July 18, 1939. E. L. ANDERSON 2,166,276

TUNNEL FAN

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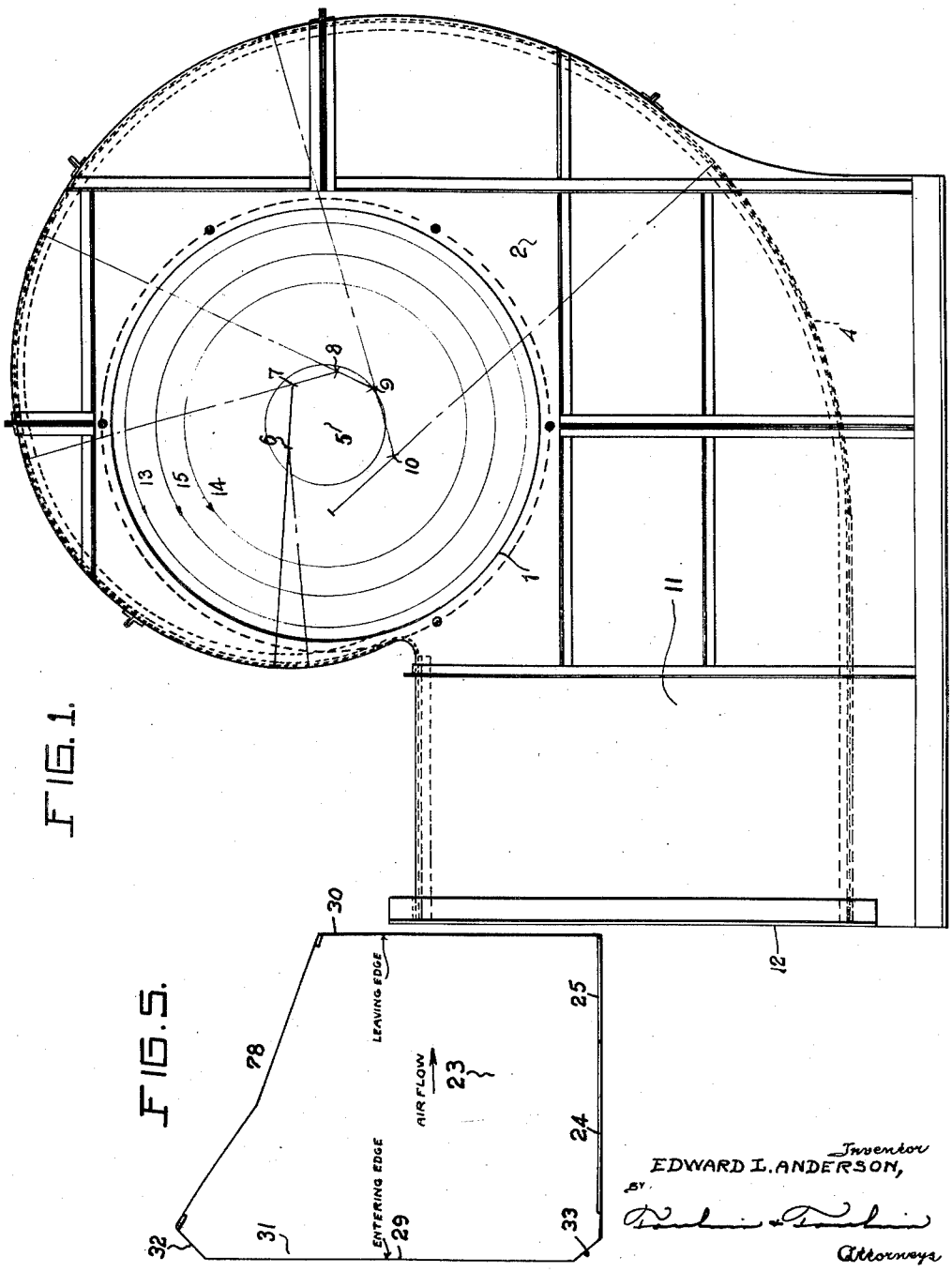


FIG. 1.

FIG. 5.

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FIG. 2.

