Dec. 7, 1965 C. J. TRICKLER ETAL 3,221,983

CENTRIFUGAL FAN

Filed Dec. 6, 1963 2 Sheets-Sheet 1

FIG. 1

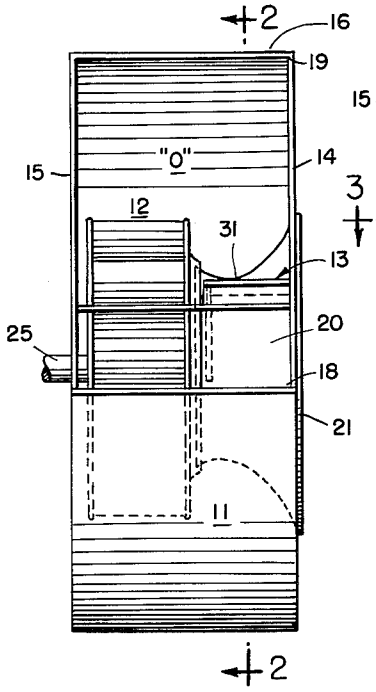

FIG. 2

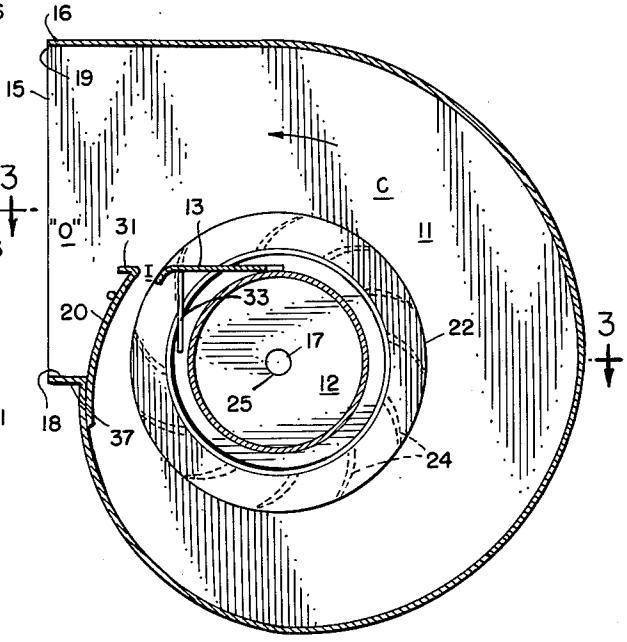

FIG. 4

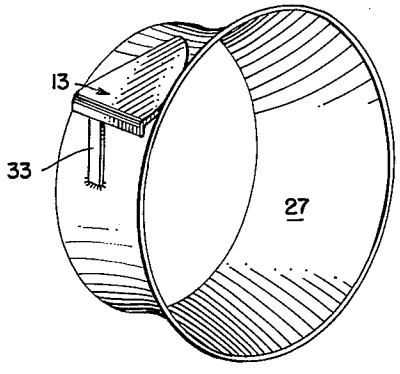

FIG. 3

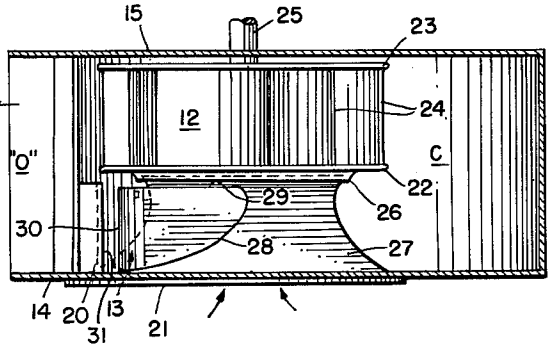

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FIG. 5

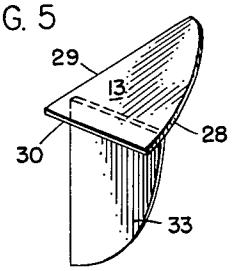


FIG. 6

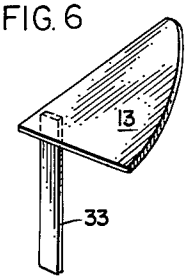


FIG. 7

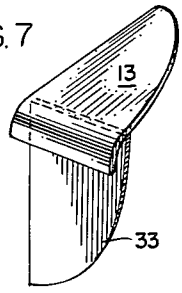


FIG. 8

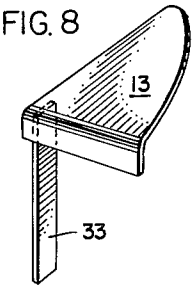


FIG. 9

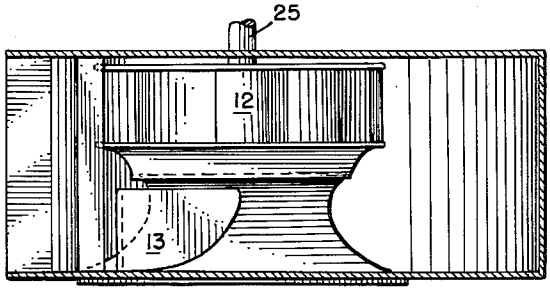
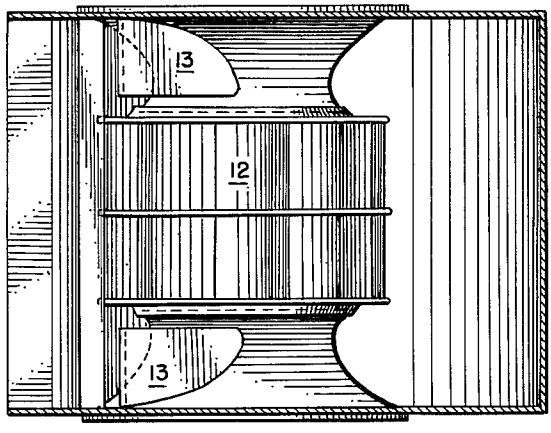


FIG. 10



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United States Patent Office 3,221,983 Patented Dec. 7, 1965

3,221,983

CENTRIFUGAL FAN

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Filed Dec. 6, 1963, Ser. No. 328,600
5 Claims. (Cl. 230—127)

This invention relates to improvements in the construction of centrifugal fans.

Centrifugal fans, of the type to which this invention relates, involve a fan-wheel rotatively mounted in a scroll-type housing having an axial air-inlet and an air-outlet in a plane parallel to the axis of rotation. The air flow is drawn in axially by the fan-wheel from the housing air-inlet and discharged peripherally therefrom into the housing structure to effect an enlarging spiral flow to a housing air-outlet. Generally, the fan-wheel comprises a series of circumferentially-spaced, radially-extending blades fixed between a pair of axially spaced plates. An annular element spans the housing interior to connect the housing air-inlet with the fan-wheel air-inlet.

It is well known that there are two distinct types of air currents that tend to circulate around the inside of this spiral or volute housing chamber. One of these air currents is close to the front or air-inlet plate of the fan-wheel. This current is caused by the "skin" friction of this front plate dragging the air along with it. Because of the high velocity of the fan-wheel rotation this skin-friction-induced air current tends to concentrate adjacent the face of this front plate and move at a speed much faster than the more distant portions of the air flow through the housing.

The other type of air current is one that tends to circulate in the housing around the annular element or inlet cone. Such circulation tends to cause some of the air flow, induced by the fan-wheel, to recirculate through the space between the fan-wheel and the annular element instead of discharging through the housing air-outlet.

Many have been the attempts to reduce or eliminate this second air current to the end of increasing the over-all efficiency of such centrifugal fans. The problem, however, has been to achieve such an increased air-discharge without interfering with the high-velocity, "skin"-induced current adjacent the fan-wheel plate, and without causing turbulence and instability.

