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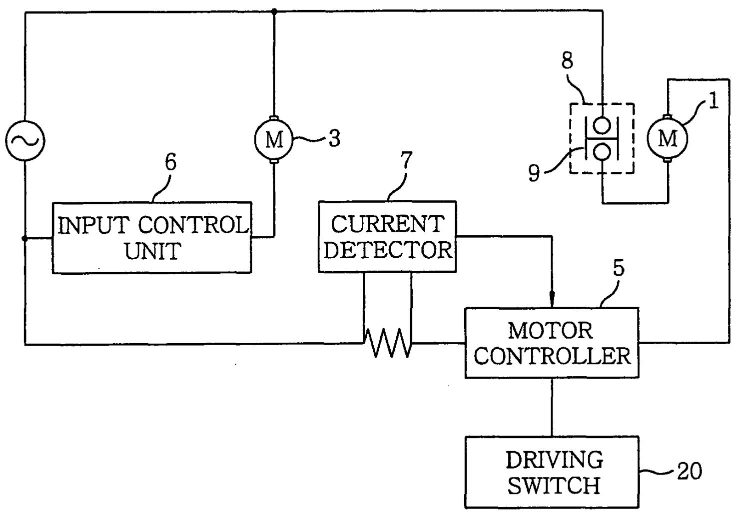
(54) **Vacuum cleaner with motor overheating safety device**

(57) A vacuum cleaner includes an electric motor for driving a rotational brush for brushing dust particles from a surface to be cleaned, an electric blower for generating a suction air stream for sucking in the dust particles, a dust chamber for collecting the dust particles therein, a motor controller for controlling the electric motor, an input controller for controlling the electric blower, a current detector for detecting a current flowing through the motor controller, and a temperature detector for detecting a temperature of the electric motor. If the temperature of the electric motor increases over a predetermined temperature value, the electric motor is stopped and the stoppage of the electric motor is detected by the current detector.

FIG.2



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Description

[0001] The present invention relates to a vacuum cleaner; and, more particularly, to a control mechanism for an electric motor for driving a rotational brush which brushes dust particles.

[0002] Conventional vacuum cleaners in general are configured as illustrated in Figs. 5 and 6.

[0003] As shown in the figures, vacuum cleaner main body 50 includes electric blower 51 for generating a suction air stream for sucking in dust particles and dust chamber 52 for collecting dust particles therein, wherein dust chamber 52 is provided at a suction side of electric blower 51, i.e., above electric blower 51. Hose 60 communicated at one end thereof with dust chamber 52 is installed at a frontal portion of vacuum cleaner main body 50, and the other end of hose 60 is connected to suction head 80 including rotational brush 53, electric motor 81 for driving the rotational brush 53, and so forth. Suction head 80, hose 60 and dust chamber 52 form an air suction passage.

[0004] In general, a user controls operations of electric blower 51 and electric motor 81 for rotating rotational brush 53 depending on the state of a floor to be cleaned by manipulating switch 82 installed on handle 54. Here, electric motor 81 is cooled down by the air stream that is made to flow in the air suction passage by the operation of electric blower 51 (see, for example, specification of US Patent No. 6533611).

[0005] However, if the air stream is not generated sufficiently strongly in the air suction passage due to dust particles accumulated in dust chamber 52, electric motor 81 cannot be adequately cooled down, and electric motor 81 is heated up. As a solution to this problem, a temperature sensor having a self-hold function is installed at a vicinity of electric motor 81 to prevent electric motor 81 from being abnormally overheated. Further, recently, there is proposed a vacuum cleaner having an operational mode in which rotational brush 53 is operated at a low rotational speed to prevent a scratch on the floor to be cleaned.

[0006] However, in accordance with the above-described configuration of the conventional vacuum cleaner, when electric motor 81 is operated in a mode in which the rotational speed of electric motor 81 is low, thereby lowering the torque of electric motor 81, electric motor 81 can be easily locked. For the reason, the temperature sensor is installed near electric motor 81 to prevent it from being overheated.

