ADJUSTABLE CONTROL FOR AUTOMATIC VACUUM CLEANERS

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My invention relates to vacuum cleaners and more particularly to vacuum cleaners of the automatic type wherein the operation of the cleaner is controlled in accordance with variations in air pressure occurring within the cleaner during use.

A preferred arrangement involves a pressure differential diaphragm or the like which is responsive to the pressure drop in the air passing through the dust bag or other dust separating member for actuating a switch in an electric control circuit. Such device is so designed and constructed that it will actuate the switch upon the attainment of a predetermined pressure drop. This actuation may cause merely the operation of a visible or audible signal, or it may include stopping the motor of the cleaner, opening the front cover and ejecting the dust container, or any one or more of these operations.

However, the value of the pressure drop at which it is desirable to have the control responsive may vary under different conditions. For example, if the dirt being picked up is relatively fine, it will quickly clog the pores of the dust bag with the result that a predetermined pressure drop of the air passing therethrough will result from a comparatively small quantity of this dirt. An increase in the pressure drop through the bag results in a decrease in the suction available at the nozzle and it is for this reason that it is desirable to stop the operation of the cleaner, or at least give warning to the operator, when the nozzle suction has reached such a low value that continued operation would be inefficient in that the nozzle would not pick up sufficient dirt. However, if the dirt being picked up is of the coarsest fine character, less suction at the nozzle is required to remove it and therefore a greater pressure drop through the bag is permissible before the cleaning becomes inefficient.

Also, variations in the voltage of the electric current supplied to the motor of the cleaner changes the speed of the motor and of the fan driven thereby, and this results in changes in the suction produced by the fan which in turn varies the pressure drop through the dust bag without correspondingly altering the suction at the nozzle. Thus, an increase in voltage above normal increases the pressure drop through the bag but also increases the suction at the nozzle, whereas an increase in pressure drop due to a greater accumulation of dirt would decrease the nozzle suction. Consequently, under conditions of high voltage a greater pressure drop is permissible while still maintaining satisfactory cleaning efficiency.

Consequently, the prime object of my invention is to provide a control which may be readily adjusted from the exterior of the cleaner so as to vary the pressure drop through the dust bag at which the control will operate.

Further objects and advantages of my invention will be apparent from the following description when considered in connection with the accompanying drawings of which:

Fig. 1 is a front view of a vacuum cleaner embodying my invention;
The lower chamber is connected by means of a conduit 72 with a passage 74 formed in a member 78 disposed immediately below an opening 39 formed in the lower end of the latched 92 being provided for preventing leakage of air. Member 78 is supported by and may be integral with an arm 84 extending across the open top of housing 26.

A coil spring 86 is disposed within the lower chamber between the bottom wall thereof and the diaphragm and tends to urge the latter into the uppermost position as shown in Figs. 5 and 6. The lower surface of the diaphragm carries a movable electric contact 85 which is mounted on a metal plate 99 to the outer edge of which plate is secured the spring 96. The other end of the spring bears against a metal ring 92 which is held in place by means of a copper rivet or the like extending through the housing 64, to the outer end of which end is connected to an electric lead 96. Consequently the rivet 94, the washer 92, the spring 96 and the plate 90 serve to conduct electricity from the lead 96 to the contact 88. Rotatably and slidably disposed in the lower wall of the housing 64 is a pin 98, the inner end of which carries a power member 60. As shown in Fig. 4, the pin 98 is in substantially vertical alignment with the movable contact 88 carried by the diaphragm. A hairpin shaped resilient member 102, shown in Figs. 5, 6 and 9, embraces the pin 98 so as to make sliding contact therewith and thus connects the pin and the contact 108 carried thereby to an electric lead 104. The inner end of pin 98 carries a cross pin 106, which, in the position shown in Figs. 5 and 7, is received in a recess 108 formed in the inner surface of the bottom wall of the housing 64, while in the position shown in Figs. 6 and 8 the cross pin 106 extends at right angles to its previous position and rests against the inner surface of the lower wall. A coil spring 110 is disposed between the outer surface of the housing and a manually operable knob 112 secured to the lower end of the pin 98, which knob extends through an opening 114 in the control housing 26 so as to be readily accessible for operation. In order to shift the cross pin 106 from the position shown in Figs. 5 and 7 to that shown in Figs. 6 and 8, the knob 112 is first forced inwardly against the resistance of spring 110 until the cross pin is moved upwardly out of the recess 108, and is then turned to 90°, a stop 116 being provided. This movement of the pin has of course raised the normally fixed contact 108 so as to bring it closer to the movable contact 88 carried by the diaphragm.

