

[54] **MULTISTAGE AXIAL FLOW COMPRESSOR**

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[58] Field of Search..... 415/190, 191, 192, 415/193, 194, 199, 217, 218, 219, 143, 170 R, 171, 172

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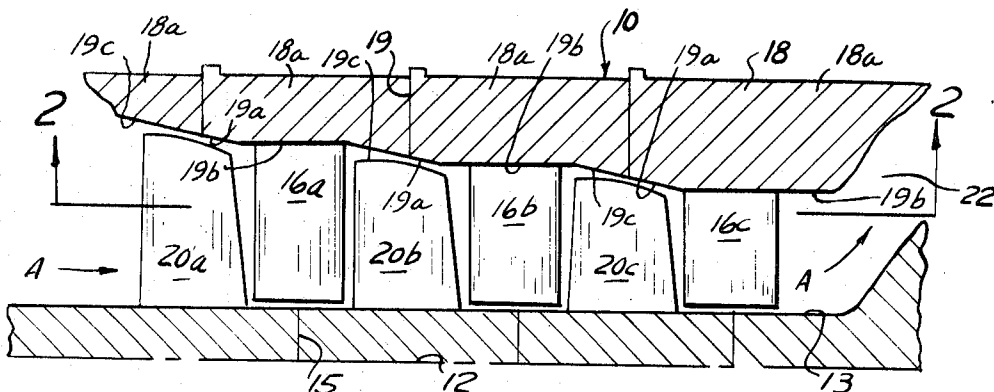
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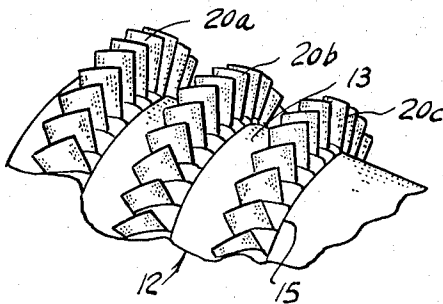
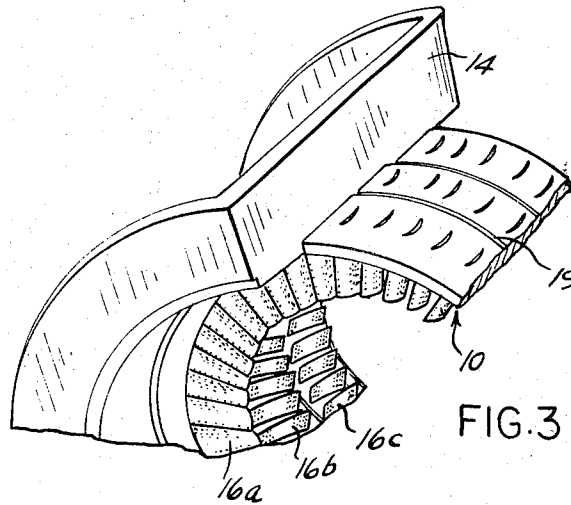
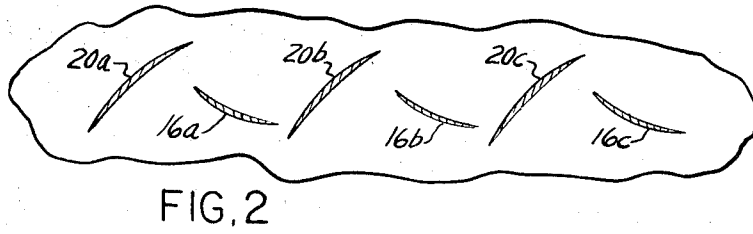
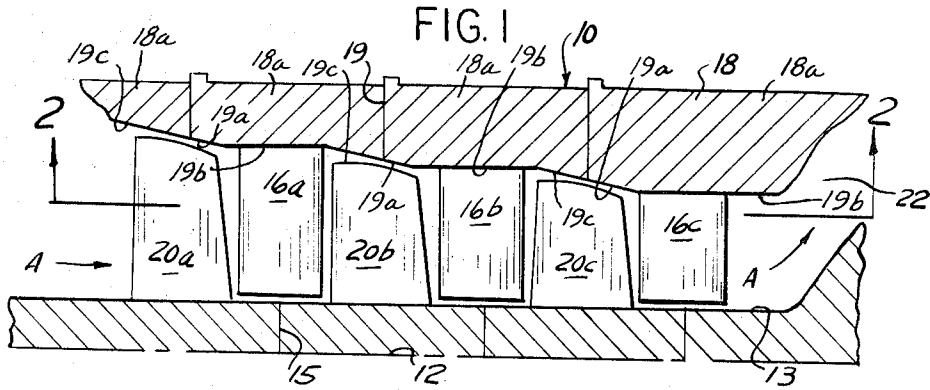
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[57] **ABSTRACT**

