April 1, 1952 G. E. LOFGREN ET AL 2,591,567

VACUUM CLEANER

Filed May 29, 1948 6 Sheets-Sheet 1

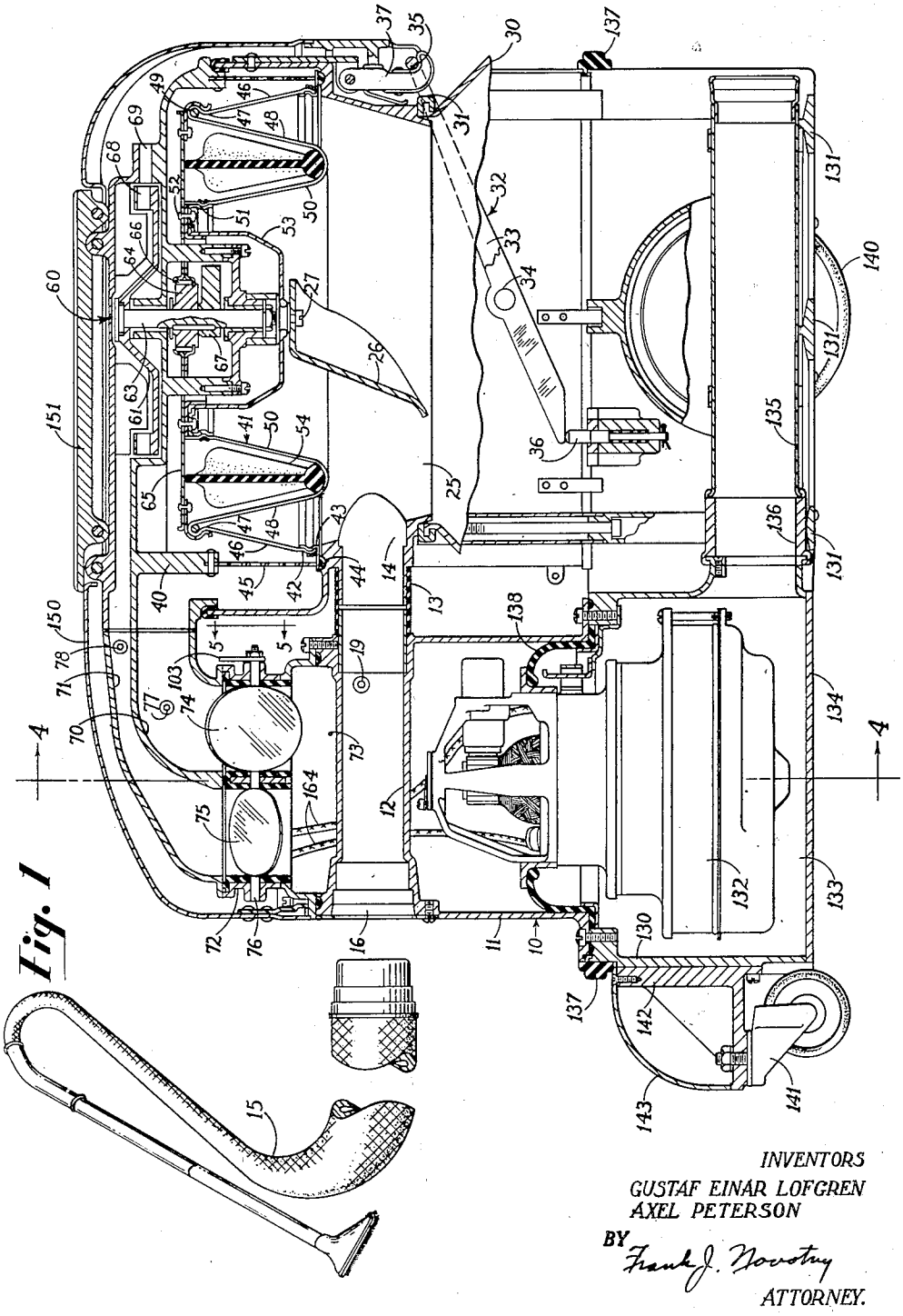

Fig. 1

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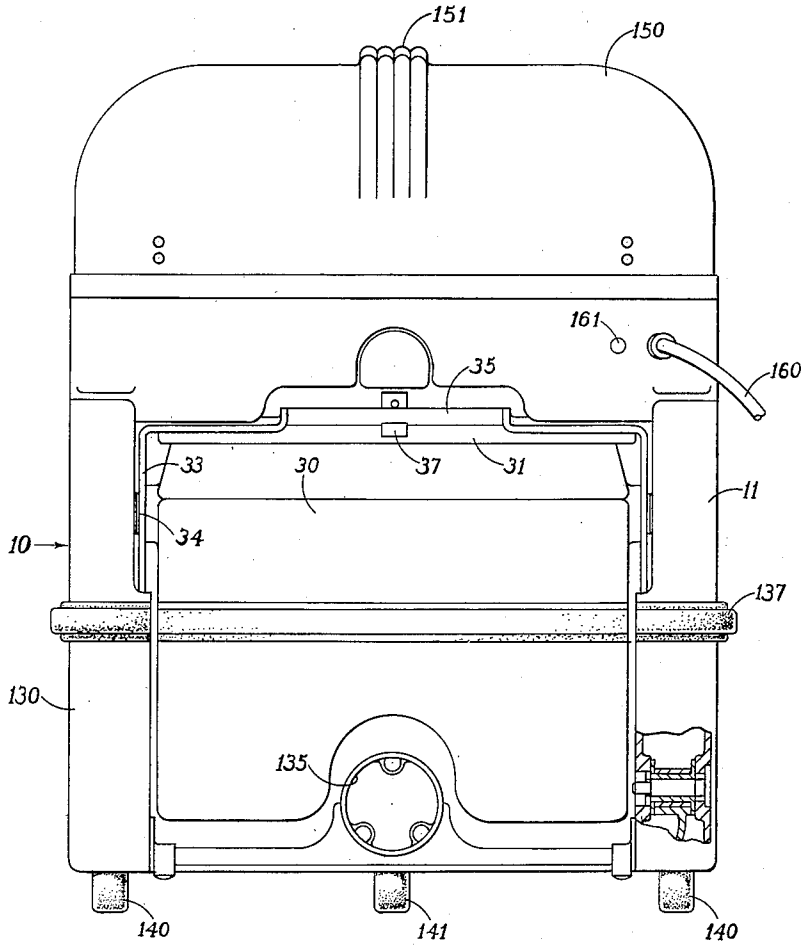
Fig. 2



