Dec. 13, 1955 R. K. LEWIS 2,726,807

VACUUM APPARATUS FOR WATER AND DIRT REMOVAL

Original Filed Sept. 28, 1950 4 Sheets-Sheet 1

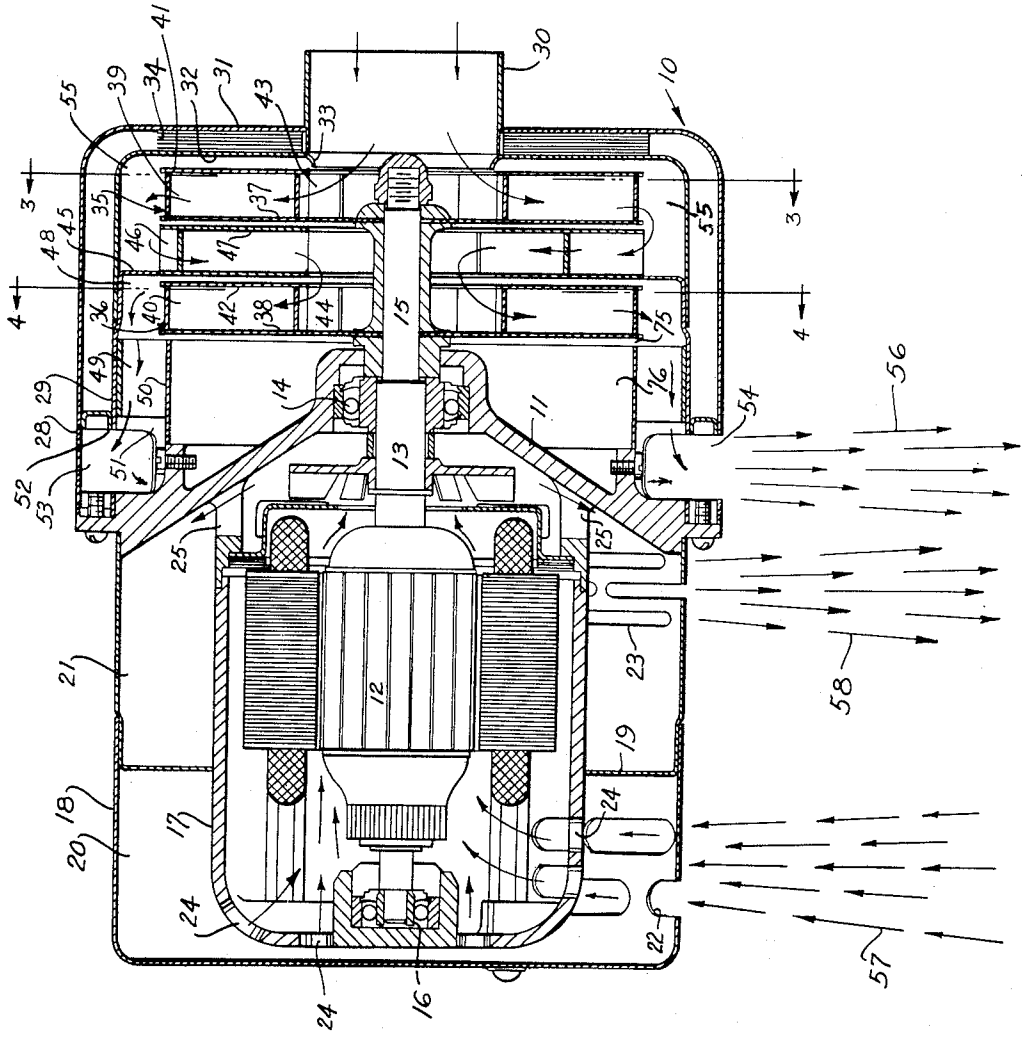


FIG. 1

