Jan. 22, 1957 D. I. DOYLE 2,778,563

VACUUM AND BLOWER PRODUCER

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FIG. 1

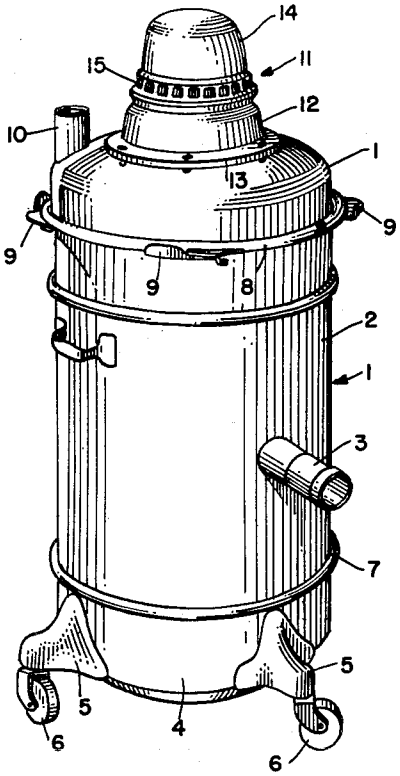


FIG. 2

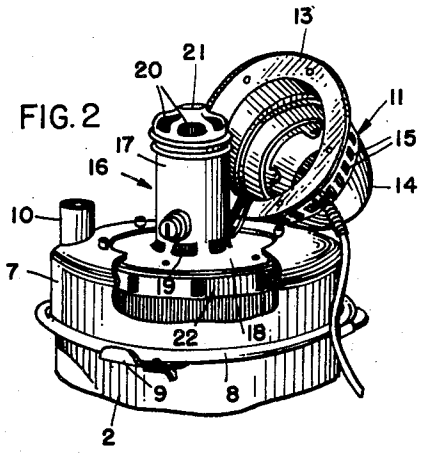
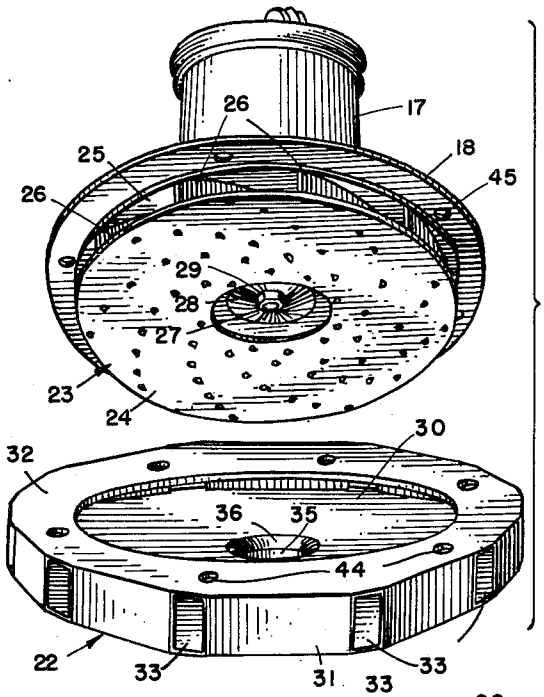