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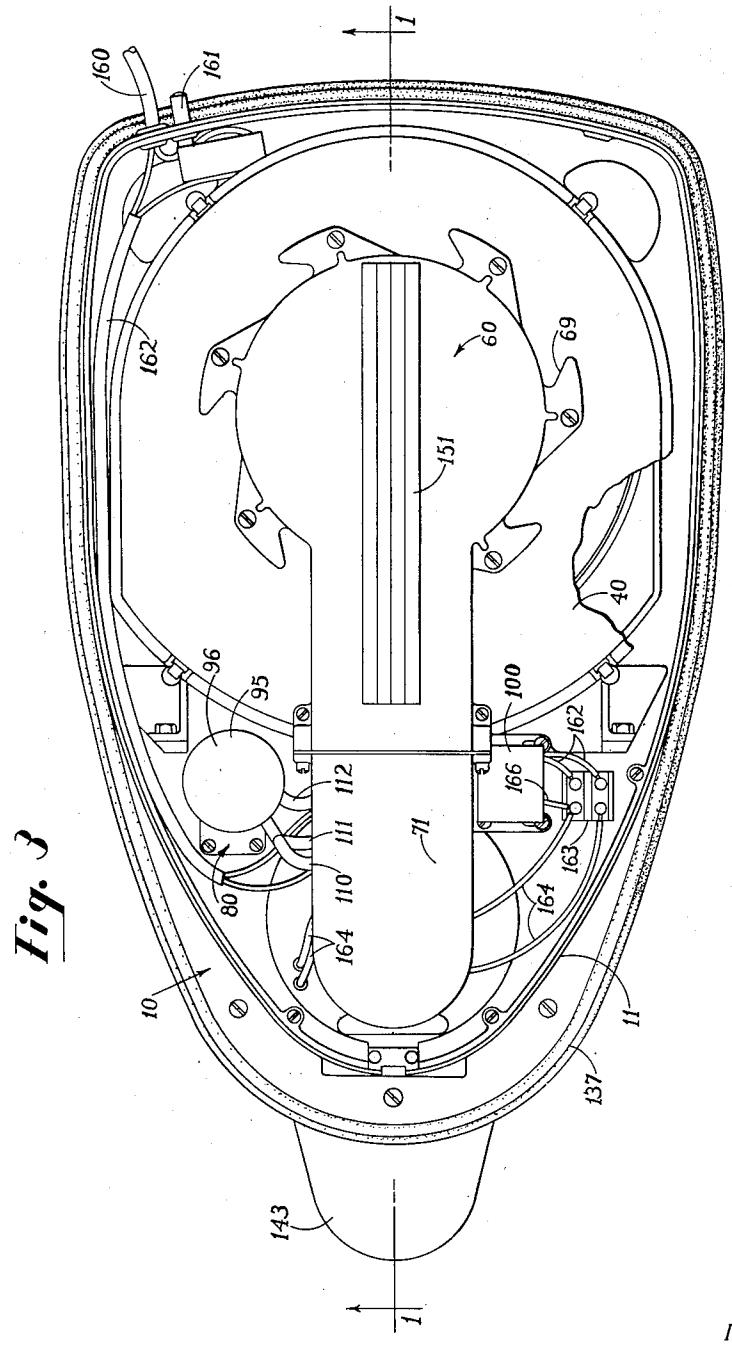

Fig. 3

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Fig. 4

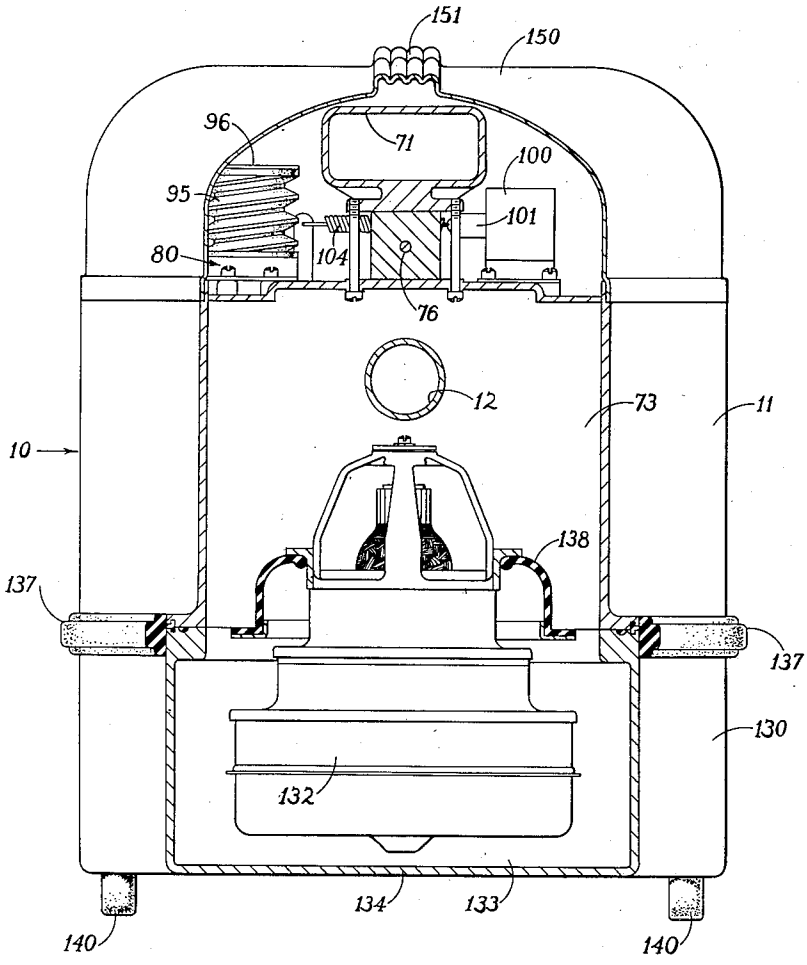
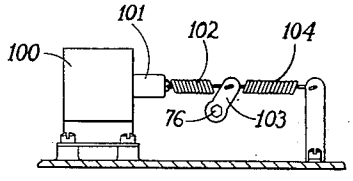


