C. L. GOUGHNOUR.

VACUUM CLEANER.

APPLICATION FILED DEC. 4, 1912. RENEWED FEB. 12, 1916.

1,316,442. Patented Sept. 16, 1919.

4 SHEETS—SHEET 1.

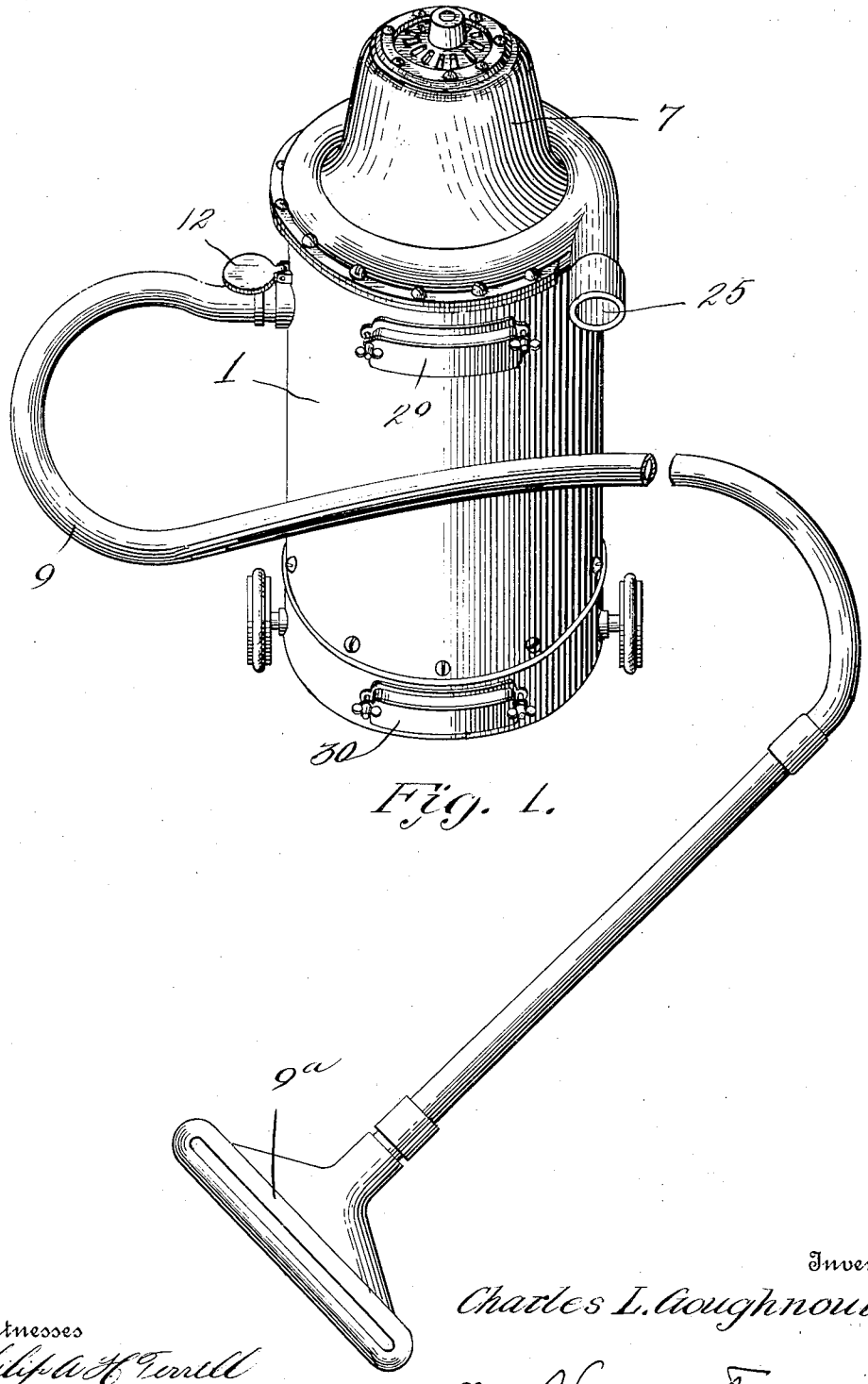


Fig. 1.

