

April 23, 1957

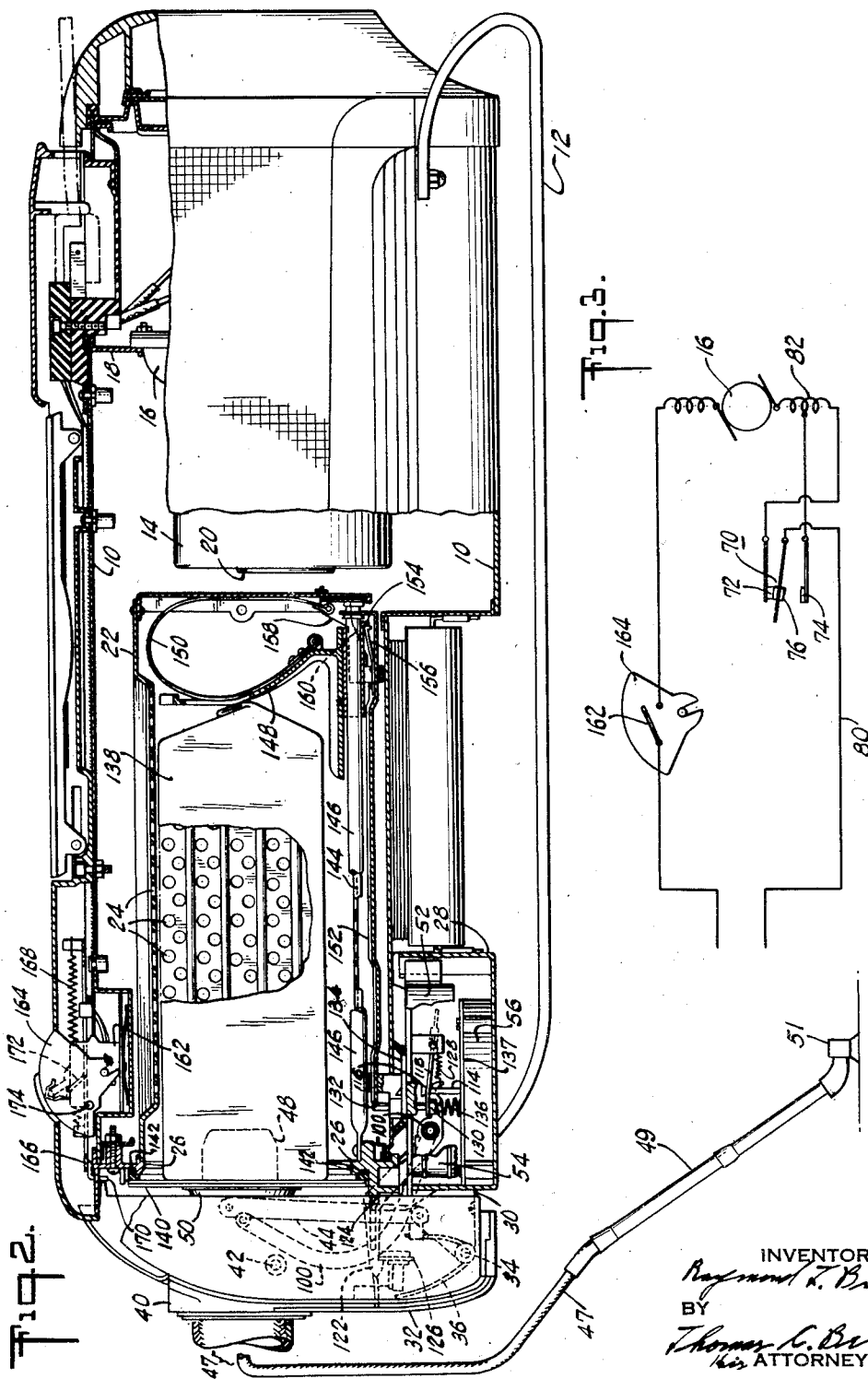
R. L. BROWN

2,789,660

AUTOMATIC VACUUM CLEANERS

Filed May 12, 1954

4 Sheets-Sheet 2



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