Aug. 11, 1953 J. B. KIRBY 2,648,396

VACUUM CLEANER

Filed Feb. 3, 1949 7 Sheets-Sheet 1

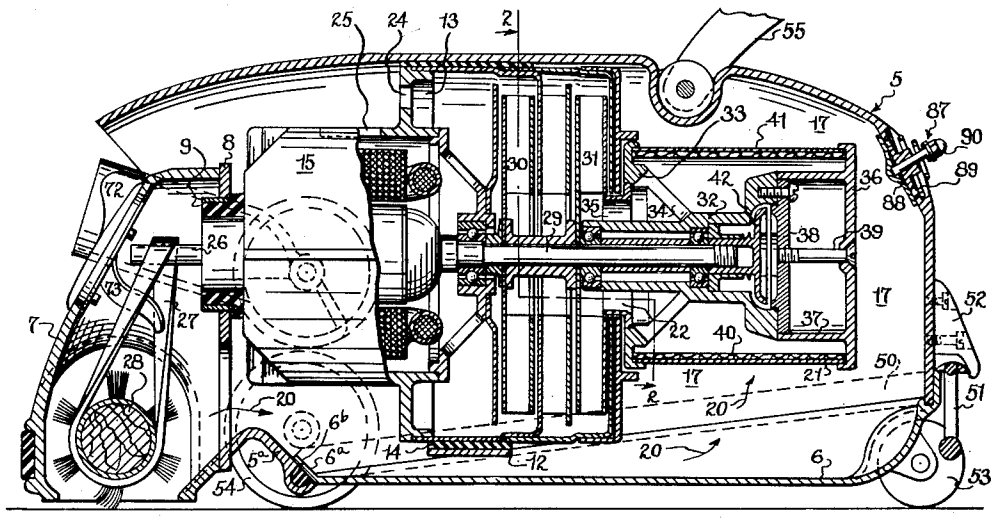

Fig. 1

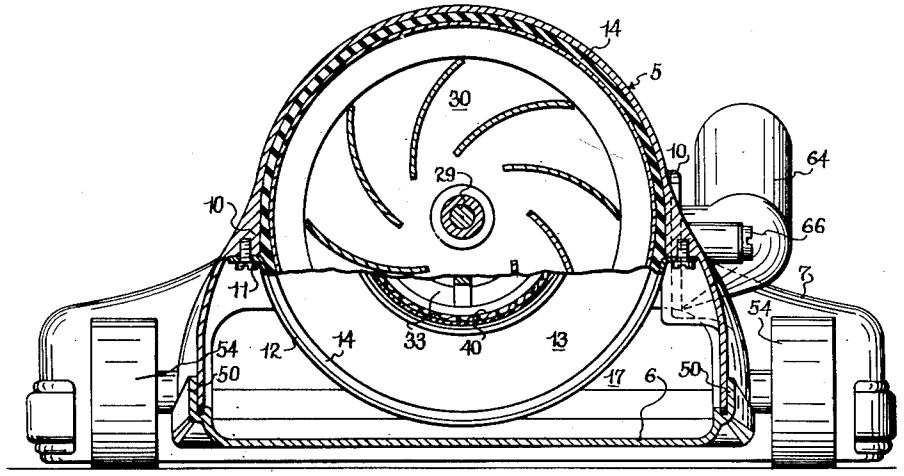

Fig. 2

INVENTOR.
JAMES B. KIRBY
BY
Ricky & Watts
ATTORNEYS

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VACUUM CLEANER

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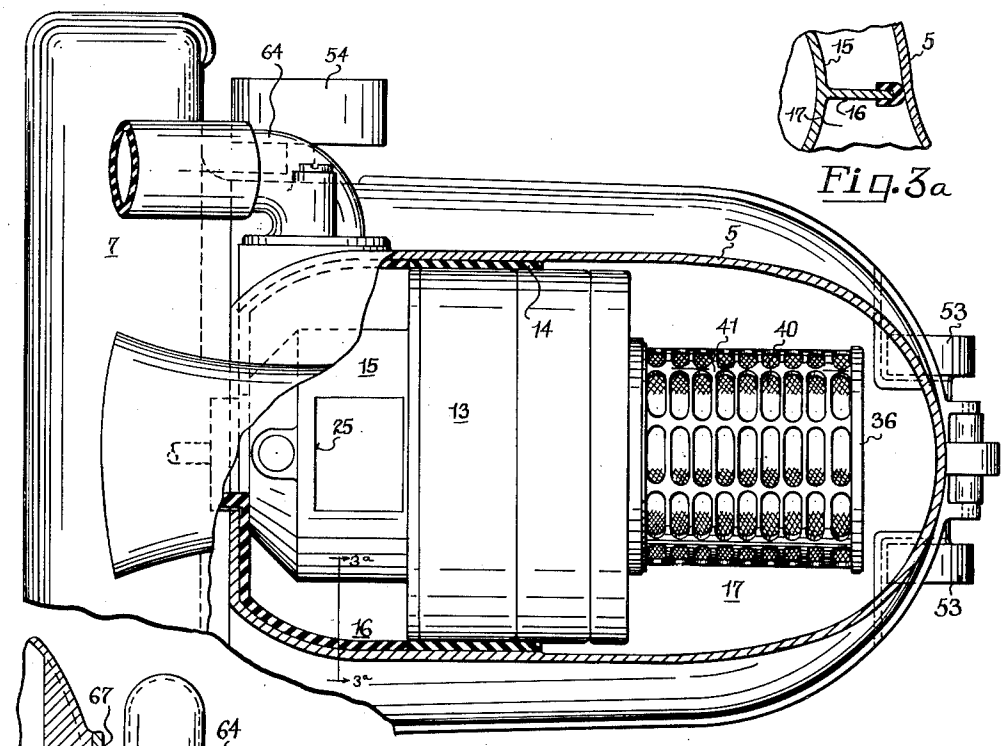