Witnesses
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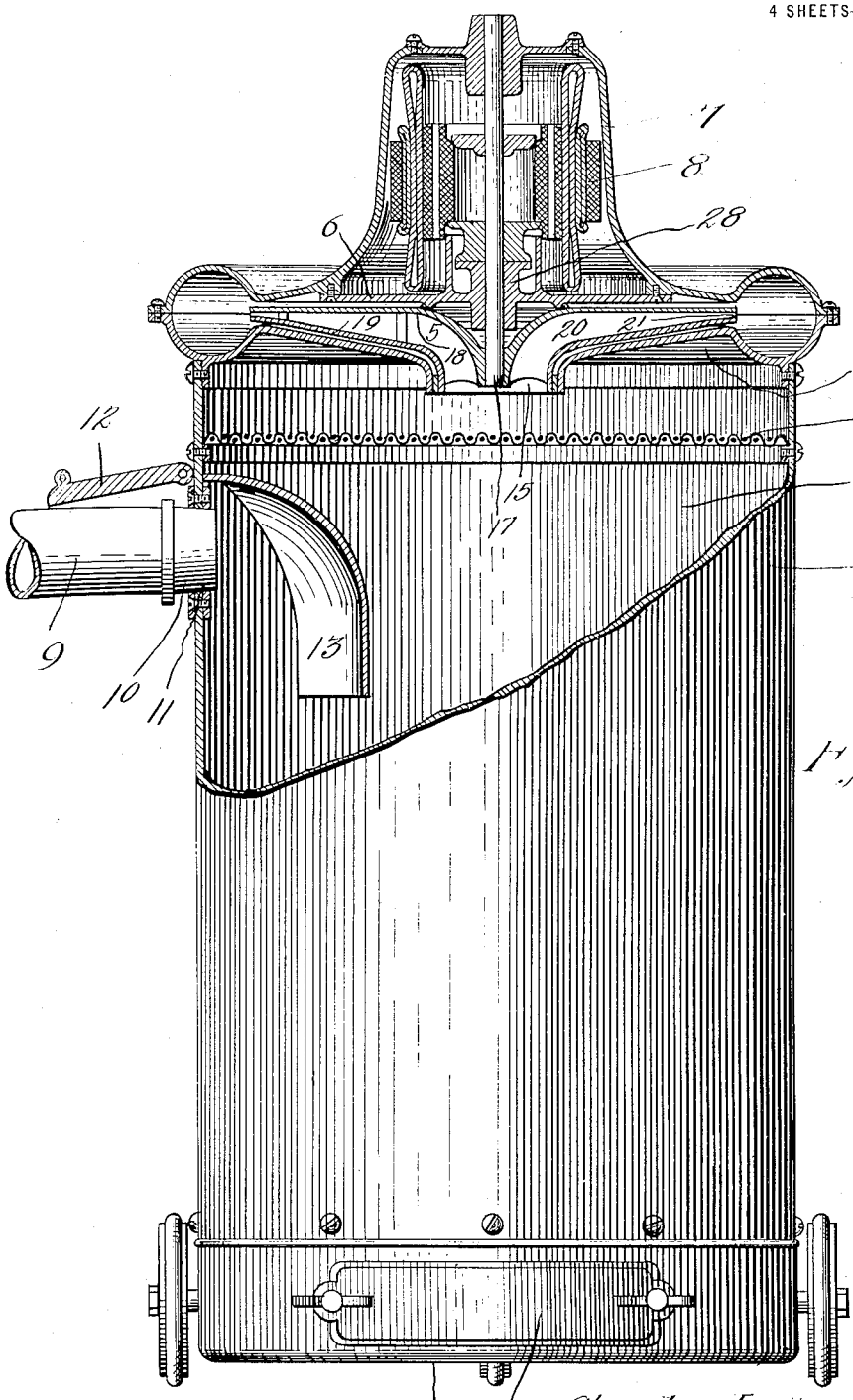


Fig. 2.