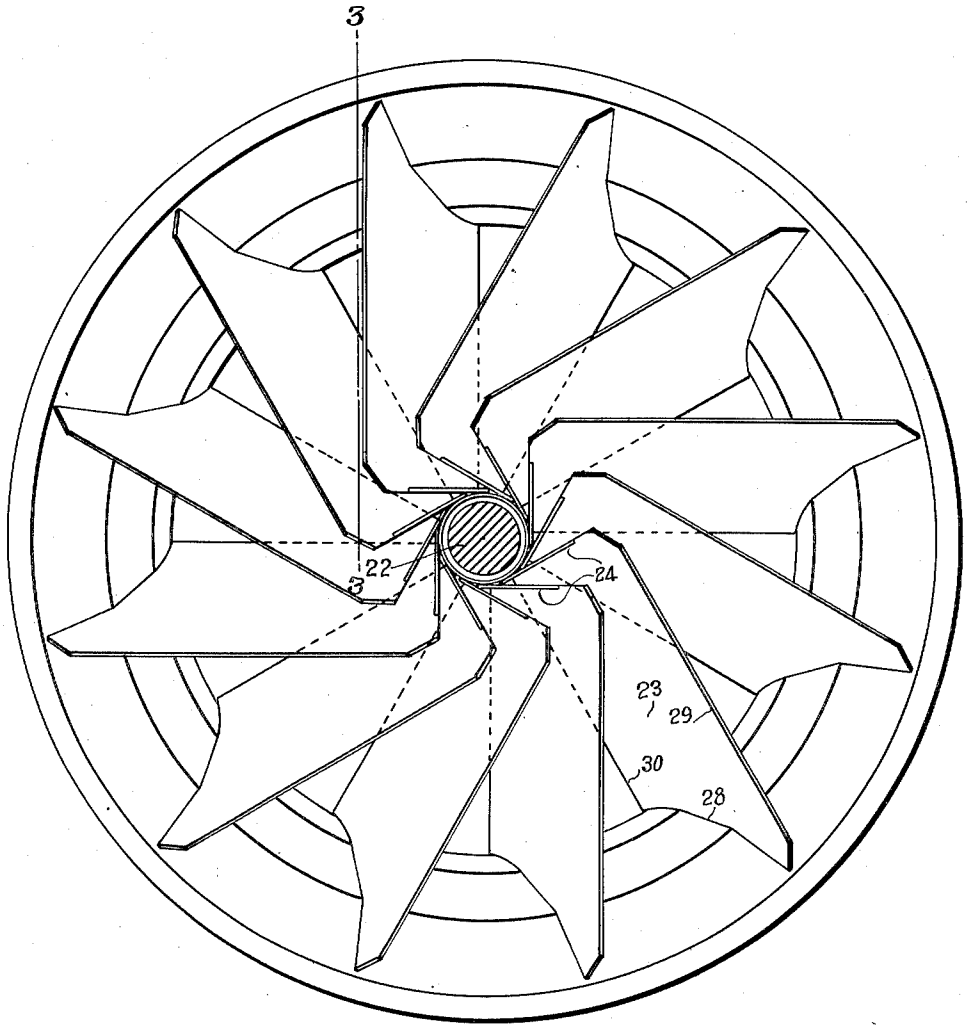
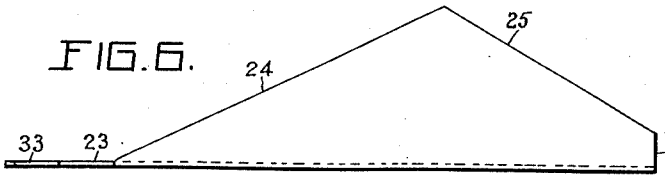


FIG. 6.



