Feb. 13, 1968 L. J. JENN 3,368,744

VENTILATOR FAN IMPELLER

Filed March 8, 1967 4 Sheets-Sheet 1

Fig. 1.

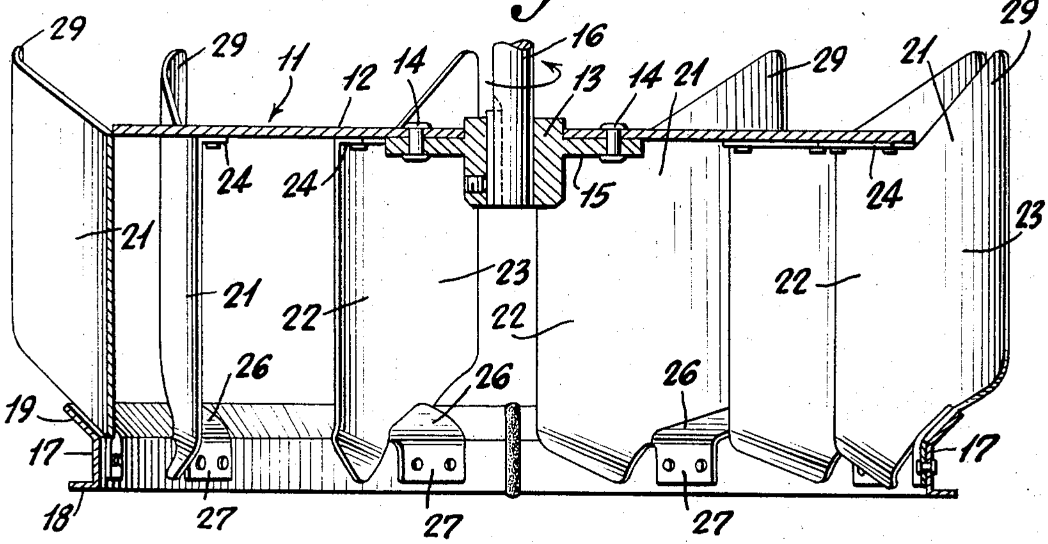
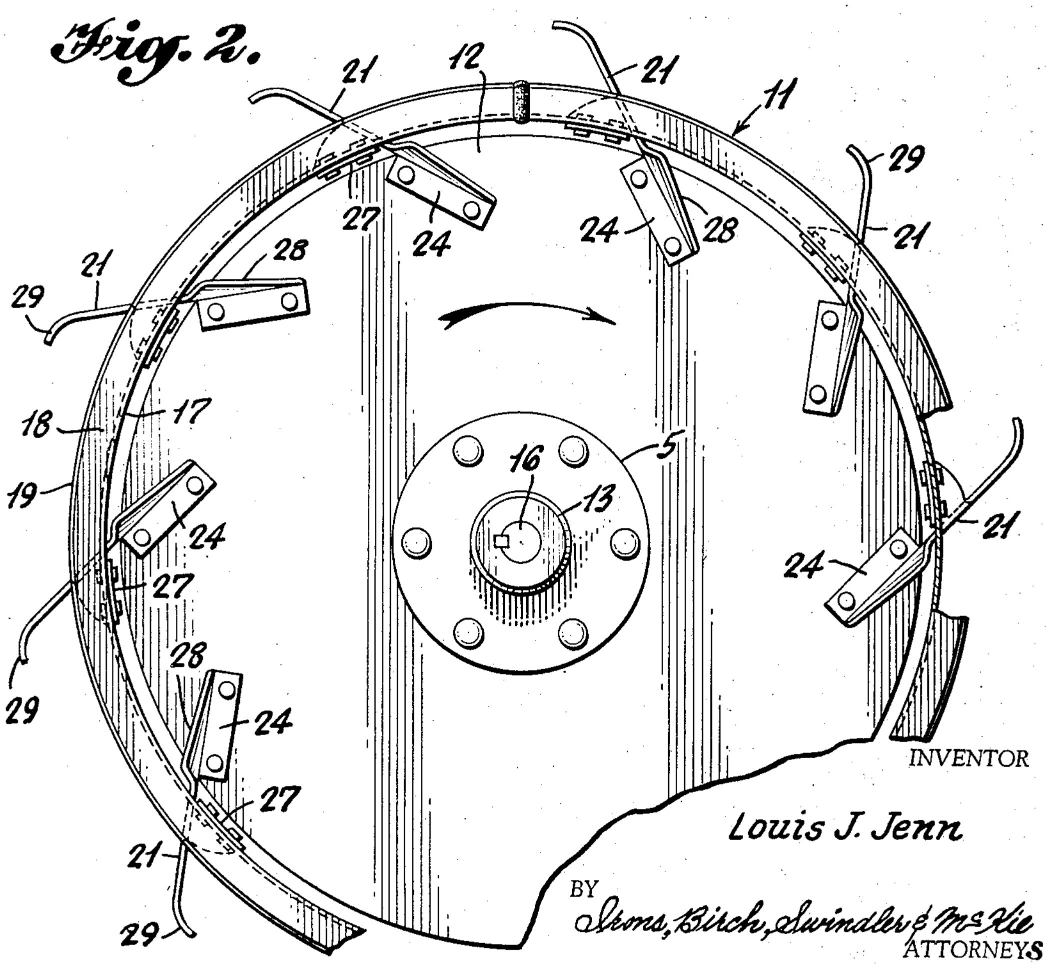


Fig. 2.