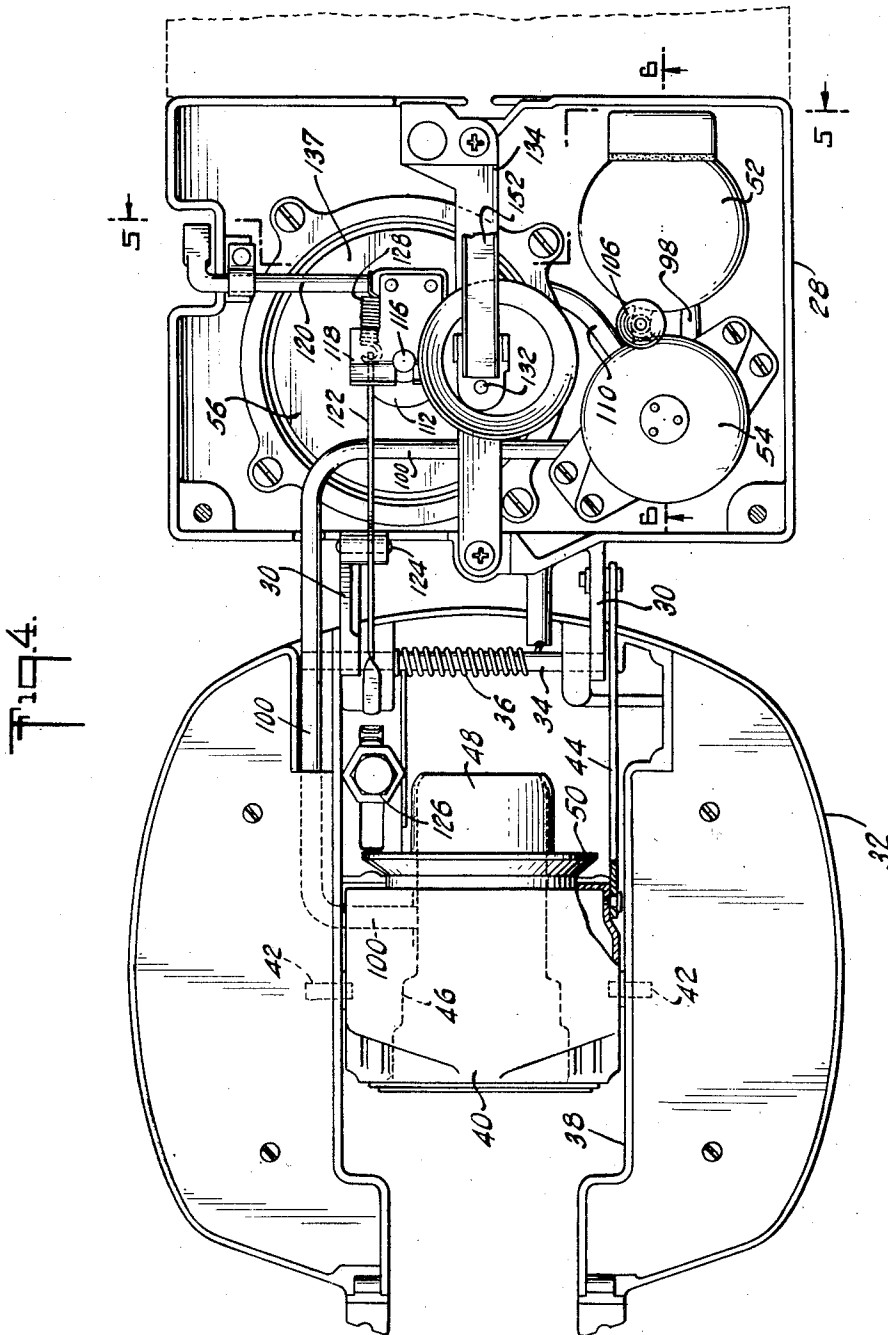
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4 Sheets-Sheet 3



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Fig. 6.