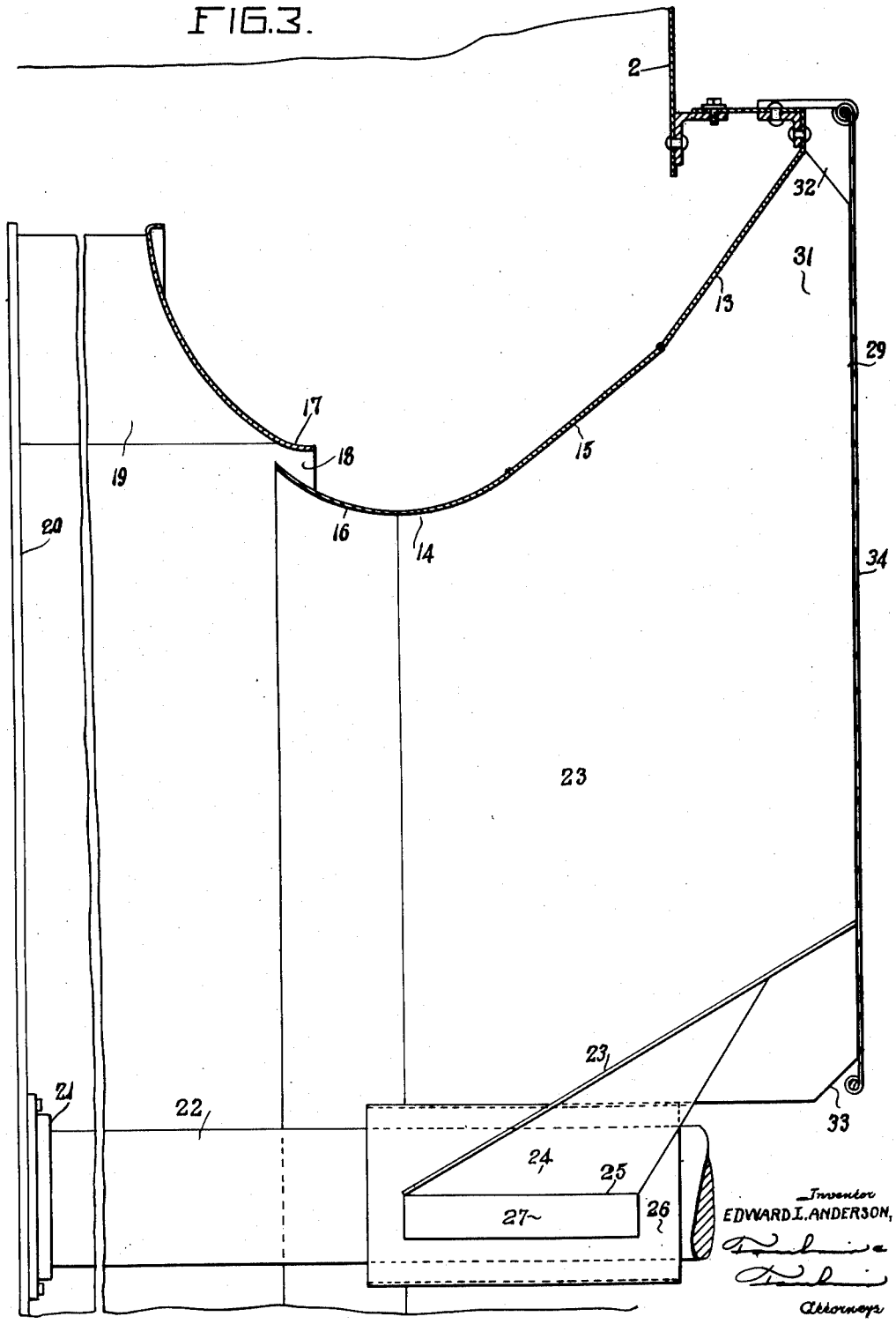
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FIG. 3.