FIG. 3



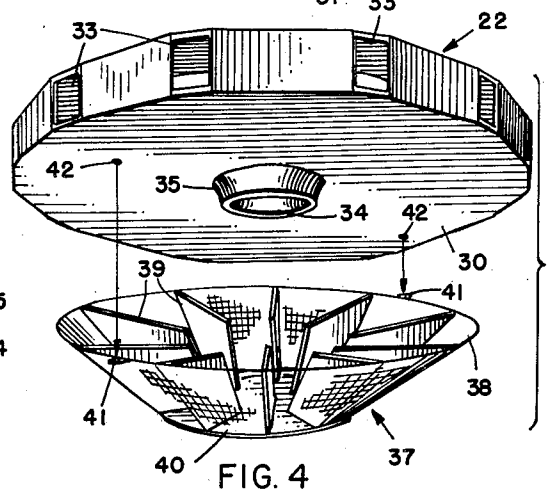


FIG. 4

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VACUUM AND BLOWER PRODUCER

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FIG. 5

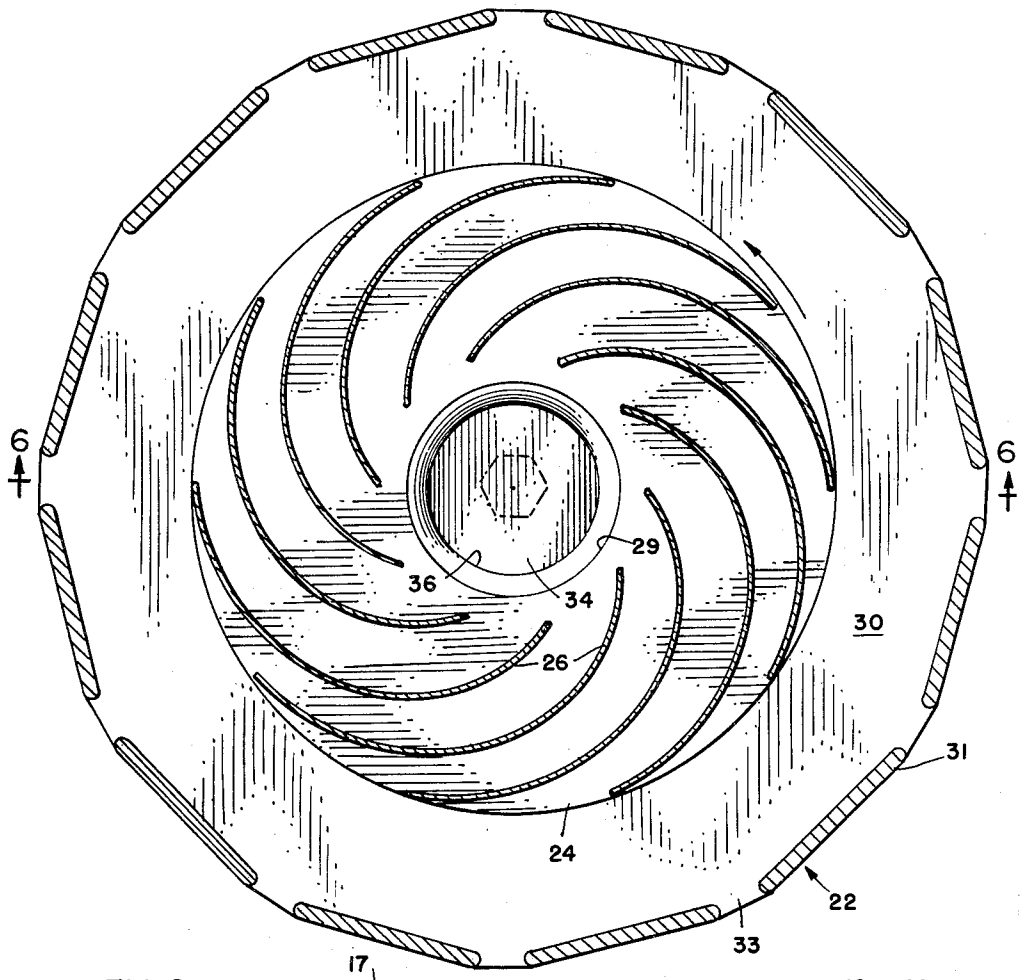
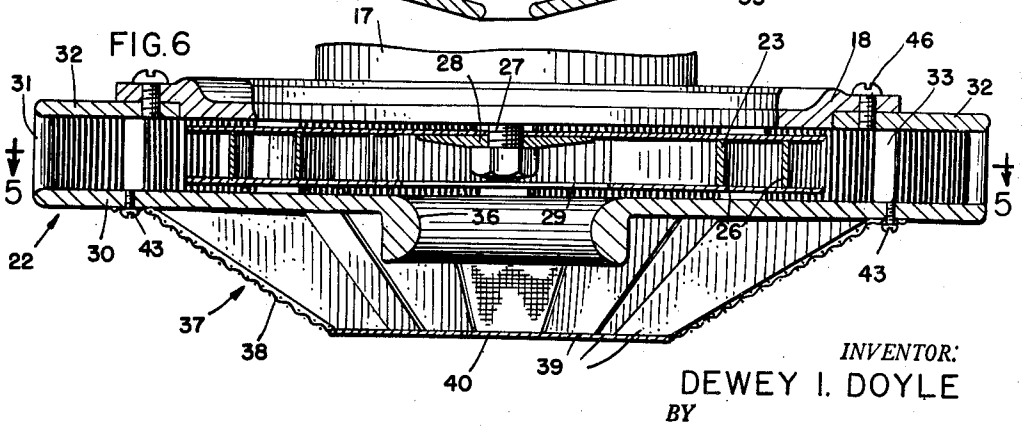