Fig. 3

Fig. 3a

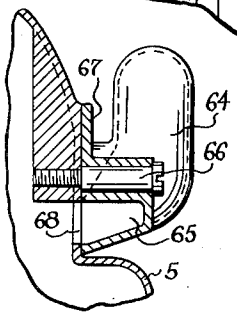

Fig. 4

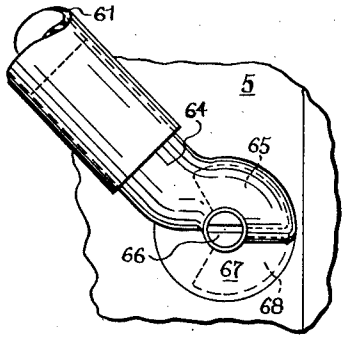

Fig. 6

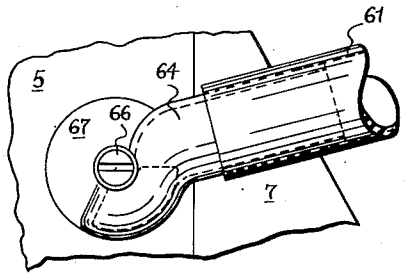

Fig. 5

INVENTOR.
JAMES B. KIRBY
BY
Richey & Watts
ATTORNEYS

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VACUUM CLEANER

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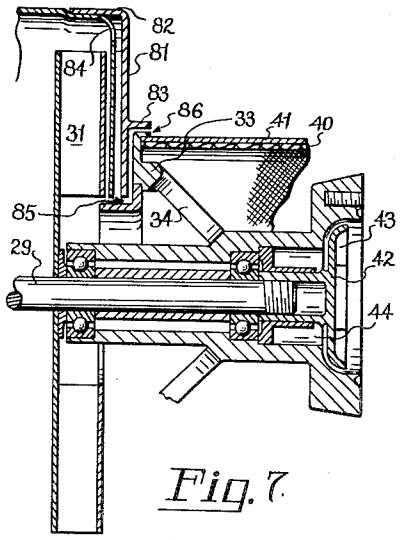

Fig. 7.

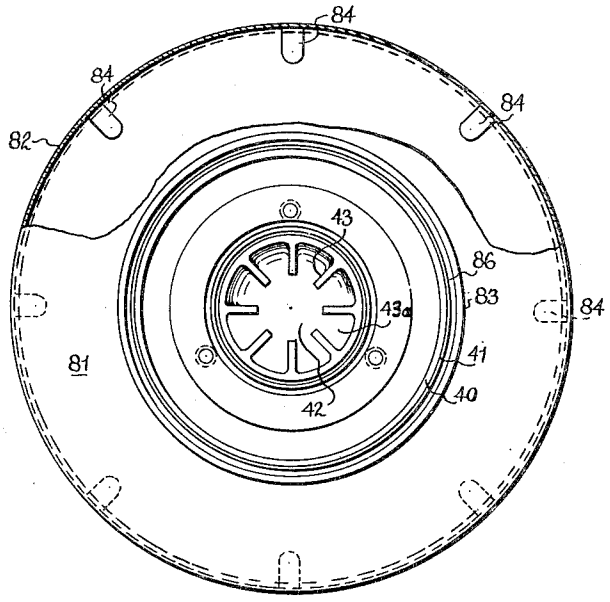

Fig. 8

INVENTOR.
JAMES B. KIRBY
BY
Richey & Watts
ATTORNEYS

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VACUUM CLEANER

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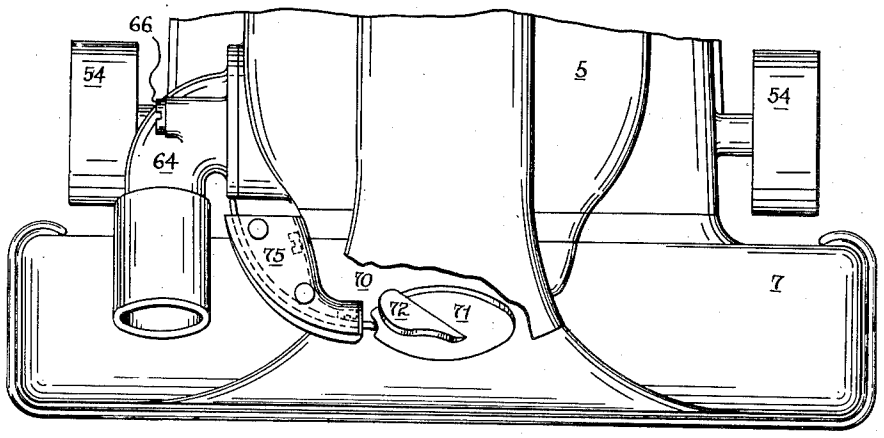