A multistage axial flow compressor with stacked stages in an axial direction, each stage including a rotor and a stator. The stages include vanes of identical vane geometry throughout the stator stages and the blades are of identical blade geometry throughout the several rotor stages. The blade and vane heights decrease from stage to stage in the direction of exiting fluid flow from the compressor. A constant hub diameter is maintained throughout the several rotor stages.

1 Claim, 4 Drawing Figures





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MULTISTAGE AXIAL FLOW COMPRESSOR

BACKGROUND OF THE INVENTION

This invention relates generally to axial flow compressor machines of the kind having a plurality of consecutive stages of mutually cooperating relatively rotating blading carried by two generally cylindrical members. The two members are arranged one within the other and are of different outer and inner diameters to provide an annular passage therebetween. The fluid acted upon by the blading is progressively compressed so that the sectional area of the passage will change progressively along its length. One of such cylindrical members may be stationary and the other rotated. It is generally more convenient to rotate the inner one with the blading carried by the outer member then constituting a guide blading. Alternately, the two members may both be rotated in opposite directions to provide a contour rotational arrangement. It will be understood that the invention includes within its scope arrangements where either member may be fixed and the other rotated.

Conventional multiple stage axial compressors are generally comprised of rotors and stators having differently shaped blades from stage to stage. As the air in the compressor is pressurized, the flow area to each successive stage must be rendered in order to prevent excessive separation which itself tends to cause premature surge and low efficiency. Compressors known to the prior art generally accomplish the decrease in flow area by adjusting the hub radius for the individual blades in each different stage. This dimensioning of flow area has in turn made it necessary to design the rotors and the stators of different stages with different blade sizes and shapes. The geometry of the blades which is typically described by hub and tip radius, camber, thickness and chord length, must be optimized and custom designed for each stage individually based on inlet conditions and flow area requirements.

SUMMARY OF THE INVENTION

The present invention has particular application to air or gas compressors for internal combustion or gas turbine plants primarily for the propulsion of aircraft or other like craft. The present invention involves the incorporation in multiple stage axial compressors of substantially identical stages with respect to both the blades and the vanes. Since all the respective rotor and stator blades are of the same air foil section, they can be manufactured from the same master. This makes possible a relatively inexpensive compressor that is easy to design, manufacture and fabricate. In addition, the inventory of spare parts is greatly minimized. The use of a constant diameter hub on the rotor has been found to maximize the axial exit blade height, provide a reasonable radius ratio centrifugal and reduce the number of blades and vanes required.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings illustrate the present invention wherein like numerals refer to like parts throughout the several views and wherein:

FIG. 1 is a longitudinal half-sectional view taken parallel to the centerline of the rotor;

FIG. 2 is a sectional view of the apparatus of FIG. 1 taken along the section lines 2—2;

FIG. 3 is a perspective fragmentary view of the compressor stator of FIG. 1; and

FIG. 4 is a perspective view of the compressor rotor of FIG. 1 with parts broken away.

DETAILED DESCRIPTION

FIG. 1 shows the detail of a multiple stage compressor incorporating the present invention. Included in the compressor are an outer stator 10 and an inner rotor 12. The rotor 12 and the stator 10 are arranged typically within a stationary cylinder or casing 14 which is shown in part in FIG. 3 hereinafter. The stator 10 includes three successive rings or stages each of which contains a plurality of uniformly spaced, circumferentially arranged vanes 16a, 16b and 16c, which vanes are affixed in pre-machined slots by welding, brazing or other like methods to the cylinder 18 of the stator 10. The cylinder 18 may be of one piece construction or may include a plurality of cylindrical rings in which the rings are separately assembled with the vanes 16a, b or c, and finally fixed together along the joints 19. The detail of this type of construction is shown in greater detail in FIG. 3 hereinafter.