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VENTILATOR FAN IMPELLER

Filed March 8, 1967 4 Sheets-Sheet 2

Fig. 3.

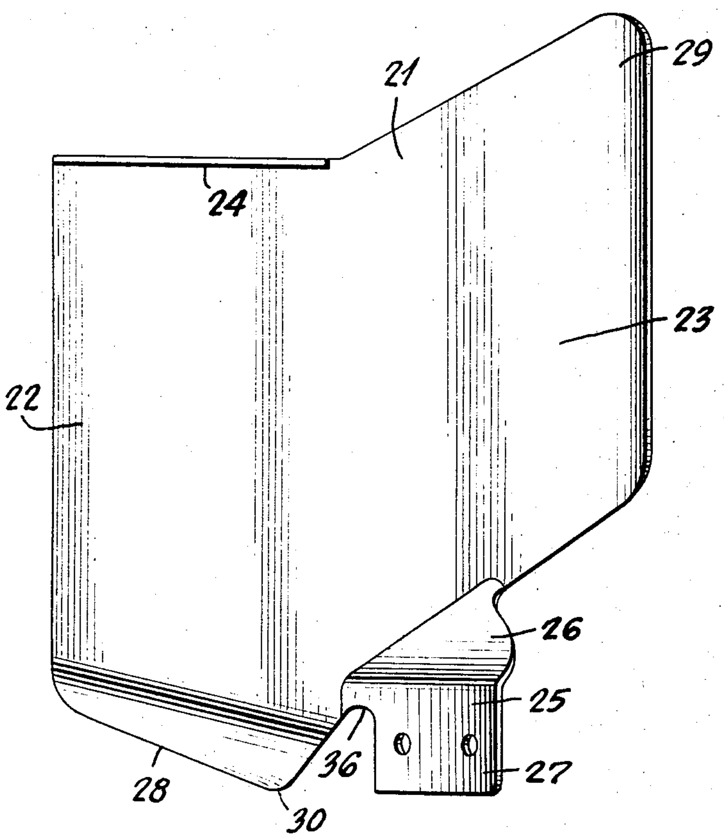


Fig. 4.

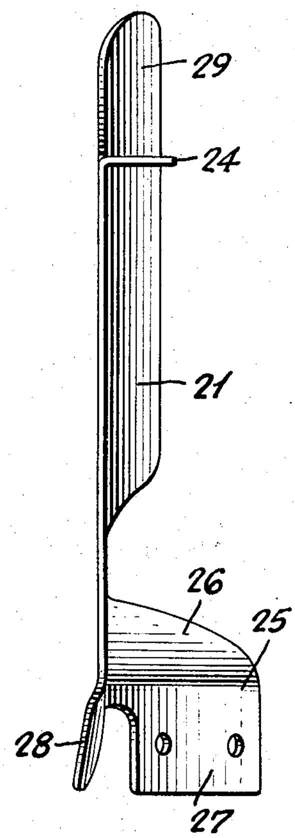
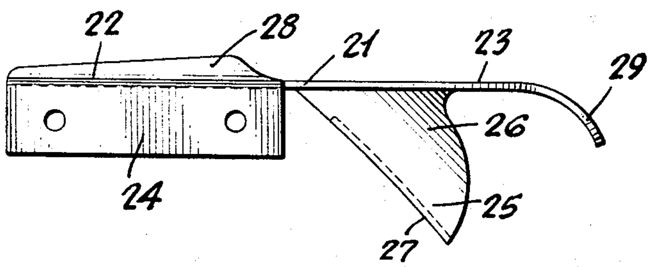


Fig. 5.



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VENTILATOR FAN IMPELLER

Filed March 8, 1967 4 Sheets-Sheet 3

Fig. 6.