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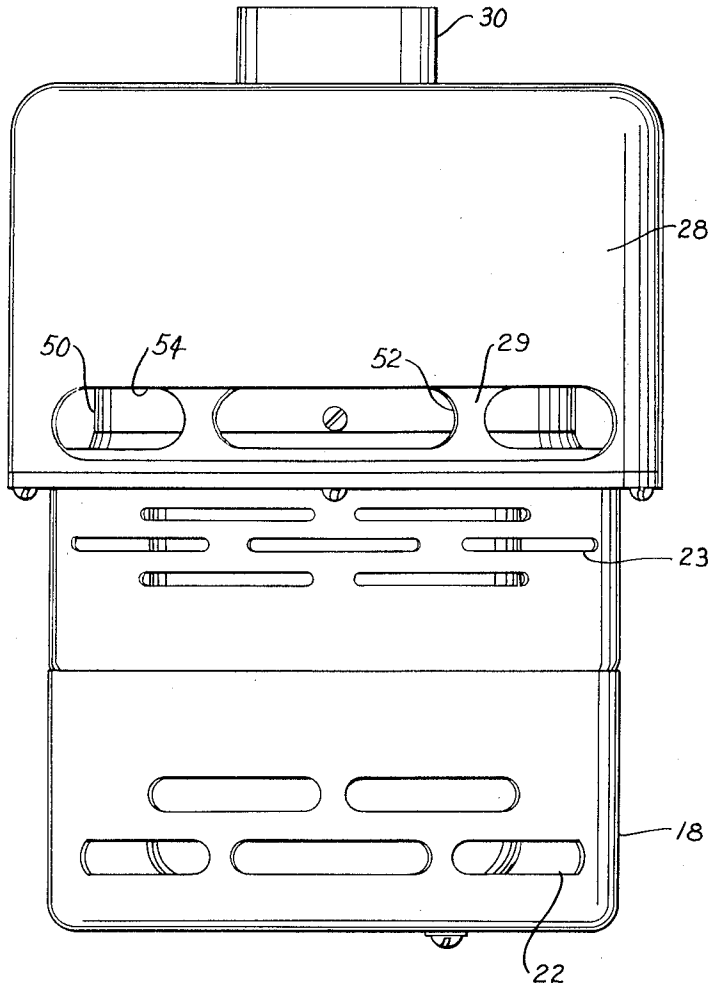


FIG. 2

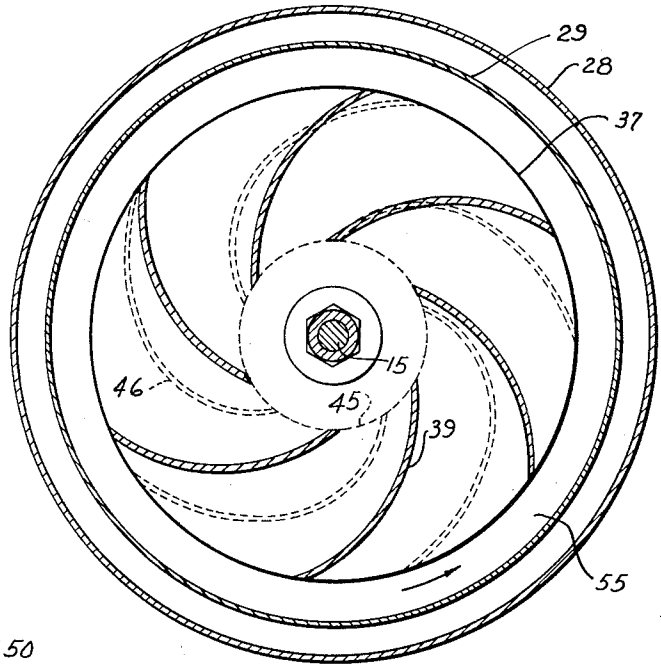
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VACUUM APPARATUS FOR WATER AND DIRT REMOVAL