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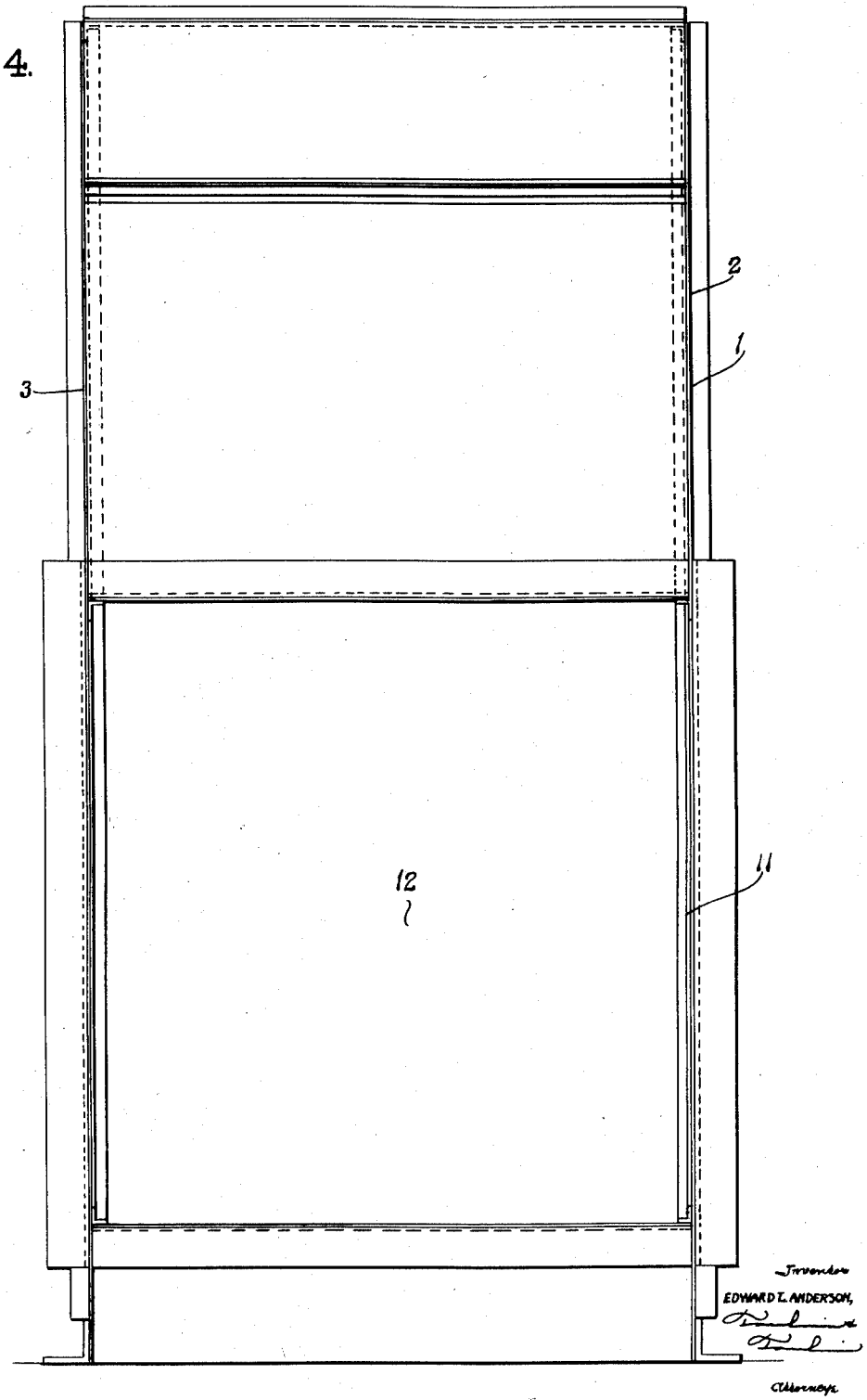
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FIG. 4.



