’ may be adapted to alternatively receive the AC/DC power cable 44a or the DC power cable 80a.

[0039] The modified vacuum cleaner 10” may further include a circuit, generally designated 84, for selectively coupling power received from the DC power input port 52’ to the motor 14” and the battery pack 16”.

[0040] The power switch 58 and the charging switch 82 may selectively provide four current paths 84a-84d. These four paths are illustrated, in bold, in Figs. 7a-7b, respectively.

[0041] The first current path 84a is illustrated in bold in Fig. 7a. This occurs when the power switch 58 is in the “on” position and the charge switch 82 is in the “battery/charge” position. In this situation, the motor 14” may operate, powered by the battery pack 16”.

[0042] The second current path 84b is illustrated in bold in Fig. 7b. This occurs when the power switch 58 is in the “off” position and the charge switch 82 is in the “battery/charge” position. In this situation, the motor 14” may not operate. If the AC/DC charger 44 is

plugged into the DC power input port 52a, a DC potential may be applied across the battery pack 16", thereby charging the battery pack 16", until the voltage across the battery pack 16" reaches the DC output voltage of the AC/DC charger 44", such as 14.5-14.8v DC.

[0043] If the 12v DC power adapter 80 is plugged into the DC power input port 52a, a potential of 12v DC may be applied across the battery pack 16". However the nominal voltage of the battery pack 16", even when discharged, does not drop below its nominal output voltage, such as 12v DC. Therefore the 12v DC power adapter 80 may not charge the battery pack 16" when the 12v DC power adapter 80 is plugged into the DC power input port 52a. This prevents depleting the source of the 12v DC power, such as the vehicle's car battery.

[0044] The third current path 84c is illustrated in bold in Fig. 7c. This occurs when the power switch 58 is in the "on" position and the charge switch 82 is in the "car" position. In this situation, the motor 14 may operate if the 12v DC power adapter 80 is plugged into the DC power input port 52'. However the motor 14" may not operate if the AC/DC charger 44 is plugged into the DC power input port 52', as the output power of the AC/DC charger 44 is current limited and therefore insufficient to power the motor 14".

[0045] The fourth current path 84d is illustrated in bold in Fig. 7d. This occurs when the power switch 58 is in the "off" position and the charge switch 82 is in the "car" position. In this situation, the motor 14 may not operate, nor may the battery pack 16" charge, regardless of whether the AC/DC charger 44, or the DC power adapter 80, is plugged into the modified vacuum cleaner 10".

[0046] One embodiment of particular wiring of the circuit 84 is illustrated in Fig. 8. The wiring includes a first conductor 86 coupling the positive input power terminal to the first power switch terminal 58b and to the first charger switch terminal 82b and a second conductor 88 coupling the common power switch terminal 58a to the common charger switch terminal 82a.

[0047] The wiring further includes a third conductor 90 coupling the negative input power terminal to the negative battery terminal 16a (not shown in Figure 8), via a connector 30a and to the negative motor terminal 14b and a fourth conductor 92 coupling the second charge switch terminal 58c to the positive battery pack terminal 16b. The wiring still further

includes a fifth conductor 94 coupling the second power switch terminal 82c to the positive motor terminal 14a.

[0048] While specific embodiments have been illustrated and described, numerous modifications may come to mind without departing from the spirit of the disclosure. The scope of protection is only intended to be limited by the scope of the accompanying claims.

[0049] In the claims which follow and in the preceding description of the disclosure, except where the context requires otherwise due to express language or necessary implication, the word “comprise” or variations such as “comprises” or “comprising” is used in an inclusive sense, i.e. to specify the presence of the stated features but not to preclude the presence or addition of further features in various embodiments of the disclosure.

CLAIMS

What is claimed:

1. A portable vacuum cleaner comprising:
 - a rechargeable battery having a nominal battery voltage output at a first voltage level;
 - a DC motor operable at a voltage level substantially equal to the first voltage level;
 - a DC power input port for receiving DC power, the DC power input port adapted to electrically couple the vacuum cleaner alternatively to:
 - a first a source of DC power at a first voltage output level substantially equal to the first voltage level; and
 - a second source of DC power at a second voltage output level, the second voltage level substantially greater than the first voltage level; and
 - a switch having four output states switchable to selectively cause four operational states, the operational states comprising:
 - a first operational state wherein the motor will operate as powered by the battery;
 - a second operational state wherein the motor will not operate, and the battery will not charge if coupled to the first source of DC power and the battery will charge if coupled to the second source of DC power;
 - a third operational state wherein the motor will operate if coupled to the first source of DC power but will not operate if coupled to the second source of DC power; and
 - a fourth operational state wherein the motor will not operate and the battery will not recharge.
2. The vacuum cleaner of claim 2 wherein the nominal motor voltage is 12v DC.
3. The vacuum cleaner of claim 3 wherein the AC/DC converter output is limited to provide a trickle charge to the battery.
4. The vacuum cleaner of claim 1 wherein the second source of DC power comprises an AC/DC converter.

5. The vacuum cleaner of claim 4, wherein the AC/DC converter provides a current output of approximately 300 mA and a voltage output in the range of 14.5-14.8v.