Fig. 5



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VACUUM CLEANER

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Fig. 6

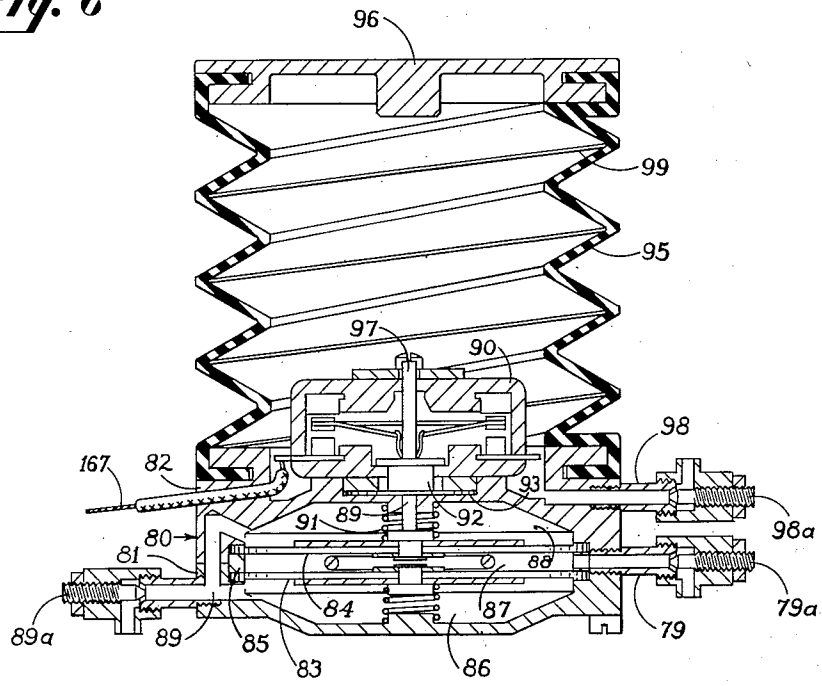
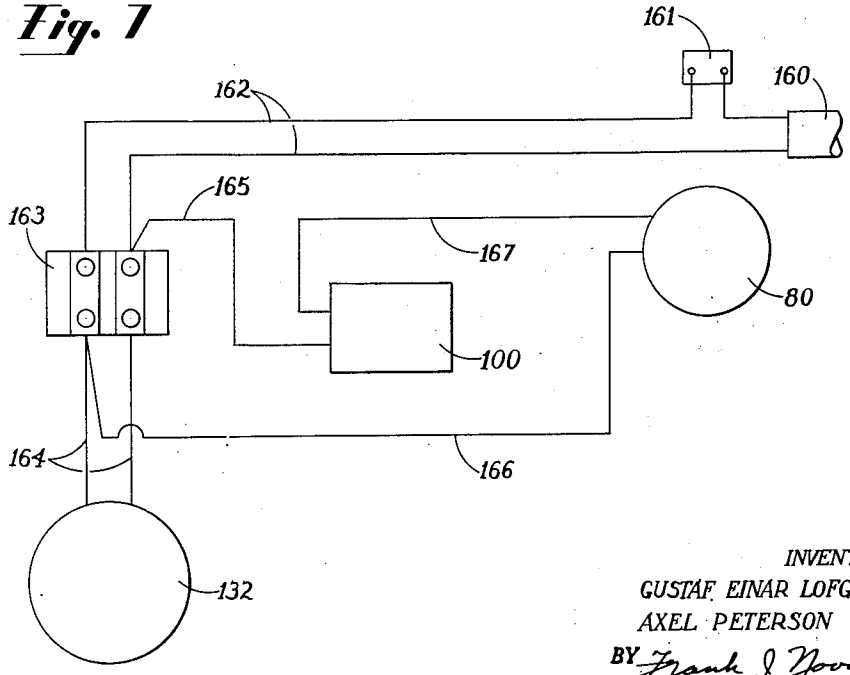


Fig. 7



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VACUUM CLEANER

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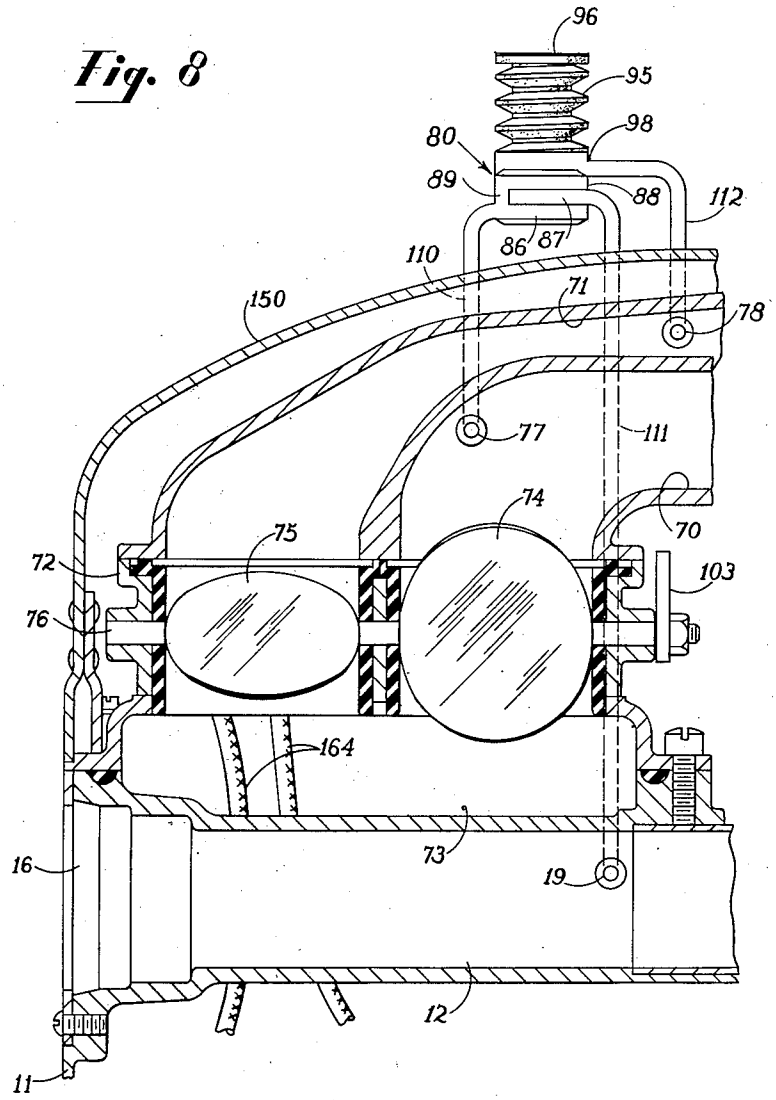
Fig. 8



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Patented Apr. 1, 1952

2,591,567

UNITED STATES PATENT OFFICE

2,591,567

VACUUM CLEANER

Gustaf Einar Lofgren, Wesskum Wood, Riverside, and Axel Peterson, Stamford, Conn., assignors to Electrolux Corporation, Old Greenwich, Conn., a corporation of Delaware

Application May 29, 1948, Serial No. 29,964

18 Claims. (Cl. 183—54)

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This invention relates to a vacuum or suction type cleaner adapted for use as an industrial or similar large scale cleaning device for hotels, apartment houses, hospitals and the like. More particularly it embraces an automatically conditioned unit of large capacity and one which maintains itself operating at maximum efficiency by means of self-contained control mechanisms.

Heretofore considerable difficulty has been experienced in maintaining the operation of vacuum cleaners at optimum efficiency, particularly in industrial usage where various types and sizes of dust particles are picked up, some of which particles clog the conventional filtering devices most commonly used after but a short interval of use. Invariably, the flexible cloth or paper bag forming the dust separating element of the conventional vacuum cleaner unit shows progressively decreasing efficiency with use due principally to surface adhering and internally entrapped dust particles which close the interstices of the particular dust filtering or separating element used.

It is a major object of this invention to provide improved means for dislodging dirt, dust and foreign matter accumulated on and between the interstices of the fabric or other material used to filter out foreign matter from the air stream coursing through the filter screen.

A further and important object is to provide a new and improved type of suction cleaner wherein the source of suction is automatically diverted upon the attainment of a predetermined condition or change in the air pressure characteristics within the various cleaner compartments, whereupon the dust collecting and screening or dust separating action is discontinued and an auxiliary unit is brought into operation to effect an agitation of the screen of such intensity and duration that the adhering dust particles are dislodged from the interstices and separated out of the general path of the air current and deposited into a receptacle or dust chamber of comparatively large capacity for subsequent removal.

Still another object is to provide a large scale vacuum cleaner which is light and readily maneuvered as by the cleaning hose or flexible wand connection without necessitating the provision of additional or auxiliary handling means.

A still further object is to provide a cleaner having an unusually large dust capacity.