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FIG. 3



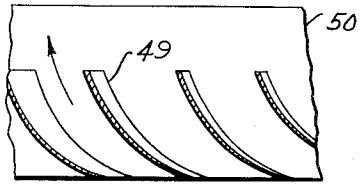


FIG. 5

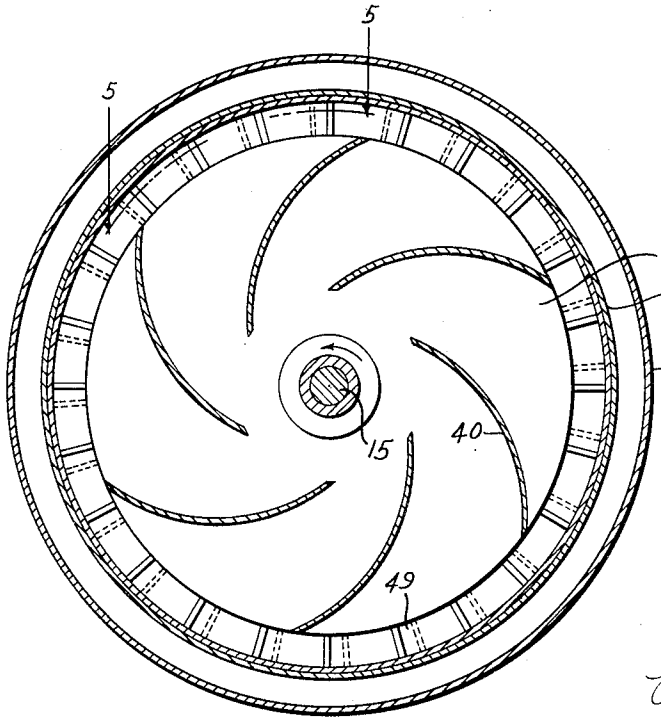


FIG. 4

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VACUUM APPARATUS FOR WATER AND DIRT REMOVAL

Original Filed Sept. 28, 1950 4 Sheets-Sheet 4

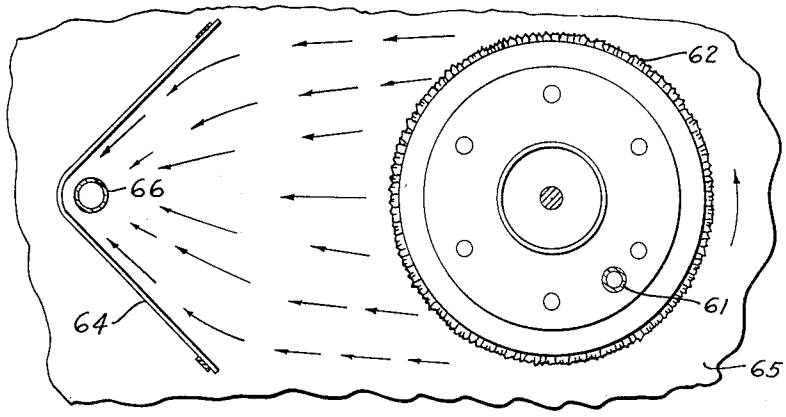


FIG. 7

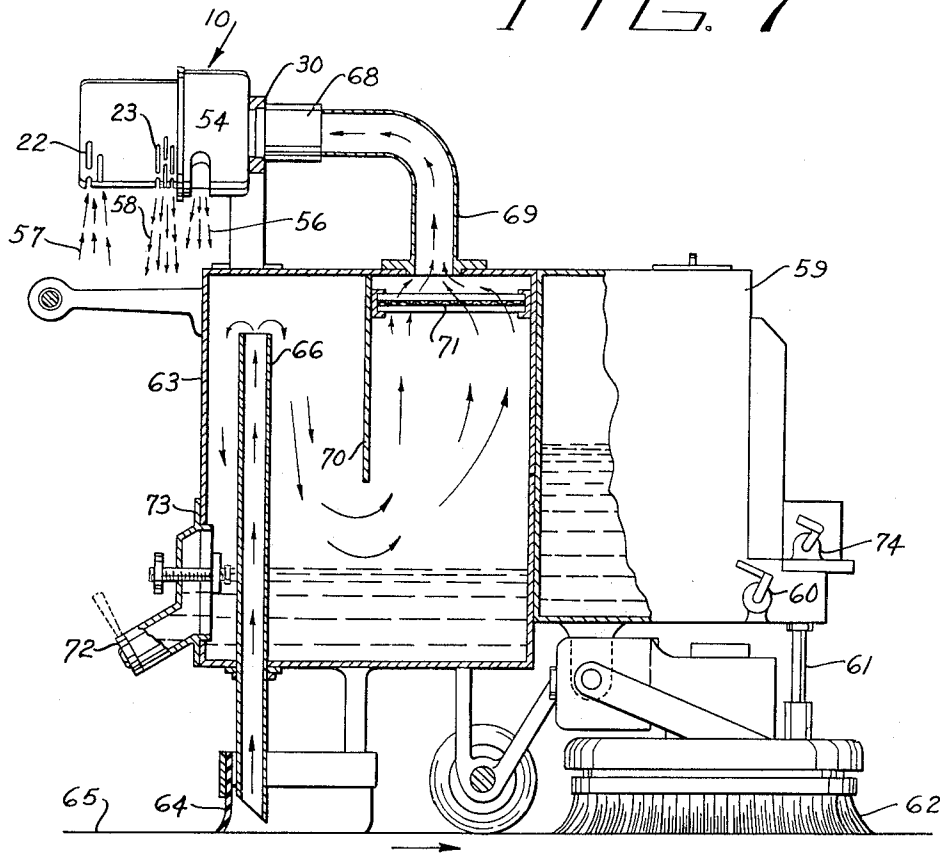


FIG. 6

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2,726,807

VACUUM APPARATUS FOR WATER AND DIRT REMOVAL

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Original application September 28, 1950, Serial No. 187,289. Divided and this appliaction June 25, 1952, Serial No. 295,499

4 Claims. (Cl. 230—130)

The present invention pertains to improvements in vacuum apparatus for water and dirt removal.

This application is a division of application Serial No. 187,289 filed September 28, 1950.

An object of the invention is to provide improved electrical means for effective removal of dirt, dirty water and relates substances incident to such operations as floor scrubbing, shampooing carpets and the like.

A further object is to provide an improved vacuum fan structure for use in devices of the above nature.

A further object is to provide an improved unitary fan and motor combination in which cooling air entering the motor housing is shielded from moist air emerging from the fan by combined end-shielding and the mutual relation of the two outgoing air streams.

Another object is the provision of a device of the above nature including a multi-stage fan having improved means for directing and diffusing the air therethrough by which even flow, quiet operation and low velocity exhaust are achieved.

A further object is the provision of a fan of the above type including both radial concentrating and longitudinal stationary diffusing vanes cooperative with curved fan blades to eliminate sharp reversals in direction and local pressure areas within the casing.

Another object is to provide a fan and motor unit of the above type in which the motor cooling air inlet and exhaust and the fan exhaust may be disposed on the same side of the housing, but wherein effective separation of the motor inlet air from the fan exhaust is achieved without the use of exterior baffles, pipes and the like.