FIG. 6



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FIG. 7

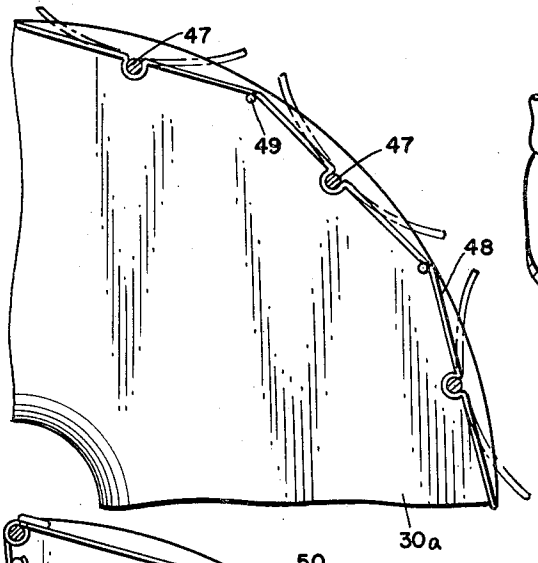


FIG. 8

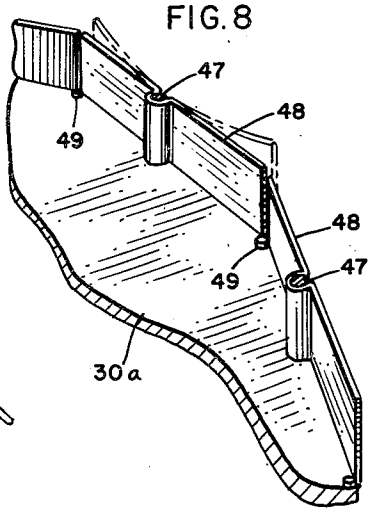


FIG. 9

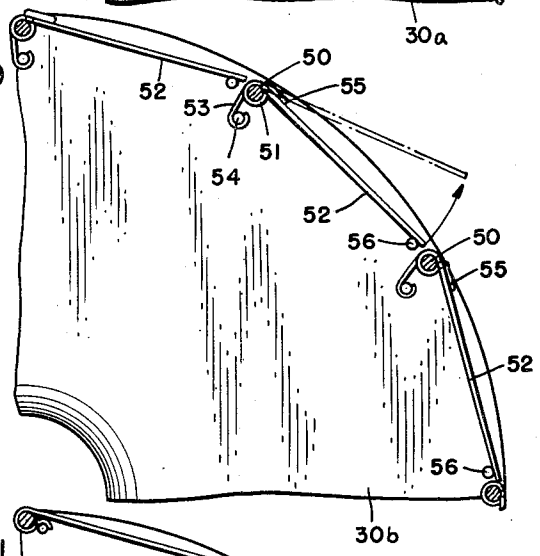


FIG. 10

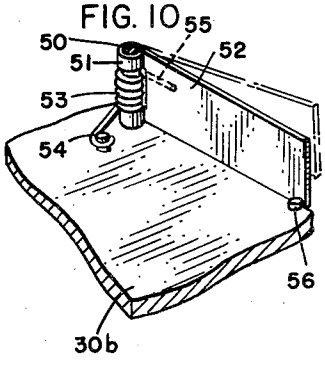


FIG. 11

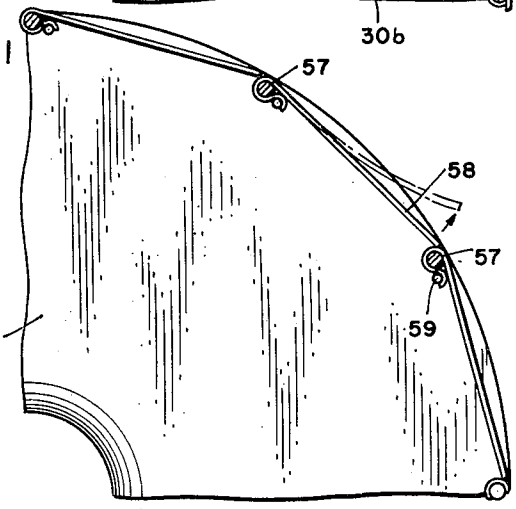
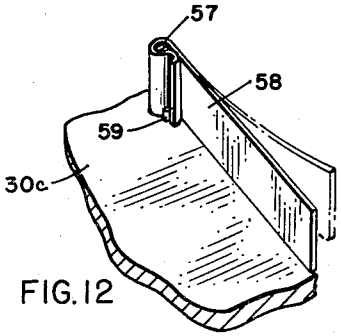


FIG. 12



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United States Patent Office

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Patented Jan. 22, 1957

2,778,563

VACUUM AND BLOWER PRODUCER

Dewey I. Doyle, Grand Rapids, Mich., assignor to Doyle Vacuum Cleaner Company, Grand Rapids, Mich., a corporation of Michigan

Application March 16, 1953, Serial No. 342,521

17 Claims. (Cl. 230—114)

This invention relates in general to a vacuum and blower producing machine and is more particularly directed to improvements in the unit which creates the vacuum whereby improved results occur.

In my copending application Serial No. 319,375, filed November 7, 1952, there is disclosed and claimed an improved design for a centrifugal fan wheel capable of producing both high static pressure and high volume in a machine of this general character. The present invention utilizes the centrifugal fan wheel of the said copending application in combination with certain other elements of structure.

Heretofore vacuum cleaners and particularly industrial vacuum cleaners have been designed either for the production of high volume or the production of what is known as high static pressure. Where the purchaser of the vacuum cleaner expects to use the machine with the hose substantially open, he is ordinarily more interested in a high volume of air passing through the machine. Where the machine is to be used under conditions where the hose end will be substantially closed, such as in the cleaning of rugs and upholstered furniture, it is more desirable that the machine develop a high static pressure.

Up to the present time vacuum cleaners which are designed to produce a high volume inherently have a low static pressure. Likewise, a machine that is particularly designed to develop high static pressure will inherently have a reduced volume.

In order to understand more clearly what is meant herein by the terms "high static" or "low static" as well as "high volume" or "low volume," a brief description of the test involved in determining these factors will be presented. The actual amount of static or volume is usually stated in terms of water lift. In running tests to determine these factors a U-shaped tube is employed having a predetermined number of inches of water therein. One end of the U-tube is allowed to remain open to the atmosphere and the other end of the U-tube is connected by means of a hose to an opening in the side of the inlet port to the tank of the vacuum cleaner. With the machine in operation and creating a vacuum to draw air inwardly through the inlet port to the tank the water lift will be increased as the size of the inlet is decreased. When the inlet port is completely closed the number of inches that the water is drawn upwardly into one side of the U-tube and is forced downwardly at the other side of the U-tube is referred to as the "closed water lift." This is a measure of the static pressure.

As the inlet opening to the tank is enlarged in area, the water in the U-tube will fall and the number of inches of water lift for a given size opening may then be translated into terms of volume.

Industrial tank type vacuum cleaners designed especially to produce a high volume or a fairly high water lift when the inlet to the tank is completely open usually have a single vacuum producing fan wheel and this type of vacuum producer is known as a single stage. Fan

wheels and the manner in which they cooperate with other parts of the device which have been designed up to the present time, when used as a single stage, are incapable of producing a very high static pressure and can, therefore, be used only for specific purposes where high volume is required.

It has been the custom heretofore to increase the static pressure in a vacuum cleaner by increasing the number of fan wheels to two, three or even more, all mounted on the same motor shaft. Such units are commonly called "multi-stage units," the number of stages depending upon the number of fan wheels used. In a multi-stage unit the air drawn into the tank passes through the center and out of the periphery of the first fan wheel and is then directed back into the center if the second wheel and so on, until the periphery of the last wheel is reached. This type of unit increases considerably the static pressure developed by the machine or may be said to increase the closed water lift, but at the same time the volume of air passing through the machine will be materially reduced.

It is thus evident that if the end use of a vacuum producing device requires a high volume, then a single stage unit may be used. If, however, the end use requires a relatively high static pressure, then it has been necessary to use a multi-stage unit. It will be evident that these units cannot be used interchangeably but must be designed for a specific purpose.

