Sept. 4, 1945. F. P. SOLLINGER 2,384,265

CENTRIFUGAL COMPRESSOR ENTRY VANE CONSTRUCTION

Filed Jan. 11, 1944 2 Sheets-Sheet 1

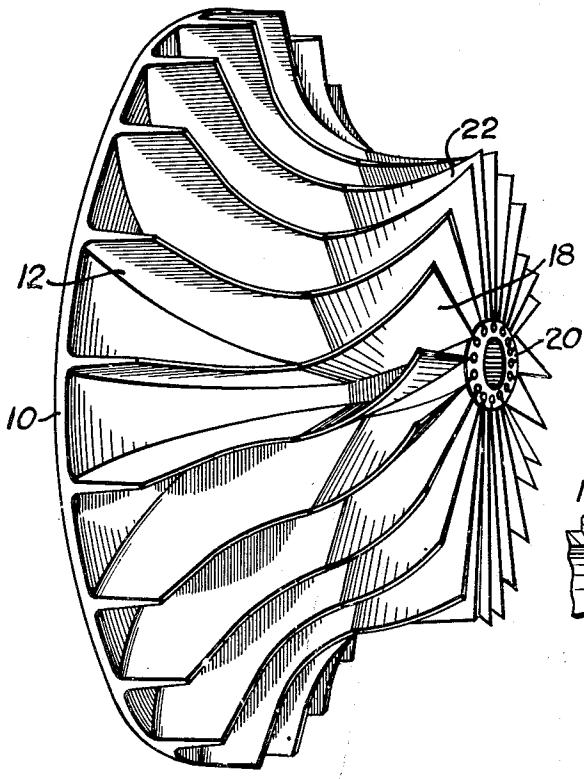


FIG. 1

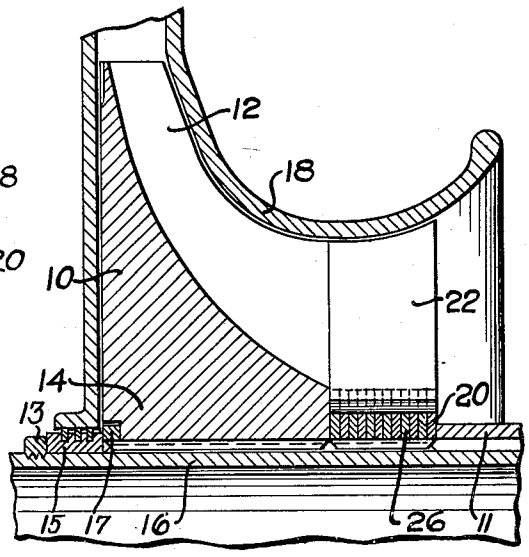


FIG. 2

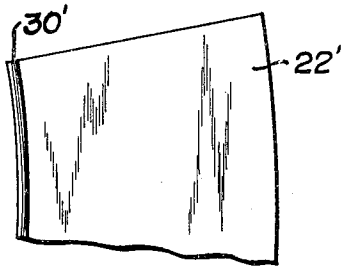


FIG. 4

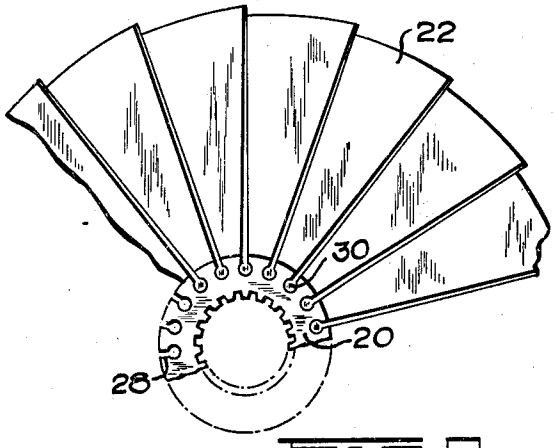


FIG. 3

INVENTOR.
Ferdinand P. Sollinger.

BY

ATTORNEY

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CENTRIFUGAL COMPRESSOR ENTRY VANE CONSTRUCTION

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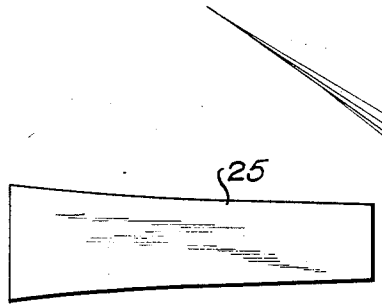