Fig. 9

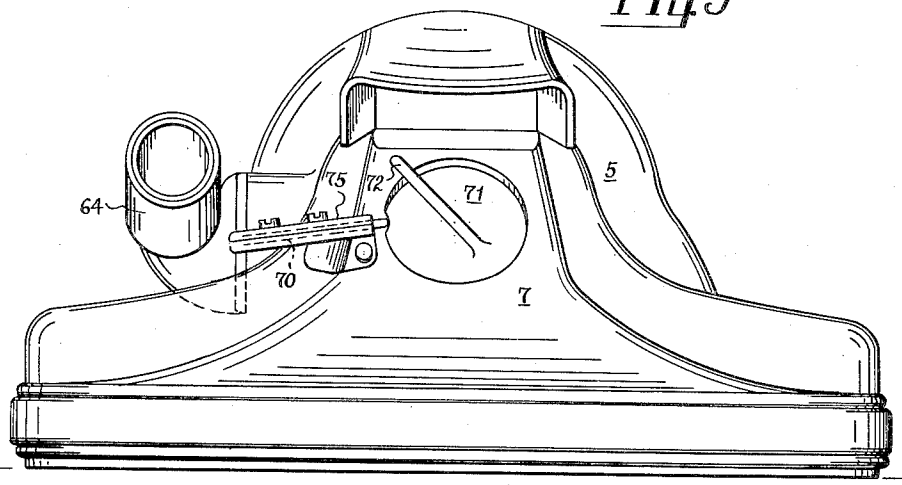

Fig. 10

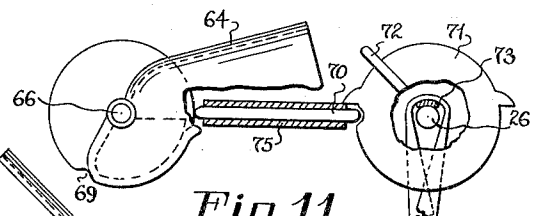

Fig. 11

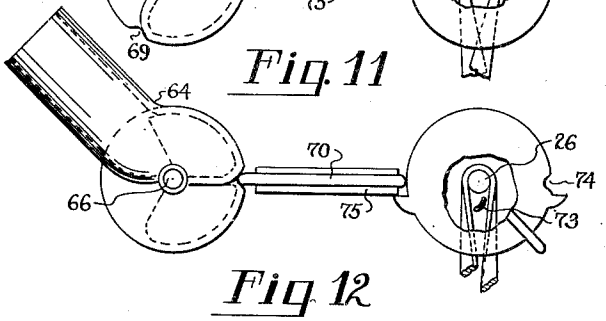

Fig. 12

INVENTOR.
JAMES B. KIRBY
BY
Richey & Watts
ATTORNEYS

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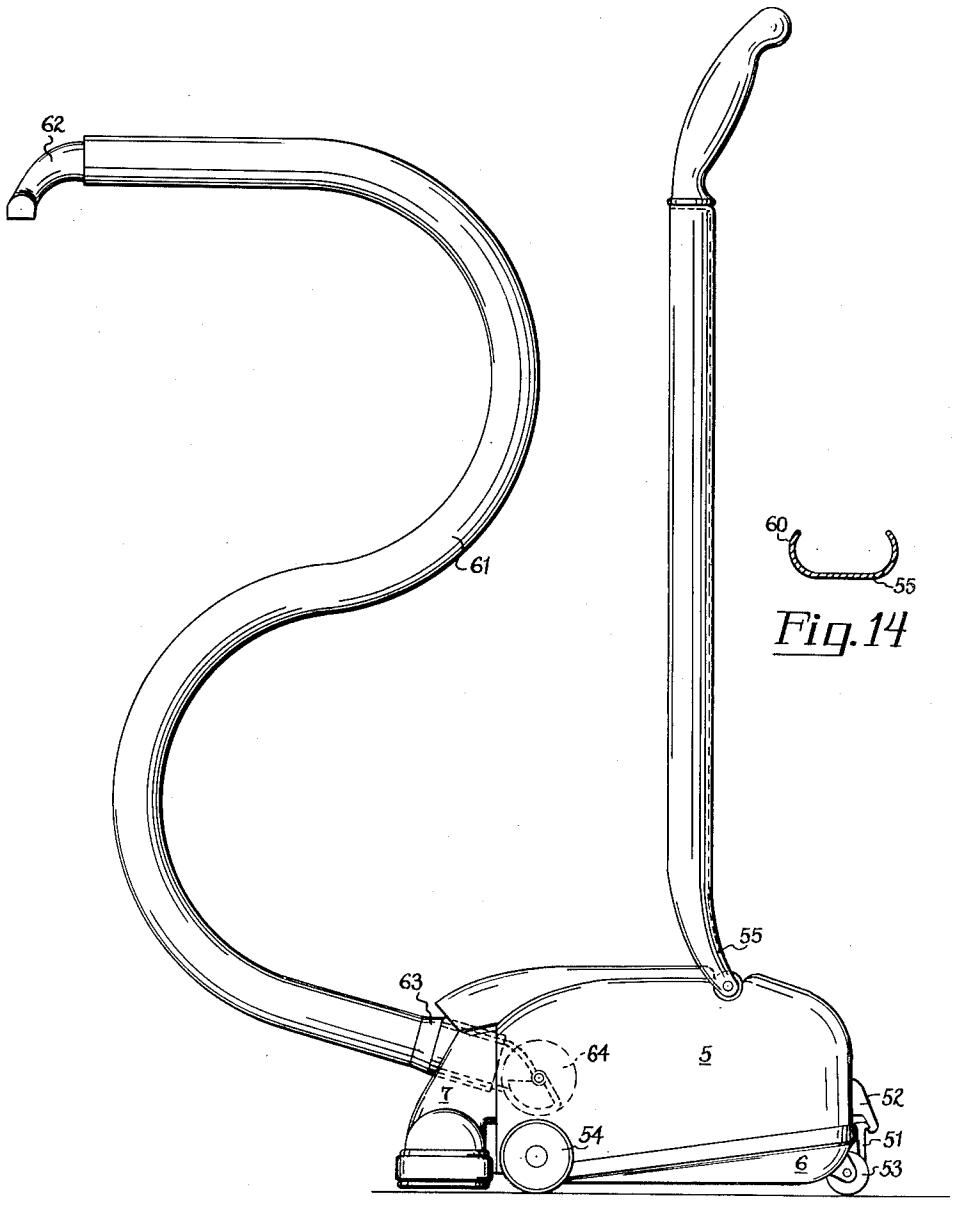