6. A portable vacuum cleaner comprising:

a DC motor operable at a nominal DC voltage, the DC motor having a positive motor terminal and a negative motor terminal;

a rechargeable battery having nominal output voltage substantially equal to the nominal DC voltage of the motor, the battery having a positive battery terminal and a negative battery terminal;

a power switch having a common power switch terminal selectively coupled to a first power switch terminal and a negative power switch terminal;

a charging switch having a common charging switch terminal selectively coupled to a first charging switch terminal and a negative charging switch terminal;

a DC power input port having a positive input terminal and a negative input terminal, the DC power input port adapted to alternatively electrically couple to a DC adapter and an AC/DC converter, the DC adapter adapted to provide a DC voltage substantially equal to the nominal DC voltage of the motor and an AC/DC power converter adapted to provide DC power at a voltage substantially greater than the nominal DC voltage of the motor; and

a circuit for selectively coupling the DC power input port to the motor and the battery, the circuit comprising:

a power switch having a common power terminal and first and a second power terminals, the power switch being switchable between a first power position wherein the common power terminal is coupled to the first power terminal and a second power position wherein the common power terminal is coupled to the second power terminal;

a charging switch having a common charging terminal and first and a second charging terminals, the charging switch being switchable between a first charging position wherein the common charging terminal is coupled to the first charging terminal and a second charging position wherein the charging terminal is coupled to the second charging terminal;

a first conductor coupling the positive input power terminal to the first power switch terminal and to the first charger switch terminal;

a second conductor coupling the common power switch terminal to the common charger switch terminal;

a third conductor coupling the negative input power terminal to the negative battery terminal and to the negative motor terminal;

a fourth conductor coupling the second charge switch terminal to the positive battery terminal; and

a fifth conductor coupling the second power switch terminal to the positive motor terminal;

wherein a the power switch and the charging switch cooperatively provide four selectable output states, the operational states comprising:

a first operational state wherein the motor will operate as powered by the battery;

a second operational state wherein the motor will not operate, and the battery will not charge if coupled to the first source of DC power and the battery will charge if coupled to the second source of DC power;

a third operational state wherein the motor will operate if coupled to the first source of DC power but will not operate if coupled to the second source of DC power; and

a fourth operational state wherein the motor will not operate and the battery will not recharge.

7. The vacuum cleaner of claim 6 wherein the nominal motor voltage is 12v DC.
8. The vacuum cleaner of claim 7 wherein the AC/DC converter output is limited to provide a trickle charge to the battery.
9. The vacuum cleaner of claim 8, wherein the AC/DC converter provides a current output of approximately 300 mA and a voltage output in the range of 14.5-14.8v.

10. A portable vacuum cleaner comprising:
a DC motor operable at a first voltage level;
a rechargeable battery having nominal voltage output at the first voltage level;
a DC power input port having a positive input terminal and a negative input terminal, the DC power input port adapted to alternatively receive a first power cable for coupling a source of external DC power substantially at the first voltage level to the DC power input port and a second power cable for coupling a source of external AC power to the DC power input port, the second power cable including an AC/DC converter adapted to convert AC power from the AC power source to DC power at a second voltage level, the second voltage level being greater than the first voltage level; and a circuit coupled to the DC power input port, the battery and the motor, the circuit including a power switch and a charge switch for selectively blocking current flow or directing current flow to operate the motor or recharge the battery, depending upon the relative positions of the power switch and the charge switch and the DC power received at the DC power input port.

11. The vacuum cleaner of claim 10 wherein the AC/DC converter output is limited to provide a trickle charge to the battery.

12. The vacuum cleaner of claim 11, wherein the AC/DC converter provides an current output of approximately 14.5-14.8v DC and 300 mA.

13. The vacuum cleaner of claim 12 wherein the first voltage level is 12v DC.

14. The vacuum cleaner of claim 10 wherein:

the power switch has a common power terminal and first and a second power terminals, the power switch being switchable between an “off” power position wherein the common power terminal is coupled to the first power terminal and an “on” power position wherein the common power terminal is coupled to the second power terminal;

the charging switch has a common charging terminal and first and a second charging terminals, the charging switch being switchable between a “car” charging position wherein the common charging terminal is coupled to the first charging terminal and a “battery/charge” charging position wherein the common charging terminal is coupled to the second charging terminal;

and the circuit includes:

a first conductor coupling the positive input power terminal to the first power switch terminal and to the first charger switch terminal;

a second conductor coupling the common power switch terminal to the common charger switch terminal;

a third conductor coupling the negative input power terminal to the negative battery terminal and to the negative motor terminal;

a fourth conductor coupling the second charge switch terminal to the positive battery terminal; and

a fifth conductor coupling the second power switch terminal to the positive motor terminal.

15. The vacuum cleaner of claim 14, wherein there are four operational states depending upon the position of the power switch and the charge switch, the four operational states comprising:

a first operational state wherein the power switch is in the on position and the charging switch is in the battery/charge position, and the motor will operate as powered by the battery;

a second operational state wherein the power switch is in the off position and the charging switch is in the battery/car position, the motor will not operate, and the battery will not charge if coupled to the first source of DC power and the battery will charge if coupled to the second source of DC power;

a third operational state wherein the power switch is in the on position and the charging switch is in the car position, the motor will operate if coupled to the first source of DC power but will not operate if coupled to the second source of DC power; and

a fourth operational state wherein the power switch is in the off position and the charging switch is in the car position the motor will not operate and the battery will not recharge.