The present invention is directed to a novel combination of elements including the centrifugal fan wheel of the above referred to copending application together with other elements whereby a single stage machine is capable of developing a very high static pressure as well as a relatively high volume. Thus, the same machine may be used for any purpose whether a high volume or a high static pressure is required.

In view of the foregoing it is a principal object of the present invention to provide a vacuum producer or blower designed to overcome the disadvantages of similar machine heretofore known wherein only a high static pressure or a high volume was capable of being produced.

Another object of the invention is to provide a vacuum producing and blower unit capable of developing a combination of a high static pressure and a high volume to a greater degree than has been possible heretofore with other machines of this type.

A further object of the invention is to provide a vacuum producing and blower unit which is particularly adapted for use in a vacuum cleaner and which is capable of developing both high static pressure and high volume by the use of but a single stage.

Still another object is to provide a vacuum producing and blower unit for developing both high static pressure and high volume in a vacuum cleaner wherein a centrifugal fan wheel operates in combination with a housing having a plurality of peripheral openings therein for the passage of air.

A still further object of the invention is to provide in a vacuum cleaner a single centrifugal fan wheel having a plurality of involute blades thereon and a housing around said fan wheel provided with a plurality of peripheral openings whereby both high static pressure and high volume may be obtained by the use of but a single stage.

Still another object of the invention is to provide a vacuum producing and blower unit capable of developing both high static pressure and high volume wherein a centrifugal fan wheel having a plurality of circumferentially spaced involute blades is positioned within a housing having an air inlet and a plurality of peripheral air outlets, and wherein the combined area of

the outlets is substantially equal to the area of the inlet, thereby tending to produce a balanced blend of static pressure, velocity pressure and volume.

Still another and more specific object of the invention is to provide a vacuum producer and blower unit capable of developing both high static pressure and high volume wherein a centrifugal fan wheel having a plurality of circumferentially spaced involute blades is positioned within a housing having an air inlet and a plurality of peripheral air outlets and wherein means are provided to vary the area of the air outlets depending upon the velocity pressure and volume conditions whereby a balanced blend of these various characteristics may be obtained for the particular end use involved.

A still further and particular object of the invention is to provide a vacuum producer and blower unit capable of developing both high static pressure and high volume wherein a centrifugal fan wheel having a plurality of circumferentially spaced involute blades is positioned within a housing having an air inlet and a plurality of peripheral air outlets and wherein means are provided to vary automatically the area of the air outlets in response to the velocity pressure and volume conditions.

Other objects and advantages of the invention will become apparent upon reading the following description taken in conjunction with the accompanying drawings in which:

Fig. 1 is a perspective view of a tank type vacuum cleaner embodying the present invention.

Fig. 2 is a fragmentary perspective view of the upper portion of the machine shown in Fig. 1 with the shroud removed from the motor housing and with parts broken away for the sake of clarity.

Fig. 3 is an exploded perspective view of the fan wheel and housing therefor prior to assembly.

Fig. 4 is an exploded perspective view of the fan wheel housing and the directional vanes associated therewith prior to assembly.

Fig. 5 is an enlarged horizontal sectional view through the fan wheel housing and the fan wheel associated therewith.

Fig. 6 is a vertical sectional view through the fan wheel housing and directional vanes taken along the plane of lines 6—6 of Fig. 5.

Fig. 7 is a fragmentary plan view of a fan wheel housing with the upper flange thereof removed and illustrating a modified form of air outlet construction.

Fig. 8 is a fragmentary perspective view of the form of fan wheel housing shown in Fig. 7.

Fig. 9 is a view similar to Fig. 7 but showing a further modified form of air outlet construction.

Fig. 10 is a fragmentary perspective view of that form of the invention shown in Fig. 9.

Fig. 11 is a view similer to Figs. 7 and 9 but showing a still further modified form of air outlet construction, and

Fig. 12 is a fragmentary perspective view of the construction shown in Fig. 11.

Briefly described, the invention contemplates the use of a single stage fan wheel wherein the blades thereof are in the form of an involute and preferably with the center of the generating circle in offset relation with the center of the wheel. As explained in the above referred to co-pending application, this design of fan wheel having the involute blades located as mentioned above obtains a minimum of feed-back, minimum resistance and the desired compression of the air.

This fan wheel has been combined with a housing also having a predetermined design so that the net result of the combination of these elements will be to create a maximum static pressure without reducing the volume, thereby enabling a single machine to be operated whether the end use requires high static pressure or high volume.

The housing which surrounds the fan wheel is provided with a plurality of air outlets around the periphery thereof to permit the exhaust of air drawn into the tank by the fan wheel and which passes between the blades of the fan wheel to the outer periphery thereof. The area of these outlet ports in the fan wheel housing is an important consideration since the larger the area of these ports the greater volume of air may be handled. At the same time, however, such increased volume will decrease the maximum static pressure but will also increase leak-back.

Conversely, when the area of these exhaust ports is made smaller, the effect will be to increase the maximum static pressure but the volume is then reduced. The primary purpose in utilizing a housing around the fan wheel is to increase the static pressure. The size or area of the outlet ports in the housing must thus be balanced with the intake so that the increased static pressure may be obtained without reducing the volume.

Referring now more particularly to the drawings and especially to Figs. 1 and 2, the tank type vacuum cleaner to which the present invention has been applied is indicated generally by the numeral **1** and includes a body or tank **2** having an inlet opening **3** through which air passes during operation of the machine. The suction or vacuum created will draw air, dirt and other objects through the inlet **3** and through a suitable hose which may be applied thereto.

The particular type of machine shown herein for purposes of illustration also includes in general a caster ring **4** having supports **5** welded or otherwise secured thereto which support the casters **6** thus enabling the machine to be easily moved from place to place.