[0007] However, a temperature sensor in general, especially the one with the self-hold function is of a high price.

[0008] It is, therefore, an object of the present invention to provide a low-cost vacuum cleaner having a high safety and an increased user convenience.

[0009] In accordance with a preferred embodiment of the present invention, there is provided a vacuum cleaner including: an electric motor for driving a rotational brush for brushing dust particles from a surface to be cleaned; an electric blower for generating a suction air stream for sucking in the dust particles; a dust chamber for collecting the dust particles therein; a motor controller for controlling the electric motor; an input controller for controlling the electric blower; a current detector for detecting a current flowing through the motor controller; and a temperature detector for detecting a temperature of the electric motor, wherein if the temperature of the electric motor increases over a predetermined temperature value, the electric motor is stopped and the stoppage of the electric motor is detected by the current detector.

[0010] In accordance with another preferred embodiment of the present invention, there is provided a vacuum cleaner including: an electric motor for driving a rotational brush for brushing dust particles from a surface to be cleaned; an electric blower for generating a suction air stream for sucking in the dust particles; a dust chamber for storing the dust particles therein; a motor controller for controlling the electric motor; an input controller for controlling the electric blower; a motor detector for detecting whether the electric motor is being driven or not; and a temperature detector for detecting a temperature of the electric motor, wherein the electric motor is stopped unless outputs from the motor detector and the temperature detector are in.

[0011] The above and other objects and features of the present invention will become apparent from the following description of preferred embodiments given in conjunction with the accompanying drawings, in which:

Fig. 1 is a side view of a vacuum cleaner in accordance with a first preferred embodiment of the present invention;

Fig. 2 sets forth a circuit block diagram of the vacuum cleaner in accordance with the first preferred embodiment;

Figs. 3A and 3B provide partial cross sectional views of major components of a vacuum cleaner which stands upright in a standing state and is being used in a cleaning state, respectively, in accordance with a second preferred embodiment of the present invention;

Fig. 4 presents a circuit block diagram of the vacuum cleaner in accordance with the second preferred embodiment of the present invention;

Fig. 5 shows a perspective view of a frontal portion of a conventional vacuum cleaner; and

Fig. 6 depicts a perspective view of a rear portion of the conventional vacuum cleaner.

[0012] Hereinafter, preferred embodiments of the present invention will be described with reference to the accompanying drawings. Here, it is to be noted that the present invention is not limited thereto.

(First preferred embodiment)

[0013] Fig. 1 is a side view of a vacuum cleaner in accordance with a first preferred embodiment of the present invention and Fig. 2 sets forth a circuit block diagram thereof.

[0014] Referring to Figs. 1 and 2, the vacuum cleaner includes electric motor 1 for driving rotational brush 2 for brushing dust particles on a floor to be cleaned; electric blower 3 for generating suction air stream for sucking in dust particles; dust chamber 4 for collecting dust particles therein; motor controller 5 for controlling the rotational speed of electric motor 1; input control unit 6 for controlling electric blower 3; and current detector 7 for detecting an electric current flowing through motor controller 5.

[0015] Further, temperature detector 8 detects the temperature of electric motor 1. In the first preferred embodiment, temperature detector 8 includes cheap thermostat 9 (of a self-reset type) and is connected to electric motor 1 in series. As for thermostat 9, if the temperature of electric motor 1 increases up to a first predetermined value (e.g., 120 °C), a closed contact point of thermostat 9 is opened, whereas the opened contact point is closed again if electric motor 1 is cooled down such that its temperature decreases to a second predetermined value (e.g., 70 °C). Further, switch 10 installed on a handle of the vacuum cleaner is used for a user to turn on or off the operation of the vacuum cleaner.

[0016] Below, operation of the vacuum cleaner having the above-described configuration will be explained in detail.

[0017] If the temperature of electric motor 1 is low, the contact point of thermostat 9 of temperature detector 8 is closed. As a result, power supply to electric motor 1 is continued, and current detector 7 detects the amount of the current flowing through motor controller 5.