Lead 104 is connected to one side of an electric circuit while lead 96 is connected to one terminal of a solenoid 118 forming part of an electromagnetic valve 62. The other terminal of the solenoid is connected by means of a lead 120 with the other side of the circuit. The armature of solenoid 118 is connected to a valve stem 122 and is normally urged in an upward direction, as viewed in Fig. 5, by means of a spring 124 so as to close the valve. Energization of the solenoid moves the stem downwardly so as to open the valve. This valve is disposed in a conduit 126 leading from conduit 72 to the pneumatic power source. As shown more particularly in Fig. 4, the device 60 includes a comparatively large power diaphragm 128 closing the top of a diaphragm chamber 130. The conduit 126 communicates with this diaphragm chamber, while the upper surface of the diaphragm is exposed to atmospheric pressure.

Diaphragm 128 carries a stem 132 the upper end of which is provided with a head 134 which engages above a plate 136 which is pivotally mounted by means of a rod 138. The right-hand end of this rod, as viewed in Fig. 4, extends outside the control housing 26 and is formed with a manually operable handle 140. A front cover latch 142 is pivotally disposed to the plate 136 and its right-hand end, as viewed in Figs. 2 and 3, extends underneath pivoted plate 136. The other end of the latch is provided with a shoulder which is adapted to engage a keeper member 150 mounted on the front cover so as to retain the latter in closed position. A coil spring 152 is disposed between the end of the latch 146 underneath plate 136 and the bar 138 and tends to urge this end of the bar into contact with the lower surface of plate 136 and to urge the plate upwardly against the head 134 on stem 132 of the diaphragm.

Sidestayed within the member 78 is a pin 154, the upper end of which extends through the opening 80 in the bottom wall of body 10. The lower end of this pin is provided with a head 156 which contacts the lower surface of pivoted plate 136. A spring 158 is disposed between the head 156 and a cover plate 160 over diaphragm 128 and tends to urge the pin upwardly.

Mounted within an elongated slot 161 in the bottom wall of the inner perforated body 22 is a cylindrical rail 162 on which is sidestayed mounted an ejector member 164. A normally flat spring 166 tends to urge the ejector 164 towards the left, as viewed in Fig. 2. The ejector may be held in the retracted position shown in Fig. 2 by a lip 168 formed on the portion of the ejector underneath the rail 162 being engaged by a spring member 170. The other end of the latch 172 is disposed beneath the rail 162. As shown in Fig. 2, the right-hand end of bar 172 has a vertically extending portion 173 which is formed with an opening through which extends rail 162 so that the bar is sidestayed supported from the rail. The left-hand end of bar 172 is held against movement to the left by abutting against the raised end of pin 154. A bracket secured to the inner body is formed with an inclined surface 174 so disposed that if the pin 154 is withdrawn to permit the latch bar 172 to move to the left, the spring 170 is cammed downwardly by this inclined surface so as to disengage it from the lip 168, thus freeing the latch bar 172 to be moved to the left by means of the spring 166 through a distance determined by the length of the spring.

Mounted in a recess 176 formed in the upper wall of casing 10 is an electric switch 178. This switch includes a pivotally mounted actuating member 180 which may be pivoted from the position shown in Fig. 2, in which the switch is open, in a clockwise direction so as to close the switch.

This switch may also be opened by means of a sidestable bar 182 which is urged to the left, as viewed in Fig. 2, by means of a tension spring 184. The bar is provided with a downwardly extending portion which is held in the position shown by being contacted by the front cover when the latter is closed. The bar 182 is formed with an upwardly extending arm 186 which, when the switch is in the closed position, is closely adjacent to a pin 190 carried by the switch actuating member 180. Upon opening of the front end cover, the spring 184 urges the bar 182 to the left and consequently the arm 188 thereof strikes the pin 190 so as to pivot the switch actuating member 180 in a counterclockwise direction to thereby open the switch.