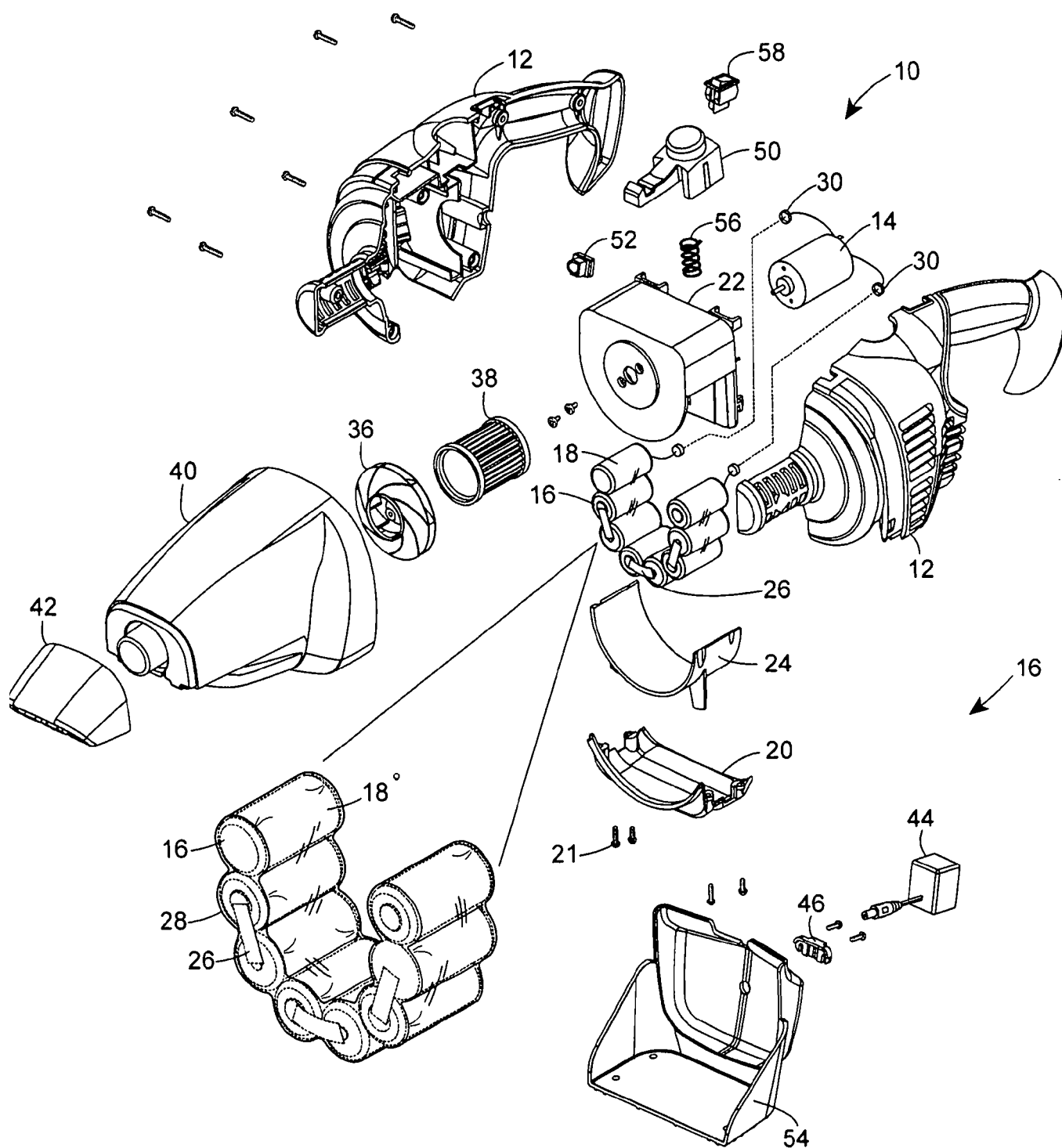


FIG. 2

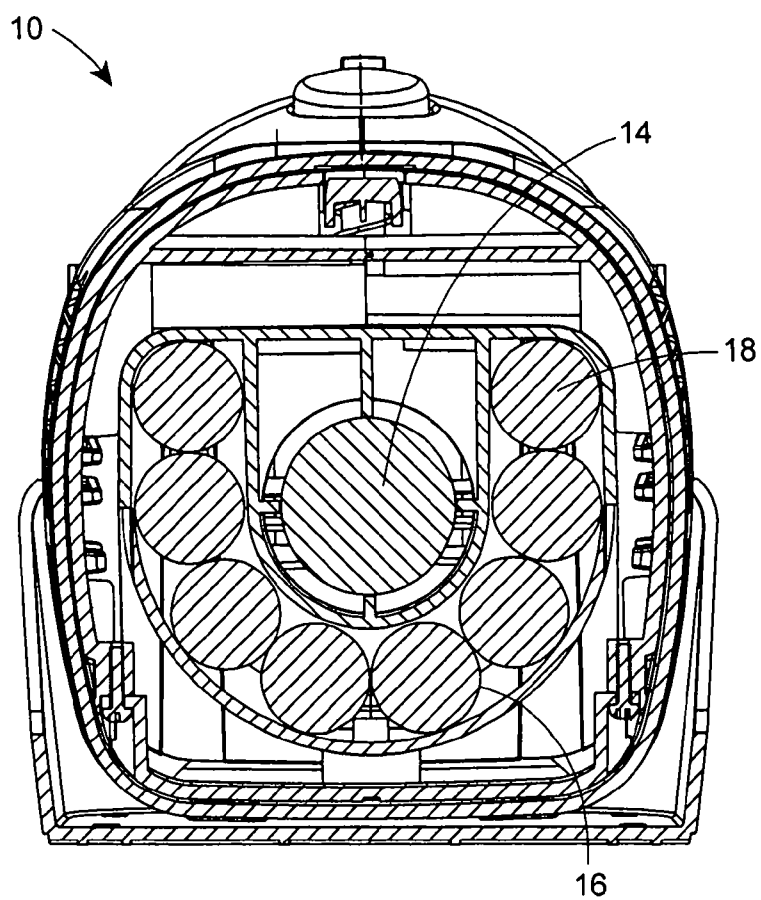


FIG. 3