Fig. 13

Fig. 14

INVENTOR.
JAMES B. KIRBY
BY
Richey & Watts
ATTORNEYS

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VACUUM CLEANER

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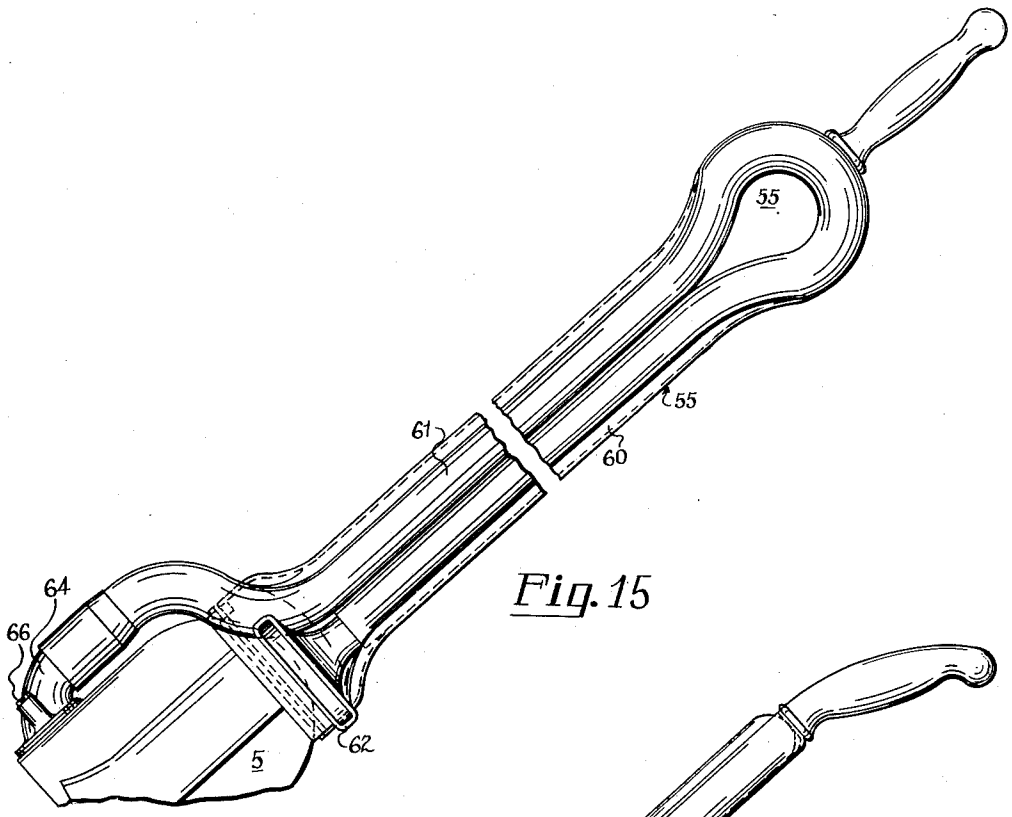

Fig. 15

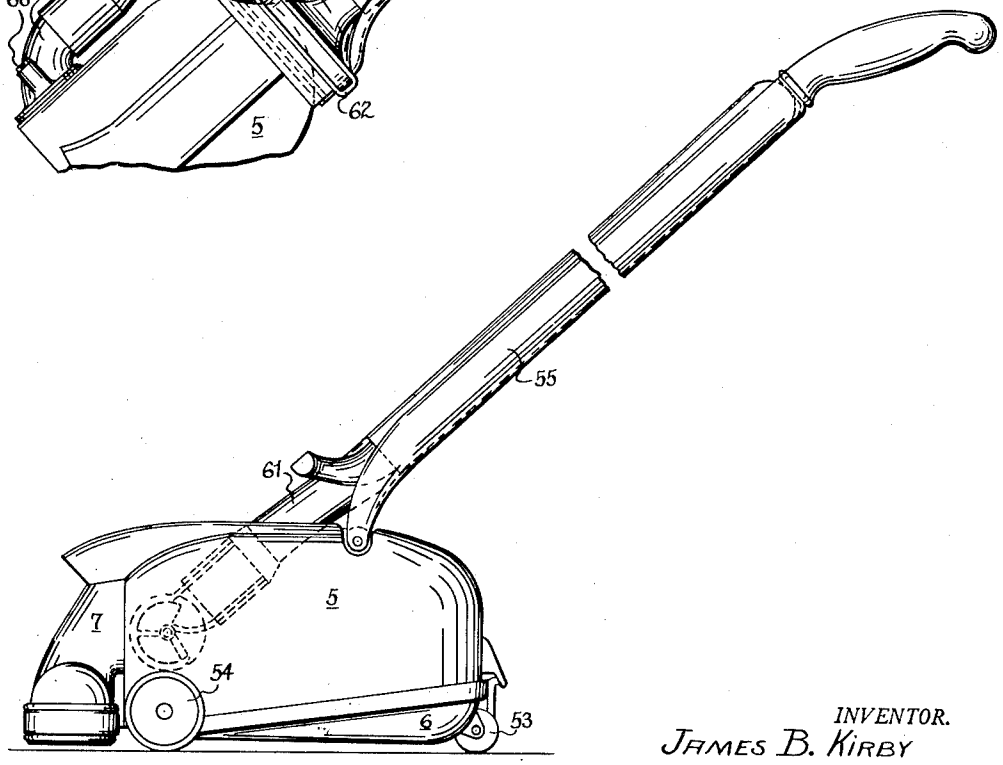

Fig. 16

INVENTOR.
JAMES B. KIRBY
BY
Richey & Watts
ATTORNEYS

Aug. 11, 1953 J. B. KIRBY 2,648,396

VACUUM CLEANER

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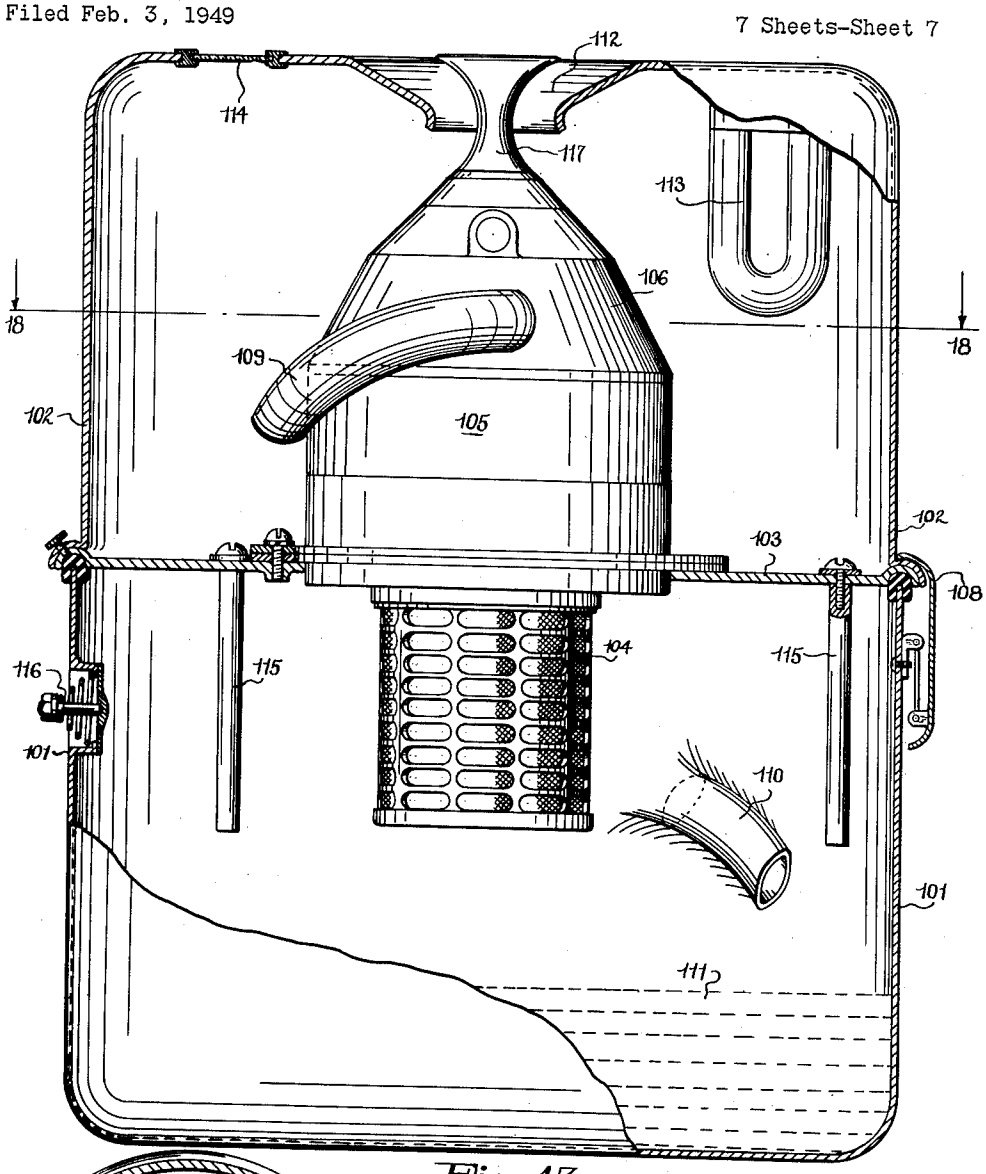