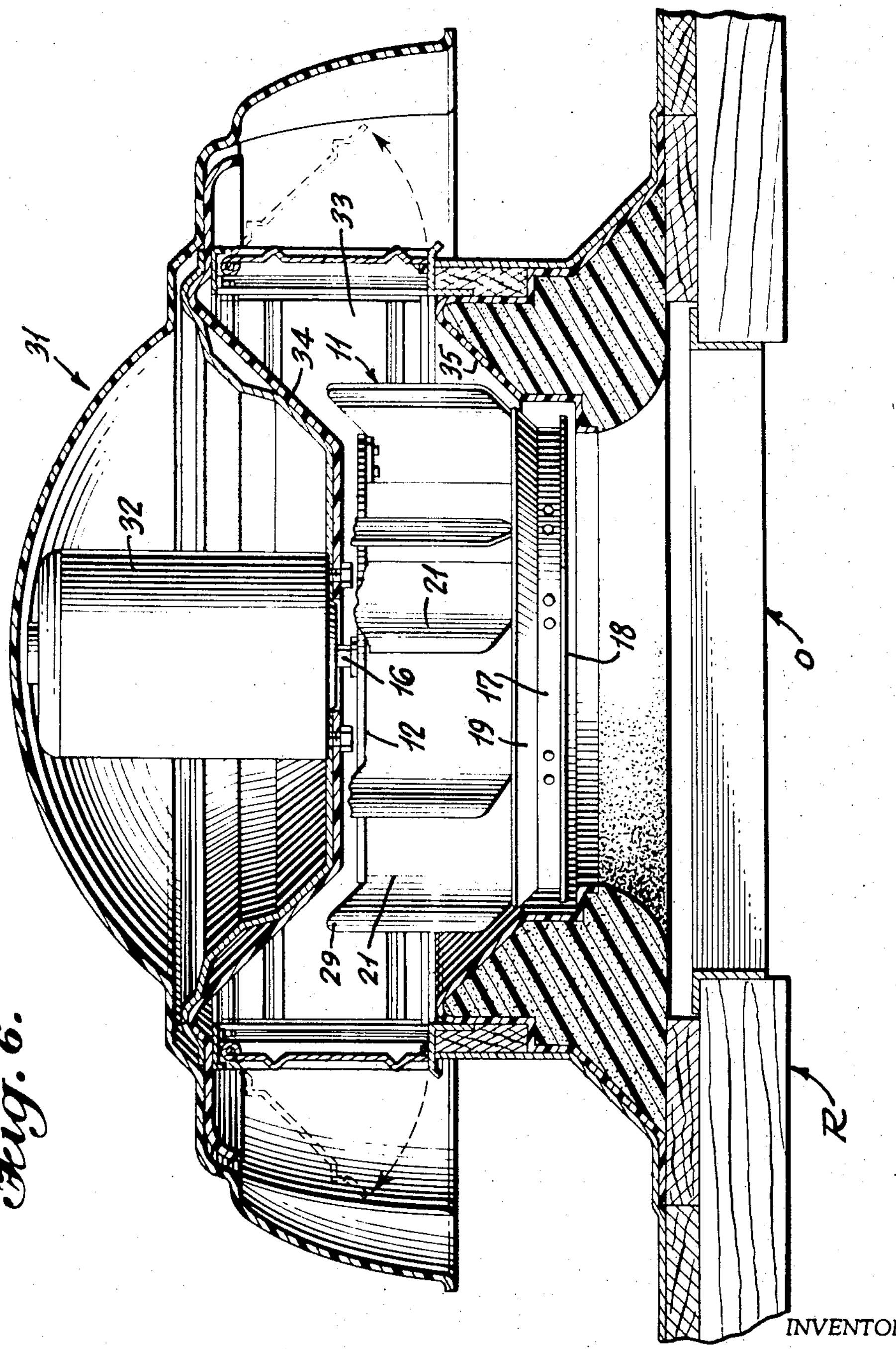

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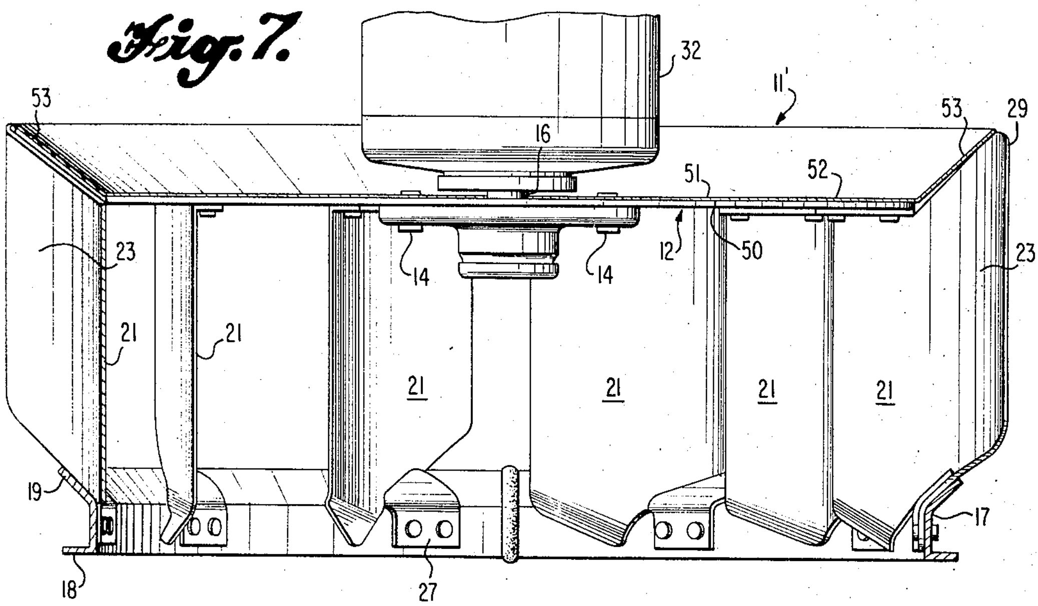
Fig. 7.