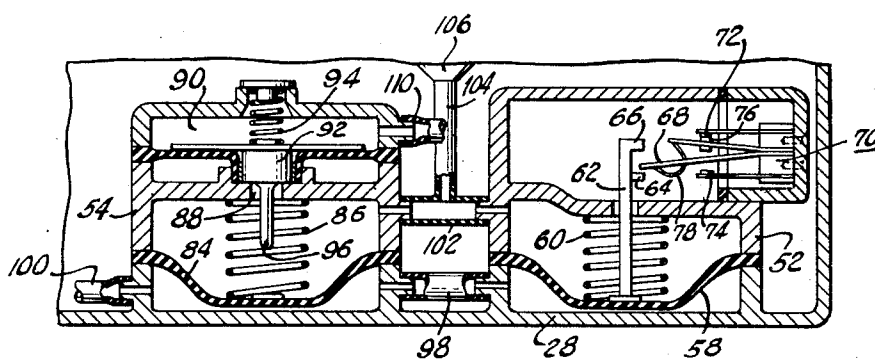
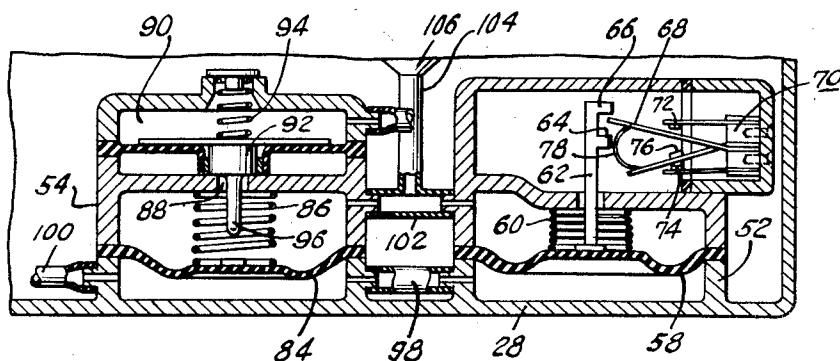


Fig. 7.



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2,789,660

AUTOMATIC VACUUM CLEANERS

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5 Claims. (Cl. 183—37)

My invention relates to vacuum cleaners and more particularly to automatic controls therefor.

In the operation of a vacuum cleaner, dust-laden air drawn in through the nozzle is passed through a dust separating member, which may be in the form of a bag made of cloth or porous paper, the dust and dirt being retained in the bag and the clean air passing through the pores. As the dust and dirt accumulate within the bag it tends to clog up the pores, thus increasing the resistance to the flow of air, which in turn decreases the degree of vacuum available at the nozzle, which of course decreases the cleaning efficiency. The efficiency may be restored by emptying the dust bag or, in the event a disposable paper bag is used, by replacing it with a new one. However, emptying a cloth bag is a disagreeable task, while frequent replacing of a disposable bag entails some expense. Consequently, it is desirable to make such cleaning or replacing of the bag as infrequent as possible.

In accordance with my present invention, when the resistance to flow of air through the dust separating member has increased to the point where the cleaning efficiency has fallen to the lowest desirable value, automatic means act to increase the flow of air, thus increasing the value of the suction at the nozzle and hence at least partially restoring the cleaning efficiency.

The increase in air flow may be accomplished by increasing the speed of the air pump or fan which is used to create the air flow. This fan is usually directly driven by an electric motor and my invention provides means for increasing the speed of the motor. This may be accomplished conveniently by providing the motor with a series wound field together with an automatically operated switch for shunting out a portion of the field. As is well known, reducing the strength of the field in a series wound motor will increase its speed.