Witnesses

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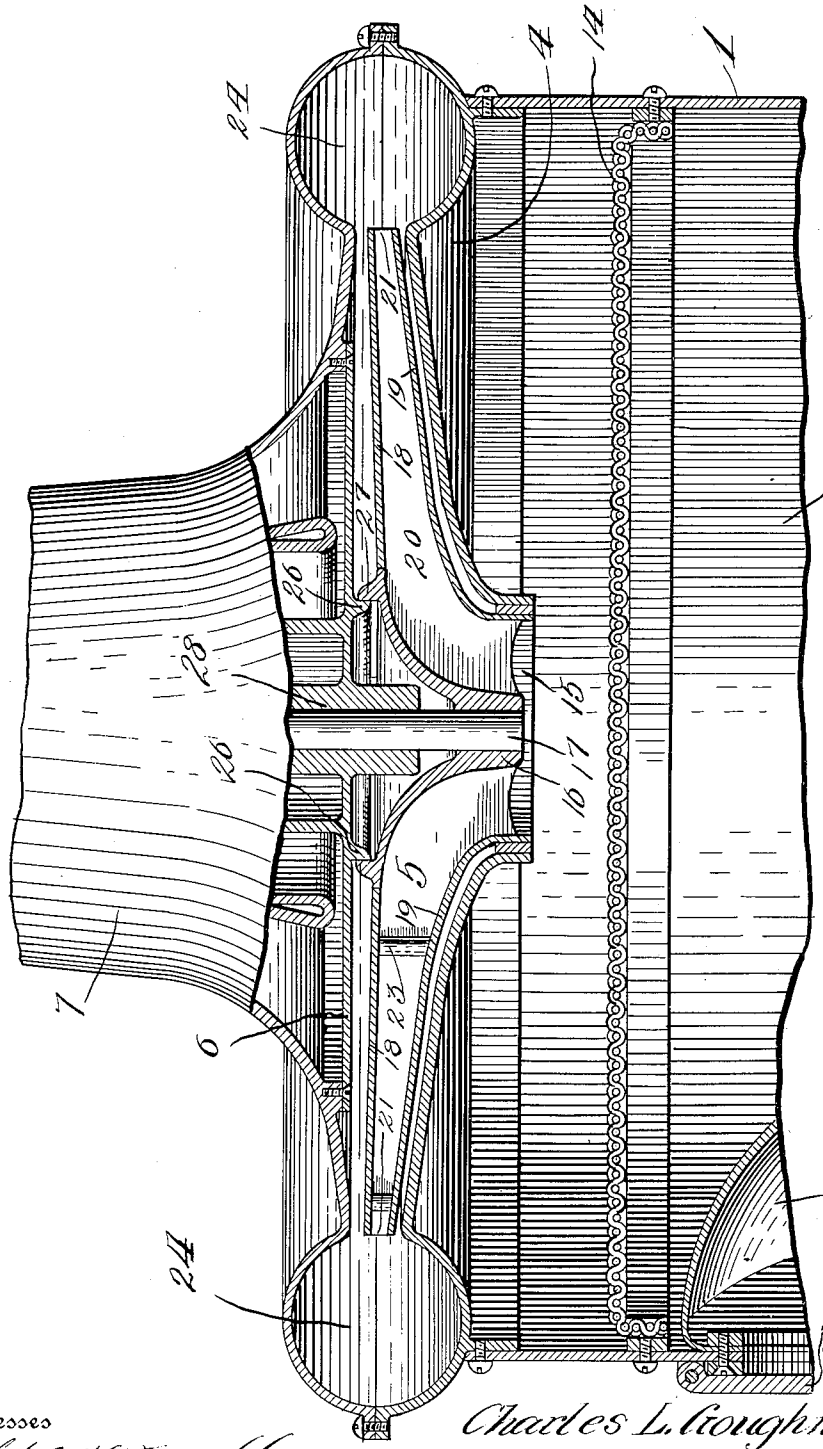


Fig. 3.