This invention relates to centrifugal fans generally, and specifically to centrifugal fans designed to operate with stable flow characteristics through a wide range of flow volume versus pressure ratios, and at the same time operating relatively quiet and with high efficiencies. Fans of this character pertain to those commonly having blades inclined backwardly in relation to their rotation and with blade cross sections of air-foil shape, curved single thickness or straight single thickness. Such centrifugal fans, designed for high efficiencies, often tend to be unstable in performance at one or more ratios of volume to pressure.

The main objects of this invention are: to provide a centrifugal fan with an improved diverter for limiting the re-circulation of the low-velocity air current around the air-inlet element while leaving space between the diverter and cut-off or housing to allow enough air to flow to retain stability; to provide an improved diverter of this kind structured and mounted on the air-inlet element so as to avoid interfering with the relatively high velocity air-current set up by the inner plate of the fan-wheel; and to provide an improved diverter of this kind of such simple form as to permit variously-contoured adaptations for various mounting in functioning position.

In the adaptations shown in the accompanying drawings;

FIGURE 1 is an elevational view of the discharge end of a centrifugal fan wherein is incorporated a diverter constructed and mounted in accordance with this invention;

FIG. 2 is a vertical, sectional view of the same taken on the plane of the line 2—2 of FIG. 1;

FIG. 3 is a horizontal, sectional view taken on the plane of the line 3—3 of FIG. 2;

FIG. 4 is a perspective view of the air-inlet element whereon this improved diverter is mounted;

FIGS. 5–8 are perspective views of differently-contoured diverters and mounting therefor constructed in accordance with this invention;

FIG. 9 is a modified form of fan-wheel air-inlet structure mounting a diverter constructed in accordance with this invention; and

FIG. 10 is a view showing a double fan-wheel construction with diverters constructed in accordance with this invention.

The essential concept of this invention involves a diverter, for scroll-type centrifugal fans, in the form of a flat plate contoured and mounted to reduce recirculation of the air current in the fan-wheel housing while allowing a small amount of air to pass between the diverter and cut-off or housing to stabilize air flow, without interfering with the "skin"-induced air current adjacent the face of the inner plate of the fan-wheel.

The intent of this invention is to provide a fan construction that will cause the fan to have a stable performance through a much greater range of volume to pressure ratios than is ordinarily experienced, to develop higher efficiencies, and operate more quietly than heretofore obtained with this type of centrifugal fan.

A centrifugal fan embodying the foregoing concept and designed to realize the above expressed intent comprises a scroll-type housing 11, enclosing a fan-wheel 12 between which is arranged a diverter plate 13.

The housing 11 is a conventional structure formed of sheet-metal side walls 14 and 15 and a peripheral covering 16 bonded together along their respective perimeters. The side walls 14 and 15 have identical volute perimeters centered about a predetermined axis 17 and at their opposite inner and outer extremities terminate in parallel portions 18 and 19. The covering 16, bonded along its perimeters to the respective perimeters of the side walls 14 and 15, defines a volute chamber C of rectangular cross-section embracing the fan-wheel 12 and terminating in an enlarged air-discharge outlet O. The wall 14 is formed with an air-inlet 21.

The housing 11 herein shown includes a particular form of cut-off sheet 20, shaped to continue upwardly and inwardly the volute air-flow chamber C embracing the fan-wheel 12. The use of such a cut-off sheet 20, of course, is optional. Its use depends upon the over-all conditions under which the centrifugal blower is to be used. When used, such a cut-off sheet 20 may extend across only the major portion of the space between the housing wall 14 and the fan-wheel 12, as shown in FIG. 3, or it may extend entirely across the space between the housing sides 14 and 15, as shown in FIGS. 9 and 10.