The body **2** of the machine may be received by the caster ring **4**, the upper edge of which abuts the annular rib **7** on the tank body to limit the movement of the tank within the ring. This feature of the over-all construction is described in greater detail and is claimed in my co-pending application Serial No. 344,136, filed March 23, 1953.

The top part of the tank body includes a head assembly which includes a clamp ring **8** having thereon a plurality of spaced clamp members **9**. These clamp members **9** are fixed to the ring **8** and are adapted to cooperate with an outwardly extending flange (not shown) on the upper end of the tank body to hold the head assembly in assembled relation with the body. The filter bag which filters the dirt prior to exhaust of the air to the atmosphere may be either enclosed within the tank body or may be positioned outside of the tank and fixed to the air outlet. The particular design of vacuum cleaner in general is not an important consideration as far as the present invention is concerned. It may be either of the type which has an inner or an outer filter bag and it may be a horizontal as well as a vertical tank, the type of machine shown herein being primarily for purposes of illustration only.

In the embodiment shown, the outlet for the air is indicated by the numeral **10** and is positioned on the head assembly and exhausts the air to the atmosphere after the air has been filtered inside of the tank and after it has passed through the fan wheel which creates the vacuum.

The head assembly above the tank body includes a shroud generally indicated by the numeral **11** which consists essentially of a lower portion **12** provided with an outwardly extending flange portion **13** thereon mounted in spaced relation to the head to permit motor cooling air to be drawn inwardly through the space. The upper part of the shroud includes a cap **14** provided with a plurality of circumferentially spaced air outlet ports **15** for passage of air after it has been utilized for cooling the motor.

The motor is located within the shroud **11** and is more clearly shown in Fig. 2. Although the motor itself cannot be seen in the drawings, it is nevertheless positioned within a housing generally indicated by the numeral **16** which includes an upwardly extending cylindrical portion

17 and an outwardly flanged portion 18 at the lower end thereof. The openings 19 in the motor housing are inlet ports for the air which cools the motor. This air is drawn inwardly at the lower end of the motor and passes upwardly therethrough performing its cooling function and thereafter passes outwardly through the ports 20 in the cap 21 located on the upper end of the cylindrical portion 17. The details of this particular construction are explained more fully and are claimed in my co-pending application Serial No. 344,135, filed March 23, 1953.

The fan wheel housing which forms a part of the present invention is indicated in the various figures by the numeral 22. The fan wheel itself is indicated at 23 and includes a lower plate 24 and upper plate 25 spaced therefrom and a plurality of circumferentially spaced involute blades 26. The center of the generating circle of each blade 26 is offset from the center of the wheel 23. This fan wheel 23 is mounted on the lower end of the motor shaft 27 and is held thereon by suitable retaining means 28. The lower plate or shroud 24 of the fan wheel 23 is provided with a centrally disposed air inlet opening 29 for the inward passage of air due to the suction created by the rotation of the fan wheel 23.

As stated hereinbefore, the proper balance or blend of static pressure and volume for the majority of end uses is effected by the cooperation of the fan wheel 23 and the fan wheel housing generally indicated at 22. A preferred form of this fan wheel housing is illustrated in Figs. 3 to 6 inclusive and includes a bottom plate 30 provided with an upstanding peripheral flange 31 which has formed integral therewith or otherwise suitably secured thereto an inwardly extending annular flange 32.

The upstanding peripheral flange 31 has a plurality of circumferentially spaced air outlet ports 33. The material of the housing between the ports 33 is preferably shaped as the cord of an arc rather than being in the form of an arc itself. This construction is brought out more clearly in Fig. 5 where it will be seen that the bottom plate 30 is polygonal in configuration rather than being circular. The unit would operate even if these partitions or dividing walls between the outlet ports 33 were to be arcuate although experience has shown that when these dividing walls are provided as cords the best action results, if it is considered that the best action is one that is most generally desired in an industrial vacuum producing device.

The plate 30 of the housing 22 is provided with a centrally disposed opening 34 therethrough which acts as an air inlet port for the air drawn through the unit by the fan wheel. This inlet port 34 is given an axial length greater than the thickness of plate 30 by means of a downwardly extending annular flange 35. The inner edge or surface surrounding the inlet port 34 is preferably in the form of an arc as seen at 36 to form a double bell-mouth for the opening.

It has also been determined by actual experiment that for the best results, best combination of static pressure and volume, the total area of the outlet ports 33 should be approximately the same as the area of the inlet port 34. The ratio of these two areas can, of course, be modified to suit specific needs. For example, if a purchaser of the unit put it to an end use where more volume and less static pressure was desired, it would be possible to manually machine out the ports 33 at the factory and by doing so the power would be converted in large measure to more volume and less static pressure, the velocity remaining about the same. Conversely, the same unit could be furnished with a somewhat higher static pressure by making these outlet ports 33 somewhat smaller by extending the cords or dividing walls farther in the same direction and in the same relative location from the tip of the fan wheel blades. For general overall usage, however, the static pressure and volume resulting from the outlet ports having approximately the same area as the inlet port and the volume resulting

from such a construction are most satisfactory for practically all end uses. As will be described more fully hereinafter, it is possible to form the cords or peripheral wall members in such a way as to automatically vary the size of the outlet ports depending upon the velocity and volume of the air.