Of course it would be possible to have the fan run at the increased speed at all times, but this would cause unnecessary wear of the motor bearings and commutator brushes and would result in inefficient operation from an electrical standpoint whenever the bag were clean. This is so because the increased air flow resulting from the high fan speed would increase the resistance to flow through the entire vacuum cleaner system, including the nozzle, hose and bag to such an extent that a substantial increase in the electrical input to the motor would result in only a very small increase in the value of the suction at the nozzle. Also, when running at the higher speed with a partially clogged bag, the fan moves less air and hence the motor requires less electrical power than it would if it ran at the same high speed with a clean bag. Consequently, for the above reasons, it is not desirable to operate the motor and fan at the higher speed when the bag is clean.

Further objects and advantages of my invention will be apparent from the following description when considered in connection with the accompanying drawings which form a part of the specification and of which;

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Fig. 1 is a front view of a vacuum cleaner in accordance with my present invention;

Fig. 2 is a view chiefly in cross-section taken on the line 2—2 of Fig. 1;

Fig. 3 is a wiring diagram of an electric circuit in accordance with my invention;

Fig. 4 is a top view on an enlarged scale of a control unit and front cover of the vacuum cleaner shown in Figs. 1 and 2;

Fig. 5 is a cross-sectional view taken substantially on the line 5—5 of Fig. 4;

Fig. 6 is a cross-sectional view taken on the line 6—6 of Fig. 4; and

Fig. 7 is a view similar to Fig. 6, but showing certain parts in different positions.

Referring more particularly to Fig. 2, reference character 10 designates an airtight body mounted on a pair of runners 12 which movably support it upon a surface, such as a floor. Disposed in the right-hand portion of body 10 is a motor-fan unit comprising a fan 14 driven by an electric motor 16, the fan preferably being mounted directly on the shaft of the motor. This unit is mounted within the body 10 by being secured to an airtight bulkhead 18, the fan 14 being provided with an inlet opening 20 which communicates with the space within body 10 to the left of bulkhead 18. Within this space there is provided an inner body 22 which is formed with a large number of apertures 24 which provide practically unrestricted communication between the interior of the inner body and the inlet 20 of the fan. The left-hand end of the inner body 22 is secured to a ring 26 which in turn is secured to the left-hand end of the outer airtight body 10.

Mounted underneath the body 10 adjacent to its left-hand end, as viewed in Fig. 2, is a housing 28 which encloses a control chamber. Extending forwardly from the forward wall of housing 28 is a pair of projections 30 to which is hinged a front cover 32 by means of a pin 34. A spring 36 surrounds pin 34 and tends to pivot the cover to the open position shown in Fig. 4. As here seen, the left-hand portion of the cover, which is the upper portion when the cover is in the closed position shown in Fig. 1, is formed with a cut-out portion 38 within which is pivotally mounted a hose connector member 40 by means of pins 42. A link 44 is pivotally connected to the hose connector and to one of the projections 30, this link together with the cover 32 constituting parallel motion linkage for causing the hose connector 40 to move parallel to itself as the cover is moved through an arc as it is opened and closed.

The hose connector is formed with a passage 46 extending therethrough and communicating with an inlet conduit 48 which is surrounded by a flexible gasket 50. The outer end of passage 46 is formed as a portion of a separable coupling whereby a flexible suction hose 47 may be connected thereto. This hose is usually about five or six feet in length and may be connected to a rigid hollow handle 49 to which in turn may be connected a suction nozzle 51.

Disposed within the control chamber formed by the housing 28 are the automatic controls for the vacuum cleaner. These include a first differential pressure diaphragm chamber 52, a second differential pressure diaphragm chamber 54 and a power diaphragm chamber 56.

As is clearly shown in Figs. 6 and 7, a diaphragm 58 is disposed in chamber 52 and is provided with a loading spring 60 which tends to displace the diaphragm to its lowermost position as is shown in Fig. 6. This diaphragm carries a stem 62 formed with a pair of spaced projections 64 and 66 between which is disposed an actuating arm 68 of an electric switch designated generally by reference

character 70. This switch includes a pair of fixed contacts 72 and 74 between which is disposed a movable contact 76. This movable contact is mounted on an arm which is connected to the actuating arm 68 by means of a U-shaped spring 78, the arrangement being such that when the actuating arm is in the lower position shown in Fig. 6, the movable contact 76 completes the circuit through the upper fixed contact 72, while when the actuating arm 68 is in the upper position shown in Fig. 7 the movable contact 76 completes the circuit through the lower fixed contact 74. Furthermore, the construction is such that spring 78 is an over center spring so that it will quickly throw the movable contact from one of its extreme positions to the other as the actuating arm 68 moves through the center position.