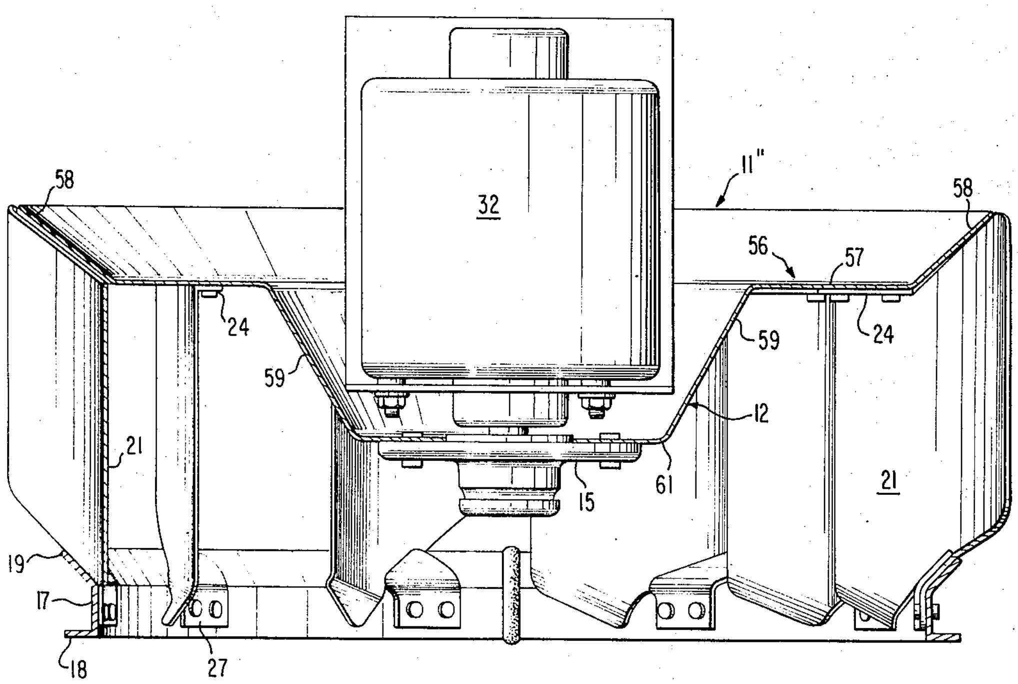


Fig. 8.

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VENTILATOR FAN IMPELLER

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Continuation-in-part of application Ser. No. 450,437, Apr. 23, 1965. This application Mar. 8, 1967, Ser. No. 629,348
22 Claims. (Cl. 230—134)

ABSTRACT OF THE DISCLOSURE

An impeller for a roof ventilator for exhausting air in which the ventilator has a low profile and an oblique discharge with respect to its vertical axis. The impeller has a generally cylindrical inlet ring and a generally disc shaped back plate between which are mounted a plurality of circumferentially spaced blades. The vertical plane of each blade is disposed at an angle with respect to the vertical axis of the ventilator and is not coincident therewith. The blades have first portions which extend inwardly of the inlet ring for gathering the air, and second portions which extend outwardly and axially from the inward portions so that air moved by the impeller is discharged peripherally therefrom at an oblique angle with respect to the vertical axis of the impeller.

This application is a continuation-in-part of U.S. application Ser. No. 450,437 for "Fan Impeller," filed Apr. 23, 1965, now abandoned.

This invention relates generally to centrifugal fans and more particularly to a fan impeller for use with such fans as may be employed in ventilating or exhaust systems.

Centrifugal fans presently enjoy wide usage in a variety of fields. Most conventional centrifugal fans employ an impeller comprised of a plurality of circumferentially spaced and axially extending blades connected between two end supports. Such fans have found wide application in ventilating installations. In particular, they are commonly employed in ventilators adapted to be mounted on building roof openings to exhaust air, fumes, etc. from the building.

Most heretofore known prior art centrifugal fans employed in roof ventilators have been relatively tall, thus necessitating use in an installation which towers above the building roof line. This is particularly true of higher capacity ventilators such as are required for large commercial and industrial structures. This often is objectionable from an architectural standpoint in that such installations create an unsightly appearance for the building roof line. In addition, many such prior art centrifugal fans are of relatively complex construction and are not capable of being readily adjusted or varied in design so as to vary the air flow capacity thereof.

A further disadvantage of many prior art centrifugal fans is that they draw the air in axially and only discharge it radially, requiring the air to be diverted through a 90° turn in its flow through the impeller. While such fans are efficient in discharging air radially, they lose efficiency where the air is diverted at an oblique angle or delivered from the fan obliquely to the fan axis.

To overcome the disadvantages of the prior art centrifugal fans, it is a principal object of the present invention to provide an improved fan impeller which is capable of delivering or discharging fluid upwardly and outwardly at an oblique angle with respect to the axis of the impeller.

Another object of the invention is to provide such an impeller whose trailing blade edges can be readily adjusted or varied in design to provide varying capacities for a given impeller speed.

A further object of the invention is to provide an improved fan impeller having a large inlet and recessed central area to accommodate the ventilator motor or drive whereby a relatively low overall height is permitted in ventilating installations desirably having a low profile appearance when mounted in position on a building.