Witnesses

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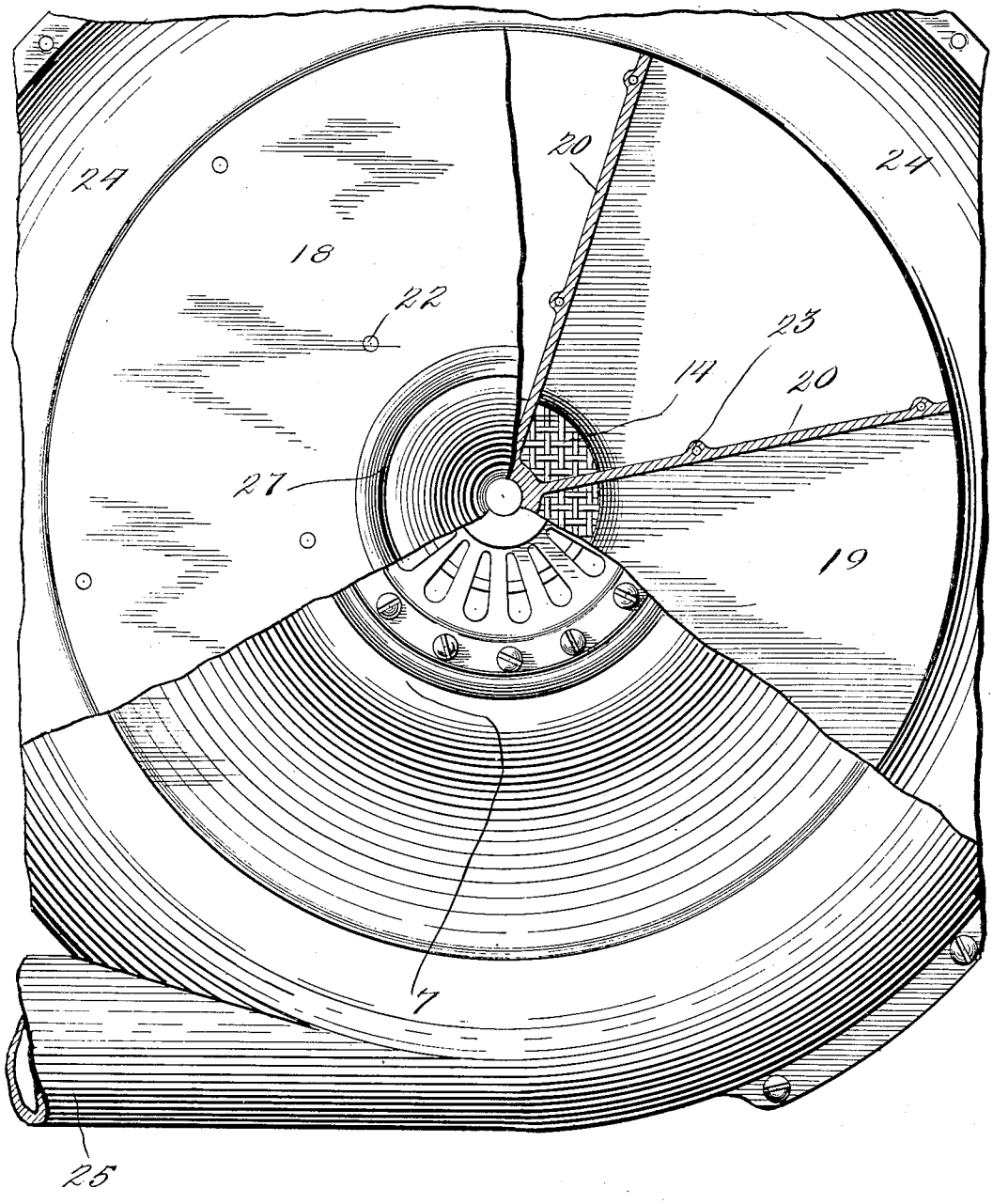


Fig. 4.

Witnesses
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UNITED STATES PATENT OFFICE.

CHARLES L. GOUGHNOUR, OF PASADENA, CALIFORNIA, ASSIGNOR TO THE UNITED ELECTRIC COMPANY, OF CANTON, OHIO, A CORPORATION OF OHIO.

VACUUM-CLEANER.

1,316,442. Specification of Letters Patent. Patented Sept. 16, 1919.

Original application filed July 26, 1909, Serial No. 509,482. Divided and this application filed December 4, 1912, Serial No. 734,903. Renewed February 12, 1916. Serial No. 78,076.

To all whom it may concern:

Be it known that I, CHARLES L. GOUGHNOUR, a citizen of the United States, residing at Pasadena, in the county of Los Angeles and State of California, have invented a new and useful Vacuum-Cleaner, of which the following is a specification.

The invention relates to a machine and apparatus for cleaning carpets, draperies, floors, walls and other objects and surfaces by means of suction through a tube having a suitable mouth piece or nozzle; and this application is a division or continuation of my original application filed July 26, 1909, Serial No. 509,482, and of my first divisional application filed Nov. 18, 1909, Serial No. 528,692.