The air drawn inwardly to the tank by means of the fan wheel will have a rotary movement within the tank and this movement of the air must be transformed into axial movement in order that it may be picked up by the fan wheel. The means provided for accomplishing this conversion of air movement from rotary to axial is a factor of both volume and static pressure. Although various means may be provided to accomplish this result, the preferred form contemplates the use of a plurality of vanes surrounding the inlet port 34 and positioned immediately below the housing 22. This feature of the invention is illustrated more clearly in Figs. 4 and 6 where the numeral 37 indicates in general the air stabilizing unit. This unit as illustrated includes a frustro-conical screen member 38 provided with a plurality of circumferentially spaced and radially directed vanes 39. The lower or smaller end of the screen 38 may be provided with a closure plate 40 to make the screen more rigid and to form a more firm support for the vanes 39. The screen 38 may also be provided with ears 41 having openings therein adapted to be aligned with threaded holes 42 in the plate 30 of the housing, whereby screws 43 may be utilized for mounting this stabilizing unit on the underside of the housing 22. The stabilizing unit 37 will stabilize or straighten the air flow converting it from a rotary movement to an axial movement directing it through the inlet port 34 and to the space between the sides of the fan wheel 23 where it is picked up by the heels of the involute blades 26 and discharged outwardly toward the upstanding flange 31 of the housing. This air then passes outwardly through the outlet ports 33 to a suitable channel within the head assembly of the machine where it passes outwardly through the outlet 10.

In assembling the driving motor, fan wheel and housing it will be noted that the inwardly extending annular flange 32 on the housing has a plurality of spaced openings 44. Likewise the flange 18, formed as a part of the motor housing 16, has a plurality of similar holes 45 which may be brought into alignment with the holes 44 in the fan wheel housing. The fan wheel housing and motor housing may then be secured together by means of bolts 46 and the entire unit suitably mounted within the head assembly of the machine.

In operation when the motor is started, the fan wheel 23 will be rotated at a predetermined and suitable rate of speed whereupon the involute blades 26 will create a movement of air inwardly through the inlet 3 on the tank body. This air is deposited within the tank 2 in a tangential direction thereby creating a rotational flow thereof. The stabilizing unit 37 stabilizes or straightens out the rotating air and changes the direction thereof to an axial flow so that it may be picked up by the fan wheel. The double bell-mouthed inlet port 34 increases and facilitates the radial flow of the air to the blade heel from its axial movement.

The vanes 39 can, if desired, be formed as an integral part of the plate 30 of the fan wheel housing or may otherwise be secured directly thereto rather than be supported by the screen 38, as shown herein, without in any way affecting the end result of their operation.

Since the housing 22 is utilized primarily to increase static pressure, it will be clear that if the outlet ports 33 in the peripheral flange thereon are to large, this function of the housing will not result. Since it is one of the primary objects of the invention also to maintain maximum volume even though static pressure may be increased, it will be evident also that these outlet ports 33 should not be too small unless volume is not a consideration in the particular end use to which the unit is to be

put. The best balance and blend of static, velocity and volume for general usage has been found to exist when the total area of the outlet ports 33 substantially equals the area of the inlet port 34.

Figs. 7 to 12 inclusive illustrate various modifications of structures for automatically controlling the area of the outlet ports in the peripheral flange of the fan wheel housing 22. Referring especially to Figs. 7 and 8, the plate of the housing is indicated at 30*a*. In this form the housing will also be provided with the supporting flange 32 in order that it may be secured to the motor housing although this flange is not shown in these particular figures. Suitable posts, as shown at 47, extend vertically between the plate 30*a* and the supporting flange which will be disposed thereabove. These posts 47 are spaced circumferentially around the plate 30*a* and have mounted thereon flexible closure members 48. One such member 48 is mounted on each post 47 in any suitable manner and preferably at a point intermediate the ends thereof so that when each member 48 is caused to flex, the ends thereof will move outwardly in the manner shown in dot-dash lines in Figs. 7 and 8.

Between adjacent posts 47 there is positioned a stop member 49 against which the ends of adjacent closure members or blades 48 may abut when in normal or closed position. The full line position of these flexible blades 48 as shown in the drawings is the position which they assume when the machine is not in operation and in the absence of any air flow. When the motor is started and the fan wheel begins its vacuum producing function, the outgoing air from the fan wheel will come against the inward surfaces of the blades 48 and urge them outwardly to the dot-dash line position as shown. The amount of flexing and movement of the blades will depend upon the velocity and volume. As the intake opening into the tank is opened, a greater volume is permitted whereupon the outlet ports provided between the adjacent ends of the flexed blades 48 will become larger. As less volume is present the blades 48 will approach closed position, thereby decreasing the size of the outlet ports between the ends of the blades. This effect, of course, would be to increase the static pressure.

This action of the blades tends to produce a balanced blend of static pressure, velocity and volume commonly desired in industrial vacuum units and is automatic in principle.

A still further form of blade which may be used to carry out this automatic principle is illustrated in Figs. 9 and 10 where the plate of the fan wheel housing is indicated at 30*b*. In this form the supporting posts 50 are also provided in spaced relation around the circumference of the plate 30*b* but in this case the post 50 supports not only the end 51 of the blade 52 but also a coiled spring 53. One end of this spring is anchored around the anchor post 54 while the other end 55 thereof bears against or is affixed to the outer surface of blade 52. The spring is designed to hold the blade normally closed so that the outer free end thereof will normally bear against the stop member 56.

Here again the blades 52 extend in substantial end-to-end relation around the periphery of the fan wheel housing so that normally when the machine is not in operation the outlet ports through which exhausted air will pass will be closed. When, however, the fan wheel is rotating and creating an inward movement of air into the tank and an outward movement thereof between the involute blades and against the inner surfaces of the blades 52, these blades will tend to open against the force of springs 53 and will move toward the dot-dash line position as shown in Figs. 9 and 10. The extent to which these blades will move outwardly will depend upon the size of the inlet opening into the tank and consequently the volume being produced. The operation will be the same as that explained above with respect to Figs. 7 and 8, the only difference being in the specific arrangement of the parts and blade mounting. The desired balanced blend of static pressure, velocity and volume will still be obtained and will still be automatic in operation.