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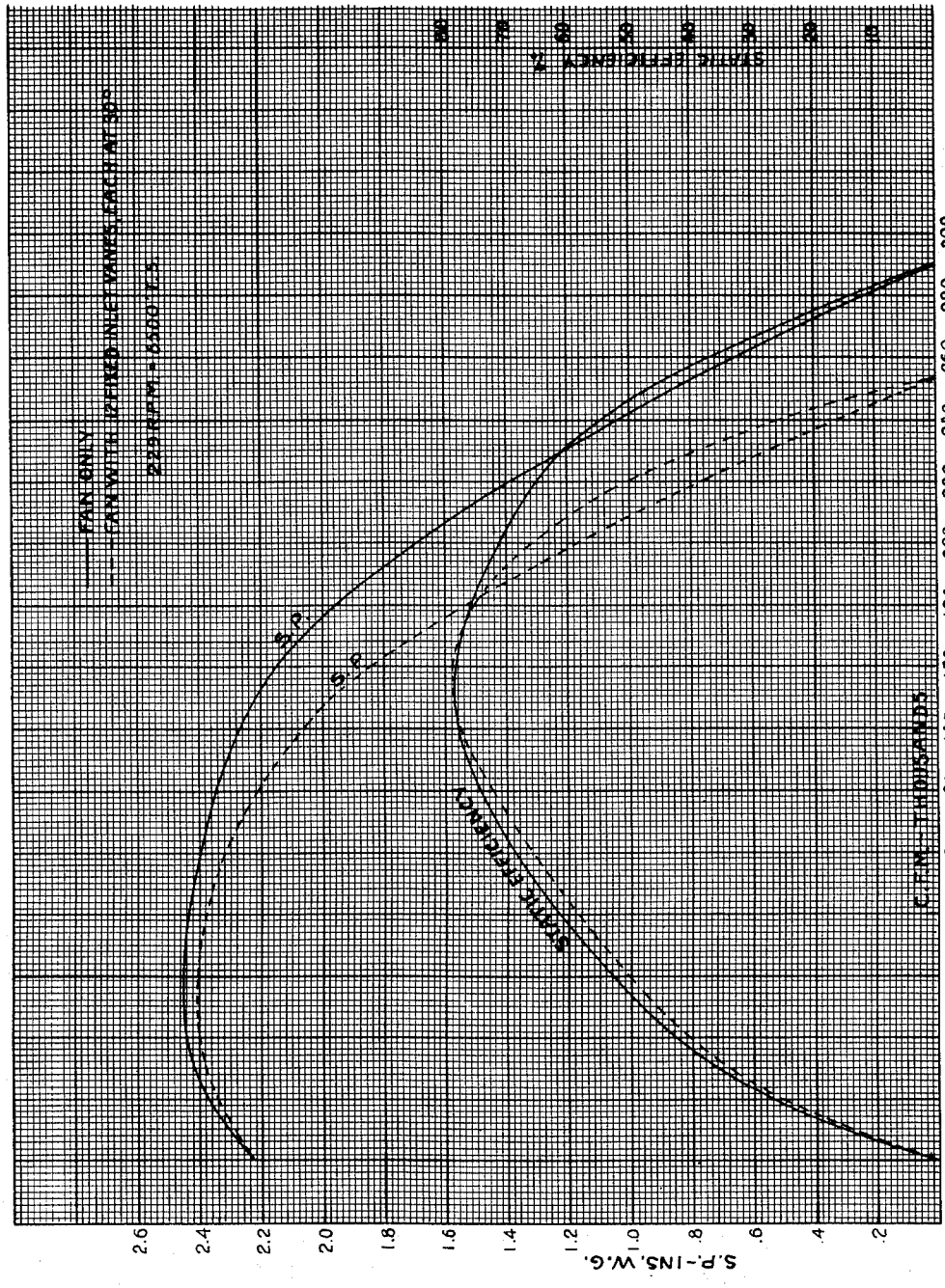


FIG. 7.

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UNITED STATES PATENT OFFICE

2,166,276

TUNNEL FAN

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Application October 6, 1937, Serial No. 167,620

17 Claims. (Cl. 230—114)

My invention relates to fans.

It is the object of this invention to provide a fan in which the change in direction of the flow of the air into the fan is achieved by use of least velocity and the lowest pressure loss.

It is a further object to provide a method of introducing air at the required angle and preventing swirls or readjustment of the angular velocity of the air just prior to entering the wheel of the fan.

It is a further object of this invention to provide means by which the angular direction of the air is altered most rapidly at the largest area where the air enters, and the angular change of direction of the air from this point on becomes less until it is substantially parallel to the shaft at the point of greatest restriction of the section of the inlet of the fan. This line approaches a hyperbolic curve thus changing the angular direction of the air flow at the point of least velocity and consequently the point of least loss, the angular change being less as the area is decreased.

It is a further object to provide inlet vanes of substantially flat sheets having the leaving edges radial to the center line of the shaft, this leaving edge being approximately at the point of least area of the inlet cone. The air entry edge is arranged on an angle dependent upon the amount of effort required by the entering vane. It is non-parallel to the axis of the shaft, this line being determined purely by the angle of the blade as the inlet blade is rotated around the leaving edge, which is radial to the shaft.

The reason for the use of inlet vanes is that the characteristics of the fan may be altered by rotating the air in the direction of the wheel rotation by the use of vanes thus changing the relation of the shaft revolutions per minute to a given pressure. The greater this angle, the less the pressure for a given speed. It is possible to change the direction of the air entry up to and including an angle of 30 degrees without affecting the efficiency of the fan. Up to 30 degrees, the efficiency in that part of the curve where the pressures are fairly high, is greater than that of a fan having no such inlet vanes.

It is a further object to provide a fan casing having a scroll which is not a true volute.

Referring to the drawings:

Figure 1 is a diagrammatic view of the scroll casing of the fan showing the points of description of the scroll. The inlet blades of the fan and the fan are not indicated for the purpose of clarity.

Figure 2 is a front elevation of the inlet side of the fan with a shaft in section.

Figure 3 is a section on the line 3—3 of Figure 2.

Figure 4 is a view of Figure 1 looking from the left end of Figure 1.

Figure 5 is a plan view of one of the air entry blades.