[0018] Here, if rotational brush 2 is operated at a low rotational speed for a long period of time or if rotational brush 2 is locked due to a heavy load of the surface to be cleaned, such as a thick, heavy carpet or electric motor 1 itself is locked, the temperature of electric motor 1 increases. In this case, if the temperature of electric motor 1 is detected to reach the first predetermined temperature value by temperature detector 8, the contact point of thermostat 9 of temperature detector 8 is opened, and at the same time current detector 7 will detect there is no current flowing through motor controller 5.

[0019] When it is determined that electric motor 1 has been stopped, motor controller 5 controls to have switch 10 to be turned off or outputs a stop signal of electric motor 1 continuously until switch 10 is turned off or power supply is cut off. For example, if it is determined that electric motor 1 is stopped, the power is not supplied to electric motor 1 until switch 10 is turned off or power supply is cut off.

[0020] By this mechanism, even in case the temperature of electric motor 1 is reduced down to the second predetermined value, electric motor 1 is maintained stopped.

[0021] Further, though the first preferred embodiment has been described for the case of detecting the current flowing through motor controller 5, it is also possible to detect a current flowing through electric motor 1 or to employ a rotational number detector, e.g., a revolution-counter, for detecting a rotational status of electric motor 1. In addition, though switch 10, which is a power switch for starting or cutting off a power supply, is exemplified as an "off" switch for use in stopping the load on electric motor 1 or electric blower 3 in the above-described first preferred embodiment, it is also preferable to use a signal switch (not shown) instead of the power switch to generate an "off" signal. In this case, by processing the "off" signal through a microprocessor, the load can be stopped. That is, the "off" switch can be implemented by an element other than the power switch.

(Second preferred embodiment)

[0022] Figs. 3A and 3B present partial cross sectional views of major components of a vacuum cleaner in accordance with a second preferred embodiment of the present invention. Fig. 4 is a circuit block diagram thereof. Here, parts identical to those described in the first preferred embodiment will be assigned same reference numerals, and description thereof will be omitted.

[0023] Referring to Figs. 3A to 4, electric motor detector 11 detects whether electric motor 1 is being driven or not. In the second preferred embodiment, employed as electric motor detector 11 is micro switch 12 for distinguishing a state where rotational brush 2 is not driven, i.e., a main body standing state (as shown in Fig. 3A) in which main body 15 stands upright from a state where main body 15 is inclined to drive rotational brush 2, i.e., a cleaning state (as shown in Fig. 3B). Reference numeral 12a is a lever of micro switch 12.

[0024] When main body 15 is in the standing state, lever 12a of micro switch 12 is opened, as illustrated in Fig. 3A, so that a contact point of micro switch 12 is also in an open state. When the vacuum cleaner is in the cleaning state, on the other hand, lever 12a of micro switch 12 is closed, as shown in Fig. 3B.

[0025] Furthermore, as illustrated in Fig. 4, temperature detector 8 includes thermostat 9 and first fixed resistor 13 (e.g., 1 kΩ) connected to thermostat 9 in parallel. Also, electric motor detector 11 is connected to temperature detector 8 in series, which is also connected to second fixed resistor 14 (which is set to have a value of 1 kΩ identical to that of first fixed resistor 13) in series. In this configuration, a voltage divided by first and second resistor 13 and 14 can be inputted to motor controller 5.

[0026] Hereinafter, operation of the vacuum cleaner configured as described will be explained.

[0027] When main body 15 is in the standing state, the contact point of micro switch 12 is in an open state. Therefore, 0V is inputted to motor controller 5 regardless of the current state of temperature detector 8. In case main body 15 is inclined in the cleaning state, however, the contact point of micro switch 12 is in a closed state, and a voltage is inputted to motor controller 5 as follows.

[0028] If the temperature of electric motor 1 is low, the contact point of thermostat 9 is closed, so that 5V is inputted to motor controller 5.

[0029] However, if the temperature of electric motor 1 is high, the contact point of thermostat 9 is opened, so that 2.5V is inputted to motor controller 5.