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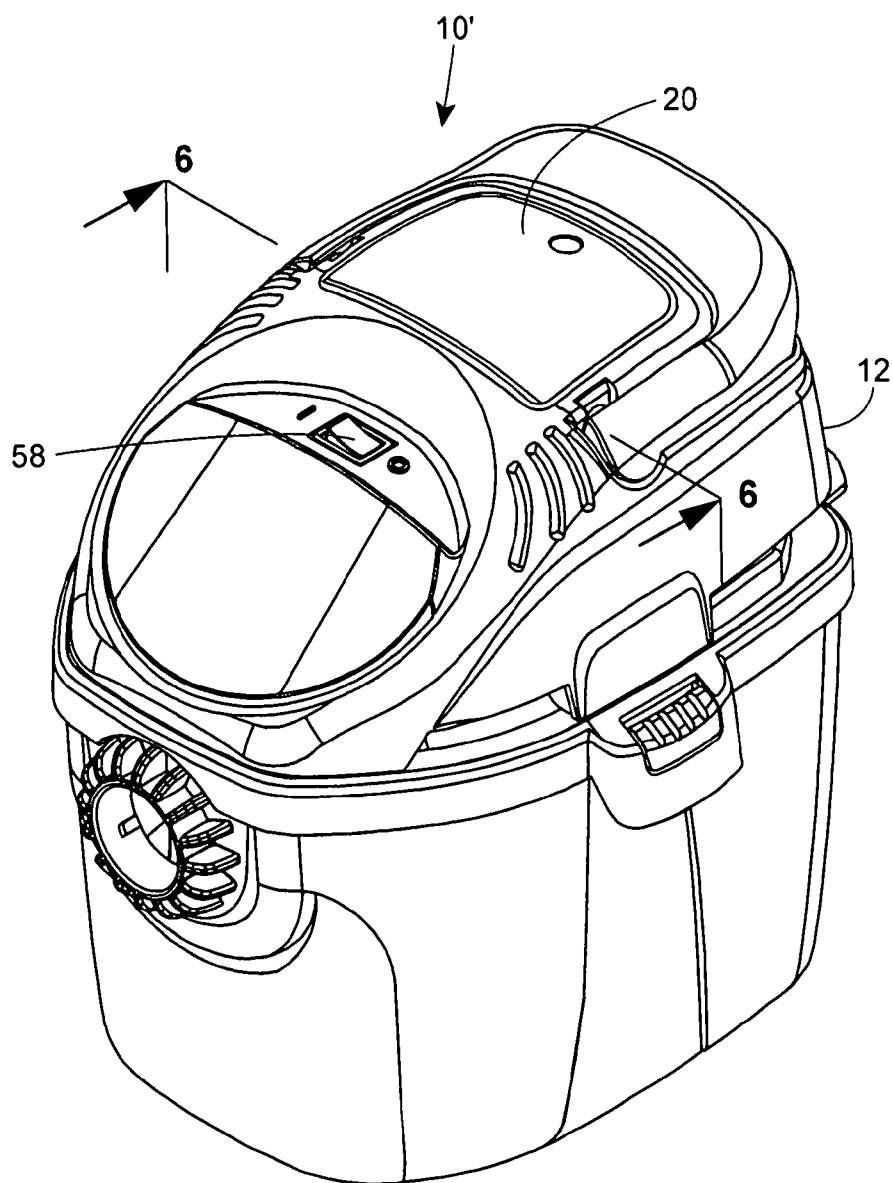