It is an additional object of this invention to provide a vacuum cleaner having a large capacity dust or dirt settling chamber into which the dust

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collected is readily deposited from the surface of its filter cloth.

A further object is to provide a dust or dirt canister which is housed in the base of the cleaner apparatus and which is readily removable therefrom for disposal of the accumulated dirt.

A further object is to provide means for removing dust adhering to a dust collecting screen filter member, the dust being loosened therefrom and removed from contact therewith without necessitating dismantling of the cleaner unit.

Still other and further objects will be disclosed below or will become obvious from a study of the following description together with the accompanying drawings wherein:

Fig. 1 is a vertical sectional view taken along the line 1—1 of Fig. 3;

Fig. 2 is a plan view of the rear end of the cleaner of Fig. 1 taken from the right-hand side thereof;

Fig. 3 is a top plan view of the cleaner of Fig. 1 with the cover thereof removed;

Fig. 4 is a sectional view taken on the line 4—4 of Fig. 1;

Fig. 5 is a view of the solenoidal spring biased valve actuating mechanism;

Fig. 6 is a sectional view through the air actuated switching mechanism of Fig. 1;

Fig. 7 is a diagrammatic illustration of the wiring connections; and

Fig. 8 is a diagrammatic sketch of the pneumatic tubular connections for the operation of the automatic controls.

It is a feature of this invention that provision is made for automatically utilizing an air pressure or suction operated agitator for shaking a clogged filter screen element in order to dislodge dust therefrom. In a specific embodiment, the air flow or suction for the operation of the agitator is shown as provided by the usual vacuum cleaner motor fan unit, the air suction from which is completely cut off or diverted from its dust collecting function and instead is used to operate a screen agitating device, preferably by means of an intermediate air suction operated turbine or similarly air driven device. In a preferred embodiment the turbine drives an eccentric which shakes a screen support to knock the adhering dust and dirt loose from the clogged dust screen. This loose dirt then drops through a dead or motionless air space into a receptacle for collection and subsequent disposal without being subjected to such disturbing air currents as are incident upon and accompany the normal cleaning operation during which air suction is

effected through the filtering screen. The result is practically complete dislodgement of most of the adhering and clogging dust particles and the reestablishment of an efficient, high speed air suction for the subsequent dust collecting operation of the cleaner.

In the past it has been found that such dirt and dust adhering to the screen and in the interstices of the screen and on the fibers thereof greatly impairs the dust separating and cleaning efficiency of the cleaner unit. In the embodiment of the invention herein disclosed, the thorough shaking or agitation of the screen effectively loosens any adherent or accumulated dirt from the surface of the screen. This agitation of the screen is effected by an eccentrically driven shaking device which in a preferred type of construction is powered by an air actuated turbine, the eccentric causing a rotation in the nature of a gyratory oscillation of a plate supporting the dust separating screen or dust bag. This shakes most, if not all of the adhering dust particles loose. The most effective dust removal possible is attained when no air courses through the screen filter during the shaking interval. Then the losened particles can readily fall by gravity to the bottom of the dust receptacle and out of the general path of the vacuum cleaner air current.

The shaking device is essentially a turbine comprising air current driven blades mounted on a rotor plate which is used to revolve an eccentric mounted on a common shaft. An improved valve mechanism is used to operate, selectively, the cleaner cycle or the filter screen agitating cycle. The valve arrangement is such that air flow through the dust chamber is discontinued and instead an air current is established to operate the turbine which agitates the dust separating filter screen and restores its dust removal efficiency.

The entire operation is automatic and effected by the movement of air current control valves which are normally spring biased to vacuum cleaner position and are shifted automatically under predetermined conditions in order to terminate all air flow or suction through the dust chamber and screen filter member and to initiate air flow or suction over the turbine blades to effect the dust disengaging or shaking step whereby the original dust removing efficiency of the screen filter cloth is restored for subsequent vacuum cleaner operation.

Referring now more particularly to the drawings, the vacuum cleaner housing **10** is of tear drop or streamlined design and may conveniently be fabricated from a number of castings suitably screwed, riveted or otherwise fastened together and sealed at the joints against air leakage by means of suitable gaskets. Thus the cleaner comprises an inlet housing **11** having an air inlet tube **12** connected by a rubber hose **13** and suitable sleeves to inlet port **14** which opens somewhat tangentially into dust chamber ring **25**. These units are appropriately supported on the vertical walls of a base **130** which is open at the top and bottom except for transverse cross bracing members **131**. A motor fan unit **132** is resiliently supported from housing **10**, the lower portion of the unit being disposed in a compartment **133** formed in base **130**, the bottom of the compartment being sealed by motor plate cover **134**. An air outlet tube **135** is connected to compartment **133** by means of a flexible coupling **136** and extends to the rear of base **130**. A

removable dust container or dust receptacle **30**, sealed tightly against the lower rim portion of dust chamber ring **25** by gasket **31**, is also supported by suitable means in the base **130**. Finally the base **130** is supported on three ball bearing wheels, two at the rear, one of which is shown at **140**, and one caster **141** mounted at the front end by bracket **142**.

Top casting **40** has means for mounting the reentrant frusto-conical filter screen **41**, turbine assembly **60**, air conduits **70**, **71** and valve housing **72**. The vacuum cleaner unit is provided with a removable hood **150** which may have a handle integral therewith or folded into an opening therein as shown at **151**.

The cleaner unit is provided with a flexible hose **15** fitted into a coupling **16** at the front or outer end of conduit **12**. The flexible hose provides the means by which the cleaner is moved or pulled across the floor. No device for pushing the cleaner unit is necessary since the ball bearing wheels **140** on each side of the body together with the swivel mounted front wheel **141** make for easy rolling motion in any direction across the floor. The handle **151** which folds into and below the top cover or hood **150** is provided to facilitate carrying the cleaner, such as up and down stairs. A rubber bumper strip **137** around the entire lower portion of the frame base **130** serves to buffer the cleaner against extraneous contacts and prevents scratching and otherwise marring furniture, walls, etc., encountered in its path. The elongated casing has ample room at the rear for the removal canister, dust pan or dust receptacle **30**. This receptacle fits tightly into the cleaner frame and is provided with an inner top flange and rubber sealing ring or gasket **31** which forms an air-tight fit with the bottom of cylindrical dust chamber ring **25** when pressed into position by handle **32**. This handle includes a pair of arms **33** disposed on either side of the receptacle and pivoted thereto at **34**, the outer end of the arms being joined by a transverse hand grip member **35**. When the receptacle is in place, within the casing, the inner ends of the arms are disposed above spring biased abutments **36** mounted within the casing, and consequently when the outer end of the handle is raised, the inner ends of the arms bear against the abutments **36** and the entire receptacle is raised so as to resiliently press the gasket **31** against the bottom of ring **25**. The handle is retained in raised position by means of a spring latch **37** which engages hand grip member **35**.

The internal structure of the automatic vacuum cleaner comprises tube means **12** for conveying dust-laden air to a dust separator unit which is divided into two parts by a filtering area comprising the cloth dust separator **41**.