Other objects and advantages of the invention will become evident during the course of the following description in connection with the accompanying drawings, in which:

Figure 1 is a longitudinal sectional view of the unitary motor and fan structure;

Figure 2 is a bottom view of the same;

Figure 3 is a cross-sectional view in the plane 3—3, Figure 1;

Figure 4 is a similar view in the plane 4—4, Figure 1;

Figure 5 is a fragmental detail view illustrating the contour of the axial or longitudinal diffusing vanes;

Figure 6 is a vertical view partially in section illustrating the combination of the motor and fan unit with means for removing dirt and water from a floor and collecting the refuse in a suitable receptacle; and

Figure 7 is a vertical detail view showing a preferred means of concentrating the water and dirt on the floor for removal therefrom.

Referring to Figure 1, the numeral **10** generally denotes an exhausting or vacuum unit having a conical internal plate **11** comprising the inner end plate of a motor **12**. The shaft **13** of the motor **12** is journalled in a sealed bearing **14** in the plate **11** and has an extension **14** projecting beyond the latter, while the rear

end of the shaft is carried in a second bearing **16** in the end of the motor frame **17**.

The plate **11** is of substantially greater diameter than the motor frame **17**, and forms the front closure of an outer motor housing **18**. An interior transverse partition **19** divides the space between the housing **18** and the motor frame **17** into substantially annular rear and front chambers **20** and **21**. A group of wide slots **22** is provided in the housing **18** near the rear end of the chamber **20**, and a second group of comparatively narrow slots **23** is disposed near the front or inner end of the chamber **21** in axial alignment with the rear group of slots **22**. The motor frame **17** has a plurality of holes **24** connecting the chamber **20** with the rear interior of the motor. Circumferentially spaced openings **25** similarly lead from the front interior of the motor to the chamber **21**, an annular baffle **26** being provided to prevent direct connection between the openings **25** and the rear chamber **20**.