[0030] Accordingly, detection of a current state of the vacuum cleaner and control operation are performed as follows based on an input voltage to motor controller 5. If an input of 0.0V is detected, main body 15 is determined to be in the standing state, so that electric motor 1 is stopped; if an input of 2.5V is detected, main body 15 is determined to be in the cleaning state, but since the temperature of electric motor 1 is high, electric motor 1 is maintained stopped; and if an input of 5.0V is detected, main body 15 is determined to be in the cleaning state and the temperature of electric motor 1 is low, so that electric motor 1 is operated.

[0031] Conventionally, determination of whether main body 15 is in a standing state or in a cleaning state and whether the temperature of electric motor 1 is high or low has been performed individually by dual systems. However, in accordance with the second preferred embodiment, by connecting first fixed resistor 13 to thermostat 9 in parallel, detection of a standing or a cleaning state of main body 15 and a high or a low temperature of electric motor 1 can be carried out by a single system at a low cost.

[0032] If it is found that electric motor 1 is stopped in the cleaning state, a stop signal indicating the stoppage of electric motor 1 is continuously outputted until an "off-operation" is inputted by switch 10 or power supply is cut off. Thus, even in case the temperature of electric motor 1 is reduced to, e.g., the second predetermined value, electric motor 1 is maintained stopped without being driven to rotate unprepared.

[0033] Moreover, in the second preferred embodiment, though thermostat 9 and first fixed resistor 13 connected thereto in parallel are used as temperature detector 8, if a thermistor or the like is employed as temperature detector 8, installation of the fixed resistor becomes unnecessary and it is still possible to perform a delicate control of the temperature of electric motor 1 (for example, with regard to a determination value for use in stopping a driving signal of electric motor 1 when the temperature of electric motor 1 increases and a determination value for allowing an output of the driving signal of electric motor 1 when the temperature of electric motor 1 decreases, the two values can be changed properly.

[0034] In particular, driving switch 20 for use in resuming the driving operation of electric motor 1 manually is provided as shown in Fig. 4. If the temperature of electric motor 1 is reduced down to or below the second predetermined temperature value after electric motor 1 is stopped because its temperature increases up to or over the first predetermined value, it is possible to resume an output of a driving signal of electric motor 1 from motor controller 5 by manipulating driving switch 20. Thus, by using driving switch 20, unprepared rotation of electric motor 1 can be prevented when the temperature of electric motor 1 is reduced, and, also, a normal cleaning operation can be resumed by operating driving switch 20 at a point in time when the temperature of electric motor 1 falls below the second predetermined temperature value.

[0035] As described, the vacuum cleaner in accordance with the present invention has merits in that it can be fabricated at a low cost and there is little limit in the number of wirings therein. Furthermore, it can detect the stoppage of the electric motor accurately, thus providing improved safety and user convenience. Therefore, the present invention has advantages when it is applied to various vacuum cleaners or dust collectors for use in household and commercial environments. In addition, the rotational state of the electric motor can be detected at a low cost to secure a high level of safety readiness and it is possible to securely control the rotation of the electric motor when, e.g., the electric motor is abnormally overheated or the vacuum cleaner is not in a cleaning state. Moreover, it is possible to properly setting the stop temperature and the drive temperature of the electric motor to prevent the electric motor from being overloaded.

[0036] While the invention has been shown and described with respect to the preferred embodiments, it will be understood by those skilled in the art that various changes and modifications may be made without departing from the scope of the invention as defined in the following claims.

Claims

1. A vacuum cleaner comprising:

an electric motor for driving a rotational brush for brushing dust particles from a surface to be cleaned;
an electric blower for generating a suction air stream for sucking in the dust particles;
a dust chamber for collecting the dust particles therein;
a motor controller for controlling the electric motor;
an input controller for controlling the electric blower;
a current detector for detecting a current flowing through the motor controller; and
a temperature detector for detecting a temperature of the electric motor,
wherein if the temperature of the electric motor increases over a predetermined temperature value, the electric motor is stopped and the stoppage of the electric motor is detected by the cur-

rent detector.