Fig. 17

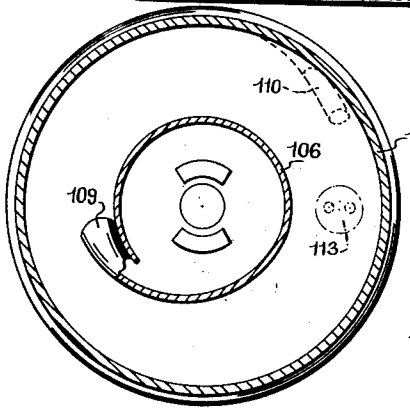

Fig. 18

INVENTOR.
JAMES B. KIRBY
BY
Richey & Watts
ATTORNEYS

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UNITED STATES PATENT OFFICE

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VACUUM CLEANER

James B. Kirby, West Richfield, Ohio

Application February 3, 1949, Serial No. 74,271

2 Claims. (Cl. 183—35)

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This invention relates to vacuum cleaners and more particularly to a vacuum cleaner of general utility that may be quickly and easily converted from a floor cleaner to an off-the-floor-cleaner without adding or removing parts of the cleaner.

Numerous efforts have been made to provide a household vacuum cleaner of general utility, that is, a cleaner that is ready for use as a floor cleaner or a cleaner for upholstered furniture. The reason such efforts have been generally unsuccessful is that to transform or convert the conventional floor cleaner to an off-the-floor-cleaner is that the conversion operation required the use of separate attachments involving the exercise of mechanical skill in their manipulation and adjustment above and beyond the skill of the average housewife. The result is that in those establishments where the use of both a floor cleaner and an off-the-floor-cleaner are warranted, two separate cleaners are generally employed, one for each type of cleaning. Among the attempts to convert a floor cleaner to an off-the-floor-cleaner the most common expedient has included the bodily removal of a part of the floor cleaner so as to gain access to a suction chamber and thereafter attaching to the floor cleaner a dusting hose which is a separate device that is not transported with the cleaner when it is employed as a floor cleaner.

According to the present invention a cleaner is provided that may be operated by the housewife in the usual manner as a floor cleaner and which may be readily converted to an off-the-floor-cleaner for use with a dusting hose without removing any of the parts of the cleaner and one wherein the dusting hose is carried by the cleaner in an operative position with respect to the dust separating functions of the cleaner so that movement of the dusting hose by the operator into a position of use automatically transforms the cleaner into an off-the-floor-cleaner. It is generally known that the dust bag used to separate the dust from the air in a conventional cleaner drops off in efficiency as the cleaner is being used due to the clogging of the minute openings around the threads of the fabric with fine particles of dust. Such particles are not removed by a mere emptying of the bag and the decomposition of such particles produces an unsanitary and odoriferous condition. I have found that the dust bag may be eliminated and the dust separating functions thereof effected with an arrangement of parts that maintains its initial high efficiency and one which will remain clean and sanitary throughout its continued use. I have found

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that this may be accomplished by means of a rotary filter having a very small filter area where that small filter area is rotated at an optimum speed so that the air may pass through the filter during its rotation without appreciable resistance and yet the filter is maintained free of dust by the centrifugal force resulting from its rotation.

It is an object of my invention to provide a cleaner wherein a rotating dust separating filter is continuously cleaned by centrifugal force and the optimum speed to effect the separating and cleaning is obtained even though that speed differs from the speed of the fan and motor employed to move the air through the cleaner.

It is a further object of my invention to provide a cleaner having a dust separating chamber within the body of the cleaner wherein the dust is separated from the air moving through the cleaner by a rotary filter that is turned at a speed less than the rotational speed imparted to the fan which moves the air through the cleaner. It is a further object of my invention to provide a cleaner in accordance with the preceding object, wherein the reduced rotational speed of the filter, with respect to the fan, is obtained by means of a fluid coupling.

It is a further object of my invention to provide a cleaner wherein a motor fan and rotary filter are connected in alignment in the sequence named and wherein an efficient relationship between filter and fan is maintained by means of a fluid coupling.

It is a further object of my invention to provide a vacuum cleaner having a dust separating chamber, a floor cleaning nozzle having a rotary brush therein and connected to the dust separating chamber and an off-the-floor-cleaning hose carried by the cleaner and also connected to the dust separating chamber with an interlock arrangement which effectively prevents simultaneous use of the cleaning hose and floor cleaning nozzle.

It is a further object of my invention to provide a cleaner having an inlet chamber where the air is cleaned and an exhaust chamber wherein the cleaned air is circulated near a germicidal lamp.