As is shown in the wiring diagram in Fig. 2n, the switch 178 is connected to a conductor 192 leading from a source of electric current to the motor 16. The other side of this source is connected by a conductor 194 with the other side of the motor 16. Conductor 104 leading to pressure responsive member 58 is connected to conductor 192 between the switch and the motor, while conductor 120 from the solenoid of magnetic valve 62, is connected to conductor 194.

The operation of the above described apparatus is as follows:

With a dust bag 50 in place within the inner body 22 and the front cover closed, as shown in Fig. 2, manual closure of the switch 178 will supply electric current to the motor 16 which will thus drive the fan 14 so as to draw air in through the inlet 20 thereof. This air is discharged through an exhaust opening (not shown) located at the right end of the cleaner, as
viewed in Fig. 2. Operation of the fan will thus create a suction within that portion of the airtight body 10 to the left of the partition 13. This in turn will cause air to flow through the inlet conduit 46 and if a hose and nozzle connector 38 is passed over a dusty surface, dust-laden air will be introduced into the bag 50. The porous nature of the bag will retain the dust therein, while the air will pass through the walls of the bag and through the perforations 24 of the inner body to the inlet 20 of the fan 46. Air stream through the walls of the dust bag a pressure drop occurs and as more dirt is collected in the bag this pressure drop increases. The upper side of the differential pressure diaphragm 66 is connected through the flexible tube 68 with the interior of the inlet conduit 46, and consequently the upper side of the diaphragm is subjected to the pressure existing ahead of the dust bag. The underside of the diaphragm is connected by means of the conduit 72 with the pressure existing within the casing 10 between the dust bag and the inlet 20 of the fan, and consequently this diaphragm is subjected to a pressure differential with the result that the diaphragm starts to move downwardly against the force of the spring 86. However, as the pressure drop increases, the result of the two pressures acting on opposite sides of the diaphragm also increases with the result that the diaphragm starts to move downwardly against the force of the spring. It is characteristic of a coil spring that the further it is compressed, the greater is the force required to compress it still further and hence the distance the diaphragm moves downwardly is proportionate to the pressure drop through the dust bag.

As the resistance to flow through the bag increases the suction existing at the nozzle of the cleaner decreases and consequently the vacuum cleaner becomes less efficient in picking up dirt. However, before efficiency drops to an unendurable value, the diaphragm 66 is moved downwardly sufficiently so that the contacts 88 and 100 are closed, thus completing an electric circuit through the solenoid 62, which results in opening the valve 122 against the force of the spring 124. High suction is established from the interior of the body 10 through the conduits 72 and 126 to the diaphragm chamber 130. This causes the diaphragm 132 and its stem 132 to be quickly pulled downwardly, thus pivoting the plate 126 downwardly against the inner end of front cover latch 146. This releases the latch from the keeper 150 of the front cover and the spring 34 causes the cover to pivot approximately 90° in a counterclockwise direction, as viewed in Fig. 2, to its open position.

Opening of the cover permits the spring 184 to move the rod 182 to the left, as viewed in Fig. 2, thus causing arm 188 to strike pin 190 of the switch actuating member 188, thus throwing the switch to the open position and interrupting the supply of current to the motor 16.

Downward pivoting of the plate 136 also pulls the pin 154 downwardly, thus permitting the latch bar 172 to move to the left, as viewed in Fig. 2, a short distance which is sufficient to cause the spring 170 to contact the inclined surface 174, thus camming the free end of the spring downwardly and out of engagement with the lip 163 on the ejector 164. The ejector spring 166 therefore travels to the left along from the rail 162, thus ejecting the dust bag 50 from the casing of the cleaner, the left-hand end of which has been opened by the cover 30.

As previously explained, if the dirt being picked up by the cleaner is very fine, it will clog the pores of the dust bag much more rapidly than will coarse dirt and hence a pressure drop through the bag sufficient to close the contacts 88 and 100 will be attained with a much smaller quantity of fine dirt than with coarse dirt. However, less suction at the nozzle is required to pick up fine dirt than coarse dirt and therefore it is desirable that a greater pressure drop through the bag be attained when picking up fine dirt than coarse dirt. Consequently, a smaller pressure differential is required to close the contacts in the former position than with them in the latter position.