The general object of the improvement is to provide an air-cleaning apparatus which shall be efficient in operation with a minimum consumption of power, and so simple in construction as to render the apparatus available for use in individual homes.

In the practical development of the art of vacuum cleaning, it has been found that the efficiency of a vacuum cleaner does not depend so much upon the amount of vacuum which can be created either in the separating chamber or in the suction nozzle, but rather upon the volume and the velocity of the air which can be continuously drawn into and through the suction nozzle. In other words, the cleaning of a fabric or other object is not accomplished by the pressure of the air, but by the movement or momentum of the air in passing through or along the object or surface to be cleaned.

And again, in the practical development of the art, it has been found that a laterally elongated suction nozzle having an inlet slot of from ten to fourteen inches long and from one-fourth to one-half of an inch wide with surrounding lips adapted to contact directly with the objective surface, is the most convenient kind of tool for general work; and it has furthermore been found that the most efficient results in the use of such a nozzle are attained by the movement of some eighty cubic feet of air per minute into the nozzle; wherefore such type of tool and movement of air have become conventional in the art, and the ultimate problem in vacuum cleaning is to continuously maintain the proper movement of air into the nozzle with a minimum expenditure of power.

Many of the earlier inventors in the development of the art, sought to solve the problem by the use of an ordinary free-vane centrifugal fan, probably because of the well known capacity of such form of fan to move a large volume of air; but the use of such fans for the purpose intended did not result in a practically or commercially successful apparatus, no doubt because the large volume capacity was not accompanied with a sufficiently positive action to move the desired amount of air at the proper velocity through the comparatively constricted slot of the suction nozzle.

More recent inventors in the development of the art have sought to solve the problem by the use of some form of positive pump, either of the piston, diaphragm or rotary type; and it is evident that a very high vacuum can be produced within the apparatus by such a form of pump, and that when the suction nozzle is completely closed, such high vacuum will extend to and be present in the nozzle. But it is likewise obvious that when the mouth of the nozzle is partically or entirely open for performing its functions as a cleaning tool, the inrushing air will rapidly fill the cavity of the apparatus, and whatever may be the initial volume per minute of such inrushing air, the same cannot be maintained at the desired rate of eighty cubic feet per minute, unless the suction pump has a capacity for exhausting a like amount of air from the apparatus.

The continuous movement of such a large volume of air, renders the use of the forms of positive pumps which have heretofore been employed in vacuum cleaners, undesirable, to say the least, for the reason that such types of pumps can only exhaust the same at an excessive, if not a prohibitive expense of power. And a further waste of power results from the fact that when the opening of the nozzle is closed or partially closed, as frequently occurs in the use of the

nozzle, a higher than necessary vacuum is created in the apparatus with a corresponding useless expenditure of power in operating such positive pump. And a final disadvantage results from the presence of an excessive vacuum in the nozzle, because the greater than necessary pressure upon or adherence to the objective surface, renders it very difficult and in extreme cases impossible to move the nozzle along such surface; and when the nozzle is partially or wholly opened, the excessive velocity of the inrushing air unduly wears and sometimes tears the fibers of an objective fabric.

The present invention overcomes the difficulties thus briefly set forth, by combining a positive centrifugal fan with the other elements making up a vacuum cleaner; thereby overcoming the inefficiency of the ordinary centrifugal fan on the one hand, and the excessive waste of power involved in the use of the various positive pumps heretofore employed, on the other hand. In other words, the invention embodies an exhausting fan having the capacity of continuously moving a large volume of air with a sufficiently positive action to most efficiently perform the work of cleaning at the nozzle, without the use or waste of an excessive or prohibitive amount of power.

Other important features of the invention pertain to the proportions and position of the separating chamber and its arrangement with reference to the inlet, the outlet and an intervening screen, when a screen is used, whereby the dust and other articles of refuse are segregated from the larger floating particles thereof and deposited in the bottom of the separating chamber; it being the special purpose and result of this feature of the invention to segregate and deposit the dust and other articles of refuse from the larger floating articles by the action of gravity as distinguished from any method of screening or filtering the same, the coarse screen when used, being employed to stop the larger fluffy articles, as for instance, feathers, lint and the like, from passing into the blower and lodging against the edges of the blades thereof.