A still further object of the invention is to provide such a fan impeller having a large inlet area in relation to the impeller diameter, thus permitting lower inlet velocities and a lower noise level for a given speed and capacity of the fan.

Still another object of the invention is to provide an improved fan impeller which is economical and simple in construction wherein the inlet is defined by a generally cylindrical ring interconnecting the impeller blades.

A further object of the invention is to provide such a fan impeller which is particularly adapted to move air through a generally conical chamber with the fan impeller nested or recessed in the chamber as formed by the walls of the ventilator housing in which the impeller is mounted.

The above and other objects and advantages of the present invention will be readily apparent from the following description and the accompanying drawings.

In general, the invention relates to a fan impeller comprising a circular disc, an inlet ring, a plurality of circumferentially spaced blades connected between said disc and said ring, each of said blades having an inner and an outer portion, said outer portion projecting outwardly and upwardly from said inner portion to permit fluid moved by said impeller to be discharged peripherally therefrom at an oblique angle with respect to the axis of said impeller. In addition, each of said blades is angularly disposed with respect to a radial plane intersecting the axis of said impeller whereby said outer portion thereof is generally situated at an angle in a direction opposite that of a normal direction of rotation of said impeller.

The invention having been broadly described, a specific embodiment thereof will now be set forth in detail with reference to the accompanying drawings in which

FIGURE 1 is a side elevational view, partially in section, of a fan impeller according to the invention;

FIGURE 2 is a bottom plan view of a substantial portion of the fan impeller;

FIGURE 3 is a side elevational view of an individual blade of the fan impeller shown in FIGURES 1 and 2;

FIGURE 4 is an end elevational view of the blade as viewed from the left in FIGURE 3;

FIGURE 5 is a top view of the blade of FIGURE 3;

FIGURE 6 is a sectional view of a roof ventilator having a fan impeller constructed according to the principles the present invention mounted therein;

FIGURE 7 is a side elevational view, partially in section, of another embodiment of a fan impeller according to the invention; and

FIGURE 8 is a side elevational view, partially in section, of still another embodiment of a fan impeller according to the invention.

Illustrated in the drawings is a fan impeller, generally designated by the numeral **11**, comprised of a circular disc **12** having a hub **13** mounted at the center thereof by any suitable means such as rivets **14** extending through the disc **12** and a radial flange **15** integrally connected to the main body of the hub. The hub **13** in turn may be appropriately secured by any suitable drive means such as a motor shaft **16**. The hub **13** furnishes a convenient means for pulling the impeller off the shaft **16** when necessary.

The disc **12** preferably is substantially smaller in diameter than the overall impeller diameter. The disc **12** is disposed at the outlet end of the fan impeller while the other end or inlet end of the impeller is formed with a generally channel shaped, cylindrical inlet ring 17. The channel shape of ring 17, as best shown in FIGURE 1, is formed by a radially extending flange 18 at its lower end while the upper end thereof has an outwardly flaring flange 19 extending upwardly from the main cylindrical center portion of the ring at an angle of approximately 45° with respect to the axis of the impeller. While the inlet ring 17 is described and illustrated in the preferred embodiment is channel shaped in cross section, it will be understood that it may be constructed of other suitable configurations such as an angular configuration. The generally cylindrical character of inlet ring 17 conveniently and economically may be constructed from a strip of metal or other suitable strip stock material simply by rolling the strip stock into the generally channel shaped configuration described above and illustrated on the drawings. The angle of both the lower radially extending flange and the upper outwardly flaring flange may be varied as desired for the particular ventilating design in which the impeller is to be employed. The rolled inlet ring construction provides great strength and durability as well as permitting a relatively large inlet area. The use of strip stock avoids any waste of material such as occurs where an annular inlet ring is stamped out of a sheet of material to form the impeller inlet in many prior art impeller constructions.

The impeller 11 is completed by a series of circumferentially spaced blades 21 which are connected between the disc 12 and the inlet ring 17. Each blade 21 is constructed so as to have an inner portion 22 and an outer portion 23 as best shown in FIGURES 3, 4 and 5.

Each of the blades 21 is mounted on the disc 12 and inlet ring 17 is angularly disposed with respect to a radial plane intersecting the axis of the impeller whereby the outer portion 23 thereof, excluding the outer tip 29, is generally situated at an angle of approximately 45° extending in a direction away from the normal direction of rotation of the impeller. The impeller normally rotates in the direction of the arrow shown in FIGURES 1 and 2 so that the outer tip 29 of outer portion 23 becomes the trailing edge.

The end of inner portion 22 to be connected to disc 12 is provided with a mounting tab or extension 24 which is bent at an angle of approximately 90° with respect to the principal plane of the inner portion of the blade 21. This tab is connected by any suitable means, such as rivets, to circular disc 12. At the other end of the blade the outer portion 23 similarly is provided with a tab or extension 25 for connection by any suitable means, such as rivets, to inlet ring 17.