Further objects and advantages relating to efficiency in operation, convenience in use, and economy in manufacture will appear from the appended drawings wherein:

Fig. 1 is a sectional view taken longitudinally of a cleaner made according to my invention;

Fig. 2 is a transverse view with parts in sec-

tion taken along the plane indicated at 2—2 of Fig. 1;

Fig. 3 is a plan view with parts in section of the cleaner of Fig. 1;

Fig. 3a is a sectional view taken as indicated at 3a—3a of Fig. 3;

Fig. 4 is a sectional view of the pivoted dusting hose coupling;

Fig. 5 is an elevation of the dusting hose coupling showing the parts in open position;

Fig. 6 is an elevation of the dusting hose coupling showing the parts in closed position;

Fig. 7 is a sectional view showing details of the air pressure seal between the rotary filter and the fan;

Fig. 8 is an elevation or end view showing details of the air pressure seal and parts of the fluid coupling employed to drive the rotary filter;

Fig. 9 is a plan view showing the interlock arrangement between the dusting hose coupling and the control for the floor nozzle;

Fig. 10 is a front elevation showing the interlock arrangement;

Fig. 11 is a diagrammatic showing of the dusting hose coupling and the floor nozzle control showing the dusting hose coupling in open position;

Fig. 12 is a view similar to Fig. 11 showing the dusting hose coupling in closed position;

Fig. 13 is an elevation of the cleaner in its entirety showing the dusting hose in position for use;

Fig. 14 is a sectional view of the handle for the cleaner;

Fig. 15 is a plan view, with parts broken away, showing the dusting hose in stored position on the handle of the cleaner;

Fig. 16 is a side elevation showing the cleaner in position for use as a floor cleaner;

Fig. 17 is a sectional view of a modified form of my invention particularly adapted for the sterilization of the air moved through the cleaner;

Fig. 18 is a plan view with parts in section taken on the plane 18—18 of Fig. 17.

Referring to the drawings, the cleaner body indicated in its entirety as at 5 comprises an elongated casing having a removable dust box 6 at the underside thereof and a transverse floor nozzle 7 at the forward end thereof. The body is given a generally semi-circular contour in the upper half thereof, as shown best in Fig. 2, and a forward web or wall 8 is apertured to receive the resilient motor support ring 9 extending therethrough. The cleaner body is provided with opposed bosses 10 to receive fastenings 11 carried by a supporting band 12 which embraces the underside of the fan and motor assembly 13. A resilient cushion 14 encircles the fan and motor assembly so that the noise developed by the fan and power unit will not be transmitted to the body 5. The motor casing 15 is provided with oppositely extending webs 16 as best shown in Figs. 3 and 3a which are shaped to conform to the inner side walls of the body and cooperate with other parts of the assembly to form a dust separating chamber 17. The arrangement of the motor, fan and filter is such that the air is drawn toward the rear of the cleaner body beneath the fan casing as indicated by the arrows 20 and thence through the walls of the filter indicated in its entirety as at 21 and thence to the fan inlet 22.

The air from the fan is discharged from the fan casing through the openings 24 and out through the opening 25 in the motor casing. The motor shaft is extended forwardly of the motor as at 26 to provide a driving pulley for the belt 27 to drive the brush 28 mounted for rotation in the floor nozzle 7. The motor shaft is extended rearwardly of the motor as at 29. That portion of the extension 29 immediately adjacent the motor is employed to turn the fans 30 and 31 fixed to the shaft and the portion therebeyond is utilized to support and drive the rotary filter 21.

The filter assembly includes a sleeve 32 mounted for free rotation on ball bearings carried by the motor shaft extension 29. Integrally formed with the sleeve 32 is a rear filter wall 33 supported by the spider 34. Said wall 33 is apertured as at 35 so as to lead air drawn through the filter into the fan inlet 22 at the first stage of the fan and thus admit air to the inner end of the blades of the fan 31. The opposite end of the filter comprises a plate 36 having an integrally formed ring 37 surrounding a driven fluid clutch part 38. The member 36 is secured to the driven clutch part 38 by a screw or the like 39. The periphery of the driven clutch part 38 is secured to the end of the sleeve 32 so that the two end portions of the rotary filter turn with the sleeve 32 as a unit and are freely rotatable as a unit about the motor shaft extension 29. The filter is preferably cylindrical in shape, as shown, since this shape provides for the same speed of rotation at the periphery throughout the area of the filter. Fibrous filter material forming the cylindrical wall of the filter is indicated at 40 and is held in its cylindrical shape against the centrifugal forces developed by rotation by an apertured metallic sleeve 41, shown best in Fig. 3. Since the effective filtering area is limited to the area of the apertures in the sleeve 41, a similar sleeve may be arranged inside of the porous filter 40 with the apertures in alignment so as to support the filter against collapse occasioned by the vacuum resulting from the operation of the fan. It will be observed that the filter material 40 may be replaced, if desired, by merely removing the fastening 39 and the end member of filter assembly 36.

To drive the rotary filter at a speed less than the speed of the fan and motor, a driving section 42 of the fluid coupling is secured to the end of the motor shaft extension 29. The coupling section 42 is provided with radial webs 43 forming pockets 43a which cooperate with complementary pockets formed on the driven coupling member 38. The sleeve 32 is spaced from the driving coupling section 42 so as to provide a chamber 44 to receive and hold the coupling fluid in the event the cleaner is displaced from its normal horizontal operating position. The amount of coupling fluid employed is such that the filter will be driven at a speed about 25 per cent less than the rotational speed of the motor shaft so that the fan may be turned at a relatively high speed and thus obtain the maximum efficiency from the fan. The filter is turned at a lower speed so as to obtain the maximum efficiency from the filter. To maintain the efficiency of the rotary filter it is important that the diameter of the filter and its rotational speed be such that dust particles are centrifugally thrown from the surface of the filter while the air at the same time is drawn through the filter. I have found that a two stage fan, of the type shown, having a diameter of about five and one-half inches is efficiently operated at a rotational speed of about 14,000 R. P. M. I have also found that a filter constructed and arranged as shown, having a diameter of about three and one-half inches

should be turned at about 10,000 to 11,000 R. P. M. and that the desired fan and filter operating speeds are obtained by means of a fluid coupling ararnged as shown, having a diameter of about one and one-half inches.