FIG. 6

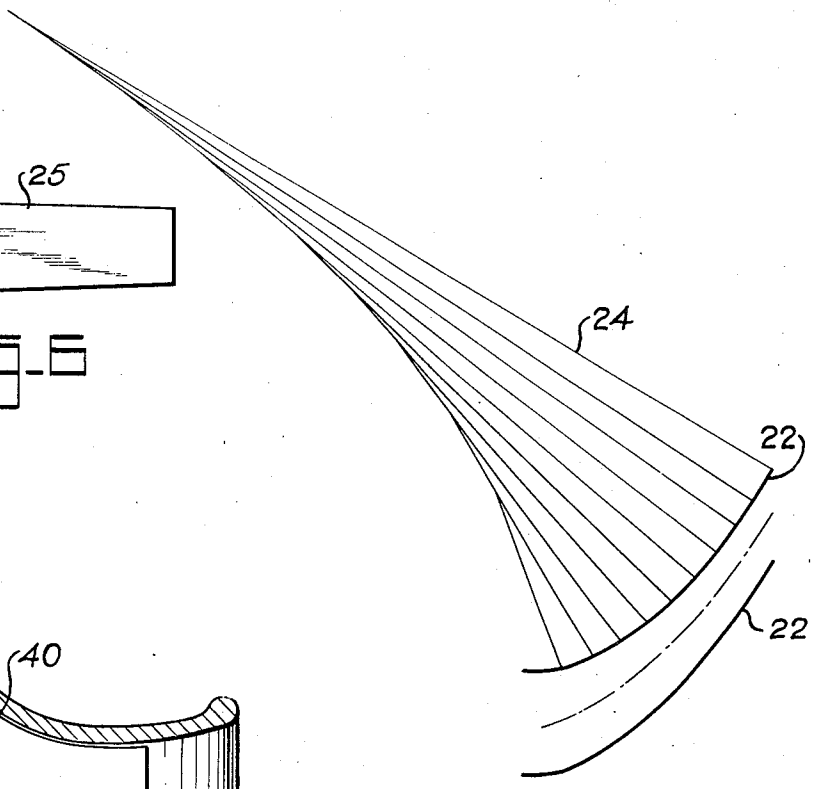


FIG. 5

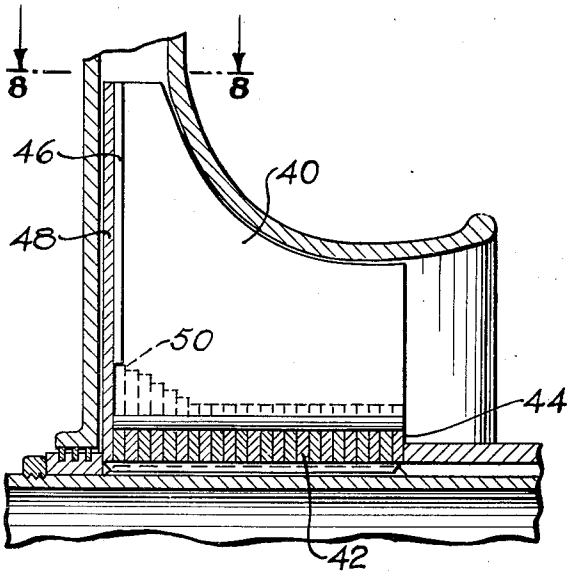


FIG. 7

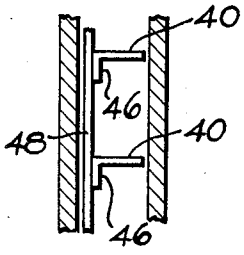


FIG. 8

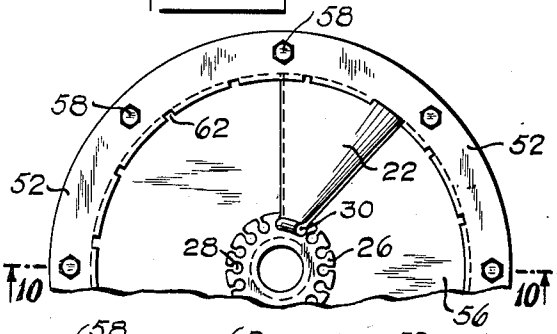


FIG. 9

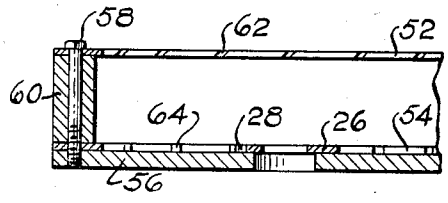


FIG. 10

INVENTOR.
Ferdinand P. Sollinger.

BY

ATTORNEY

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UNITED STATES PATENT OFFICE

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CENTRIFUGAL COMPRESSOR ENTRY VANE CONSTRUCTION

Ferdinand P. Sollinger, Paterson, N. J., assignor to Wright Aeronautical Corporation, a corporation of New York

Application January 11, 1944, Serial No. 517,881

3 Claims. (Cl. 230—134)

This invention relates to blowers and is concerned with improvements in the blower fabrication, particularly of the type illustrated in the copending application Serial No. 511,149 of K. Browne, filed November 20, 1943.