FIG. 4

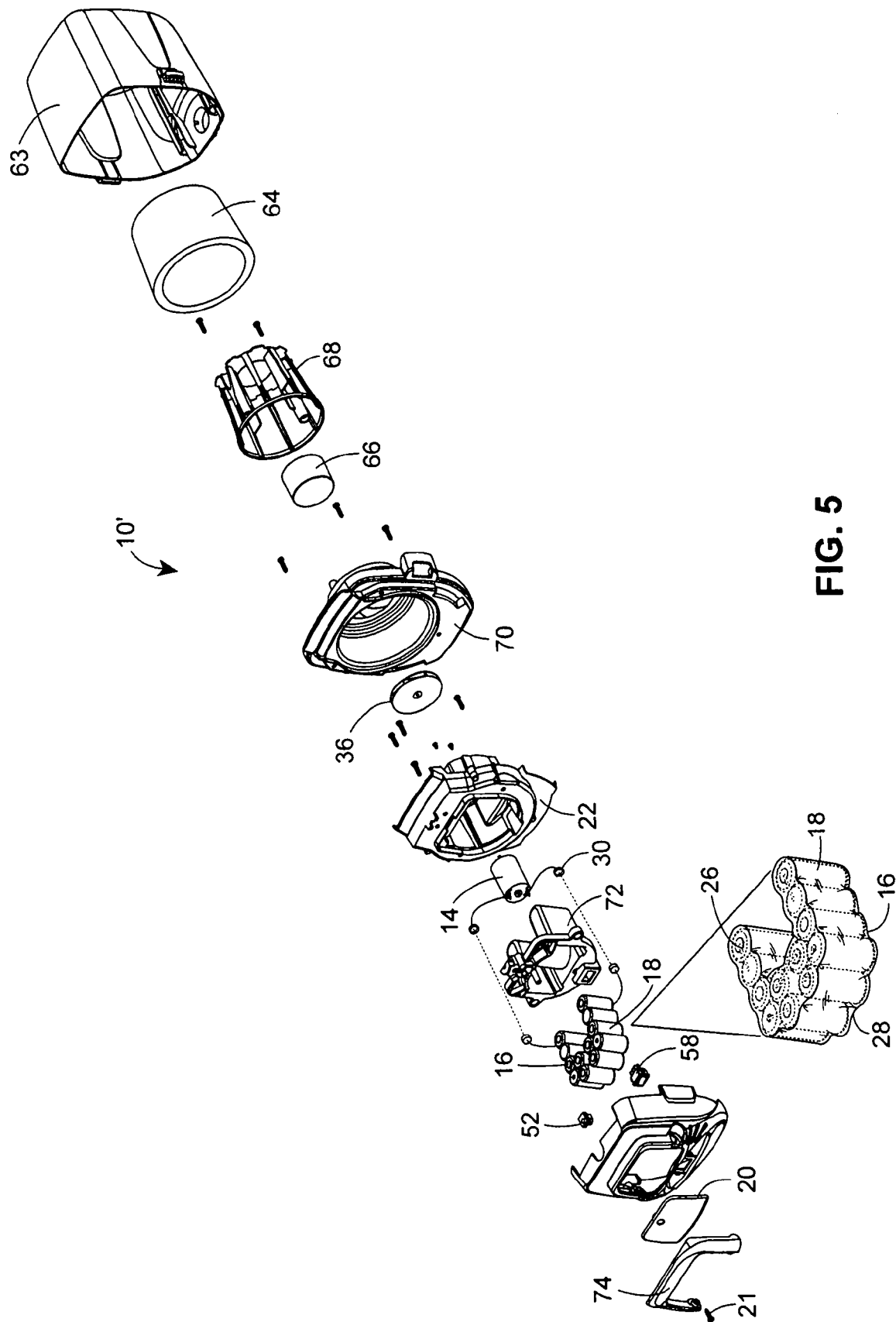


FIG. 5

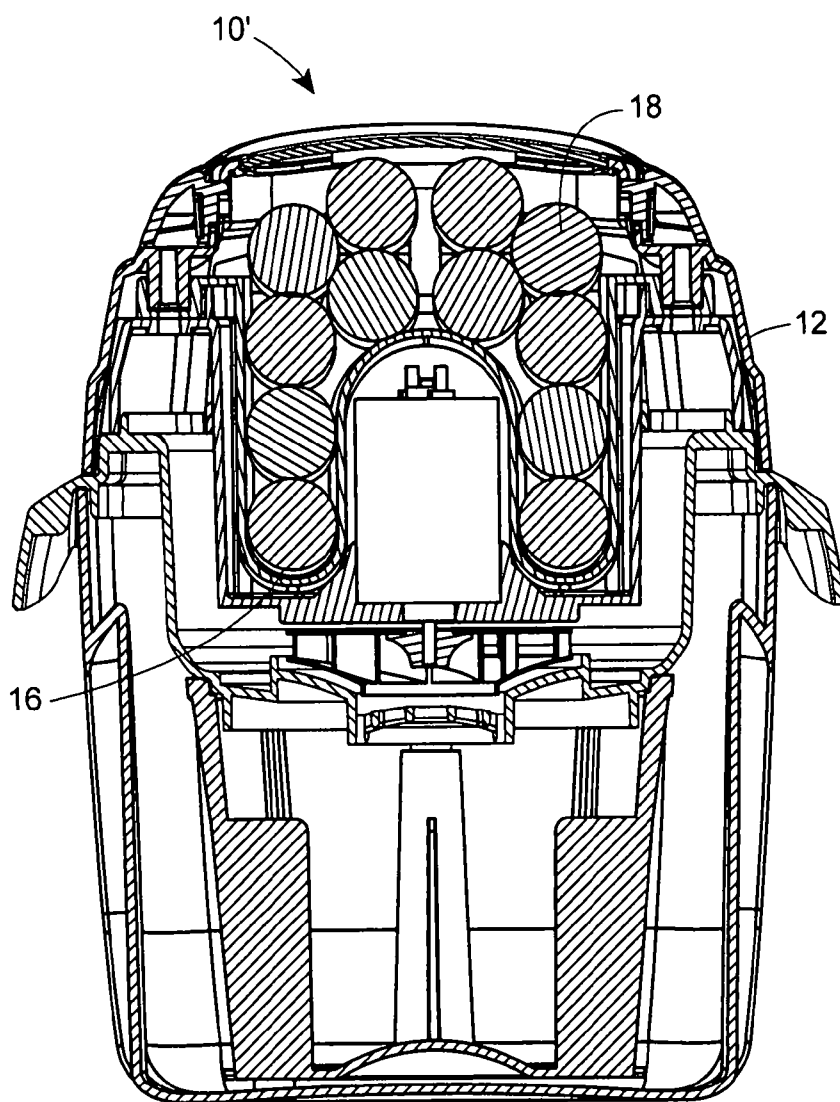


FIG. 6