The dust separator or filter bag **41** is of a reentrant frusto-conical form, the various elements of the filter being folded back upon themselves in zig-zag portions when viewed in section. Thus, the outer edge **42** of the cloth forms a large open mouthed section which is secured to a ring **43** which in turn is provided with a rubber packing or sealing material **44**, the edge **42** being held firmly in place by dust bag spacer **45**. The filter cloth extends upwards and inwards from edge **42** to form an external frusto-conical section **46**, the upper and smaller end of which is secured at **47** to a normally stationary supporting plate **65** from which the filter screen cloth extends downwardly and inwardly to form an inner frusto-conical section **48**. The folds **47** are held in

flanges on the outer edge of plate 65 by a split retaining ring 49 which may be collapsed and inserted therein and then expanded to bring the ends into engagement and finally locked into position, clamping the dust separator firmly in place.

The downwardly disposed inner fold 48 forms an innermost reentrant frusto-conical portion 50 which is secured at its inner open end to a ring 51 which in turn is fastened by spring clips 52 to the plate 65. A final cup-shaped segment either of rubber or filter cloth 53 is affixed at its outer edge by spring clips 52 and at its center by the upper end of deflector 26 and machine screw 27. A toroidal separator 54 of metal screen meshwork or of joined rubber sections is suspended freely between folds 48 and 50 to keep these respective frusto-conical portions distended and free from collapse during the passage of air therethrough.

The air current in its course enters one portion of the dust chamber, goes through the filter 41 where dust particles are excluded from the air stream, and the dust free air is then drawn by suction through exit conduit 70 into a compartment 73 in casting 11 into, which extends the upper end of motor fan unit 132. From here the air is drawn through the motor fan unit and is exhausted through conduit 135. A flexible diaphragm 138 separates chamber 73 from chamber 133. A second normally closed conduit 71 also connecting with the exhaust or suction chamber 73 of the motor fan unit supplies the necessary air suction when valve 75 is open to operate an air driven filter cloth shaking device 60. This valve 75 is mounted on a common spindle 76 with a valve 74 which latter valve controls the air flow through conduit 70, the valves being so arranged that when one is open the other is closed.

Automatic means is provided to operate a valve switching mechanism shown in Fig. 6, which is responsive to the establishment of predetermined air pressure conditions within the cleaner to terminate the vacuum cleaner cycle and effect the filter screen cleaning cycle of operations. The air pressure changes necessary to effect this switching to the screen cleaning cycle result from the continued use of the cleaner as a dust gathering device. Then, after a second predetermined condition, usually the lapse of a certain time interval of operation of the screen shaking device, the automatic switching means returns the cleaner to its former mode of operation as a vacuum cleaner or dust collector. In the then relatively dust free condition of the filter, the vacuum cleaner is thereafter capable of a correspondingly highly efficient dust collecting operation. This continues until the filter screen clogs with dust, whereupon the filter agitating cycle is repeated.

In a normal dust collecting cycle of operations, dust-laden air enters through air inlet tube 12 and flows tangentially around and upwardly over the inner border of the cylindrical upper dust chamber 25 immediately above the large dust receptacle 30. As the air velocity decreases and simultaneously changes its direction after leaving opening 14, the heavier dust particles are deposited out of the decelerated air stream and fall downward into the dust receptacle 30 where they are collected for subsequent disposal.

A curved deflecting plate 26 is secured to the under side of the bag mount by machine screw 27. Dust-laden air striking this deflecting plate 26 is diverted sidewise and upward to form a tangentially and helically swirling stream of air in the form of an upwardly disposed spiral air column. The incoming air current is hence caused to flow upwards and against the filter cloth 41. Thus any dust remaining entrained in the air stream is carried along until separated out by contacting the screen filter cloth 41, the surface of which serves to stop and separate out the remaining dust particles, while the air current itself proceeds through the filter openings to the exhaust conduit.

The somewhat tangentially disposed entry port 14 for the incoming air stream accentuates this type of air swirling action. This air current also results in the formation of horizontally disposed spiral air currents of progressively and downwardly decreasing intensity in the canister 30. Thus the baffle plate 26 and the tangential entry port 14 tend to keep the incoming air swirling in horizontal planes, thereby further facilitating the settling out of the heavier dust particles, all without unduly disturbing the dust already settled or deposited on the bottom of the canister. The air in the canister 30, as compared to the air in the upper part of the dust chamber, is relatively immobilized and particularly so towards the bottom of the settling chamber. At most, it rotates or swirls at a progressively decreasing velocity as it approaches the surface of the dust deposited in the bottom of container 30.

This type of construction makes it possible to precipitate the heavy particles out of the incoming air stream with a maximum of efficiency and deposit them in the canister or dust receptacle container 30. In this way the heavy particles are kept from physically contacting and possibly abrading dust bag filter cloth 41 which separates the dust canister 30 from the motor fan unit 132.

The motor fan unit 132 draws the filtered air upwardly through the filter cloth 41 by way of connecting conduit 70 when the valves are in the position shown, Fig. 1, with valve 74 open and valve 75 closed.

Any continuous operation of the cleaner unit or operation over many intermittent periods, causes the filter cloth 41 to become coated and clogged with dust and as a result the air pressure in the region between the filter cloth 41 and the motor fan unit 132 becomes progressively lower and lower. An opening 77 into this increasing vacuum or decreasing pressure region connects directly through rubber tube 110, Fig. 8, to an air actuated valve operating mechanism 80, Fig. 6 (described in more detail below) which operates at a predeterminable point to trip a microswitch 90 which in turn closes a circuit to energize solenoid 100. Plunger 101 of solenoid 100 actuates spring link 102 against the bias of spring 104 and causes the valve arm 103 on spindle 76 to change the position of butterfly valves 74 and 75 whereby valve 74 closes and valve 75 opens. This, respectively, terminates all air flow through the air filtering screen cloth 41 and initiates the flow of a current of air through exhaust conduit 71 which connects directly to air turbine 60 causing the latter to rotate.

Air turbine 60 includes a rotor 61 which drives a shaft 63 and an eccentric 64 affixed on the shaft. Thus, the opening of valve 75 causes a current of air to flow through conduit 71 and drives the turbine 60. This, in turn, causes screen filter cloth or dust bag holding plate 65 mounted by needle bearings 66 on eccentric 64 to undergo a gyratory rotation, whereupon dust

and dirt particles attached to the filter cloth 41 are shaken loose and fall downwardly by gravity to be collected in receptacle 30. A counterbalance 67 mounted to rotate with the eccentric 64 prevents any excessive vibration being transmitted throughout the body of the cleaner unit. Turbine blades 68 integral with rotor 61 are driven by the air current entering through inlet ports 69.

The air pressure actuated valve control unit 80 comprises an air pressure actuated switching device shown in sectional view in Fig. 6. This control unit is responsive to predetermined changes in air pressure within the cleaner unit to operate a switch 90 which serves to make and break a circuit for energizing and deenergizing solenoid 100. The latter, operating through plunger 101 and link 102, positions the valves for the selective operation of the correspondingly associated air powered devices.