Figure 6 is an end elevation thereof, showing the angle extension of the blade, which is used to attach it to the sleeve about the axle of the fan.

Figure 7 is a diagrammatic view showing a curve illustrating the features of advantage of the fan of this invention.

Referring to the drawings in detail, 1 designates an inlet opening of a scroll casing having side walls 2 and 3. This casing has a volute wall 4. The angular advance or increase of the scroll is not a true volute. It varies in more than two of its points out of the true volute circle. 5 represents the center of the inlet opening 1. The points 6, 7, 8, 9 and 10 are points about which portions of the scroll are described. 11 designates the discharge passageway, and 12 designates the discharge opening for the air that is discharged.

The air inlet opening 1 is provided with an air inlet passageway having two cones of different angles. The angular direction of the air is altered more rapidly at the larger area defined by the conical portion 13. This is the entry area. The angular change of direction from this point on becomes less until it is vertically parallel to the shaft at the point of greatest restriction at the inlet chamber, such as at 14. Intermediate 13 and 14 is the section 15 which is arranged at a lesser angle than the section 13. This line of flow which approaches a hyperbolic curve thus changes the angular direcetion of air flow at the point of least velocity and consequently the point of least loss, the angular change being less at the area is decreased.

The inner end of this conical inlet having the several sections described, is provided with an inwardly flaring section 16, which overlaps the vane shroud 17 to form a reentry air space to provide the maximum flow over the outer ends of the fan blades 19. These blades are carried upon the back disc 20, which is in turn mounted upon the hub 21 of the driving shaft 22.

In this inlet passageway composed of these several sections are a plurality of guide vanes 23, the outer ends of which are fastened, preferably by welding, to the inner side of the inlet passageway sections 13, 14 and 15. The axle end

of the blade 23 is turned at right angles, as at 24. The edge 25 lies against the sleeve 26. It may be supported by a strip 27 mounted on the sleeve. The edge of the blade 23 that engages the conical inlet is designated 28. The air entering edge is 29, and the leaving edge is 30. This entering edge 29 projects beyond the conical inlet as at 31 and has outer cut-off ends 33. A protecting screen 34 is suspended over the inlet.

It will thus be seen that the inlet vanes are comprised of flat sheets 23 having leaving edge 30 radial to the center line of the shaft 22. This leaving edge is approximately the point of the least area of the inlet cone. The air entering edge 29 is on an angle dependent upon the amount of effort required for the vane 23. It is non-parallel to the axis of the shaft. This line is determined purely by the angle of the blade as the inlet blade is rotated around the leaving edge 30 which is radial to the shaft 22.

The change in direction in the flow of the air is therefore achieved at the point of least velocity and lowest pressure loss. The leaving edge of the blade acts purely as a means of introducing air at the required angle into the fan, and to prevent swirls or readjustment of the angular velocity just prior to entering the fan wheel. The characteristics of the fan may be altered by rotating the air in the direction of the wheel rotation by use of these vanes 23, thus changing the relation of the shaft revolutions per minute to a given pressure. The greater this angle, the less the pressure for a given speed. It is possible to change the direction of air entry up to and including an angle of 30 degrees without effecting the efficiency of the fan. The efficiency in the curve where the pressures are fairly high, is greater than that of a fan having no such inlet vanes.

With reference to the diagram or curve of Figure 7, the full lines indicate the performance of the fan only without the inlet vanes. The dotted lines indicate the performance with the inlet vanes of this invention. It will be seen that the characteristics of the fan are altered considerably by rotating the air in the direction of the wheel rotation by use of the vanes, thus changing the relationship of shaft R. P. M. to a given pressure. The greater this angle, the less the pressure for a given period. It is possible to change the direction of air entry up to and including an angle of thirty degrees without affecting the efficiency of the fan with the result that where the pressures are fairly high, the efficiency is greater than that of a fan having no such inlet vanes, as shown in Figure 7.

Method of operation

The method of operation of this fan is as follows. By the use of successive cones of different angularity in inlet followed by a rolled section the angular direction of the air is altered most rapidly at the area of largest cross section of the body of the entering air. The angular change of direction of the air from this point on becomes less until it is virtually parallel to the shaft at the point of greatest restriction of the rolled section. This line approaches a hyperbolic curve. Thus the changes of the angular direction of the air flow occur at the point or area of least velocity, and consequently the point of least loss because the angular change of direction of the air becomes less as the cross sectional area of the body of the air is decreased.