As pointed out in this copending application, in connection with a centrifugal impeller it is desirable to provide an axially extending entrance-vane section having vanes curved such that their radius of curvature gradually decreases in the direction of the fluid flow therethrough. At the same time, each section of the impeller vanes in a plane perpendicular to the axis of the impeller should be radial in order to avoid bending stresses in the blades resulting from rotation of the impeller. With this construction, the entrance vane section comprises a hub portion having a plurality of vanes extending radially therefrom, with each of the vanes having a rather complicated twisted profile. Obviously, such an entrance vane section is difficult to cast and/or machine. Accordingly, it is an object of this invention to provide a novel construction of such an impeller to facilitate its fabrication.

Specifically, the invention comprises a hub construction comprising a stack of co-axial annular sheet metal stampings, each having a plurality of keyhole-like slots circumferentially spaced about its periphery for the reception of the enlarged root ends of the vanes. In assembly, the vanes are supported in their proper spaced relation and the sheet metal stampings are slipped into place one at a time with the root ends of said vanes disposed in said keyhole slots. This construction may be applied to any separate section of the impeller or to the entire impeller.

Other objects of this invention will become apparent upon reading the annexed detailed description in connection with the drawings in which:

Fig. 1 is a perspective view of an impeller embodying the invention,

Fig. 2 is an axial section illustrating the impeller mounted on its drive shaft,

Fig. 3 is a front view of the impeller of Fig. 1,

Fig. 4 is a partial view of a modified entrance vane,

Fig. 5 is a development of the peripheral curvature of the entrance vanes,

Fig. 6 is a view of an equivalent round cone diffuser,

Fig. 7 is an axial section through a modification,

Fig. 8 is a sectional view along line 8—8 of Fig. 7,

Fig. 9 is a partial end view of a suitable fixture for supporting the vanes, and

Fig. 10 is a sectional view taken along lines 10—10 of Fig. 9.

Referring to the drawings, a conventional impeller 10 for a supercharger of an aircraft engine is provided with radial vanes 12 formed on a hub 14 splined to an impeller driveshaft 16 for rotating the impeller within the shroud 18. In order to prevent axial movement of the impeller 10 along the shaft 16, a sleeve 11 is disposed between one end of the impeller 10 and a shoulder (not shown) on the shaft 16 while a nut 13 threaded on the shaft 16 acts through a sealing bushing 15 and ring 17 to hold the impeller 10 and sleeve 11 against said shoulder.

The impeller 10 is provided with a vaned entrance portion comprising a hub 20 and a plurality of radially disposed vanes 22 forming a continuation of the impeller vanes 12. The vanes 22 are curved in the direction of rotation of the impeller to an extent such that the resultant of the velocity of the entering air and the tip velocity of the outer periphery of the entrance vanes is tangent to these vanes, whereby the air enters the vanes without shock. Furthermore, the radius of curvature 24 of the entrance vanes gradually decreases in the direction of flow of the entering air in order to provide a gradually increasing channel area between the vanes. The change in the radius 24 is such that, assuming the area between the outer periphery and the vanes, illustrated in Fig. 5, to be of unit height, then the relation between the length and cross sectional area of this unit-height space is identical to that of the round cone diffuser 25, illustrated in Fig. 6. The round cone diffuser 25 has an initial cone angle of not more than 10° and preferably the diffuser has an initial cone angle of approximately 4° with a small gradual increase in the cone angle toward the discharge end.

The impeller illustrated in the drawings is designed for use as a supercharger impeller for an aircraft engine. Such impellers rotate at exceptionally high speeds, in the neighborhood of 20,000 R. P. M., and therefore, it is essential that the major portion of the vanes be radial in order to avoid the high bending stresses which would otherwise be imposed thereon by the high speed rotation. The profile or surface of the entrance vanes 22, resulting from a radial projection of their peripheral curvature, illustrated in Fig. 5, is quite complicated and, therefore, it

is quite difficult to machine or cast the entire vane section 20, 22. It is proposed to separately form each vane 22 and to receive the root end of the vanes within grooves along the periphery of the hub for securing the vanes thereto. However, such hub grooves are also difficult to machine because of the curved nature of the radial projection of the outer periphery (illustrated in Fig. 5) of the vanes 22 on the hub 20. This difficulty is overcome by providing a laminated hub construction as hereinafter described.