POWER SWITCH: ON
SELECTOR SWITCH: BATTERY/CHARGE

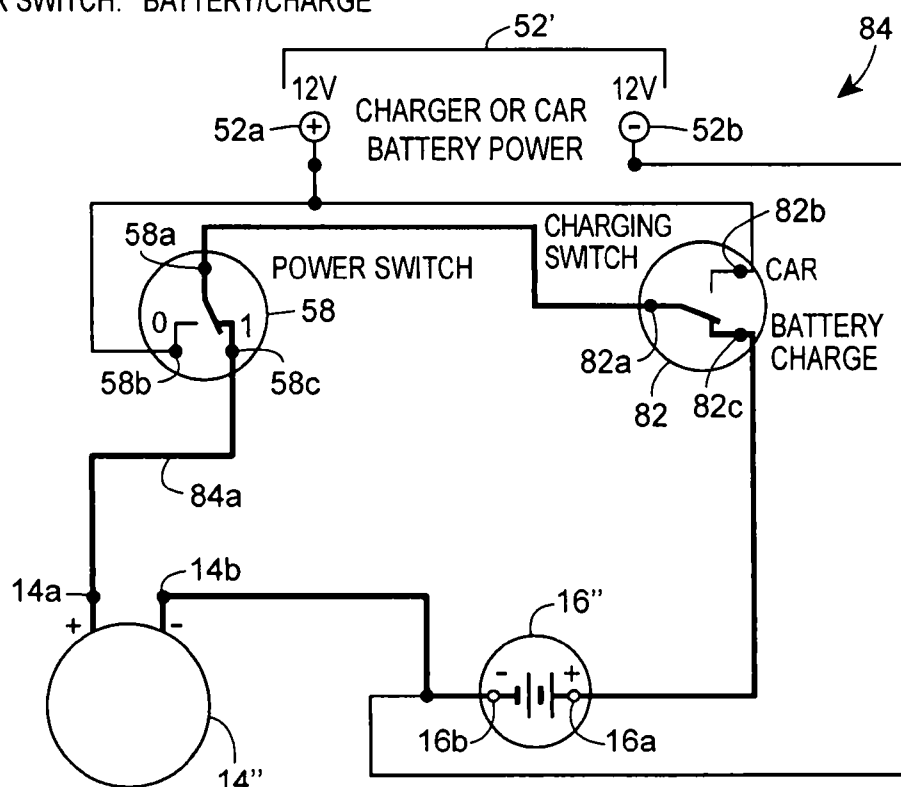


FIG. 7a

POWER SWITCH: OFF