To this end, the centrifugal fan employed serves to positively draw the air at a comparatively slow constant speed, from the upper part of the separating chamber, preferably near the axis thereof, and to discharge it at a relatively rapid speed from the periphery of the fan, without undue agitation or churning of the air within the chamber or the fan, which action of the fan permits a most complete segregation of the dust and refuse within the separating chamber.

The accompanying drawings illustrate a preferred embodiment of the invention in an apparatus and machine, by which the general objects thus briefly set forth, and ancillary advantages, are attained; in which drawings—

Figure 1 is a perspective view of the machine and apparatus as a whole;

Fig. 2, is a side elevation of the case, showing the upper part thereof and the centrifugal fan and the motor in section;

Fig. 3, an enlarged section of the centrifugal fan and adjacent parts; and

Fig. 4, a plan view of the case, with parts broken away to show details on the centrifugal fan;

Similar numerals refer to similar parts throughout the drawings.

The case 1 of the separating chamber 2 is preferably made in the form of a vertically-elongated upright-cylinder, provided with the bottom closure 3 and a top closure consisting of the lower wall 4 of the case of the fan 5; the upper wall 6 of which fan case preferably forms the bottom of the case 7 of the motor 8, which is preferably an electric motor as shown. The separating chamber should be at least as high as its diameter, and is preferably made two or three or more times as high as its diameter when it is shaped as a cylinder, and should have a similar height with reference to its average cross-section or corresponding cross-area when it is shaped otherwise; thus producing a separating chamber of substantial height and volume.

The suction tube 9 is provided with the tapered bushing 10 on its near end, which bushing is adapted to be entered and wedged into the reversely-tapered round inlet opening 11 provided in the upper part of the case, preferably in the side wall and above the middle thereof; and the door 12 is hinged above said opening and is arranged to drop by gravity to close the opening whenever the tube is withdrawn therefrom, thus insuring a complete closure of the separating chamber at all times. The nozzle 9^a, conventionally shown in Fig. 1 of the drawings, is provided on the remote end of the suction tube, which nozzle is applied to the object or surface to be cleaned, according to the common practice in the art.

The deflecting plate 13 may be provided in the case, and when used, extends from the wall above the inlet opening 11, inward and downward in front of the same, and serves to positively deflect the heavier refuse downward into the lower portion of the separating chamber, and prevents the same from striking and cutting the opposite wall of the case. The deflecting plate is of substantially the same width as the opening of the inlet tube, so that its side edges stand away from the wall of the chamber, which permits the greater portion of the incoming air to pass the sides of the plate, thus avoiding an agitation of the air in the lower part of the chamber.

The substantial height and volume of the separating chamber and the comparatively slow movement of air from the upper end thereof maintains such a uniform quiescent condition of the rarefied air therein that upon entering the chamber substantially all the dust and refuse drops or falls to the bottom of the chamber by the action of gravity and only the larger fluffy articles and the impalpable dust are carried upward by the suction of the fan; of which the larger fluffy articles may be caught by the screen 14, and the very fine impalpable dust may be discharged through the fan without interfering with the operation thereof.

The coarse screen 14 is preferably provided in the case, and extends transversely across the separating chamber above the inlet opening 11 at a substantial distance below the opening 15 leading from the separating chamber to the fan. This screen is not made fine enough, nor is it intended to stop or separate the dust and other articles of refuse from the air; but is merely employed to stop the floating articles, such as feathers and the like, which would otherwise be drawn into the fan and might lodge against the inner edges of the blades thereof and obstruct the free operation of the same.

The centrifugal fan or impeller 5 is conveniently secured by its hub 16 to the lower end of the spindle 17 of the motor, with which it is adapted to rotate; and is composed of the upper wall 18, the lower wall 19 and the intervening vanes 20. The upper wall 18 may curve first upward and outward to the periphery of the fan, and the inner edge portion of the lower wall 19 may be located substantially as a ring around and at an interval from the hub of the fan; thus forming the annular intake chamber 15 of the fan communicating directly and freely with the upper part of the separating chamber and preferably located substantially co-axial therewith. Thence the lower wall 19, curves upward and outward to the periphery of the fan, and in so doing gradually converges toward the upper wall, so that the outlet 21 of the fan is substantially in the form of a peripheral slot. It will be understood that the free communication between the intake chamber of the fan and the upper part of the separating chamber referred to herein, relates to the absence of an intervening element, as for example a dust filtering screen; and is not intended to require either the immediate proximity or the particular alinement of these parts, herein shown.