2. The cleaner of claim 1, further comprising a switch for turning on and off an operation of the vacuum cleaner, wherein once the stoppage of the electric motor is detected by the current detector, the stoppage of the electric motor is maintained until the operation of the vacuum cleaner is turned off by the switch or a power supply to the vacuum cleaner is cut off.

3. A vacuum cleaner comprising:

an electric motor for driving a rotational brush for brushing dust particles from a surface to be cleaned;
an electric blower for generating a suction air stream for sucking in the dust particles;
a dust chamber for storing the dust particles therein;
a motor controller for controlling the electric motor;
an input controller for controlling the electric blower;
a motor detector for detecting whether the electric motor is being driven or not; and
a temperature detector for detecting a temperature of the electric motor,
wherein the electric motor is stopped unless outputs from the motor detector and the temperature detector are in predetermined ranges.

4. The cleaner of claim 3, wherein the motor detector and the temperature detector are connected in series.

5. The cleaner of claim 4, further comprising a switch for turning on and off an operation of the vacuum cleaner, wherein once the electric motor is stopped because the outputs from the motor detector and the temperature detector are not in the predetermined ranges, the stoppage of the electric motor is maintained until the operation of the vacuum cleaner is turned off by using the switch or a power supply to the vacuum cleaner is cut off.

6. The cleaner of claim 2 or 5, further comprising a driving switch for use in driving the electric motor manually, wherein if the temperature of the electric motor is reduced to or below a preset temperature value after the electric motor is stopped, the electric motor can be reset to be controllable by the motor controller by manipulating the driving switch.

7. The cleaner of any one of claims 1 to 6, wherein, as for a determination value for use in stopping a driving signal from the motor controller in case the temperature of the electric motor increases and a determination value for use in allowing an output of the driving signal from the motor controller in case the temperature of the electric motor decreases, the two determination values are set to be differently changeable.

