

Nov. 26, 1968

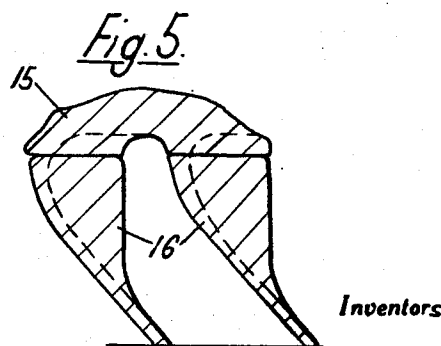
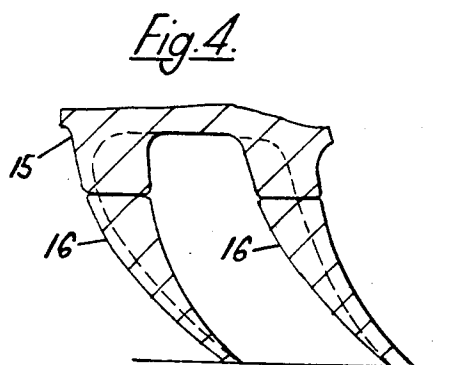
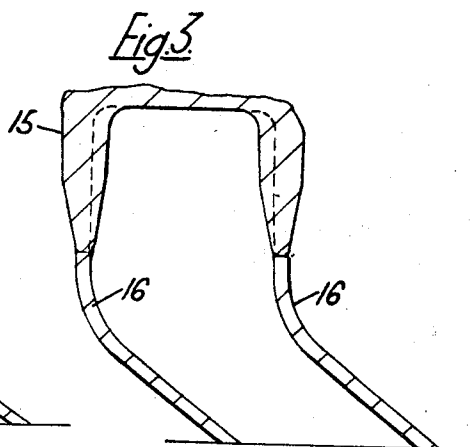
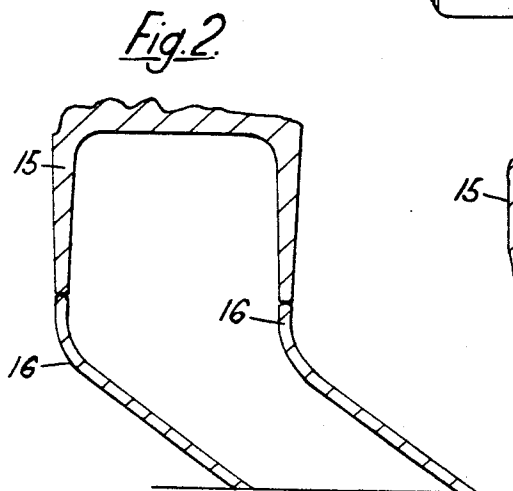
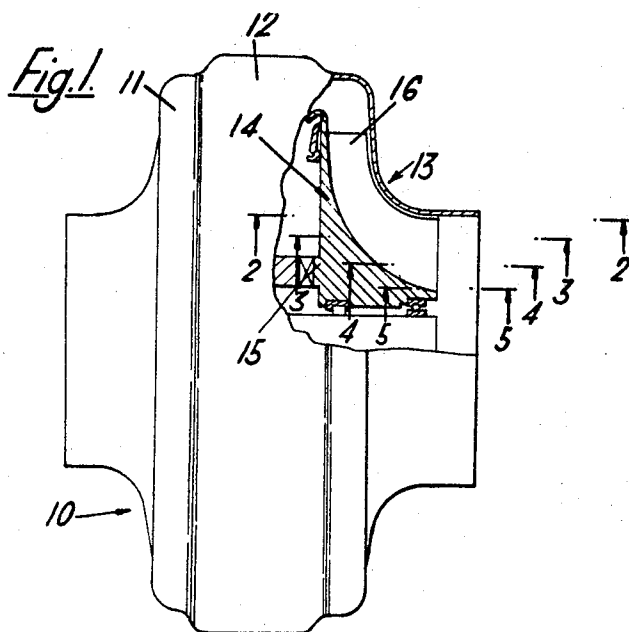
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3,412,978

RADIAL FLOW TURBINE OR COMPRESSOR ROTOR

Filed July 21, 1966

2 Sheets-Sheet 1



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Fig. 6.