SELECTOR SWITCH: BATTERY/CHARGE

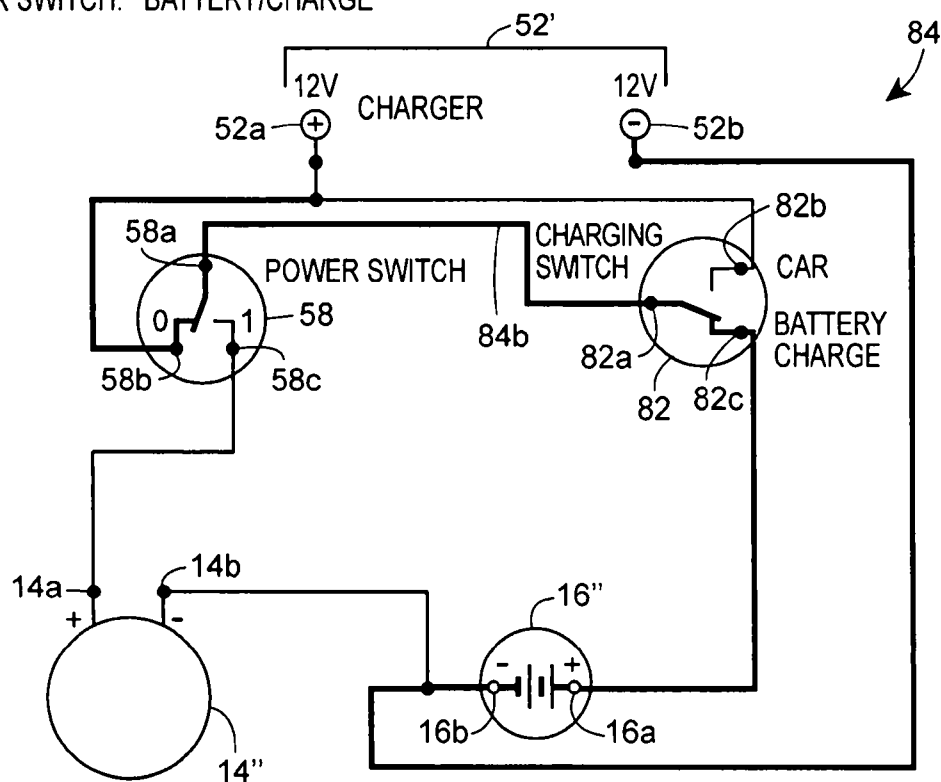


FIG. 7b

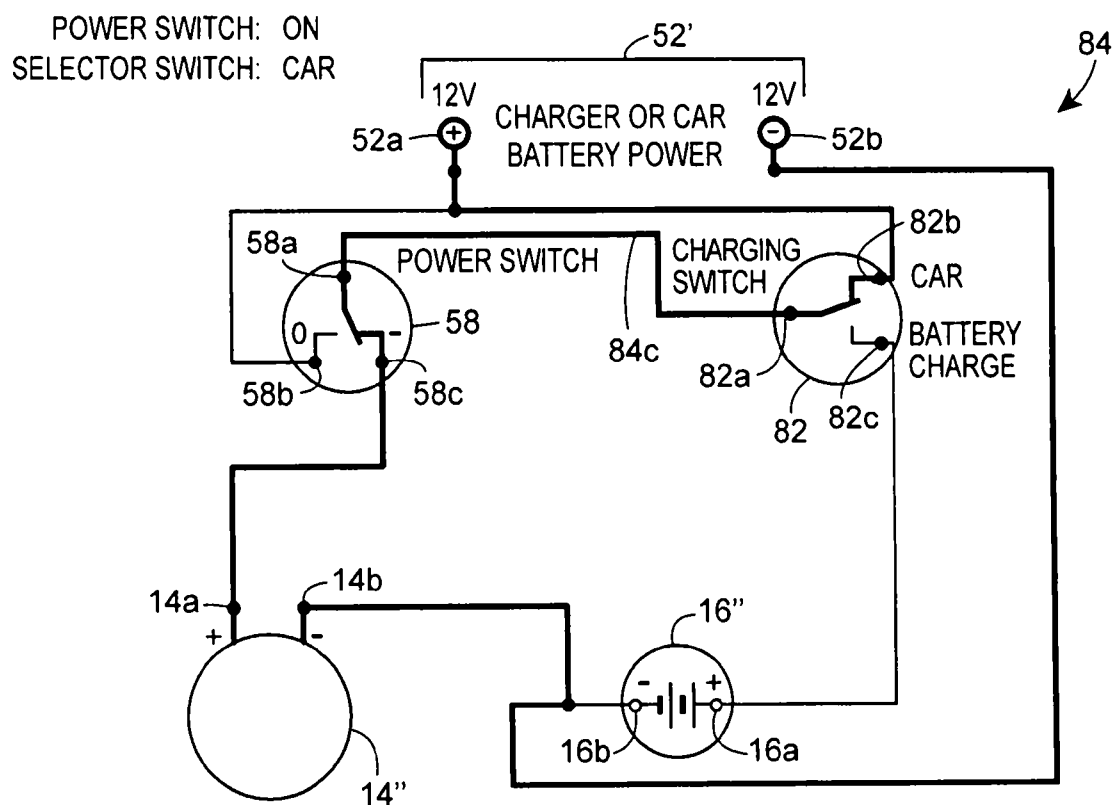