A centrifugal fan **27**, secured on the shaft **13** immediately in front of the baffle **26**, is adapted to draw air inward through the slots **22**, chamber **20**, and holes **24**, thence through the interior of the motor **12**, and discharge the air via the openings **25**, chamber **21** and slots **23** to the outer atmosphere. By this means a positive blast of cooling air is provided for the motor at all times during its operation.

The plate **11** has secured thereto a blower housing comprising an outer shell **28** and an inner shell **29** concentric therewith. A short annular inlet tube **30** is centrally secured in the end-wall **31** of the outer shell **28**, while the end-wall **32** of the inner shell **29** has an inwardly curved lip **33** registering with the inner end of the inlet tube **30**. A resilient gasket **34**, compressed between the walls **31** and **32** around the tube **30**, acts as a spacer and eliminates possible vibration and noise at this point.

The motor shaft extension **15** has secured thereon two spaced fan rotors **35** and **36** comprising disks **37** and **38** carrying sets of blades **39** and **40** respectively, the blades being braced on their forward edges by annular rings **41** and **42**. The blades **39** and **40**, as shown in Figures 3 and 4, are of arcuate shape with their convex sides in the forward rotational direction, the inner ends of the blades being disposed ahead of the outer ends. By this arrangement the blades receive the air from their respective central inlet chambers **43** and **44** with a substantially tangential scooping motion, thus avoiding the sudden and violent impingement of the air against impelling surfaces such as occurs for instance in fans employing flat radial blades or the like.

Disposed between the fan rotors **35** and **36** is an annular concentrator comprising a plate **45** secured to the inner shell **29** and carrying a plurality of vanes **46** provided with a bracing end plate **47**. Referring to Figure 3, it will be noted that the vanes **46** are shaped approximately as segments of logarithmic spirals having their concave sides facing the direction of rotation of the fan rotor **35**. The angular direction of the vanes **46** varies from slightly less than tangential at their edges in the outer transfer chamber **47** to substantially radial at their discharge to the inner chamber **44**, their radius of curvature decreasing from entry to discharge.

The second rotor blades **40** discharge into an annular outer chamber **48** opening into an axial diffuser comprising a plurality of curved vanes **49**, Figs. 1, 4 and 5, secured on a cylindrical member **50** which in turn is secured to the plate **11**, the member **50**, the inner shell **29** and the plate defining a diffusion chamber **51** of substantially greater volume than that of the fan chamber **48**. The vanes **49**, as shown in Fig. 5, are adapted to convert the residual rotary motion of the air leaving the fan chamber

48 to substantially axial motion, at the same time evenly diffusing both the pressure and velocity of the air as it expands into the chamber 51. A plurality of wide circumferential openings 52 lead from the diffusion chamber 51 to an annular discharge chamber 53 comprised between the inner and outer shells 28 and 29. The chamber 53 is provided with a large arcuate discharge opening 54, preferably disposed adjacent the motor air discharge slots 23 as shown in Figures 1 and 2.

In operation, air is drawn in through the tube 30 and impelled by the rotor blades 39 to the outer transfer chamber 55 surrounding the latter, the low attack angle of the blades 39 and their rearward curvature effecting maximum air movement quietly and with minimum rotational velocity of the delivered air. This rotational movement is converted to a combination of substantially radial velocity and pressure by the concentrator vanes 46, the concentration taking place with smoothness and high efficiency due to the spiral contour of the vanes. It will be noted in Figure 3 that the number of concentrator vanes 46 is prime to the number of impeller blades 39, there being five concentrator vanes and six impeller blades. This relationship prevents the possibility of synchronous pulsation in the air transfer, thereby avoiding the vibration, noise and loss of efficiency which accompany such pulsations.