Thus, for ordinary cleaning where a mixture of fine dirt, coarse dirt and some nap is being picked up, the pin 98 should be positioned as shown in Fig. 6. However, for picking up fine dirt, pin 98 should be in the position shown in Fig. 5. To shift the pin to this position, the knob 112 is turned 90° to align cross pin 106 with recess 108, whereupon spring 110 retracts pin 98 and contact 106, to thus increase the distance diaphragm 66 must move contact 88 to close the circuit. Obviously, provision could be made for intermediate positions by providing additional grooves at different elevations and angularly disposed with respect to groove 108.

This adjustment of the value of the pressure drop required for closing of the contacts may also be employed to compensate the vacuum cleaner for different operating voltages. As is well known, while the standard voltage for domestic use throughout the United States is supposed to be 115 v., actually it is impossible to maintain this voltage constant in all areas served by a power company due to voltage drop through the transmission lines and other reasons. If a vacuum cleaner is operating in a region of high voltage, the motor will run faster than normally and the fan will produce greater than normal suction. This results in more air flow and hence a greater pressure drop through the dust bag. However, it also results in a greater suction at the nozzle, whereas a greater pressure drop caused by more dirt in the bag results in a reduction in suction at the nozzle. Consequently, for equal efficiency a greater pressure drop through the bag is permissible if the cleaner is operating on higher than average voltage and therefore the control may be set in the position shown in Fig. 5 that a greater pressure drop is required to close the contacts.

If it is desired to obtain a greater change in the pressure difference required to close the contacts than results from changing the location of the contact 110, an additional spring load may be imposed on the diaphragm. As shown in Figs. 5 through 8, a circular member 200 is disposed in the chamber beneath the diaphragm 66, and this member is formed with a plurality of upwardly extending spring fingers 202. With the parts in the position shown in Fig. 6, the contacts 88 and 100 will be closed before the diaphragm has moved downwardly sufficiently to contact the free ends of the spring fingers. However, with the parts in the position as shown in Fig. 5, the diaphragm 66 will contact the spring fingers 202 before the contacts are closed and consequently during the last portion of its travel the diaphragm will have to overcome not only the increasing resistance offered by the spring 86, but also that offered by the spring fingers 202.

It will thus be seen that the present invention makes it possible to readily adjust the controls of an automatic vacuum cleaner so as to obtain the desired control under different varying operating conditions. While I have shown a more or less specific embodiment of my invention, it is to be understood that this has been done for illustration only and that the scope of my invention is not to be limited thereby, but is to be determined from the appended claims.
What I claim is:

1. In combination with a vacuum cleaner having a dust separating member and means for producing flow of air therethrough, an electric circuit for controlling the operation of said cleaner, a differential pressure diaphragm movable in response to variations in the pressure drop of air passing through said dust separating member, a movable electric contact movable by said diaphragm, a normally fixed electric contact disposed in operative relation to said movable contact, said contacts being connected in said circuit and being movable to establish flow of current therethrough, and means to adjust the position of said normally fixed contact with respect to said movable contact for varying the value of the pressure drop through said dust separating member required to cause said diaphragm to close said contacts.

2. In combination with a vacuum cleaner having a dust separating member and means for producing flow of air therethrough, an electric circuit for controlling the operation of said cleaner, a casing forming a diaphragm chamber, a differential pressure diaphragm in said chamber movable in response to variations in the pressure drop of air passing through said dust separating member, a movable electric contact movable by said diaphragm, a normally fixed electric contact disposed in said chamber in operative relation to said movable contact, said contacts being connected in said circuit and being movable to establish flow of current therethrough, and means accessible from the exterior of said chamber to adjust the position of said normally fixed contact with respect to said movable contact for varying the value of the pressure drop through said dust separating member required to cause said diaphragm to close said contacts.

3. In combination with a vacuum cleaner having a dust separating member and means for producing flow of air therethrough, an electric circuit for controlling the operation of said cleaner, a casing forming a diaphragm chamber, a differential pressure diaphragm in said chamber displaceable in response to variations in the pressure drop of air passing through said dust separating member, resilient means for resisting displacement of said diaphragm resulting from an increase in said pressure drop, a movable electric contact movable by said diaphragm, a normally fixed electric contact disposed in said chamber in operative relation to said movable contact, said contacts being connected in said circuit and being movable to establish flow of current therethrough, and means accessible from the exterior of said chamber to adjust the position of said normally fixed contact with respect to said movable contact for varying the value of the pressure drop through said dust separating member required to displace said diaphragm sufficiently to close said contacts.