The converging relation of the walls of the fan is such that the annular cross area of the cavity between the walls is substantially the same at all points between its annular intake chamber and its peripheral outlet slot. The vanes of the fan are preferably located in radial lines and extend from the annular intake chamber to the peripheral outlet slot, so that the cross-section of the air passages are substantially uniform from the intake chamber to the outlet of the fan, thus forming what is referred to herein as a positive centrifugal fan. The fan may be constructed by forming a portion of the upper wall and the whole of the vanes integral with the hub, and securing the remainder of the upper wall and the whole of the lower wall to the vanes by means of the bolts or rivets 22 passed through the bosses 23 which are provided on the rear sides of the vanes, having reference to the direction of their rotation.

The walls 4 and 6 of the fan case converge near to but without touching the corresponding walls of the fan proper at the periphery thereof, outside of which they diverge and again converge and are joined together and form the tubular channel 24 around the periphery of the fan case, into which channel the air is discharged directly and freely from the peripheral outlet slot 21 of the fan; whence the air escapes through the tangential exhaust tube 25 in the usual manner. The exhaust tube 25 of the fan case may communicate with the first chamber or flue of a stove or furnace, in or through which the fine floating particles may be burned or discharged; or it may be extended for discharging through a window or other opening, as may be desired. The upper and lower doors 29 and 30 are provided in the case, through which respective doors the screen may be cleaned and the deposited refuse removed.

The lower wall 4 of the fan case extends inward around but not touching the inner edge portions of the lower wall 19 of the fan proper, thus forming a transverse partition substantially closing the upper end of the separating chamber from the cavity of the fan case, excepting only through the annular opening of the intake chamber 15 of the fan which constitutes the outlet from the separating chamber; and the upper wall 6 of the fan case, forming the bottom of the motor case, serves to completely partition the fan from the motor, the overlapping annular ribs 26 and 27 being respectively provided on this partition and the upper wall of the fan, to prevent any dust from entering the lower bearing 28 of the spindle, which bearing may be formed integral with the transverse partition.

The beneficial results which have been attained by providing a positive centrifugal fan in a vacuum cleaner, and by applicant's arrangement of the parts, pertain to the more efficient operation of the nozzle, the more efficient operation of the separating chamber, and the elimination of air churning and slipping within the fan, and of friction in its operation; each and all of which

several results effect an economy in general construction and a saving of power in the motor.

The more efficient operation of the nozzle arises from the fact that the positive centrifugal fan is adapted to exhaust a sufficient volume of air from the apparatus, with such a positive action, as to maintain a movement of eighty cubic feet per minute at the desired velocity through the suction nozzle; the large volume capacity inhering in the general type of fan, and the positive action being caused by the substantially uniform air passages which prevent any slipping, eddying or churning of the air within the fan.

Furthermore, it is found that when air is prevented from moving to or from a centrifugal fan, the same will cut its way through the air with a less consumption of power than when there is such a movement of air, so that when the nozzle of the suction cleaner is closed, as by being pressed tightly against an impervious objective surface, there is less consumption of power by applicant's fan, than when the nozzle is open, instead of the greater consumption of power under like circumstances which is inherent in the types of positive pumps heretofore used in vacuum cleaners.

And again, the positive centrifugal fan has a vacuum producing capacity of from one to three inches of mercury when rotated at the preferred rate of about thirty five hundred revolutions per minute in the several sizes of machines in common use, before it will cut through the air, which is found to be quite sufficient for all practical purpose in a vacuum cleaner when coupled with the large air volume capacity and positive action of the fan; thus saving the power expended in the positive piston, diaphragm or rotary types of pumps in producing an excessive vacuum in the apparatus; and also preventing an excessive pressure and adherence of the nozzle against the objective surface and any injury thereto, by an excessive vacuum within the nozzle.