The blades 40 of the second rotor 36, operating in the same manner as described for the first rotor blades 39, impel the air from the inner transfer chamber 44 to the outer chamber 48, thence to the chamber 51. The axial diffuser blades 49, as previously noted, smoothly convert substantially all the rotary component of the air motion to axial motion, both the velocity and static pressure of the air being diffused as the latter expands. From the chamber 51 the air is delivered in all radial directions through the openings 52 to the discharge chamber 53, from which it escapes laterally through the large opening 54.

From the foregoing description it will be evident to those skilled in the art that the construction, proportion and inter-relation of the rotary and stationary parts utilizing the entire circumferential extent of the structure throughout the working zone, provide high capacity with minimum rotational air velocity as well as avoidance of sharp speed or directional changes, localized points of high velocity, and the like. Due to this combination as set forth, including the final diffusing and discharge structure from which the air issues at comparatively low speed, the fan achieves a maximum degree of quietness even when operating at high speeds of the order of 10,000 R. P. M., being free from the loud whistling or whirring and vibration common to prior rotary vacuum devices.

In prior vacuum devices for removing water from floors and the like, trouble has been caused by the moist and sometimes dirty discharge from the fan entering the motor's cooling system with consequent damage to the motor. The present structure avoids such difficulty by the inter-relation of the two air systems. As previously noted, the air stream 56 from the fan emerges laterally through the large opening 54 at relatively low speed, while the inlet air 57 for the motor's cooling system enters through the slots 22 near the rear of the motor housing 18, the speed of entry also being comparatively low due to the large size of the slot. The outlet slots 23, however, are narrow, with the result that the motor-cooling air is forced out through them at relatively high speed. This blast from the overlapping slots 23 establishes a flat curtain 58 of high velocity air adjacent the fan discharge opening 54 and directly between the latter and the motor's air inlet. By this means the motor's air supply is effectively shielded from the wet fan discharge stream at all times, regardless of the position in which the device is operated, and without need for exterior ducts, baffle walls or similar cumbersome separating means which are obviously disadvantageous in any type of installation and especially so in portable or semi-portable applications. A further advantage of the described air curtain is that while eliminating exterior shields and the like as noted, it allows the three air-stream openings to be disposed on the same side of the housing, for example directed away from the operator of a portable device or downward as in the case of the semi-portable machine illustrated in Figure 6.

Figure 6 shows semi-diagrammatically a floor scrubbing machine having a clean water tank 59 adapted to supply water via a valve 60 and a duct 61 to a rotary brush 62. The numeral 63 designates a tank for collecting dirty water resulting from the scrubbing operation. A squeegee 64, preferably of V-shape as shown in Figure 7, is disposed in contact with the floor 65 below the tank 63.

A suction pipe 66, secured in the bottom of the tank 63, extends from a point closely adjacent the floor 65 in the apex of the squeegee 64 to a point near the interior top of the tank. The vacuum fan unit 10 is mounted on a bracket 67 surmounting the tank 63, the forwardly directed inlet tube 30 being connected via a short hose 68 to an elbow 69 leading out of the top of the tank 63 near the front end thereof. A vertical baffle 70 is disposed in the tank 63 and a removable screen 71 is also disposed therein below the elbow 69. The tank is provided with a drain valve 72, the large mounting plate 73 thereof being bodily removable to allow periodic scraping of accumulated heavy dirt from the bottom of the tank.

In operation the device is moved along the floor while clean water is fed from the tank 59 through the brush 62, accompanied if desired by soap or other cleansing compound from a feeder 74. The brush is rotated by suitable power means, thereby performing the scrubbing operation. The fan unit 10 being in operation, a partial vacuum is created in the tank 63 which causes a strong uprush of air through the relatively narrow suction pipe 66. As the scrubbing device is moved forward the water, carrying the dirt removed from the floor, is caught by the squeegee 64 and concentrated in the apex thereof under the inlet of the suction pipe 66, as illustrated in Fig. 7. Here the mixture is entrained in the air stream and drawn rapidly upward through the pipe 66 into the upper interior of the tank 63, where it reverses direction to pass downward behind the baffle 70. The air stream moves forward under the baffle, thence upward through the screen 71, elbow 69, and connector 68 to the vacuum blower 10, from which it is discharged through the opening 54 in the manner previously described.