Mounting tab 25 is generally divided into an intermediate section 26 connecting a mounting section 27 to the outer portion 23 of the blade. The intermediate section 26 of mounting tab 25 is bent at an oblique angle with respect to the plane of the impeller to lie along the flaring flange 19 of inlet ring 17 in the mounted position of the blade on the inlet ring. Section 26 joins the outer blade portion 23 along the outwardly extending end edge of the blade. The section 27 of tab 25 extends normal to the plane of tab 24 so that it is approximately perpendicular to the axis of the impeller and is directed to mate with the inner circumference of the cylindrical portion of inlet ring 17 when mounted thereon. Moreover, mounting section 27 of tab 25 is curved so that it conforms to the curvature of inlet ring 17 to facilitate its attachment thereto.

The end edge segment 28 of inner blade portion 22 extends downwardly at an oblique angle with respect to the axis of the impeller to a point 30 adjacent to the outer portion 23 of the blade. A notch 36 is cut out between point 30 and mounting extension 25 to permit the extension to be snugly attached to inlet ring 17. The edge segment 28 of inlet portion 22 additionally may be curved toward the normal direction of rotation of the impeller, as best shown in FIGURES 4 and 5, to provide additional fluid flow capacity and better performance under high static pressure conditions. Curving the edge segment 28 toward the direction of rotation also acts to inhibit recirculation of air or other fluid at the outer edge of the inlet of the impeller as well as to impart high velocity to air moving in an axial direction, thus contributing to discharge of the air at an oblique angle with respect to the plane of the impeller rather than radially as with most conventional centrifugal fans. The degree of this curving of this segment 28 may be varied to obtain different fluid flow conditions and impeller capacities as may be desired for the impeller in use.

The outer portion 23 of each blade 21 extends outwardly and axially from the inner portion 22 of each blade at an angle of approximately 45° with respect to the axis of the impeller, thus providing a generally conical configuration at the top and bottom of the impeller at the outer peripheral portion thereof. The outer tip 29 of outer portion 23 is curved away from the normal direction of rotation of the impeller. By adjusting the angle and/or extent of curvature of the outer tip 29, it is possible to achieve desired different capacities and drive power requirements for the impeller since such an adjustment acts to change the radius of the impeller.

Referring now to FIGURE 6, the impeller 11 is shown mounted in operating position in a low profile roof ventilator generally designated by the numeral 31. The roof ventilator is shown mounted on a building roof R having an air exhaust opening O through which the ventilator is designed to draw air, fumes, etc. The impeller 11 is secured to motor shaft 16 which in turn may be driven by any suitable power means such as motor 32. The impeller is situated in a generally conical fan impeller chamber 33 formed between conical upper and lower walls 34 and 35, respectively. Such conical chambers as chamber 33 are often used where it is desired to draw air out of a recessed area. The impeller of the present invention is particularly adapted to discharge air obliquely from such a conical chamber. It also is advantageous in its design being adaptable to discharge around an obstruction such as a motor compartment with the air then being directed radially or even around the motor compartment and then axially relative to the impeller axis.

Another embodiment of an impeller in accordance with the instant invention is identified 11' as illustrated in the partial sectional view of FIGURE 7. This embodiment is similar to the impeller disclosed in FIGURE 1, except that the disc numbered 12 as shown in FIGURE 1 is formed by a back plate 51 combined with a reinforcing circular flat plate 50. The other elements shown in FIGURE 7 have been given like reference characters to their corresponding elements in FIGURE 1.

The back plate 51 is secured to the plate 50 by the rivets 14 or by any other conventional means to form disc 12. The back plate 51 includes a flat circular portion 52 with an upturned rim 53. The flat portion 52 is generally coextensive with the plate 50 and adds strength and rigidity to the structure. The upturned rim 53 is formed at an angle which generally corresponds to the angle of the outer portions 23 of the blades 21 with respect to the vertical axis of the impeller.

In this manner, the upturned rim 53 aids in directing or guiding the discharge of the impeller in the desired oblique angle with respect to the vertical axis of the impeller. Also, the need for the upper wall 34 (FIGURE 6) of the fan impeller chamber 33 is eliminated, and the discharge is directed at the desired oblique angle without that wall.

The back plate 51 forms a frusto conical dish shaped are which can be used to accommodate a vertically mounted drive motor 32, such is shown in FIGURE 6. It is to be understood that the drive shaft 16 can also be mounted on bearings and connected via appropriate pulleys and belts or by other means to a drive motor which is mounted on the side of the ventilator. In such a case, with the upper wall 34 (FIGURE 6) omitted, the top of the ventilator can be flat instead of being dome shaped as shown in FIGURE 6. It is to be understood that the back plate 51 and its upturned rim 53, although shown as a separate element, can be integrally incorporated into the plate 50.

A still further embodiment of an impeller in accordance with the instant invention identified as 11" as illustrated in the partial sectional view of FIGURE 8. In this embodiment, the impeller blades 21 and the inlet ring 17 are substantially identical to those shown in the embodiment of FIGURE 1 and have been given like reference characters.