As is shown in the wiring diagram of Fig. 3, the movable contact 76 of the switch 70 is connected to one of the electric supply conductors 80, while the fixed contact 72 is connected to the terminal of the field winding 82 of the motor, and the other fixed contact 74 is connected to an intermediate tap of the field winding. Thus, with the switch in the position shown in Fig. 3 the entire field winding of the motor is included in the circuit, but if the switch is thrown to its other position, a portion of the field winding is excluded from the circuit.

Disposed within chamber 54 is a differential pressure diaphragm 84 which is urged to the lowermost position shown in Fig. 6 by its loading spring 86. The space in chamber 54 above the diaphragm communicates through a valve port 38 with a valve chamber 90 formed above chamber 54. Communication between these two chambers is normally closed by means of a valve 92 which is urged to closed position by a valve spring 94. The valve is provided with a stem 96 adapted to be contacted by diaphragm 84 when the latter is displaced upwardly so as to open the valve to thereby establish communication between the space in chamber 54 above the diaphragm and the space within valve chamber 90.

The spaces within the chambers 52 and 54 below the respective diaphragms 58 and 84 are connected together through a conduit 98, while a flexible conduit 100 leads from the space below the diaphragm 84 to the passage 46 formed in the hose connector 40. The spaces in the chambers 52 and 54 above the respective diaphragms 58 and 84 are connected together through a conduit 102 which is also connected to a conduit 104, the upper end of which is provided with a flexible gasket 106 which bears against the lower wall of housing 10 around an opening 108 formed in this wall. Consequently, the two diaphragms 58 and 84 are each subjected to the same differential pressure, which is the difference between the pressure existing within the passage 46 in the hose connector and the pressure existing within the airtight body 10. Although these two diaphragms are subjected to the same differential pressure, the loading spring 60 of diaphragm 58 is weaker than the loading spring 86 of diaphragm 84 so that the switch 70 will be thrown from the position shown in Fig. 6 to that shown in Fig. 6 to that shown in Fig. 7 before the diaphragm 84 has been raised sufficiently to contact the stem 96 of valve 92.

Valve chamber 90 is connected by a conduit 110 with power diaphragm chamber 56 so that, upon the opening of valve 92 the high suction existing above the diaphragm 84 by virtue of its connection to the interior of body 10 through conduits 102 and 104, will be communicated through conduit 110 to diaphragm chamber 56 so that the power diaphragm 112 will be displaced downwardly, the upper surface of this diaphragm being at all times subjected to atmospheric pressure. Secured to this power diaphragm is a stem 114 the upper end of which is provided with an enlarged head 116 which engages a wide arm 118 extending generally horizontally from a pivoted rod 120. This arm 118 extends over a front cover latch 122 which is pivotally mounted on the housing 28 at 124. The outer end of this arm is formed with a shoulder which

is adapted to engage a keeper 126 formed on the front cover 32 so as to retain the cover in closed position. A spring 128 is connected between the inner end of arm 122 and the rod 120 and tends to urge the latch arm into engagement with the keeper 126.

Arm 118 engages a head 130 formed on the lower end of a pin 132 which is slidably mounted in a member 134 which is secured to and extends across the upper part of housing 28. A spring 136 is compressed between the lower end of the pin 132 and a cover plate 137 disposed over diaphragm 112 and tends to urge the pin in an upward direction, which also tends to pivot the free end of arm 118 upwardly.