The lower part of the cleaner body is closed by the dust box 6 which is provided with an upwardly sloping flange 6a at its forward end to bear against a sloping wall 5a and sealed against said wall by a gasket 6b. The dust box has an upturned flange at the sides and rear thereof as at 50, with a groove at the bottom of the flange to receive a seal and thus maintain an air tight fit with the upper part of the cleaner body. The dust box 6 is detachably secured to the cleaner box by latch 51—52 and thus dust and dirt collected in the box 6 may be removed from the cleaner. The dust box, which in effect forms the bottom of the cleaner body, has spaced wheels 53 to support the rear of the cleaner, and the forward end of the cleaner is supported by spaced wheels 54. With the parts in position as shown in Fig. 1, the cleaner may be pushed over the floor by means of the handle 55 pivoted at the top of the cleaner body and the air drawn in through the floor nozzle 7 moves rearwardly into the separating chamber 17. The rotation of the nozzle brush 28 tends to keep the rug or other floor covering from sealing the mouth of the nozzle. It is important that this rotation be interrupted when the dusting hose is being used so as to prevent undue wear on the floor covering by the nozzle brush 28. When the rotation of the nozzle brush is interrupted, as by lifting the belt 27 from the shaft extension 26, there is a tendency of the floor covering to be drawn upwardly against the mouth of the nozzle and this sealing of the floor nozzle when the dusting hose is in use may be improved by the use of vertically adjustable supporting wheels such as are well known in this art. The dust drawn into the separating chamber 17 swirls about the rotating filter where the air carrying the dust and dirt is drawn through the filter and fan and thence exhausted to the atmosphere while the dust is separated centrifugally from the moving air and deposited in the dust box 6.

The cleaner handle 55 is preferably a metal stamping having a cross section, as shown in Fig. 14, through the major portion thereof and is flared outwardly at each end, as best shown in Fig. 15, to accommodate the hose bends and support the dusting hose 61 carried by the cleaner. The dusting hose 61 is of the usual flexible or resilient construction and is pressed into storage position between the upturned flanges or side walls 60 of the handle 55. The free end of the dusting hose is provided with a dusting tool 62 suited for the cleaning of upholstery, drapes, and the like. The other end of the dusting hose 61 is coupled as at 63 to a pivoted fitting 64. The fitting 64 is provided with an opening 65 that may be turned to a position below the pivot 66 carried by the cleaner body. The opening 65 of the fitting is in communication with the tubular extension so that when the parts are in the position shown in Figs. 3, 4 and 5, the opening of the fitting is in alignment with an opening 68 in the cleaner body 5 and is thus in communication with the separating chamber 17. The fitting 64 is also provided with a flat portion 67 that serves as a closure for the opening 68 in the wall of the cleaner and when the fitting is moved to the position shown in Fig. 6, the opening 68 is closed by the portion 67. The swinging of the fitting 64 about its pivot 66 is effected by the manual movement of the operator moving the dusting hose 61 out of its storage rack on the handle and into a position of use as illustrated in Fig. 13. Before the hose may be swung to such a position of use, however, the fitting 64 must be released for pivotal movement by the interlock latch bar 70, caried at the front of the cleaner.

The front wall of the nozzle 7 has pivotally mounted thereon a belt lifter indicated in its entirety as at 71 which comprises a handle 72 on the exterior of the cleaner and a member 73 carried thereby, normally disposed beneath the motor shaft extension 26. The arrangement is such that manual rotation of the member 71, by means of the handle 72, raises the element 73 from a position beneath the shaft 26 as illustrated in Figs. 12 and 11 respectively. A notch 74 is provided at the periphery of the member 71 so that 180° of turning movement of the member 71 aligns the notch with the rounded end of the latch bar 70. The last described position, illustrated diagrammatically in Fig. 11, permits the latch bar 70 to move longitudinally through the support 75 therefor mounted on the cleaner body. The movement of the latch 70 in the direction of its length is effected by the swinging of the fitting 64. The fitting 64 has a notch 69 in its periphery and the edges of the notch 69 function as a cam when the fitting 64 is turned about its pivot so as to move the latch bar 70 in the direction of its length whereby the other end of the latch bar is received in the notch 74 on the belt lifter 71.

The result of the above described arrangement is such that the drive is interrupted between the motor and the floor nozzle brush 28 so that the floor covering seals the mouth of the nozzle and the high vacuum thus produced in the separating chamber 17 is made available for the dusting hose. It will be noted that the opening 68 in the cleaner body which is brought into alignment with the opening 65 of the dusting tool coupling is below the horizontal axis of the cleaner body and near the forward end thereof so that when the dusting hose is in use it is in a position where the operator may draw the cleaner about the floor on the wheels 53—54.

To insure that dust in the separating chamber 17 will not be admitted to the fan chamber, I have provided an air pressure seal which comprises the arrangement shown best in Fig. 7, wherein a centrally apertured plate 81, provided with flange 82 and secured to the end of the fan casing adjacent the filter member 41, is provided with an annular shoulder or rib 83 which projects axially so as to overlap the end plate 33 of the filter. The end wall of the fan chamber is apertured at 84 about its periphery so that air under pressure from the first fan stage may be discharged through the openings 84 and driven radially inward therefrom so as to flow out into the separating chamber through the passage 85 adjacent the inlet to the first stage of the fan. The air moved through the passages 84 and 85 again moves radially outward so as to pass into the separating chamber through the gap between the rotating filter and the rib 83. This gap is indicated at 86 in Figs. 7 and 8. The air passages, which provide the air pressure seal just described, have been exaggerated in the drawings for purposes of illustration and are proportioned in actual practice to provide only sufficient air between the

fixed member 81 of the fan chamber and the rotating filter part 33 to insure that dust particles in chamber 17 will not be drawn between the filter and the fan housing into the space between the fixed and moving parts.

To insure that an extremely high vacuum condition, such as would disturb the air pressure seal described in the preceding paragraph, would not occur, the separating chamber 17 is provided with a relief valve indicated in its entirety as at 87 in Fig. 1. This valve includes a disc 88 spring pressed so as to close the apertures 89 in the wall of the casing 5. In the event that an extremely high vacuum condition is produced in the separating chamber 17, such as would be produced by sealing the dusting nozzle 62, the relief valve 87 is opened to the atmosphere and thus reduces the pressure differential between the fan and the separating chamber. It will be understood that the adjusting screw 90 of the relief valve 87 may be turned so as obtain a balanced condition corresponding to that provided by the air pressure seal between the separating chamber and the fan chamber.