Additionally, there is provided a disc 12 provided by a back plate 56 which includes a flat area 57 connected by any conventional means to the flat tabs 24 of the blades 21. The back plate 56 further includes an upturned rim 58 which is formed in a frusto conical or dish shaped manner similar to that disclosed in the embodiment of FIGURE 7. The function and design of the upturned rim 58 is similar to that described with respect to the upturned rim 53 of FIGURE 7.

The back plate 56 further includes a central depression 59 which forms a second frusto conical portion for recetpion of a portion of the drive motor 32. It is to be understood that by providing the depression 59 it is possible to mount the drive motor 32 further into the space between the blades 21, thereby lowering the profile of the over all ventilator. The back plate 56 also includes at the bottom of depression 59 a generally flat portion 61 which is secured to the flange 15 by any conventional means such as rivets or bolts.

This embodiment has the advantage of reducing the height of the profile of the ventilator so that the top of the ventilator may, if desired, be made flat, thereby completely eliminating the dome shaped roof 31 shown in FIGURE 6. This design also eliminates the need for the upper wall 34 of the impeller chamber 33 by reason of the upturned rim 58.

In operation of the impeller of the present invention, as the impeller is driven by motor 32, air is drawn through the inlet ring 17 of the impeller and is discharged from the outer portions 23 of blades 21 by centrifugal force at an oblique angle of approximately 45° with rescepct to the axis of the impeller. This oblique discharge of air from the impeller is particularly advantageous in that it contributes to smooth air flow through the impeller since the fluid entering the full open inlet ring of the impeller is not required to be diverted directly radially as in the case of conventional centrifugal fan impellers, but rather is only propelled diagonally outwardly from its original axial path of movement when it enters the impeller inlet ring. This smooth flow of air results in the impeller operating at a relatively low noise level as compared with most conventional centrifugal fans.

It is readily apparent that the fan impeller of the present invention offers many significant advantages. As stated previously, the capacity of the impeller may be readily adjusted merely by changing the angle and/or extent of curvature of the outer tip portions or trailing edges 29 of the blades. This feature of each of the blades being readily adjustable to provide varying capacities and power requirements for the impeller makes the impeller very economical in that it permits the same basic blade pattern to be used for different capacity impellers and ventilators of different power requirements. Rather than having to construct several different sizes of blades, only the outer tip portions of the blades need to be changed in order to construct an impeller having a different capacity. Added performance and improved non-turbulent air flow for the impeller may also be obtained as previously stated by curving the end edge segments 28 of the inner portions 22 of the blades toward the normal direction of impeller rotation. Such curving of the end edge segments also contributes to the discharge of air at a high velocity in an axial direction along the blades so that the air then flows smoothly in an oblique direction from the impeller rather than in the usual radial discharge direction.

Other advantages of the fan impeller of the present invention reside in the fact that it permits a larger impeller inlet area in relation to the impeller diameter, thus providing a reduced air inlet velocity for a given air flow capacity. This, of course, reduces the noise level of the impeller in operation while still delivering a maximum volume of fluid. The fact that the generally cylindrical inlet ring may be constructed from strip stock by rolling it into a generally channel or angular shaped configuration also permits significant economy in construction of the fan as well as considerable strength and durability.

The impeller may be constructed of any suitable materials. The blades preferably are formed from sheet metal stock, while the inlet ring may be formed from any suitable strip stock material. In addition, if desired, the entire fan impeller may be coated with plastic such as polyvinyl dichloride to better adapt it for an installation where corrosive fumes are encountered. Moreover, such a plastic coating offers a wide variety of different colors so that the impeller may readily be adapted to conform in appearance with any particular building color or design.

A further advantage of the fan impeller of the present invention resides in the fact that it permits the discharge of air outwardly and axially at an oblique angle with respect to the axis of the impeller, thus adapting it for use in recessed or nested locations. Moreover, the conical configuration of the outer portion of the impeller leaving a recessed area in the center of the impeller permits it to be used to discharge the air around an obstruction such as a motor compartment. The additional blade depth resulting from this conical configuration of the peripheral portion of the impeller does not require increase in the over all height of the finished unit since the motor or drive components can be recessed into the conical cavity of the impeller such as shown in the ventilator illustrated in FIGURE 6.

Although the present invention has been illustrated and described with reference to specific embodiments, it will be understood that various modifications may be made by persons skilled in the art without departing from the spirit of the invention which is defined solely by the appended claims.

What is claimed is:

1. A fan impeller constructed substantially of sheet material stock comprising:
   a generally circular disc,
   an inlet ring having an axially extending generally cylindrical portion to provide a maximum air inlet area to said impeller,
   a plurality of circumferentially spaced blades connected between said disc and said ring,
   each of said blades having an inner and an outer portion and being angularly disposed with respect to a radial plane intersecting the blade and the axis of said impeller whereby said outer portion thereof is generally disposed at an angle to the normal direction of rotation of said impeller,
   said outer portion projecting outwardly and axially from said inner portion to permit fluid moved by said impeller to be discharged peripherally therefrom at an oblique angle with respect to the axis of said impeller and said outer portion projecting radially outwardly beyond the periphery and axially from said inlet ring with said inner portion extending inwardly relative to said inlet ring.

2. A fan impeller as recited in claim 1 wherein the end edge segment of said inner portion is curved toward the normal direction of rotation of said impeller.