FIG. 1

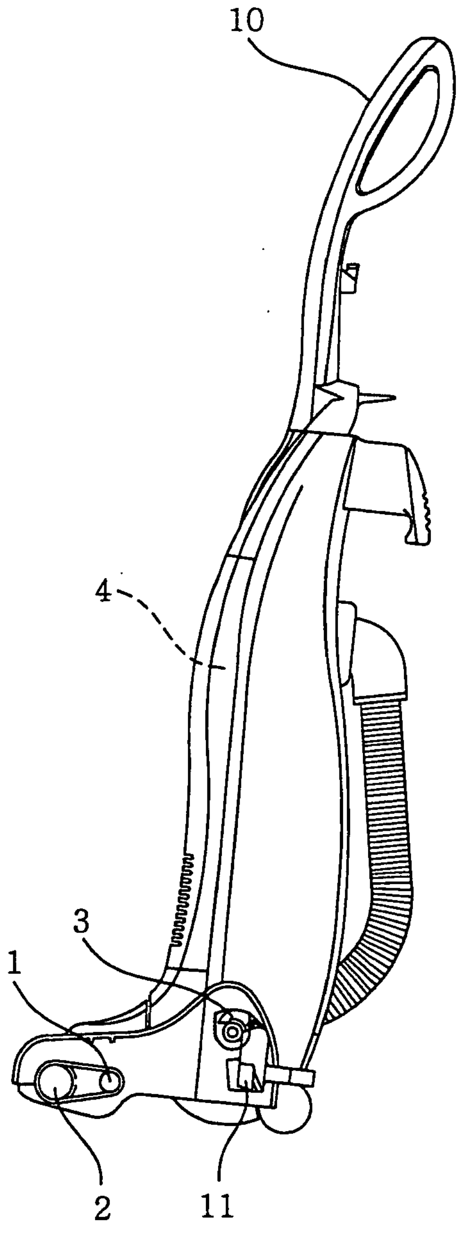

FIG.2

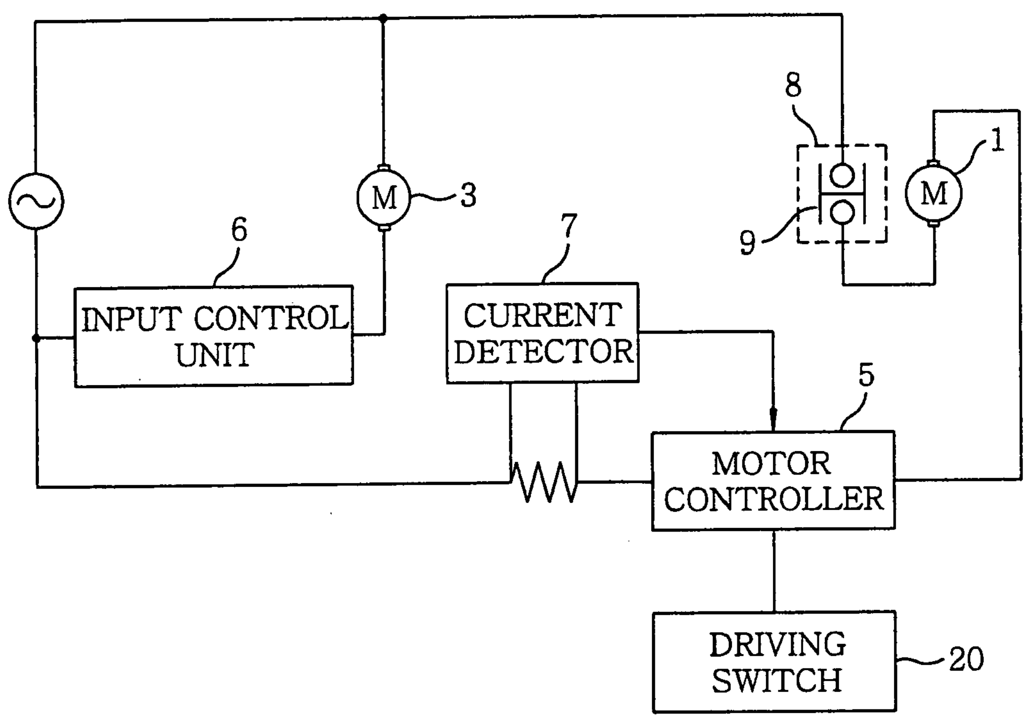
8
1
M
M
3
6
7
9
INPUT CONTROL UNIT
CURRENT DETECTOR
5
MOTOR CONTROLLER
DRIVING SWITCH
20