FIG. 7c

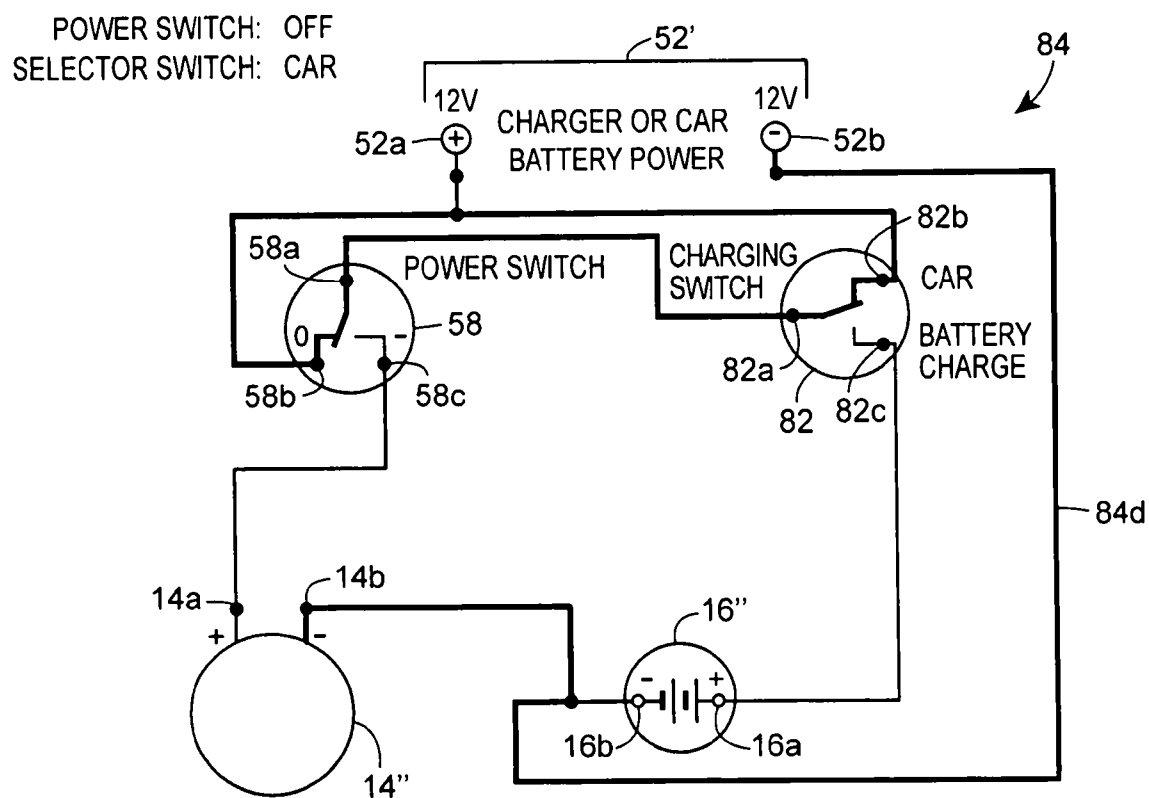


FIG. 7d

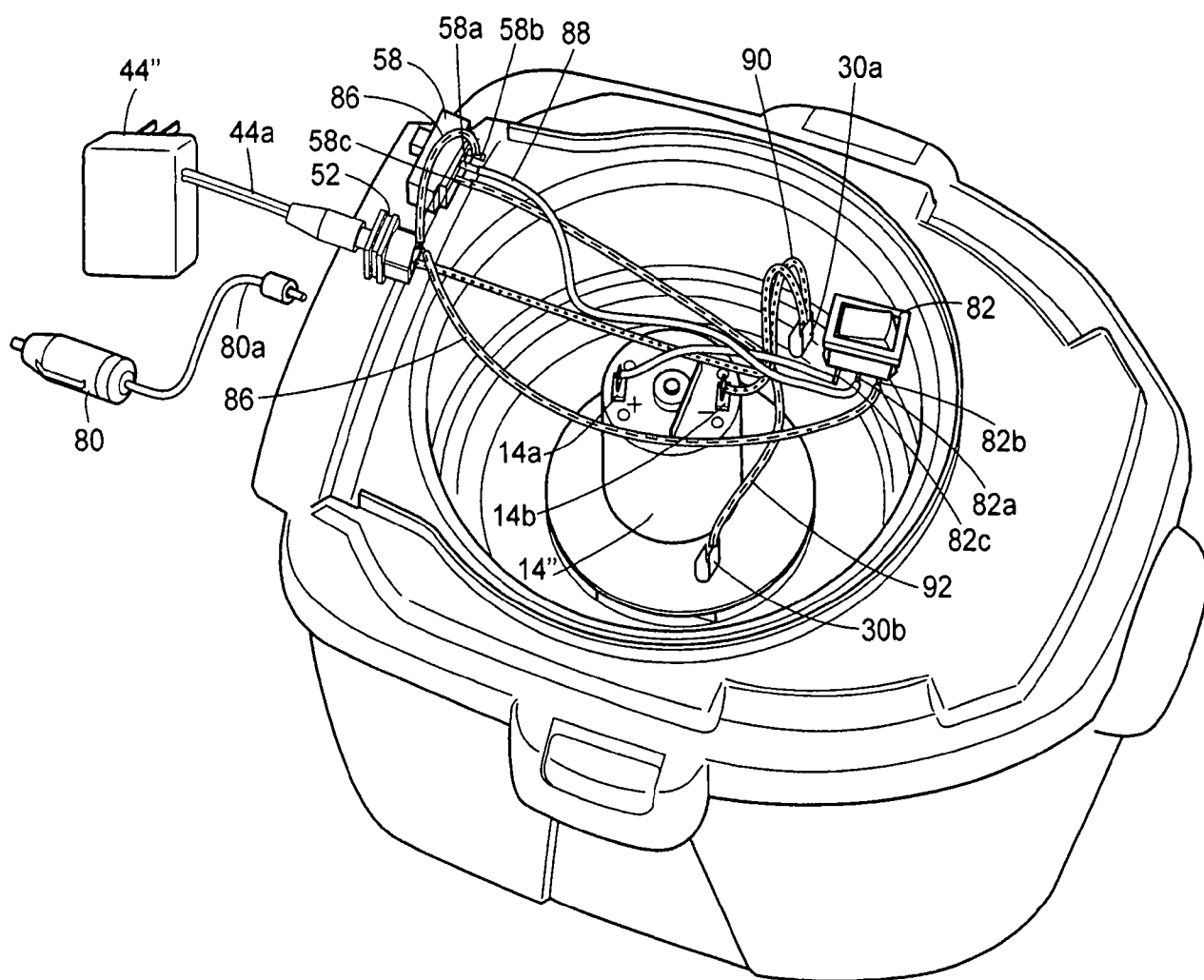


FIG. 8