The laminated hub 20 comprises a stack of sheet metal stampings 26 each of which is provided with a plurality of circumferentially spaced keyhole-like or undercut slots 28 corresponding in number to the vanes 22. The vanes 22 are each separately cast to the proper shape with a bulb section 30 on the butt or root end for reception within the slots 28. The vanes are held in proper spaced relation in a suitable fixture and the various hub laminations are slipped into place over the bulb sections 30 one at a time. The whole assembly is then subjected to a copper brazing process or other suitable bonding means to fill up the spaces formed by the punched keyhole slots in the sheet metal stampings 26 and the angularly disposed bulb sections 30 of the vanes 22 thereby forming an integral assembly. Splines 32 may then be machined within the hub 20 for providing a drive connection with the drive shaft 16 and the whole entrance vane assembly 20, 22 is clamped to the front of the impeller 10, e. g., as illustrated in Fig. 2.

Instead of casting the vanes 22 to their proper shape, these vanes may be formed flat, as illustrated at 22', Fig. 4, with a curved butt section 30'. The particular curvature of the butt section 30' of the flat blade depends on the diameter of the hub portion and the particular curvature to be imparted to the vanes. The vanes 22' may then be twisted to their proper shape in a suitable pressure die and assembled with the hub stampings 26 as previously described.

This method of constructing the entrance vane section of the impeller overcomes what would otherwise be a difficult casting and, at the same time, it permits true radial disposition of all the vanes 22. This same method of construction could also be applied to the main impeller, as illustrated in Fig. 7. The impeller vanes 40 are formed to the desired shape and are then held in their proper spaced relationship in a suitable fixture while the sheet metal stampings 42 are slipped into place to form the hub 44 of the impeller. Obviously, the vanes 40 may be formed to any desired shape but preferably they are formed to correspond to the combined vanes 12 and 22, best seen in Fig. 1. The back edge of each of the vanes 40 is provided with a right-angle flange 46 which may be suitably secured to a back plate 48. Also, if desired, the hub stampings adjacent to the back plate 48 may have a gradually increasing outer diameter as indicated at 50 in order to round out the outside corner of the airflow path through the impeller. However, this latter feature is not essential since it is now recognized that the outside corner of an airflow path may be quite sharp without seriously disturbing or hindering the airflow around this corner.

Figs. 9 and 10 disclose a suitable fixture for supporting the vanes 22 of Figs. 1 to 3, while the hub laminations 26 are assembled over the butt end 30 of the vanes. This fixture comprises a pair of annular plates 52 and 54 supported in spaced relation on a back plate 56 by bolts 58 and spacing means 60. Each of the annular plates 52 and 54 is provided with a plurality of properly oriented internal notches 62 and 64, respectively, for receiving the outer periphery of the vanes 22, as illustrated in Fig. 9. One of the sheet metal stampings 26 is disposed over the center of the back plate 56 to radially locate the vanes 22 within the fixture. With this construction, the vanes 22 may be supported in proper spaced relation with their root ends 30 received within the notches 28 of the single stamping 26. The remaining stampings may then be slipped one at a time over the butt ends 30 of the vanes. A similar fixture may be used in connection with the vanes 40 of Fig. 7. Fig. 9 discloses a single vane in position in the fixture, and for clarity this vane has been omitted in Fig. 10. It should be noted that the invention is not limited to the use of this specific fixture since, obviously, other fixtures may be provided for suitably supporting the vanes 22.

While I have described my invention in detail in its present preferred embodiment, it will be obvious to those skilled in the art, after understanding my invention, that various changes and modifications may be made therein without departing from the spirit or scope thereof. I aim in the appended claims to cover all such modifications and changes.

I claim as my invention:

1. A fluid blower comprising a rotatable hub having a plurality of vanes extending therefrom, said hub comprising a plurality of co-axial sheet-like discs stacked together and each having a similar plurality of undercut slots about its periphery, the relative disposition of the slots in adjacent discs being such that said slots define a plurality of undercut channels along said hub and within which said vanes are interlockingly received.

2. A fluid blower comprising a rotatable hub having a plurality of vanes extending therefrom, each of said vanes being so shaped that its intersection with the hub is curved, said hub comprising a plurality of co-axial sheet-like discs stacked together and each having a similar plurality of undercut slots about its periphery, the relative disposition of the slots in adjacent discs being such that said slots define a plurality of channels along said hub and within which said vanes are interlockingly received.

3. A fluid blower comprising a rotatable hub having a plurality of vanes extending substantially radially therefrom, each of said vanes being so shaped that its intersection with the hub is curved, said hub comprising a plurality of co-axial sheet-like discs stacked together and each having a similar plurality of undercut slots about its periphery, the relative disposition of the slots in adjacent discs being such that said slots define a plurality of undercut channels along a surface of said hub and within which said vanes are interlockingly received.

FERDINAND P. SOLLINGER.