4. In combination with a vacuum cleaner having a dust separating member and means for producing flow of air therethrough, an electric circuit for controlling the operation of said cleaner, a casing forming a diaphragm chamber, a differential pressure diaphragm in said chamber displaceable in a given direction in response to an increase in the pressure drop of air passing through said dust separating member, resilient means for increasing the movement of said diaphragm in said direction, a movable electric contact movable by said diaphragm, a normally fixed electric contact disposed in operative relation to said movable contact, said contacts being connected in said circuit and being movable to establish flow of current therethrough, and means accessible from the exterior of said chamber to adjust the position of said normally fixed contact with respect to said movable contact for increasing the displacement of said diaphragm required to cause said diaphragm to close said contacts, and additional resilient means for resisting movement of said diaphragm in the range of increased displacement thereof.

5. In combination with a vacuum cleaner having a dust separating member and means for producing flow of air therethrough, an electric circuit for controlling the operation of said cleaner, a casing forming a diaphragm chamber, a differential pressure diaphragm in said chamber movable in response to variations in the pressure drop of air passing through said dust separating member, a movable electric contact carried by said diaphragm, a rod extending through a wall of said casing and being mounted for axial and rotational movement, an electric contact carried in said circuit and being movable in operative relation to said movable contact, said contacts being connected in said circuit and being movable to establish flow of current therethrough, a detent extending from the side of said rod, said casing being formed with a plurality of surfaces disposed so as to be selectively engaged by said detent, said surfaces being spaced from each other axially and circumferentially with respect to the axis of said rod, and resilient means urging said rod in an axial direction to maintain said detent against any selected one of said surfaces.

6. In a vacuum cleaner, a casing having an opening, a dust separating member disposed in said casing and receiving air flow through said opening, conduit means for producing flow of air through said casing and through said dust separating member therein, a differential pressure diaphragm movable in response to variations in the pressure drop of air passing through said dust separating member, an electric contact movable by said diaphragm, a normally fixed electric contact disposed in operative relation to said movable contact, a power diaphragm, conduit means for communicating the suction produced by said suction creating means to one side of said power diaphragm, an electromagnetic valve for controlling flow through said conduit means, a closure member for said opening, means operable by said power diaphragm for opening said closure member, an electric circuit including said contacts and said electromagnetic valve, and means to adjust the position of said normally fixed contact with respect to said movable contact for varying the value of the pressure drop through said dust separating member required to cause said diaphragm to close said contacts to thereby actuate said valve.

7. In combination with a vacuum cleaner having a dust separating member, a motor-fan unit for producing flow of air through said member, a quick make and break switch for starting and stopping said motor, a differential pressure diaphragm movable in response to variations in the pressure drop of air passing through said member, an electric control circuit supplied with current through said switch, means responsive to energization of said control circuit for opening said switch, a movable electric contact movable by said diaphragm, a normally fixed electric contact disposed in operative relation to said movable contact, said contacts being connected in said control circuit, and means to adjust the position of said normally fixed contact with respect to said movable contact for varying the value of the pressure drop through said dust separating member required to cause said diaphragm to close said contacts to thereby energize said control circuit.

8. In combination with a vacuum cleaner having a dust separating member, a motor-fan unit for producing flow of air through said member, a quick make and break switch for starting and stopping said motor, a differential pressure diaphragm movable in response to variations in the pressure drop of air passing through said member, an electric contact movable by said diaphragm, a normally fixed electric contact disposed in operative relation to said movable contact, a power diaphragm, conduit means for communicating the suction produced by said fan to one side of said power diaphragm, an electromagnetic valve for controlling flow through said conduit means, a closure member for said opening, means operable by said power diaphragm for opening said closure member,
means responsive to opening of said closure member for opening said switch, an electric circuit supplied with current through said switch and including said contacts and said electromagnetic valve, and means to adjust the position of said normally fixed contact with respect to said movable contact for varying the value of the pressure drop through said dust separating member required to cause said diaphragm to close said contacts to thereby open said valve.

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