With reference to the inlet vanes and their cooperation in this combination, the air entering edge is located on an angle depending upon the amount of effort required for the vane. The non-parallel disposition of the edge to the axis of the shaft of the fan is determined by the angle of the blade as the inlet blade is rotated around the leaving edge, which is radial to the shaft. The change in direction of the flow of the air is therefore achieved at the point of least velocity and lowest pressure loss. The leaving edge of the blade acts as a means of introducing the air at the required angle to prevent swirls or readjustment of the angular velocity just prior to entering the wheel. The reason for the use on the inlet vanes is that the characteristics of the fan may be altered considerably by rotating the air in the direction of the wheel rotation by the use of the vanes, thus changing the relations of shaft R. P. M. to a given pressure. The greater this angle, the less the pressure for a given speed. It is possible to change the direction of the air entry up to and including an angle of 30 degrees without affecting the efficiency of the fan. Up to 30 degrees, the efficiency in that part of the curve where the pressures are fairly high, is greater than that of a fan having no such inlet vanes. The pressure of a scroll that is not a true volute improves the efficiency of this combination.

It will be understood that I desire to comprehend within my invention such modifications as may be clearly embraced within the claims and scope of my invention.

Having thus fully described my invention, what I claim as new and desire to secure by Letters Patent, is:

1. In a fan, the combination of a fan casing, a fan rotor and a plurality of flat air inlet vanes the maximum dimension of which is at right angles to the fan rotor axis and characterized by having the leaving edge thereof radial to the axis of the rotor, and the entry edge of the fan non-radial thereto, each of said vanes comprising flat sheets, except adjacent the points of attachment of the inner and outer edges thereof.

2. In combination in a fan of a casing, a rotor mounted on a shaft, an inlet passageway extending into said casing and a plurality of flat inlet vanes the maximum dimension of which is at right angles to the fan rotor axis, the entry edge of which is non-radial to said shaft and the leaving edge of which is radial to the shaft.

3. In combination in a fan of a casing, a rotor mounted on a shaft, an inlet passageway extending into said casing and a plurality of flat inlet vanes the maximum dimension of which is at right angles to the fan rotor axis, the entry edge of which is non-radial to said shaft and the leaving edge of which is radial to the shaft, the inner ends of said vanes being bent at right angles to the main portion of the vane to form a means of supporting said vane with its edges as described.

4. In combination in a fan having an inlet passageway of a plurality of flat sheet inlet vanes the maximum dimension of which is at right angles to the fan rotor axis with the entering edge thereof non-parallel to the axis of the shaft and with the leaving edge radial to the shaft, and means for positioning the vanes at approximately the point of least area and minimum cross section of the inlet passageway.

5. In combination, in a fan of a fan housing having an inlet passageway and a rotor within said casing having a shaft disposed on the axis

of said inlet passageway, a central sleeve surrounding said shaft, a plurality of flat inlet vanes the maximum dimension of which is at right angles to the fan rotor axis and disposed at an angle to the axis of the shaft so that the faces of the vanes are presented outwardly in the direction of the entering air, and with the entering edges of said vanes arranged non-radially of said shaft and the leaving edges of the vanes arranged radially of the shaft adjacent the fan rotor.

6. In combination, in a fan of a fan housing having an inlet passageway and a rotor within said casing having a shaft disposed on the axis of said inlet passageway, a plurality of flat inlet vanes the maximum dimension of which is at right angles to the fan rotor axis and disposed at an angle to the axis of the shaft so that the faces of the vanes are presented outwardly in the direction of the entering air, and with the entering edges of said vanes arranged non-radially of said shaft and the leaving edges of the vanes arranged radially of the shaft adjacent the fan rotor, and means for supporting the inner ends of said vanes comprising angular portions thereof connected to a central sleeve mounted around said shaft and a sleeve so mounted in spaced relationship with respect to said shaft adapted to support the inner ends of said vanes.

7. In combination, a fan casing, a rotor therein having a shaft extending through an inlet passageway and means for forming an inlet passageway comprising a generally conical inlet body consisting of two flat conical sections of different angularity and a rolled arcuate section so arranged that the angle direction of the air is altered most rapidly at the largest area at the entry point and the angular change of the direction of air from this point inwardly becomes less until it is virtually parallel to the shaft at the point of greatest restriction of the rolled section of the inlet passageway.