In Figs. 11 and 12 there is shown a still further modified form of the automatic principle of varying the area of the outlet ports and in these figures the plate of the fan wheel housing is indicated by the numeral 30*c*. Supporting posts 57 are spaced around the plate 30*c* adjacent the periphery thereof and each post 57 supports the end of a blade 58. The blade 58 is again flexible and each blade has one end thereof surrounding a post 57 and is then reversely bent around a pin 59. This arrangement is designed to hold each blade 58 in its normal closed position. During operation of the machine the air being exhausted from the fan wheel will force the blades 58 outwardly as indicated by the dot-dash lines in Figs. 11 and 12. The stationary end of one blade will act as a stop for the free end of the next adjacent blade so that when there is no air movement all outlet ports will be closed. Again, this arrangement as stated above will produce a balanced blend of the three factors, namely, static pressure, velocity pressure and volume.

It will be obvious that many further modifications may be made to accomplish this result in an automatic manner depending upon the volume and velocity of air movement. The general principle, however, is adequately disclosed in the forms shown in Figs. 7 to 12 inclusive.

From the foregoing it will be seen that a novel combination of a fan wheel having offset involute blades, a fan wheel housing and a stabilizing unit has been made, the result of which is to provide a vacuum and blower producer wherein maximum static pressure and maximum volume result in the same machine, thereby increasing tremendously the end uses to which a particular machine may be put. With this arrangement it is no longer necessary to produce a machine of one design for a purchaser desiring to use it where a high static pressure is necessary and another design for a purchaser where the end use requires a high volume. Furthermore, if a purchaser desires a machine developing a higher static pressure than that of normal production, then this increased static pressure may be obtained merely by increasing the length of the cords and decreasing the area of the outlet ports. Conversely, the balanced design disclosed herein may be modified to permit a larger volume of air merely by machining the ends of the cords to create larger outlet port areas.

The stabilizing unit aids materially in changing the direction of air flow from rotational to axial and the double bell-mouthed opening is highly desirable to facilitate and increase the radial flow of the air to the blade heel from its axial movement. All of these various features have been combined herein to produce a novel combination of elements resulting in a vacuum producer and blower machine which is capable of numerous end uses not heretofore possible.

It will be evident that certain changes may be made in the form, construction and arrangement of parts from those disclosed herein without in any way departing from the spirit of the invention or sacrificing any of the attendant advantages thereof, provided, however, that such changes fall within the scope of the claims appended hereto.

The invention is hereby claimed as follows:

1. A vacuum and blower producing machine comprising in combination a fan wheel including a plurality of circumferentially spaced involute blades, the center of the generating circle for each blade being offset from the center of the wheel, means for rotating said fan wheel, a stationary housing around said fan wheel having an inlet port therein, and a plurality of exhaust ports around the periphery thereof, the total area of said exhaust ports being substantially equal to the area of said inlet port.

2. A vacuum and blower producing machine com-

prising in combination a tank having an air inlet and an air outlet therein, a fan wheel including a plurality of circumferentially spaced blades of involute form, the center of the generating circles for each blade being offset from the center of the wheel, means for rotating said fan wheel, a central air inlet opening in one side of said fan wheel, a stationary housing around said fan wheel having an air inlet port adjacent the inlet opening in said fan wheel, and a plurality of air exhaust ports around the periphery of said housing, the total area of said exhaust ports being substantially equal to the area of said inlet port.

3. A vacuum and blower producing machine comprising in combination a tank having an air inlet and an air outlet therein, a fan wheel including a plurality of circumferentially spaced blades of involute form, the center of the generating circle for each blade being offset from the center of the wheel, means for rotating said fan wheel to draw air into said tank through said air inlet and to rotate said air rapidly, a central air inlet opening in one side of said fan wheel, a stationary housing around said fan wheel having an air inlet port adjacent the inlet opening in said fan wheel, a plurality of air exhaust ports around the periphery of said housing, the total area of said exhaust ports being substantially equal to the area of said inlet port, and means adajcent said inlet port to aid in changing the air movement from rotational to axial and facilitate entry of the air through said inlet port.

4. A vacuum and blower producing machine comprising in combination a tank having an air inlet and an air outlet therein, a fan wheel including a plurality of circumferentially spaced blades of involute form, the center of the generating circle for each blade being offset from the center of the wheel, means for rotating said fan wheel to draw air into said tank through said air inlet and to rotate said air rapidly, an air inlet opening at one side of said fan wheel, a stationary housing around said fan wheel having an air inlet port adjacent the inlet opening in said fan wheel, a plurality of air exhaust ports around the periphery of said housing, the total area of said exhaust ports being substantially equal to the area of said inlet port, and a plurality of radially positioned and axially extending fins around said inlet port to facilitate entry of the rapidly rotating air through said inlet port.

5. A fan wheel and housing assembly for use in a vacuum and blower producing device including a housing having a plate with a central air inlet port, an axially extending peripheral flange around said plate, and a plurality of exhaust ports in said flange, the combined area of said exhaust ports being substantially equal to the area of said inlet port, and a fan wheel mounted for rotation within said housing, said fan wheel having a plurality of circumferentially spaced blades of involute form wherein the center of the generating circle for each blade is offset from the center of the wheel.

6. A fan wheel and housing assembly for use in a vacuum and blower producing device including a housing having a plate with a central air inlet port with the edges of said port being double bell-mouthed, an axially extending peripheral flange around said plate, and a plurality of exhaust ports in said flange, the combined area of said exhaust ports being substantially equal to the area of said inlet port, and a fan wheel mounted for rotation within said housing, said fan wheel having a plurality of circumferentially spaced blades of involute form wherein the center of the generating circle for each blade is offset from the center of the wheel.