3. A fan impeller as recited in claim 1 wherein the

outer tip of said outer portion is curved away from the normal direction of rotation of said impeller.

4. A fan impeller as recited in claim 1 wherein the end edge segment of said inner portion is curved toward the normal direction of rotation of said impeller and the outer tip of said outer portion is curved away from the normal direction or rotation of said impeller.

5. A fan impeller as recited in claim 1 wherein the fluid is discharged peripherally from said impeller at an angle of approximately 45° with respect to the axis of said impeller.

6. A fan impeller as recited in claim 1 wherein said outer portion of each of said blades is generally disposed at an angle of approximately 45° with respect to a radial plane intersecting the blade and the axis of said impeller.

7. A fan impeller as recited in claim 1 wherein said disc is of a smaller diameter than the diameter of said impeller and the outer blade portons define at the axial ends of the impeller a conical configuration encircling said disc.

8. A fan impeller as recited in claim 1 wherein said outer portion of each of said blades extends outwardly substantially beyond the periphery of said disc.

9. A fan impeller as recited in claim 1 wherein said inwardly extending first portion of the blade includes a flat section, and each blade further includes a mounting extension integral with said flat section and bent at an angle of said flat section for connection to said disc.

10. A fan impeller as recited in claim 1 wherein said generally circular disc includes an upturned rim on the outer periphery thereof for guiding the discharge of the fluid at an oblique angle with respect to the axis of the impeller.

11. A fan impeller as recited in claim 1 wherein said generally circular disc includes a central depression which extends downwardly into an area between the inner portions of the blades.

12. A fan impeller as recited in claim 1 wherein said generally circular disc includes an upturned rim on the outer periphery thereof for guiding the discharge of the fluid at an oblique angle with respect to the axis of the impeller, and further includes a central depression which extends downwardly into an area between the inner portions of the blades.

13. A fan impeller comprising:
- a circular disc,
- an inlet ring,
- a plurality of circumferentially spaced blades connected between said disc and said ring,
- said disc being of a smaller diameter than the diameter of said impeller,
- each of said blades having a mounting extension at its opposite ends for connection with said disc and said ring, respectively,
- each of said blades having an inner and an outer portion and being angularly disposed with respect to a radial plane intersecting the axis of said impeller whereby said outer portion thereof is generally situated at an angle extending away from the normal direction of rotation of said impeller,
- said outer portion projecting outwardly and axially from said inner portion beyond the periphery of said disc to permit fluid moved by said impeller to be discharged peripherally therefrom at an oblique angle with respect to the axis of said impeller.

14. A fan impeller as recited in claim 13 wherein said mounting extension connected to said disc lies in a plane which is perpendicular to the axis of the impeller.

15. A fan impeller as recited in claim 13 wherein said mounting extension connected to said ring is slightly curved to conform to the curvature of the ring and lies in a curved plane which is parallel to the axis of the impeller.

16. A fan impeller as recited in claim 13 wherein the end edge segment of said inner portion is curved toward the normal direction of rotation of said impeller.

17. A fan impeller as recited in claim 13 wherein said inner portion of each blade includes a flat section immediately adjacent the mounting extension connected with said disc, and said mounting extension is formed integral with said flat section of the blade bent at an angle to said flat section to mate with said disc.

18. A fan impeller as recited in claim 13 wherein said disc includes an upturned rim on the outer periphery thereof for guiding the discharge of the fluid at an oblique angle with respect to the axis of the impeller.

19. A fan impeller as recited in claim 13 wherein said disc includes a central depression which extends downwardly into an area between the inner portions of the blades.

20. A fan impeller as recited in claim 13 wherein said disc includes an upturned rim on the outer periphery thereof for guiding the discharge of the fluid at an oblique angle with respect to the axis of the impeller, and further includes a central depression which extends downwardly into an area between the inner portions of the blades.

21. A fan impeller comprising
- a circular disc,
- an inlet ring,
- a plurality of circumferentially spaced blades connected between said disc and ring,
- said disc being of a smaller diameter than the diameter of said impeller,
- each of said blades having a mounting extension at its opposits ends for connection with said disc and said ring,
- each of said blades having an inner and an outer portion and being angularly disposed with respect to a radial plane intersecting the axis of said impeller whereby said outer portion thereof is generally situated at an angle extending away from the normal direction of rotation of said impeller,
- said outer portion having its outer tip thereof curved away from the normal direction of rotation and said inner portion having its end edge segment thereof curved toward the normal direction of rotation of said impeller,
- said outer portion projecting outwardly and axially from said inner portion beyond the periphery of said disc, said outer blade portions thus defining a conical configuration at each end of the impeller at the impeller periphery to permit fluid moved by said impeller to be discharged peripherally therefrom at an oblique angle with respect to the axis of said impeller.

22. A fan impeller as recited in claim 21 wherein said mounting extension connected to said disc lies in a plane which is perpendicular to the axis of the impeller, and
- said mounting extension connected to said ring is slightly curved to conform to the curvature of the ring and lies in a curved plane which is parallel to the axis of the impeller.

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