The cleaner shown in Figs. 17 and 18 is a form of my invention with the parts constructed and arranged to subject the air exhausted from the cleaner to germicidal radiation of ultra violet light so that the bacteria drawn into the cleaner and carried through the filter by the air passing through the cleaner will be killed by the ultra violet radiation of a germicidal lamp. Recent developments relating to ultra violet irradiation of air by germicidal lamps show a marked sterilization of the air. Such developments have also shown the adverse effect of such radiation directly on the human body and accordingly, the accepted installation of germicidal lamps is an installation near the ceiling of the room and well shielded with respect to the occupants of the room. Such installation and shielding limits the circulation of the air with respect to the lamp and places the lamp where dust tends to settle on it with the result that its germicidal effect is greatly diminished. According to the embodiment of my invention illustrated in Fig. 17, the large volume of air moved by the cleaner is carried through a spiral path prior to discharge from the cleaner casing and a germicidal lamp is arranged so as to subject the air moving in the spiral path to ultra violet radiation. The dust box in this modified form of my invention is so constructed that incoming dirt laden air may be washed by water in the dust box prior to the movement of such air toward the rotary filter. The cleaner of Fig. 17 comprises a pair of complementary cylindrical shells or cases 101 and 102, the lower casing 101 being the dust box and the upper casing 102 being the cover for the dust box and the housing and support for the power unit and the air sterilization unit. The upper casing 102 is detachably latched by means of a toggle clamp to the lower casing as at 108 and is provided with a horizontal supporting member 103 which is apertured centrally to receive and support the filter fan and motor unit 104, 105 and 106, respectively. The filter fan and motor unit is constructed and arranged substantially as described in connection with the preferred embodiment of my invention except that the air is discharged from the motor through a spiral outlet 109 rather than through openings spaced around the motor casing as in the preferred embodiment.

The supporting wall 103 separates the inlet or dust separating side of the cleaner from the outlet or exhaust side formed in the upper casing 102. The lower wall 103 is detachably secured by thumb screws as shown to the casing 102. The dirt laden air is moved into the lower casing 101 through a downwardly inclined tangential inlet tube 110 so that such dirt laden air moves in a spiral path downwardly of the casing 101 against a layer of water indicated at 111. The violent agitation of the swirling water washes the air, the moisture laden dust is thrown centrifugally from the filter 104 and becomes a part of the liquid contents of the container. The washed dust free air is moved by the fan through the motor casing and discharged from the motor casing through the spiral outlet 109 which, along with the correspondingly curved wall of the casing 102, produces a long spiral path. The spiral path continues upwardly along the wall of the casing 102 where the radius of the spiral is reduced by discharge of the exhaust air through the opening 112 formed centrally in the top of the casing 102.

Depending from the top of the casing is a germicidal lamp 113 and the ultra violet rays emanating therefrom penetrate the spiral path of the clean exhaust air so that the radiant energy is more effective in killing the air borne bacteria. Although I have shown a conventional U-tube germicidal lamp, it will be understood that the tubular element may have a circular form with a diameter corresponding to the diameter of the spiral air flow path in casing 102. The fact that dust has been removed from such air contributes to the germicidal effect of the ultra violet rays. The casing 102 serves as a shield to protect the user of the cleaner from the ultra violet rays. A filter glass window 114 provides visual evidence as to operation of the light 113. The top of the casing 102 is preferably depressed in the area surrounding the outlet 112 as shown, and a handle 117 fixed to the end cap of the motor 106 is contoured to efficiently direct the exhaust air from the casing. This form of my invention is also provided with a high vacuum relief valve 116 in separating chamber or dust box constructed and operated as described in connection with the form of Fig. 1. For convenience in handling the cleaner when emptying the casing 101, three depending legs 115, equally spaced from each other, are carried by the wall 103. Said legs project downwardly to a plane below the filter 104 so that the top unit of the cleaner may be supported in a stable position on the floor while the box 101 is being emptied. It will be understood that the lamp 113 and the motor 106 are connected in parallel to a suitable source of electrical energy and that, if desired, the use of water in the casing 101 may be dispensed with and the cleaner efficiently operated without the use of the washing feature. It is also pointed out that the inlet 110 may be enlarged and bushed so that when the inlet is used as an air conditioner to wash and sterilize the air the volume of air handled will be increased.

Reference is made to my earlier filed co-pending applications disclosing and claiming certain features embodied in the cleaner that is the subject matter of the instant application, namely, my application for a Filtering Device For Vacuum Cleaners, Ser. No. 709,555, filed November 13, 1946, and now abandoned, and an application for a Convertible Vacuum Cleaner, Ser. No. 797, filed January 6, 1948, and now abandoned. Al-

though I have shown and described two forms of my invention in considerable detail and have disclosed certain of the features found in the instant invention in my earlier co-pending applications, it will be understood that the invention is not confined to the particular details described but that the protection herein applied for covers variations and modifications within the scope of the following claims.

What is claimed is:

1. A vacuum cleaner comprising a motor, a rotary filter, a fan to move air through said filter, means connecting said filter to said motor including a fluid coupling having driving and driven parts normally turning about a horizontal axis and a coupling fluid chamber coaxial with the fluid coupling parts in communication with the interior of the fluid coupling to receive coupling fluid upon displacement of said axis from its normal horizontal position.

2. A vacuum cleaner comprising an elongated casing, a transverse floor nozzle at the forward end of the casing, and a dust separator chamber at the other end of the casing, a motor, fan and centrifugal filter unit coaxially arranged within

said casing in the sequence named, said unit being spaced from the bottom of the casing to provide a passageway for dust laden air leading from the floor nozzle rearwardly beneath said unit, and means operatively connecting the motor and filter comprising a fluid coupling having a driving part secured to the motor shaft and a complementary driven part secured to the filter, whereby the filter turns at a speed less than motor speed due to slip in the fluid coupling.

JAMES B. KIRBY.

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