The fan-wheel 12 is a more or less conventional structure comprising a pair of inner and outer plates 22 and 23 secured in axially-spaced relationship by an annular series of radially-disposed vanes 24. The dimension of the plates 22 and 23 and the shape and dimensions of the vanes 24 may well depend upon the particular use whereto such a centrifugal blower is to be put. The fan-wheel 12, as here shown, is fixed to a shaft 25 journaled on suitable bearing (not here shown) on the side walls 14 and 15 concentric with the axis 17 of the housing volute chamber C. The inner plate 22 has a central air opening 26 which is communicatively connected by

an annular element 27 to the air-inlet 21 of the housing wall 14.

The element 27, often referred to as an "inlet-cone," here is shown of concave annular form tapered inwardly from the larger diameter air-inlet 21 in the housing wall 14 to the smaller diameter air-inlet 26 in the fan-wheel plate 22.

The diverter 13 is shown herein as a flat plate with the edge 28 contoured to fit the curved annular wall of the element 27 and subtending a right angle formed by the two other edges 29 and 30.

FIGS. 5 and 6 show this diverter plate 13 perfectly flat, whereas FIGS. 7 and 8 show a portion thereof marginal to the edge 30, curved downward toward the element 27.

The dimensions and positioning of such a diverter plate 13 are critical to achieving the test-proven results which have been obtained therewith in centrifugal blowers of this type. Such a diverter plate 13 is mounted on the element 27 so that the plane of the diverter is disposed in substantial alignment with that portion of the housing 11 which defines the axially-disposed inner perimeter of the housing air-outlet O most nearly adjacent the fan-wheel 12. That inner perimeter may be the upper end 31 of the cut-off when this is used, or the terminal flange 37 of the covering 16 (see FIG. 2). Experience has proved that the best performance is obtained by the foregoing alignment, however, if the diverter 13 is positioned a short distance either above or below the points 31–37 the apparatus performs extremely well. Therefore such positioning is within the scope of this invention.

A suitable mounting 33 is required for fixing the diverter plate 13 in its proper relationship to the element 27 and the fan-wheel 12. This must be such that the contoured edge 28 is in contact with the exterior face of the element 27 and, as is most important, with the edge 29 properly spaced parallel with and at the requisite distance from the plate 22 of the fan-wheel 12. Such spacing may have to be determined by testing. It must be such that the plate 13 has the maximum effect in reducing to a minimum the tendency of the air current to recirculate in the chamber C and the minimum interference with the "skin"-induced air current caused by the fan-wheel plate 22.

Similarly the distances between diverter edge 30 and cut-off 31 or housing 37 must be small enough to cause most low-velocity air to pass out through the fan discharge, yet large enough to induce the proper amount of air to recirculate and prevent the formation of turbulence under the diverter.

Two forms of mounting 33 are shown for the diverter 13. One is a narrow strip of material (FIGS. 6 and 8). The other is a plate of a form quite similar to the diverter itself (FIGS. 5 and 7). The dimensions and form of a mounting 33 will be determined by the size and contour of the element 27 and/or the location of the inner perimeter 31 or 37 of the housing outlet O. Whatever the form of the mounting 33 it should dispose the plane of the plate 13 in substantial alignment with one or the other of the points 31 and 37, depending upon the use of the cut-off sheet 20.

Such a structuring of the housing 11 about a fan-wheel 12, as herein shown, serves to slow down the air-discharge from the outlet O to a desirable velocity in a manner that effects the greatest possible recovery (regain) of static pressure during the conversion from the high-velocity discharge from the fan-wheel 12.

As noted previously herein, the high velocity rotation of the fan-wheel 12 in the volute chamber C of the housing 11 creates two distinct types of air-current circulating within the chamber C, outside of the fan-wheel 12. One such air-current tends to continue the circular movement created by the fan-wheel and re-enter through the narrow throat I (FIG. 2) between the annular element (inlet-cone) 27 and the inner perimeter of the air-outlet O, as at 31 or 37 (FIG. 2). Such re-circulation of air should be arrested as much as possible to create a larger volume of air-flow through the discharge-outlet O of the housing 11. This is one function of the diverter plate 13.