8. In combination, a fan casing, a rotor therein having a shaft extending through an inlet passageway and means for forming an inlet passageway comprising a generally conical inlet body consisting of two flat conical sections and a rolled arcuate section so arranged that the angle direction of the air is altered most rapidly at the largest area at the entry point and the angular change of the direction of air from this point inwardly becomes less until it is virtually parallel to the shaft at the point of greatest restriction of the rolled section of the inlet passageway, and a plurality of flat inlet vanes the maximum dimension of which is at right angles to the fan rotor axis and angularly disposed with respect to said shaft having their outer edges mounted on the inside of said inlet passageway and their inner edges connected to one another about said shaft in such a manner that the entering edge of the vanes is non-radial to the shaft and the leaving edges are radial to the shaft.

9. In combination, in a fan of an inlet passageway comprising flat sections of different decreasing angularity with respect to the axis of the passageway and an inner arcuate section whose maximum inner diameter is greater than the minimum diameter of the inlet passageway.

10. In combination, in a fan of an inlet passageway comprising flat sections of decreasing angularity with respect to the axis of the passageway and an inner arcuate section whose maximum inner diameter is greater than the minimum diameter of the inlet passageway, and a plurality of flat vanes mounted in and upon said passageway with the side thereof facing outwardly, the entry edges thereof being arranged non-radially of the axis of the passageway and the leaving edges thereof being arranged radially thereof.

11. In combination, in a fan of an inlet passageway comprising flat sections of decreasing angularity with respect to the axis of the passageway and an inner arcuate section whose maximum inner diameter is greater than the minimum diameter of the inlet passageway, and a plurality of flat vanes mounted in and upon said passageway with the side thereof facing outwardly, the entry edges thereof being arranged non-radially of the axis of the passageway and the leaving edges thereof being arranged radially thereof, and angularly disposed means on the inner ends of said vanes for attaching them to a sleeve, and a sleeve for supporting said inner ends arranged axially of the axis of said passageway.

12. In combination, a fan housing, a rotor mounted therein having a shaft projecting through, an entry opening in said housing, a generally conical inlet passageway comprising a series of flat sections of different decreasing angularity with respect to the axis of said shaft and an inner arcuate section whose maximum inner diameter is greater than the minimum diameter of the inlet passageway arranged in overlapping spaced relationship with respect to the rotor.

13. In combination, a fan housing, a rotor mounted therein having a shaft projecting through, an entry opening in said housing, a generally conical inlet passageway comprising a series of flat sections of decreasing angularity with respect to the axis of said shaft and an inner arcuate section whose maximum inner diameter is greater than the minimum diameter of the inlet passageway arranged in overlapping spaced relationship with respect to the rotor, and a plurality of flat inlet vanes having their faces disposed at an angle to the entering air, said vanes being located with their outer ends engaging inlet passageway and inlet edges non-radial to said shaft and their leaving edges radial to said shaft.

14. In combination in a fan, a casing, a rotor therein, an inlet passageway restricted between its ends and guide vanes in said passageway, said passageway being of such angular section with respect to the axis of the passageway that the angular direction of the air is altered most rapidly at the maximum area of the passageway at the entry point and the angular direction of air inwardly becomes less as guided by the passageway until it is virtually parallel to the rotor shaft at the point of minimum diameter of the inlet passageway, and said vanes being so arranged that they are presented at an angle of not more than approximately 30 degrees with respect to the direction of entry of the air, said vanes having their entering edges non-radial to the rotor shaft and their leaving edges radial thereto.

15. In combination, a fan casing, a rotor therein and an inlet conical passageway restricted between its ends having conical sections of different angularity and a plurality of inlet vanes angularly disposed with respect to the direction of the entry of air with their entering edges non-radial and their leaving edges radial to the axis of the rotor shaft.

16. In combination, a fan casing, a rotor therein and an inlet conical passageway restricted between its ends having conical sections of different angularity and a plurality of inlet vanes angularly disposed with respect to the direction of the entry of air with their entering edges non-radial and their leaving edges radial to the axis of the rotor shaft, said fan having a scroll casing that is not a true volute.

17. In combination, a scroll casing, a conical inlet passageway restricted between its ends having a plurality of different angular sectional areas and a plurality of inlet vanes angularly disposed with respect to the incoming air with their entering edges non-radial and their leaving edges radial to the axis of the inlet passageway.

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