A dust bag 138 is removably disposed within the inner body 22. This bag includes a disc member 140 of stiff material which is adapted to seat against a gasket 142 carried by the ring 26. The center of disc 140 is provided with an opening adapted to receive the inlet conduit 48 when the cover is in the closed position shown in Fig. 2, the gasket 50 bearing against the disc to hold the latter seated against the gasket 142. Preferably, the dust bag is of the disposable type, in which case the bag itself may be made of porous paper, while the disc 140 may be made of cardboard.

Mounted within an elongated slot 144 formed in the bottom wall of inner body 22 is a cylindrical guide rail 146 upon which is slidably mounted an ejector member 148. As is shown in Fig. 2, the forward end of rail 146 is secured to ring 26, while the rear end of the rail is secured to the rear wall of the inner body. A normally flat leaf spring 150 is disposed between the ejector member and the rear wall of the inner body and tends to move the former towards the left, as viewed in Fig. 2. Slidably mounted below the rail 146 is a latch bar 152. Ejector 148 is formed with a lip 154 which, in the position of the parts shown in Fig. 2, is engaged by a leaf spring 156 carried by the latch bar 152. The front end of the latch bar 152 abuts against the pin 132 when the latter is in its raised position so as to retain the ejector 148 in its rearward position with the spring 150 compressed. A bracket 158 carried by the rear wall of the inner body is formed with a lower inclined surface 160 so arranged with respect to the spring 156 that movement of the latch bar 152 to the left causes the inclined surface to cam the free end of the spring 156 downwardly and out of engagement with the lip 154 of the ejector, thus releasing the latter for movement by its spring 150.

An electric switch 162 is provided for controlling a supply of current to the motor 16. This switch may be manually actuated by means of a pivoted member 164. In the position shown in Fig. 2, the switch is open and pivoting of the member 164 in a clockwise direction serves to close the switch. Slidably mounted adjacent the switch is a bar 166 which is urged towards the left as viewed in Fig. 2 by means of a spring 168. This bar is provided at its left end with a projection 170 which is contacted by the front cover when the latter is closed so as to hold the bar in the position shown. Extending upwardly from this bar is an inclined arm 172 which is positioned so as to strike a pin 174, extending outwardly from the switch actuating member 164, when the latter is in the "on" position. Thus, if the switch is closed and the front cover is opened, the bar 166 moves to the left under the influence of its spring 168 and the arm 172 contacts pin 174 so as to automatically pivot the member 164 counterclockwise to throw the switch to the "off" position, which of course stops the motor 16.

The above described device operates as follows:

With the parts in the position shown in Fig. 2, that is with a clean dust bag 138 in place within the body and the front cover 32 closed, operation of the motor-fan unit serves to create a partial vacuum within the airtight body 10 to the left of the bulkhead 18. This vacuum causes air to be drawn in through the inlet 48. Inasmuch as the bag 138 is clean, it offers but little

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resistance to the flow of air therethrough and hence there is but little pressure drop through the bag. Consequently, the pressure differential acting on the two diaphragms 58 and 84 is small and is not sufficient to displace these diaphragms to any considerable extent against the force of their respective loading springs 60 and 86 and the diaphragms occupy substantially the positions shown in Fig. 6.

However, if the cleaning tool 51 is passed over a dusty surface, the air flowing into the tool by virtue of the suction created by the operation of the fan will cause dirt to be entrained and conveyed by the air stream through the handle 49 and hose 47 to the interior of the bag 138. The dirt is retained within the bag, while the air passes through the porous walls of the bag and through the openings 24 of the inner body to the inlet 20 of the fan. As the dirt thus accumulates within the bag it tends to clog the pores of the paper or other porous material, thus increasing the resistance to flow through the bag and increasing the pressure drop of the air passing through the bag. Consequently, the vacuum existing at the cleaning tool 51 and in the passage 46 in the hose connector 40 decreases, while the vacuum existing within the airtight outer body 10 outside of the bag 138 increases. Inasmuch as the spaces in the diaphragm chambers 52 and 54 above the respective diaphragms 58 and 84 are connected to the interior of the body 10 through the conduits 102 and 104, while the spaces below these diaphragms are connected to the passage 46 through the conduits 98 and 100, both of these diaphragms will be gradually displaced upwardly as the pressure drop through the dust bag increases.