As can best be seen in FIG. 1 each of the cylindrical rings 18a is formed with a first inwardly sloping surface 19a, an intermediate surface 19b of constant diameter and a second inwardly sloping surface 19c. The blades 16 are centered in the rings 18a and are therefore fixed to the surfaces 19b.

It will be seen that the several stages of stator 10 have interspersed between them a plurality of rotor stages including blades 20a, b and c. The rotor blades in a manner similar to the stator vanes are arranged in rings of gradually decreasing height in the direction of exiting fluid flow through the compressor. The fluid flow direction through the compressor and toward the exit provided by centrifugal stage 22 is shown by arrows A. The rotor blades 20a, b and c are fixed to a rotor hub 13, which itself is of a constant diameter cylindrical shape, by means similar to that used to fix the stator vanes in place. The arrangement of the rotor 12 within the stator 10 typically includes within the compressor casing 14 a bearing and support mechanism, not shown, to provide for rotative movement of the rotor 12 within the stator 10. The several blade carrying rings are preferably fabricated separately and then joined along a plurality of seams 15.

FIG. 2 taken along the lines 2—2 of FIG. 1 shows the form of the several stator vanes 16a, b and c and of the several rotor blades 20a, b and c. The cross section of individual ones of the respective blades and vanes illustrates that the blades 20a, b and c are of an identical air foil configuration, particularly with respect to their blade geometry, which in more detail may be described by camber, thickness and chord length. The vanes 16a, b and c are likewise of the same air foil configuration, which may be more specifically described with respect to camber thickness and chord length. The differences reside mainly in the height differences as between the several successive rotor 12 and stator 10 stages.

FIG. 3 shows the left hand or intake end of the compressor and the several successive stages of stator vanes 16a, b and c, which are assembled in the three successive rings comprising the stator 10. It will be seen that in their assembled positions, the various stator vanes are all given a like orientation with respect to the air passage formed between the rotor and stator.

FIG. 4 shows the several successive stages provided for the rotor 12 and the manner in which the vanes 20a, b and c all have a like air foil configuration throughout the three stages with only a height difference existing between the three individual stages. The rotor 12 is shown to have a constant diameter for the hub 13 throughout the several stages.

It has been found that the optimum arrangement for pressure ratio for the lowest number of stages, for example in the range of 9:1-12:1 pressure ratio, was provided by an axial compressor having three axial stages and one final centrifugal stage. It has further been found that the compressor according to the present invention is of particular advantage in that the constant hub flow path included serves to greatly reduce the number of blades and vanes required throughout the several successive stages.

It will thus be seen that there has been provided by the present invention a new and improved axial compressor. While one preferred embodiment of the present invention has been shown above, it will be understood that it is not intended that it will be limited to the exact form of the construction set forth since various changes may be made still within the spirit and scope of the invention.

We claim:

1. An axial flow compressor including a multistage stator housing, a multiple stage rotor mounted for rotation coaxially within said housing and having a constant diameter hub, each of said rotor stages having a plurality of blades arranged circumferentially about said hub, each of said stator stages having a plurality of vanes arranged circumferentially within said housing, all of said blades and vanes in each of said stages having an identical hub radius, camber, thickness and chord length but having a gradually diminishing height in the direction of exiting fluid flow and all of the blades in each different rotor stage having a tip radius sloping in the direction of exiting fluid flow to provide optimum flow whereby all of the blades of the various stages are of the same blade geometry except for height and tip radius and therefore can be manufactured from the same master, each of said stator stages comprising a ring member with an inner surface defined by an inwardly sloped section, an intermediate section of constant diameter and a second inwardly sloped section whereby the stator stages combine to provide a passage which reduces in cross section from entrance to exit.

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