FIG.3A

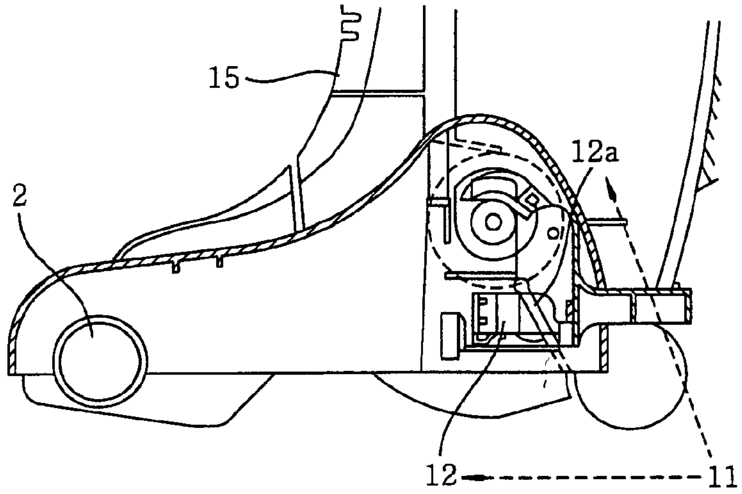

FIG.3B

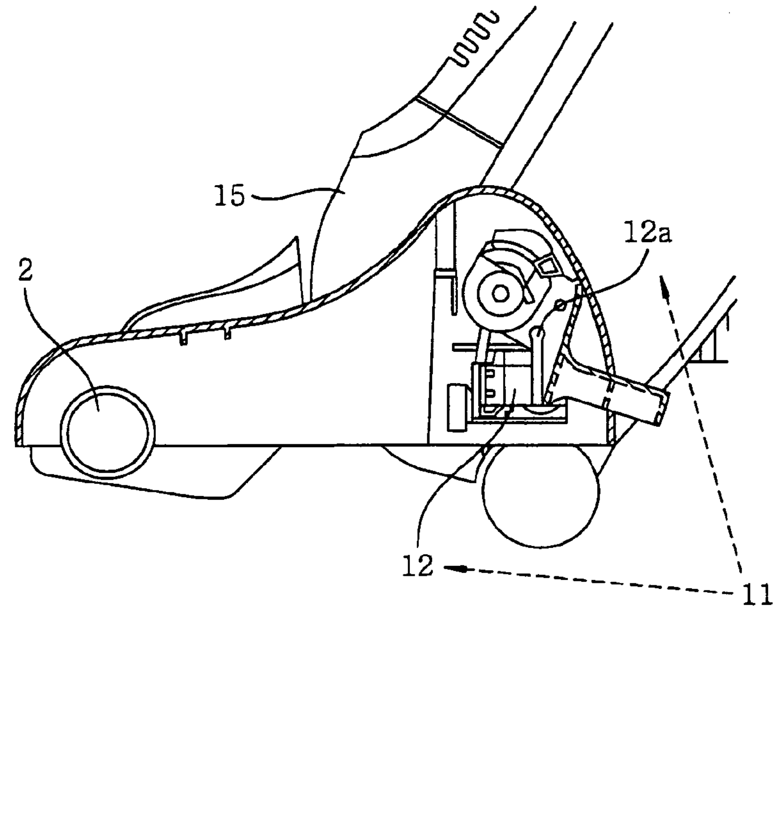

FIG. 4

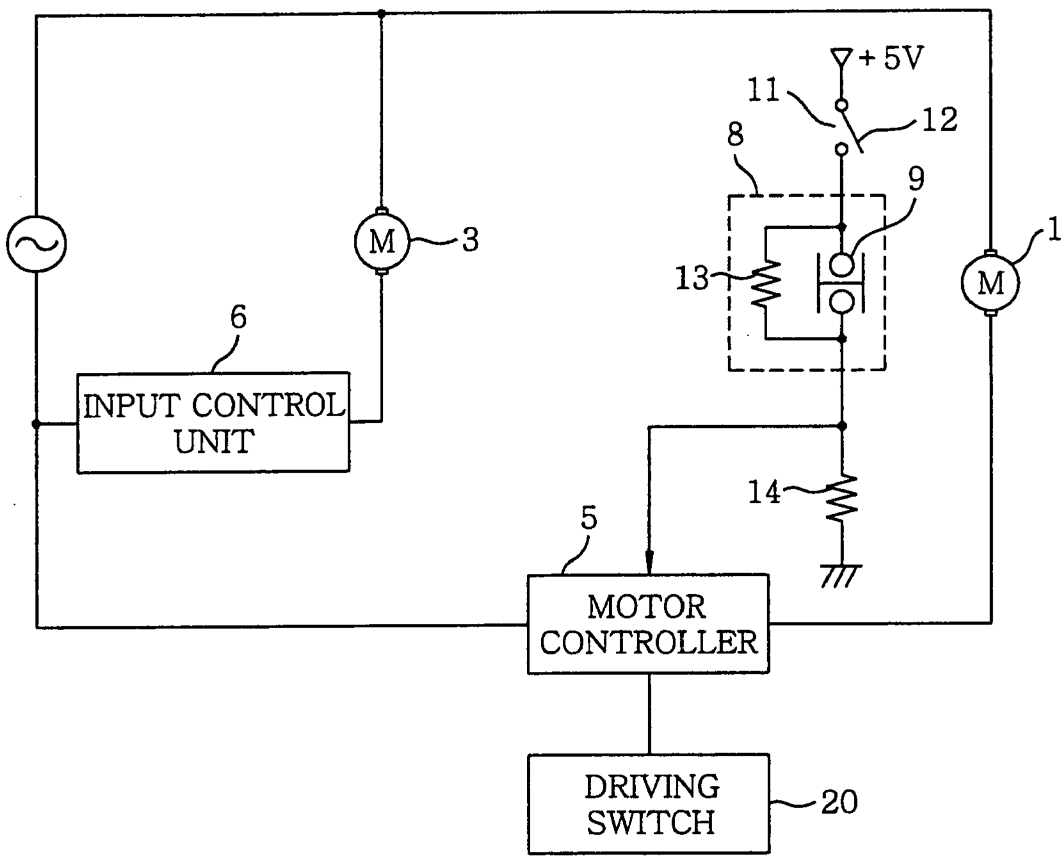
+5V
11
12
8
9
13
3
1
M
M
6
INPUT CONTROL UNIT
14
5
MOTOR CONTROLLER
DRIVING SWITCH
20