In further detail, the assembly control unit 80 comprises a mounting framework which includes a lower housing 81, an upper housing 82 and a pair of diaphragms 83 and 84 pneumatically sealed therein and separated by a ring member 85 to form three air chambers 86, 87, and 88. The outer two chambers, 86 and 88, are connected together by a common duct 89. This duct 89 is connected at opening 77 to the exhaust or outlet conduit 70 of the dust chamber through an appropriately adjusted needle valve 89*a* and rubber tube 110. As the filter cloth 41 becomes clogged, the pressure decreases in the exhaust outlet conduit 70 to which the two outer air chambers of the control unit are connected. The inner or central air chamber 87 is connected at opening 19 to the inlet conduit 12 through an appropriately adjusted needle valve 79*a* and rubber tube 111. This enables diaphragm 84 separating chambers 87 and 88 to measure pressure differences communicated from the respective sides of the filter screen 41.

It is to be noted that the increased clogging effect of the dust particles on the filter screen cloth 41 resulting from the continued use of the cleaner unit, although producing a progressive pressure decrease on the clean or outlet side of the filter screen 41, simultaneously results in a pressure increase approaching as a limit normal atmospheric pressure on the dusty or inlet side of the filter screen. These two pressures are transmitted through tubes 110 and 111, respectively, to the opposite sides of diaphragm 84. When this pressure difference reaches a predetermined valve, for all practical purposes equivalent to a 20 inch column of water, control unit 80 trips switch 90 and initiates the screen shaking cycle.

In more detail, this is effected as follows: during the vacuum cleaning operation the progressively decreasing pressure in the exhaust conduit 70 caused by the continuing dust collection and its further clogging of the filter screen 41 is communicated through tube 110 to the two outer chambers 86, 88 of the control unit 80. Simultaneously, the slightly increasing pressure in conduit 12 is communicated to chamber 87 through tube 111, whereupon the diaphragms 83 and 84 move farther and farther apart. At a predetermined pressure difference, pin 89 actuated from the center of the upper diaphragm and biased by spring 91, actuates pin 92 through sealing diaphragm 93, whereupon microswitch 90 is tripped to close a circuit for energization of the valve actuating solenoid 100. Then valve 74 is moved to closed position to discontinue the air current flow through the filter cloth 41 and terminate the vacuum cleaning operation, and simultaneously valve 75 is opened and the air current flow is diverted through conduit 71 to operate turbine 60. Thereupon air is exhausted from bellows 95 through an appropriately adjusted needle valve 98*a* and rubber tube 112 connected to opening 78 in exhaust conduit 71 and after a predetermined time interval completely collapses the bellows 95. At this point, projection 96 carried by the upper end of bellows 95 being lowered to contact pin 97 of microswitch 90 resets the latter and breaks the circuit, deenergizing solenoid 100. Then, with the reclosure of valve 75, tube 98 is opened to atmospheric pressure through tube 112, opening 78 of conduit 71, and the inlet ports 69 of turbine 60, and bellows 95 fills up with air once again under the expansion action of spring 99 interior thereto. Thus, the valves 74 and 75 are returned to their spring biased positions, the assembly control unit 80 is reset and the entire apparatus is ready for more efficient vacuum cleaner operation once again.

It may happen, however, that unless special provisions are made compensating for or delaying the transmission of sudden pressure changes in the interior of the cleaner to the unit 80, a sudden surge or gust of air may result in an unwarranted tripping of the switch mechanism. Such sudden gusts usually resulting from the sealing of an operatively associated nozzle such as 15, followed by a sudden unsealing of the nozzle, such as accompanies its being pressed against the floor, wall or the like, followed by its sudden release. In order to prevent any such unwarranted operation of the switching mechanism, constricted orifices in the form of needle valves 79*a*, 89*a*, and 98*a* are provided in the lines 110, 111, etc. communicating these pressure changes to the chambers 86, 87, 88. Thus, all sudden pressure changes do not immediately act upon the diaphragm 84 but must await the establishment of what may appropriately be termed a steady state.

In addition to the use of restricted orifices or apertures, a further assurance against unnecessary interruptions of the cleaning operation by an unwarranted tripping of the switch mechanism 90 is effected by the provision of a weaker biasing spring on the lower diaphragm 83 than that used to bias the upper diaphragm 84. With this arrangement any sudden pressure increase in chamber 87, such as that caused by the sudden release of a sealed nozzle 15, results in a movement of diaphragm 83 compressing its weak spring and effecting a pumping action whereby air contained in chamber 86 is forced through common duct 89 into upper chamber 88 where it serves to further brace or bias diaphragm 84 against any movement tending to trip switch 90.

A unit such as 80 makes possible considerable flexibility in vacuum cleaner operation. Thus, if a series wound motor is used on the motor fan unit 132, the sealing off of a nozzle such as 15 against the floor removes a considerable air current load from the motor. This results in a sudden acceleration of the motor speed and a correspondingly great decrease in air pressure within the dust chamber. However, the needle valves, together with the buffering action of the weakly biased diaphragm 83 prevent any tripping of the switch mechanism 90. Likewise, these

same auxiliary devices serve to buffer or delay the response of diaphragm 83 by acting in a corresponding though inverse manner when the sealed nozzle is suddenly lifted, the resumption of air flow load through the cleaner serving to decelerate the motor speed with a correspondingly great increase in air pressure in the various portions of the dust chamber.

It is to be noted that under most operating conditions, the resistance offered by the filter screen 41 itself, unaided by the increase in resistance effected by entrapped dust particles, is sufficient to effect some slight movement or bellowing of diaphragm 83 against its biasing spring before any motion is imparted to diaphragm 84. All of these advantages and others not specifically mentioned result in a highly flexible control unit capable of absorbing and leveling out both large and small sudden pressure variations, and one which is responsive only when the pressure differences attain the conditions of an established steady state well within a predetermined margin embracing that maximum pressure difference previously calculated as necessary and desirable for the actuation of switch 90. Such a device avoids the many inconveniences usually accompanying too frequent filter shaking with its interruption of the vacuum cleaning process. It also avoids the necessity of excessively accurate setting of the controls, the provision of tolerances for variations in the frictional engagement of moving parts as well as operational changes caused by the above-mentioned pressure surges, shocks and blows.

The various portions of the control unit are sealed against leakage by means of rubber cement gaskets and are variously otherwise adapted for efficient operation. The electrical control circuits and the pneumatic connections for effecting control are shown in Figs. 7 and 8, respectively.

The wiring diagram, Fig. 7, shows the current source in the form of a conventional plug-in cord 160, a switch 161 and wires 162 connecting the current source to terminal block 163. Conductors 164 energize the motor fan unit 132 upon closure of switch 161. Conductor 165 goes to one terminal of solenoid 100, while conductor 166 goes to one conductor of the on and off switch in control assembly unit 80. Terminal 167 completes the connection from the control unit 80 to the solenoid 100.

Upon the establishment of a predetermined pressure difference, as above described within the cleaner the circuit is closed for the energization of solenoid 100 and consequent operation of the filter cloth cleaning cycle, as previously explained. The changes in pressure conditions are communicated through the pneumatic tubular connections for the operation of the automatic controls more clearly illustrated in Fig. 8 where the assembly control unit 80 is shown somewhat out of position in order to indicate the association of the various elements more clearly. The common duct 89 between the two outer chambers 86 and 88 is connected by rubber tube 110 to opening 77 in conduit 76. The inner chamber 87 is connected by rubber tube 111 to opening 79 in air intake conduit 12 and tube 98 adapted to withdraw air from and admit air to the bellows 95 is connected by rubber tube 112 to opening 78 in conduit 71.