7. A fan wheel and housing assembly for use in a vacuum and blower producing device including a housing having a plate with a central air inlet port, an axially extending flange around the periphery of said plate, a plurality of exhaust ports in said flange, and means to vary the area of each of said exhaust ports, and a fan wheel mounted for rotation within said housing, said fan wheel having a plurality of circumferentially spaced blades of involute form wherein the center of the generating circle for each blade is offset from the center of the wheel.

8. A fan wheel and housing assembly for use in a vacuum and blower producing device including a housing having a plate with a central air inlet port, an axially extending flange around the periphery of said plate, a plurality of exhaust ports in said flange, and means responsive to the velocity of air exhausted by a fan wheel within the housing to vary the area of each of said exhaust ports, and a fan wheel mounted for rotation within said housing, said fan wheel having a plurality of circumferentially spaced blades of involute form wherein the center of the generating circle for each blade is offset from the center of the wheel.

9. A fan wheel and housing assembly for use in a vacuum and blower producing device including a housing having a plate with a central air inlet port, a plurality of axially extending side wall members around the periphery of said plate, each of said side wall members forming a cord of a circle, and air exhaust openings between adjacent side wall members, and a fan wheel mounted for rotation within said housing, said fan wheel having a plurality of circumferentially spaced blades of involute form wherein the center of the generating circle for each blade is offset from the center of the wheel.

10. A fan wheel and housing assembly for use in a vacuum and blower producing device including a housing having a plate with a central air inlet port, a plurality of axially extending rigid side wall members around the periphery of said plate, each of said side wall members forming a cord of a circle, and air exhaust openings between adjacent side wall members, the combined area of said exhaust openings being substantially equal to the area of said inlet port, and a fan wheel mounted for rotation within said housing, said fan wheel having a plurality of circumferentially spaced blades of involute form wherein the center of the generating circle for each blade is offset from the center of the wheel.

11. A fan wheel and housing assembly for use in a vacuum and blower producing device including a housing having a plate with a central air inlet port, a plurality of axially extending flexible side wall members around the periphery of said plate in substantially end-to-end relation, each of said side wall members forming a cord of a circle and being adapted to move outwardly in response to the force of air exhausted by a fan wheel within the housing, thereby to provide exhaust ports between adjacent side wall members, and a fan wheel mounted for rotation within said housing, said fan wheel having a plurality of circumferentially spaced blades of involute form wherein the center of the generating circle for each blade is offset from the center of the wheel.

12. A fan wheel and housing assembly for use in a vacuum and blower producing device including a housing having a plate with a central air inlet port, a plurality of axially extending flexible side wall members around the periphery of said plate in substantially end-to-end relation, support means mounting each of said side wall members intermediate the ends thereof on said plate, each of said side wall members forming a cord of a circle and being adapted to have portions thereof on each side of said support means move outwardly in response to the force of the air exhausted by a fan wheel within the housing, thereby to provide exhaust ports between adjacent side wall members, and a fan wheel mounted for rotation within said housing, said fan wheel having a plurality of circumferentially spaced blades of involute form wherein the center of the generating circle for each blade is offset from the center of the wheel.

13. A fan wheel and housing assembly for use in a vacuum and blower producing device including a housing having a plate with a central air inlet port, a plurality of axially extending side wall members around the periphery of said plate in substantially end-to-end relation, sup-

port means mounting each of said side wall members adjacent one end thereof on said plate, the opposite free end of each said member being movable outwardly in response to the force of the air exhausted by a fan wheel within the housing, thereby to provide exhaust ports between adjacent wall members, and means to return each said wall member to its normal closed position in the absence of air force thereagainst, and a fan wheel mounted for rotation within said housing, said fan wheel having a plurality of circumferentially spaced blades of involute form wherein the center of the generating circle for each blade is offset from the center of the wheel.

14. A vacuum and blower producing unit for vacuum cleaners comprising in combination a fan wheel including a plurality of circumferentially spaced involute blades, the center of the generating circle for each blade being offset from the center of said wheel, a housing around said fan wheel, an air inlet port at one side of said housing, and a plurality of circumferentially spaced axially extending peripheral flanges around said housing, thereby providing air exhaust ports between adjacent flanges.

15. A vacuum and blower producing unit for vacuum cleaners comprising in combination a motor, a housing for said motor having an outwardly extending flange at one end thereof, a fan wheel mounted at one end of the motor shaft adjacent said flange, said fan wheel having a plurality of circumferentially spaced blades with the center of the generating circle for each blade being offset from the center of the wheel, a housing for said fan wheel, means mounting the fan wheel housing on the flange of said motor housing, an air inlet port in the fan wheel housing, and a plurality of air exhaust ports around the periphery of said fan wheel housing.

16. A vacuum and blower producing unit for vacuum cleaners comprising in combination a fan wheel including a plurality of circumferentially spaced involute blades, the center of the generating circle for each blade being offset from the center of the wheel, a housing around said fan wheel, an air inlet port at one side of said housing for directing air into said fan wheel, and air stabilizing means adjacent the air inlet port of said housing to change the direction of air flow from rotational to axial.

17. A vacuum and blower producing unit for vacuum cleaners comprising in combination a fan wheel including a plurality of circumferentially spaced involute blades, the center of the generating circle for each blade being offset from the center of the wheel, a housing around said fan wheel, an air inlet port at one side of said housing for directing air into said fan wheel, and a plurality of air stabilizing blades positioned around said air inlet port and extending radially outwardly therefrom to change the direction of air flow from rotational to axial.

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