The other air-current is a high-velocity movement directly adjacent the fan-wheel plate 22. This movement is induced by the "skin friction" of the plate 22 dragging the air with it at nearly the same velocity of the fan-wheel 12. It has been found desirable not to interrupt this second air current. To do so sets up excessive turbulence in the housing 11 which can produce undesirable noise and instability during the operation of the fan. Hence the spacing of the edge 29 of the diverter 13 from the fan-wheel plate 22 is important.

The operation of a centrifugal fan with a diverter constructed and positioned as herein shown will be obvious from the foregoing explanation.

It will be understood that details of the construction shown may be altered or omitted without departing from the spirit of the invention as defined by the following claims.

We claim:

1. A centrifugal fan comprising,
   a. scroll-type housing with one wall having
      an axial air-inlet therein, and an air-outlet in a plane parallel to the axis of rotation,
   b. a fan-wheel with an axial air-inlet in one plate thereof rotatively
      journaled in the housing in axially-spaced relationship to the one wall of the housing,
   c. an annular element connecting the housing air-inlet to the fan-wheel air-inlet, and
   d. a flat diverter plate of a width substantially equal to the axial dimension of the annular element
      having one edge contoured to conform to the exterior of the annular element and subtending a right angle formed by the two other edges thereof,
      being mounted on the annular element with the contoured edge in direct supporting contact with the element and one of the two other edges predeterminedly spaced from the air-inlet wall of the fan-wheel,
      with the other of the two edges spaced from the upper end of the cut-off sheet, and
      having the plane of the diverter plate disposed substantially in alignment with that portion of the housing which defines the axially-disposed inner perimeter of the air-outlet most directly adjacent the fan-wheel and thereby,
      restricting the recirculation of an air current within the housing while allowing a small amount of air to pass through the space between the diverter plate and housing cut-off to stabilize the flow, but
      not interfering with an air current created skin-friction of the air-inlet wall of the fan-wheel, and thereby
      restricting the recirculation of an air current within the housing but
      not interfering with an air current created skin-friction of the air-inlet wall of the fan-wheel.

2. A centrifugal fan as set forth in claim 1 wherein a narrow portion of the diverter plate nearest the housing cut-off is curved inwardly in the direction of the fan rotation toward the annular element.

3. A centrifugal fan comprising,
   a. a scroll-type housing with one wall having
      an axial air-inlet therein and an air-outlet in a plane parallel to the axis of rotation
   b. a fan-wheel with an axial air-inlet in one plate thereof rotatively
      journaled in the housing in axial-spaced relationship to the one wall of the housing,

c. an annular element connecting
the housing air-inlet to the fan-wheel air-inlet, and
d. a flat diverter plate of a width substantially equal to the axial dimension of the annular element
having one edge contoured to conform to the exterior of the annular element and subtending a right angle formed by the two other edges thereof,
being diverter supported on the annular element by a post bonded
at one end of the diverter plate adjacent the right angle formed by the two other edges and
at the other end of the annular element with the contoured edge in direct supporting contact with the annular element and one of the two other edges predeterminedly spaced from the air-inlet wall of the fan-wheel,
with the other of the two edges spaced from the upper end of the cut-off sheet, and
having the plane of the diverter plate disposed substantially in alignment with that portion of the housing which defines the axially disposed inner perimeter of the air-outlet most directly adjacent the fan-wheel, and thereby

restricting the recirculation of an air current within the housing while allowing a small amount of air to pass plate between the diverter and housing cut-off to stabilize the flow, but
not interfering with an air current created skin-friction of the air-inlet plate of the fan-wheel.

4. A centrifugal fan as set forth in claim 3 wherein the edge of the diverter plate nearest the housing cut-off is curved inwardly in the direction of the fan rotation toward the annular element.

5. A centrifugal fan as set forth in claim 3 wherein the post is of a form substantially the same as the plate and is bonded to the plate inwardly adjacent one of the right-angle edges and to the annular element along the contoured edge.

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