The more efficient operation of the separating chamber results from the comparatively slow speed of the axial portion of the fan, the considerable height and volume of the separating chamber and the axial location of the fan inlet opening in the upper part thereof, whereby the air is slowly drawn into said inlet from the upper end only of the chamber and quite uniformly throughout the area thereof, without any material churning or agitation in the chamber; and the air in the lower portion of the chamber remains substantially quiescent, thus giving full effect to the action of gravity in segregating and depositing in the bottom of the chamber all the refuse which is not sufficiently buoyant to float in the air, and accomplishing a substantially complete separation of dust from the air by the action of gravity in the separating chamber.

A further saving of power results from the location of the inlet opening of the positive centrifugal fan in the upper end of the separating chamber which permits a settling of substantially all of the dust and dirt from the air by the action of gravity, and therefor avoids the use of any power consuming filtering walls or devices; the coarse screen set forth herein being merely employed to catch large, light and fluffy articles, as feathers and the like, without materially impeding the flow of air through the separator, and is therefore not an essential element of the apparatus; and the deflecting plate set forth, being likewise a non-essential feature of the apparatus.

The elimination of air churning and slipping within the fan, arises from the peripherally converging relation of the two walls thereof, so as to give a substantially constant channel between the adjacent blades from the axial inlet opening to the peripheral outlet slot of the fan; and the elimination of friction and other resistance in the operation of the fan, results from the use of a single stage fan and incasing the vanes between two walls, thus avoiding the necessity of drawing the air through a tortuous path and saving the friction which would necessarily be present if free vanes were employed and impinged the walls of the fan case to prevent a slipping of air around the edges thereof. Furthermore the mounting of the fan on the lower end of the motor spindle eliminates all frictional contact in the operation of the machine excepting only the bearings of the motor spindle.

An economy of construction results from the use of the positive centrifugal fan, because an increased air volume capacity can be obtained by increasing the diameter or the distance between the walls of the fan, without decreasing the positive action thereof, thus enabling vacuum cleaners of large capacity to be built without providing a plurality of fans in multistage relation.

A saving of power in the motor is thus attained by the use of the positive centrifugal fan and applicant's arrangement of the parts, because; (1) a power-consuming excessive vacuum is never created; (2) less power instead of more power is consumed when the suction nozzle is closed; (3) no power is consumed by a filtering wall; (4) no power is lost by air churning or slipping within the fan; and (5) a minimum of power is consumed by frictional contact; thus consuming less power when the maximum vacuum is produced and a less volume of air is moved, than when a less vacuum is produced and a greater volume of air is moved; and varying the consumption of

power in proportion to the volume of air moved, which directly represents the amount of cleaning being done.

I claim:

1. An air cleaning apparatus comprising, in combination, a case having a separating chamber therein, a suction tube communicating with the upper part of the separating chamber, a suction nozzle at the free end of the tube having an inlet slot with surrounding lips adapted to contact directly with an objective surface, an exhaust tube, and a single stage two-wall centrifugal impeller having air passages of substantially uniform cross area, an axial inlet opening and a peripheral outlet slot, the said inlet opening of the impeller communicating directly with the upper part of the said separating chamber and the said outlet slot of the impeller communicating directly with the said exhaust tube.

2. An air cleaning apparatus comprising, in combination, a case having a vertically disposed separating chamber therein, a suction tube communicating with the separating chamber, a suction nozzle at the free end of the tube having a narrow inlet slot, and a centrifugal impeller mounted on a vertical axis at the top of the separating chamber having an axial inlet with a free passage communicating therewith, for effecting a separation of dust from the air by gravity with a consumption of power proportioned to the movement of air.

3. An air cleaning apparatus comprising in combination, a dust separating chamber of substantial volume and of a sufficient depth below the air current to form a settling chamber, a suction nozzle communicating with the upper part of the separating chamber and having an inlet slot with surrounding lips adapted to contact with an objective surface, and a centrifugal impeller having a free passage inlet and outlet and communicating with the upper part of the separating chamber automatically maintaining a working flow of air into the nozzle when the inlet slot is fully open and a substantially uniform limited vacuum at the nozzle when the inlet slot is open or closed, and also maintaining a uniformly rarefied and quiescent condition of the air in the separating chamber and effecting therein a substantially complete separation of dust and other refuse from the air by the action of gravity, with a consumption of power directly varying in proportion to the movement of air.

CHARLES L. GOUGHNOUR.

In presence of—

ELFRIEDE SCHMIDT,

FERD J. JETTLER.