When this pressure drop has reached a value such that the degree of suction available at the cleaning tool 51 has dropped to a point where the cleaning efficiency is at a minimum desirable value, the diaphragm 58 and the stem 62 carried thereby have been displaced upwardly a sufficient distance so that the projection 64 on the stem has raised the switch actuating arm 68 sufficiently to cause the movable contact 76 to be snapped suddenly from its position in contact with fixed contact 72, as shown in Fig. 6, to a position in contact with fixed contact 74, as shown in Fig. 7. As will be seen from the wiring diagram in Fig. 3, this serves to shunt a portion of the field winding 82 of the motor 16 out of the circuit, thus weakening the field and causing the motor speed to increase. Inasmuch as the fan is directly driven by the motor, the fan speed is increased and produces a higher degree of suction within the airtight body 10. This higher suction in turn increases the flow of air through the dust bag and through the hose 47 and handle 49 and increases the suction available at the cleaning tool 51. Consequently, the cleaning efficiency of the cleaner, which had dropped to the minimum desirable value, is increased so that it is possible to continue cleaning in an efficient manner without replacing the dust bag 138 with a clean one.

The increased flow of air through the dust bag caused by the increase in motor speed also increases the pressure drop through the bag and therefore increases the pressure differential acting on the diaphragms 58 and 84. However, further upward displacement of the diaphragm 58 has no effect on the switch 70, and if desired its loading spring 60 may be so designed that it becomes fully compressed so as to constitute a solid abutment, thus preventing further upward displacement of the diaphragm. The strength of the loading spring 86 of diaphragm 84 is so selected that this increased pressure difference is still not sufficient to displace the diaphragm upwardly enough to contact the valve stem 96.

However, as cleaning is continued and more dirt is accumulated within the bag, the pressure drop therethrough continues to rise and when the point of minimum cleaning efficiency is again reached, the pressure differential has increased sufficiently so that the diaphragm

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84 unseats the valve 92, thus permitting the high suction existing in the chamber 54 above the diaphragm to be communicated to valve chamber 90 and thence through conduit 110 to power diaphragm chamber 56. This causes the power diaphragm 112 to move downwardly and the stem 114 connected thereto causes the arm 118 carried by shaft 120 to be pivoted downwardly. This movement of the arm 118 first causes front cover latch arm 122 to be pivoted in a clockwise direction, as viewed in Fig. 2, so as to disengage the outer end of the latch arm from the keeper 126. This releases the front cover, which is immediately pivoted to its open position by its spring 36. Opening of the front cover releases the switch actuating bar 166, which under the influence of its spring 168 moves to the left, as viewed in Fig. 2. During this movement the upwardly extending arm 172 strikes pin 174 on switch actuating member 164, thus pivoting the latter in a counterclockwise direction, as viewed in Fig. 2, so as to throw the switch 162 to its "off" position, which interrupts the supply of electric current to the motor 16. Thus, the switch is actuated and the motor stopped as a direct consequence of the opening of valve 92 by differential pressure diaphragm 84.

Downward movement of the arm 118 also withdraws pin 132 downwardly against the resistance of spring 136 to release latch bar 152 for movement to the left, as viewed in Fig. 2. This movement causes the leaf spring 156 carried by the latch bar to strike the inclined surface 160, thus camming it out of engagement with the lip 154 on ejector 148. The ejector 148 is thus freed for further movement to the left under the influence of its spring 150, and this movement serves to eject the dust bag 138 from the cleaner.

As soon as the fan has stopped, there is no air flow through the cleaner and consequently atmospheric pressure prevails throughout the control system and hence the diaphragms 58 and 84 are subjected to the same pressure on both sides and are returned to their lowermost positions by their loading springs. This causes the upper projection 66 on stem 62 to move the switch actuating arm 68 downwardly, which in turn snaps the movable contact 76 to its upper position in contact with the fixed contact 72.