Needle valves in each of the pneumatic circuits provide readily adjustable means for controlling the ingress and egress of air and obtaining the desired sensitivity of response and shaking time control, while varying the biasing spring tension of the diaphragms provides a means for adjusting the pressure difference at which unit 80 will trip switch 90. The functioning of the pneumatic control assembly for the on and off operation of microswitch 90 and the consequent energization and deenergization of solenoid 100 is thus efficiently and automatically carried out as heretofore described.

Various alternative arrangements and accessory elements are contemplated as equivalent embodiments of the principal invention herein more specifically described and illustrated. Thus the exhaust conduit 135 may readily be made to open out from the front rather than the rear of the vacuum cleaner body 10 by arranging an opening through base member 130, bracket 142 and bracket cover 143. Accessory filter pads can also be inserted in the air path between filter cloth 41 and the entrance of air into the motor fan unit 132 and at any conveniently positioned or readily accessible portion thereof for subsequent replacement. It is also within the comprehension of the inventive concept to vary the action of the valve mechanism substituting more positive setting or completely air or pneumatic actuation for electromagnetic actuation.

Other variations are likewise contemplated. For example, deflector plate 26 may conveniently be turned on its axis through 180° when the vacuum unit is to be used for sopping up water, the deflector then serving to deflect the water directly down into the container 35 and away from the filter cloth bag 41.

Thus it is to be understood that the embodiment more fully described and illustrated herein is merely illustrative and not a limited description of the invention since certain changes may be made in the constructions set forth embodying the invention without departing from its scope, and therefore it is intended that all matter contained in the above description, or shown in the accompanying drawings, shall be interpreted as illustrative and not as limiting the scope of the invention and that the latter is to be broadly construed within the purview of the appended claims.

We claim:

1. In a vacuum cleaner, a dust collecting casing, an air inlet and an air outlet in the casing, a motor fan unit for producing a flow of air therethrough, means in the casing situated between the air inlet and outlet for filtering dust-laden air, means for agitating the filtering means, air driven means for producing power for operating said agitating means, and means responsive to an increase in dirt contaminating said filtering means for diverting the air flow from the filtering means to operate the air driven means.

2. In a vacuum cleaner, a dust collecting casing, an air inlet and an air outlet in the casing, a motor fan unit for producing a flow of air therethrough, means in the casing situated between the air inlet and outlet for filtering dust-laden air, means for agitating the filtering means, air driven means for producing power for operating said agitating means, and means responsive to an increase in dirt contaminating said filtering means for diverting the air flow from the filtering means to operate the air driven means, and additional means for terminating the operation of said agitating means and reestab-

lishing the flow of air through the filtering means.

3. In a vacuum cleaner, a source of air suction, a dust separating chamber, a dust screen in the chamber dividing it into an inlet and outlet section, an inlet conduit for conveying dust-laden air into the inlet section of said chamber, an exhaust conduit connected with the source of air suction for withdrawing air through said screen and from the outlet section to separate out dust particles on the surface of said screen, means for agitating said screen, means for disconnecting the exhaust conduit from the suction source, means for connecting the suction source to operate said agitating means, and means responsive to the establishment of a predetermined pressure drop within said outlet section to operate said latter two means.

4. In a vacuum cleaner, a source of suction, a dust separating chamber, a dust screen in the chamber dividing it into an inlet and an outlet section, an inlet conduit for conveying dust-laden air into the inlet section of said chamber, an exhaust conduit connected with the source of suction for withdrawing air through said screen and from the outlet section to separate out dust particles on the surface of said screen, means for agitating said screen, and means responsive to the establishment of a predetermined pressure drop through said screen for diverting the suction source from the exhaust port to operate the agitating means.

5. In a vacuum cleaner, a source of suction, a dust separating chamber, a dust screen in the chamber dividing it into an inlet and an outlet section, an inlet conduit for conveying dust-laden air into the inlet section of said chamber, an exhaust conduit connected with the source of suction for withdrawing air through said screen and from the outlet section to separate out dust particles on the surface of said screen, means for agitating said screen, means responsive to the establishment of a predetermined pressure drop through said screen for diverting the suction source from the exhaust port to operate the agitating means, and means for determining the duration of operation of said last-mentioned means.

6. In a vacuum cleaner, a source of suction, a dust separating chamber, a dust screen in the chamber dividing it into an inlet and an outlet section, an inlet conduit for conveying dust-laden air into the inlet section of said chamber, an exhaust conduit connected with the source of suction for withdrawing air through said screen and from the outlet section to separate out dust particles on the surface of said screen, means for agitating said screen, a pair of valves for diverting the suction source from the exhaust conduit to operate the agitating means, and means responsive to a predetermined pressure drop through said screen for actuating said valves.

7. In a vacuum cleaner, a source of suction, a dust separating chamber, a dust screen in the chamber dividing it into an inlet and an outlet section, an inlet conduit for conveying dust-laden air into the inlet section of said chamber, an exhaust conduit connected with the source of suction for withdrawing air through said screen and from the outlet section to separate out dust particles on the surface of said screen, means for agitating said screen, a pair of valves for diverting the suction source from the exhaust conduit to operate the agitating means, and electromagnetic means responsive to a predetermined pressure drop through said screen for actuating said valves.

8. In a vacuum cleaner, a source of suction, a dust separating chamber, a dust screen in the chamber dividing it into an inlet and an outlet section, an inlet conduit for conveying dust-laden air into the inlet section of said chamber, an exhaust conduit connected with the source of suction for withdrawing air through said screen and from the outlet section to separate out dust particles on the surface of said screen, means for agitating said screen, a pair of valves for diverting the suction source from the exhaust conduit to operate the agitating means, electromagnetic means for actuating said valves, and pneumatic means responsive to a predetermined change in the air pressures within the inlet and outlet sections of the dust chamber for energizing the electromagnetic means.

9. In a vacuum cleaner, a source of suction, a dust separating chamber, a dust screen in the chamber dividing it into an inlet and an outlet section, an inlet conduit for conveying dust-laden air into the inlet section of said chamber, an exhaust conduit connected with the source of suction for withdrawing air through said screen and from the outlet section to separate out dust particles on the surface of said screen, means for agitating said screen, a pair of valves for diverting the suction source from the exhaust conduit to operate the agitating means, electromagnetic means for actuating said valves, a circuit, means in said circuit for energizing the electromagnetic means, a switch in said circuit for closing and opening the circuit, and pneumatic means responsive to a predetermined change in the air pressures within the inlet and outlet sections of the dust chamber to actuate said switch for closing said circuit.

10. In a vacuum cleaner, a source of air suction, a dust separating chamber, a dust screen in the chamber dividing it into an inlet and an outlet section, an inlet conduit for conveying dust-laden air into the inlet section of said chamber, an exhaust conduit connected with the source of air suction for withdrawing air through said screen and from the outlet section to separate out dust particles on the surface of said screen for vacuum cleaner operation, means for agitating said screen, a pair of valves for diverting the suction source from the exhaust conduit to operate the agitating means, electromagnetic means for actuating said valves, a circuit, means in said circuit for energizing the electromagnetic means, a switch in said circuit for closing and opening the circuit, pneumatic means responsive to a predetermined change in the air pressures within the inlet and outlet sections of the dust chamber to actuate said switch for closing said circuit, and means to actuate said switch to open the circuit after a predetermined time interval whereupon vacuum cleaner operation is restored.