Due to the large volume of the tank 63, with consequent reduction in velocity therein, and the reversal of direction of the air-stream around the baffle 70, the great bulk of the dirt and water normally fall to the bottom of the tank and are retained therein. However, considerable moisture is necessarily retained in the outgoing air stream and some of this moisture, if drawn into the cooling system of the motor 12 would damage the latter. The rapidly moving air curtain 58 prevents any such possibility. Even under exceptional circumstances, for example when operation with very large volumes of wash water or when by inadvertance the dirty water tank 63 may have been allowed to become too full so that heavy spray of contaminated water may be drawn into the vacuum fan, this water upon discharge is effectively screened away from the motor inlet air stream 57 by the curtain 58. Under such circumstances, due to the inherently smooth inter-action of the moving and stationary fan parts as described, the spray or even heavy slug volume of water is carried evenly and without pocketing through the device, being deposited throughout the outer circumference of the diffusion chamber 49 from which it runs into the discharge chamber 53 and out the opening 54 at relatively low speed. This low emergent speed permits such occasional discharge water to be readily collected in an auxiliary vessel or pan if desired, but in

all cases the air curtain **58** externally isolates the discharge from the motor cooling system. Internally the plate **11** with its sealed bearing **14** prevents any contact between the two circulatory systems.

Referring to Figure 1, it will be noted that the cylindrical member **50** is of slightly smaller diameter than the rear fan rotor disc **38** and has a very small clearance **75** therefrom. As a result of this arrangement the passage of air past this clearance generates an outward suction thereon which prevents the entry of any water or dirt to the space **76** surrounding the bearing housing.

It will be understood that the application of the suction unit shown in Figures 6 and 7 is by way of illustration since, as previously stated, it is adapted to a variety of portable semi-portable and stationary devices of this nature, retaining in all such applications the advantages set forth. In addition to its use as a vacuum fan, if desired the advantages of the fan's structural combination make it also well adapted to use as a blower, merely by providing a suitable saddle duct fitting for the outlet **54**.

It will further be understood that if desired for certain types of application the fan structure may include three or more stages of similar construction instead of the two stages set forth herein. In other words, while the invention has been described in preferred form, it will be evident to those skilled in the art that it is not limited to the exact structure illustrated, as various changes and modifications may be made without departing from the scope of the appended claims.

What is claimed is:

1. In a suction blower unit for a cleaning machine, in combination, a cylindrical casing including a cup-shaped end portion and a second cup-shaped portion telescopically secured therein, a rotary shaft in said casing, a plurality of centrifugal fan rotors on said shaft each having a central inlet chamber and a plurality of arcuate blades, said blades having a low attack angle at said chambers and curving rearwardly from the direction of rotation of said shaft, a sleeve on said shaft between adjacent rotors, means on said shaft to clamp said rotor and sleeve longitudinally whereby said adjacent rotors may be secured on said shaft in spaced relation, concentrating means between adjacent rotors adapted to transfer air from the peripheral zone of the lower stage rotor to said central inlet chamber of the next stage rotor, said concentrating means including a diaphragm forming the annular inward extension of said second cup-shaped portion and a plurality of fixed vanes curving inward from said zone to said central chamber in said direction of rotation, means forming an annular discharge chamber in said casing and having a discharge opening to the exterior of said casing, and a diffuser secured in said casing in axial communication between the peripheral zone of said last stage rotor and said discharge chamber.

2. A device as claimed in claim 1 wherein said diffuser includes an annular series of fixed blades curved in longitudinal planes and adapted to convert a rotary component of the velocity of said air leaving said last-named peripheral zone to substantially axial velocity within said diffuser.

3. A device as claimed in claim 1 wherein said fixed concentrator vanes have contours closely approximating segments of logarithmic spirals, the ends of said segments of smallest radius of curvature terminating at said central chamber in substantially radial directional relation thereto.

4. A device as claimed in claim 1 wherein each of said rotors includes a plurality of uniformly thin blades curved rearwardly from said direction of rotation and having a low attack angle at said respective central inlet chambers, and wherein the number of said fixed concentrator vanes is prime with respect to the number of said blades of each of said fan rotors, whereby resonant pulsation of air passing through said device is prevented.

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