Should the operation of the cleaner be stopped by manually opening the switch 162 after the differential diaphragm 58 has thrown the switch 70 to the position shown in Fig. 7, but before diaphragm 84 has opened valve 92, both of these diaphragms will of course be returned to their lowermost positions when atmospheric pressure is established throughout the control system, and consequently switch 70 will be thrown to the position shown in Fig. 6. However, when the switch 162 is again closed manually, the pressure drop through the partially filled dust bag will be sufficient to almost immediately cause the diaphragm 58 to throw the switch 70 to the position shown in Fig. 7, thus increasing the speed of the motor so that the operation will be the same as it was immediately before the switch 164 was opened.

It will be noted that provision is made for lost motion between the projections 64 and 66 on stem 62 and switch actuating arm 68. Thus, should it occur that after the switch 70 has been thrown to the position shown in Fig. 7, but before enough more dirt has been accumulated in the bag to substantially further increase the pressure drop, the air flow should be decreased, as by increasing the sealing of the nozzle, the resulting downward movement of the diaphragm and stem will not be sufficient to throw the switch back to the position shown in Fig. 6.

Thus it will be seen that with the apparatus in accordance with my invention more dirt can be accumulated within the dust bag while still maintaining an acceptable efficiency of cleaning. Consequently, if disposable bags of the type herein illustrated are used, fewer of them are required. On the other hand, if a conventional cloth bag is employed, it need not be cleaned so frequently.

While I have shown one more or less specific embodiment of my invention, it is to be understood that this has been done for the purpose of 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 a vacuum cleaner of the type in which air is drawn through a dust separator by a pump, a dust separating member, conduit means for conveying dust-laden air into said vacuum cleaner and to said dust separating member, a pump for causing flow of air through said conduit means and said dust separating member, an electric motor for driving said pump, means communicating directly with the air and responsive to its pressure on both sides of the dust separating member for increasing the speed of said pump when the pressure drop through said member increases to a predetermined value to cause said pump to increase the flow of air through said conduit means and through said member.

2. In a vacuum cleaner, a dust separating member, a pump for causing flow of air through said member, an electric motor for driving said pump, means responsive to an increase in the pressure drop of the air flowing through said member for increasing the speed of said motor to cause said pump to increase the flow of air through said member, and means responsive to a further increase in said pressure drop for stopping said motor.

3. In a vacuum cleaner, a dust separating member, a pump for causing flow of air through said member, an electric motor having a series wound field for driving said pump, an electric switch for shunting out a portion of said field, a differential pressure diaphragm responsive to an increase in the pressure drop of the air flowing through said member for operating said switch for speeding up said motor to cause said pump to increase the flow of air through said member, a second electric switch for interrupting the supply of current to said motor and a second differential pressure diaphragm responsive to a further increase in said pressure drop for opening said second switch to stop said motor.

4. In a vacuum cleaner, a dust separating member, air displacing means for causing flow of air through said member, means responsive to an increase in the pressure drop of the air flowing through said member for causing said air displacing means to increase the flow of air through said member, and means responsive to a further increase in the pressure drop of air flowing through said member for stopping the operation of said air displacing means.

5. In a vacuum cleaner, a dust separating member, a pump for causing flow of air through said member, an electric motor for driving said pump, a first differential pressure diaphragm subjected to the pressure drop of air passing through said member, a first spring for resisting displacement of said diaphragm caused by an increase of said pressure drop, a first electric switch operable by displacement of said diaphragm against said spring for increasing the speed of said motor, a second differential pressure diaphragm subjected to the pressure drop of air passing through said member, a second spring for resisting displacement of said second diaphragm caused by an increase of said pressure drop, and a second electric switch operable by displacement of said second diaphragm against said second spring for stopping said motor, the strength of said second spring being greater than that of said first spring so that a predetermined pressure drop through said member causes an increase in speed of said motor and pump and a greater predetermined pressure drop stops said motor and pump.

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