11. In a vacuum cleaner, a source of air suction, a dust separating chamber, a dust screen in the chamber dividing it into an inlet and an outlet section, an inlet port for conveying dust-laden air into the inlet section of said chamber, an exhaust conduit connected with the source of suction for withdrawing air through said screen and from the outlet section to separate out dust particles on the surface of said screen for vacuum cleaner operation, means for agitating said screen, an air turbine for operating said agitating means, a conduit connecting said turbine with said source of suction, valve means opening said

exhaust conduit and closing the other conduit for said vacuum cleaner operation, said valve means being operable to close the exhaust conduit and open the other conduit for agitating operation, electromagnetic means for selectively positioning said valve means, a circuit including a source of current for energizing the electromagnetic means and switching means for closing and opening the circuit, and an air pressure operated device responsive to predetermined changes in the air pressures within the inlet and outlet sections of the dust chamber to actuate the switching means for closing said circuit.

12. In a vacuum cleaner, a source of air suction, a dust separating chamber, a dust screen in the chamber dividing it into an inlet and an outlet section, an inlet port for conveying dust-laden air into the inlet section of said chamber, an exhaust conduit connected with the source of suction for withdrawing air through said screen and from the outlet section to separate out dust particles on the surface of said screen for vacuum cleaner operation, means for agitating said screen, an air turbine for operating said agitating means, a conduit connecting said turbine with said source of suction, spring biased valve means normally opening said exhaust conduit and closing the other conduit for said vacuum cleaner operation, said valve means being simultaneously shiftable to close the exhaust conduit and open the other conduit for agitating operation, electromagnetic means for shifting said valve means against the spring bias, a circuit including a source of current for energizing the electromagnetic means and switching means for closing and opening the circuit, and an air pressure responsive device responsive to predetermined changes in the air pressures within the inlet and outlet sections of the dust chamber to actuate the switching means for closing said circuit, and means for determining the duration of operation of said turbine comprising a bellows chamber, a slow exhaustion device for said bellows chamber for controlling the duration of turbine operation, and means responsive to the exhaustion of the bellows for opening said circuit whereupon the spring bias returns said valve means to its normal position.

13. In a vacuum cleaner, a source of air suction, a dust separating chamber, a dust screen in the chamber dividing it into an inlet and an outlet section, an inlet port for conveying dust-laden air into the inlet section of said chamber, an exhaust conduit connected with the source of suction for withdrawing air through said screen and from the outlet section to separate out dust particles on the surface of said screen for vacuum cleaner operation, means for agitating said screen, an air motor for operating said agitating means, means normally spring biased for maintaining vacuum cleaner operation and effective upon overcoming the bias for diverting the suction source from the outlet section to operate the air motor, said means comprising a pair of valves, simultaneously operable to connect the suction source to either the dust separating chamber or the air motor, a link for operatively positioning said valves, a solenoid for actuating said link, a circuit and a source of current for energizing the solenoid, and a switch for closing and opening the circuit, and an air pressure device responsive to predetermined changes in the air pressures within the inlet and outlet sections of said dust chamber to actuate the switch for closing the circuit whereby the dust and dirt accumulated on the dust screen is removed.

14. In a vacuum cleaner, source of air suction, a dust separating chamber, a dust screen in the chamber dividing it into an inlet and an outlet section, an inlet port for conveying dust-laden air into the inlet section of said chamber, an exhaust conduit connected with the source of suction for withdrawing air through said screen and from the outlet section to separate out dust particles on the surface of said screen for vacuum cleaner operation, means for agitating said screen, and air motor for operating said agitating means, means normally spring biased for maintaining vacuum cleaner operation and effective upon overcoming the bias for diverting the suction source from the outlet section to operate the air motor, said means comprising a pair of valves, simultaneously operable to connect the suction source to either the dust separating chamber or the air motor, a link for operatively positioning said valves, a solenoid for actuating said link, a circuit and a source of current for energizing the solenoid, and a switch for closing and opening the circuit, and an air pressure device responsive to predetermined changes in the air pressures within the inlet and outlet sections of said dust chamber to actuate the switch for closing the circuit whereby the dust and dirt accumulated on the dust screen is removed, means for determining the duration of operation of said air motor comprising a bellows chamber, a slow exhaustion device connected to the suction source operating the air motor for collapsing the bellows chamber and means responsive to the exhaustion of the bellows chamber for opening said circuit whereby vacuum cleaner operation is restored.

15. A pneumatic switching device comprising a make and break switch, an air conduit divided into inlet and outlet portions, a porous membrane between said portions, an exhaust chamber, a diaphragm forming a wall of said chamber, means connecting said chamber to the outlet portion, a second exhaust chamber having said diaphragm in common with said first chamber, means connecting said second chamber to the inlet portion, means on said diaphragm contacting said switch and responsive to pressure differences of a predetermined amount in said conduit portions to actuate said switch to one position, and additional means for actuating said switch to another position after a predetermined time interval.

16. A pneumatic switching device comprising a make and break switch, an air conduit divided into inlet and outlet portions, a porous membrane between said portions, an exhaust chamber, a diaphragm forming a wall of said chamber, means connecting said chamber to the outlet portion, a second exhaust chamber having said diaphragm in common with said first chamber, means connecting said second chamber to the inlet portion, means on said diaphragm contacting said switch and responsive to pressure differences of a predetermined amount in said conduit portions to actuate said switch to one position, a bellows, means for exhausting the bellows, means on the bellows contacting said switch and responsive to the exhaustion of said bellows to actuate said switch to another position.

17. A pneumatic switching device comprising a make and break switch, an air conduit divided into inlet and outlet portions, a filter member between said portions, a pair of exhaust chambers, a diaphragm forming a wall of one of said cham-

bers, a second diaphragm forming a wall of the other of said chambers, a third chamber formed in part by said diaphragms, means connecting the pair of chambers to the outlet portion, means connecting the third chamber to the inlet portion, means on one diaphragm contacting said switch and responsive to a change in the air pressures of a predetermined amount in said conduit portions to actuate said switch, said third chamber being effective to prevent sudden surges of air pressure from affecting the position of said switch actuating diaphragm.

18. A pneumatic switching device comprising a make and break switch, an air conduit divided into inlet and outlet portions, a filter member between said portions, a pair of exhaust chambers each sealed by a diaphragm, a third chamber between said pair of chambers and formed in part by said diaphragms, means connecting the pair of chambers to the outlet portion, means connecting the third chamber to the inlet portion, means on at least one of said diaphragms contacting said switch and responsive to pressure differences of a predetermined amount in said conduit portions to actuate said switch to closed position, said third chamber being effective to prevent sudden surges of air pressure from affecting

the position of said switch actuating diaphragm, and additional means for actuating said switch to open position after having remained closed for a predetermined time interval.

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