FIG.5
(PRIOR ART)

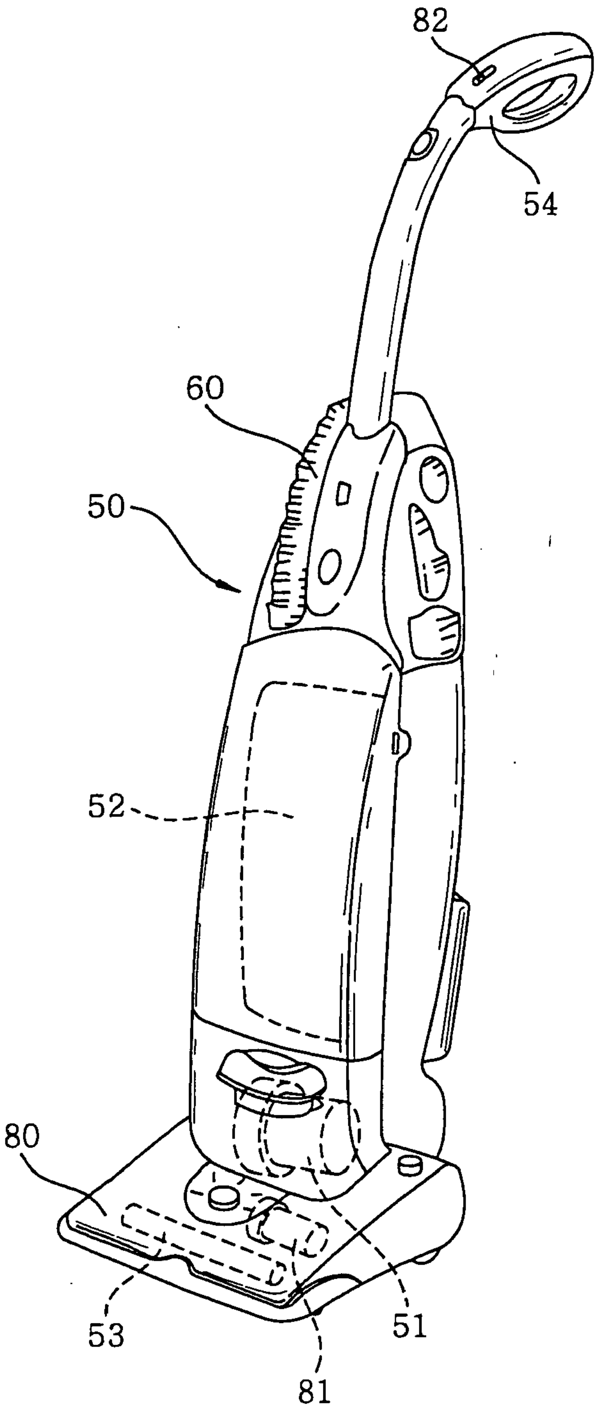

FIG.6
(PRIOR ART)