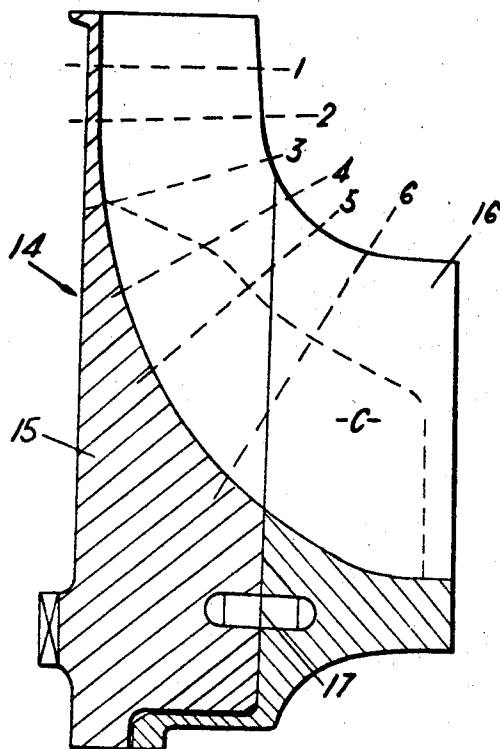
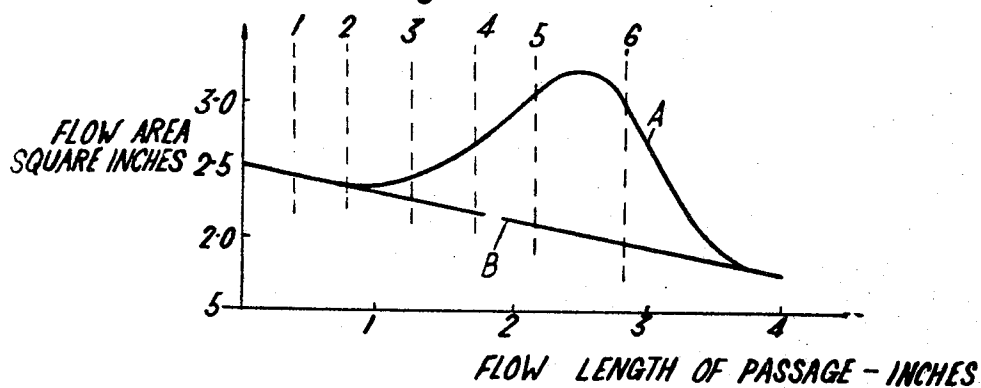


Fig. 7.



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RADIAL FLOW TURBINE OR COMPRESSOR ROTOR

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3 Claims. (Cl. 253—39)

ABSTRACT OF THE DISCLOSURE

A radial flow compressor or turbine rotor having an inlet and an outlet with vanes extending from the inlet to the outlet and defining flow passages therebetween. The radially inner portion of the vanes are thicker than the radially outer portions and the opposite axial ends of the rotor are of different diameters. Each of the vanes also has a thickness measured at a constant radius with respect to the axis of rotation which increases with increasing distance from the end of the rotor of smaller diameter. These features of the rotor provide each flow passage with an effective flow cross-sectional area varying at a substantially constant rate from the inlet to the outlet of the rotor.

This invention concerns radial flow turbine or compressor rotors and, although not so restricted, it will hereinafter be described with reference to its use on a radial flow turbine for a gas turbine engine.

In conventional radial flow turbine rotors, the vanes are substantially constant in cross-sectional area, and it has been found that the effective flow cross-sectional area of the flow passage defined between adjacent vanes varies substantially along the flow path through the rotor. Thus, in a conventional radial flow turbine, it has been found that, from the inlet, the flow cross-sectional area of the flow passages may increase by as much as 50% and then decrease by somewhat more than the initial increase to a final cross-sectional area somewhat less than the inlet cross-sectional area. It will be appreciated that such variation in cross-sectional area hinders smooth flow of the fluid through the rotor, thus causing losses due to turbulence.

Accordingly, therefore, to the present invention there is provided a radial flow turbine or compressor rotor having radially extending vanes defining flow passages therebetween, the radially inner portions of each vane being thicker than the radially outer portions thereof so that the effective flow cross sectional area of each flow passage varies at a substantially constant rate from the inlet to the outlet thereof.

In a preferred embodiment, the rotor has opposite axial ends of different diameter and the thickness of each vane, measured at a constant radius with respect to the axis of rotation of the rotor, increases, at least in the radially inner part of the rotor, with increasing distance from the smaller diameter end of the rotor.

The rotor may form part of a radial flow turbine, the flow cross-sectional area of each flow passage decreasing at a substantially constant rate in the downstream direction. Said turbine may be that of a gas turbine engine.

The invention is illustrated, merely by way of example, in the accompanying drawings, in which:

FIGURE 1 is a broken-away elevation of a gas turbine engine including a radial flow turbine in accordance with the present invention,

FIGURES 2 to 5 are cross-sectional views on the lines 2—2, 3—3, 4—4 and 5—5 of FIGURE 1,

FIGURE 6 is a cross-sectional view to a larger scale of part of the radial flow turbine shown in FIGURE 1, and

FIGURE 7 is a graph illustrating the flow characteristics of the rotor shown in FIGURE 6.

Referring to the drawings, there is shown a gas turbine engine 10 comprising a radial flow compressor 11, combustion equipment 12 and a radial flow turbine 13. Radial flow turbine 13 includes a radial flow rotor 14, comprising a hub 15 on which there are mounted a plurality of radially extending blades or vanes 16. As more clearly seen in FIGURE 6, the rotor is formed on two portions connected together by four dowel pins 17.

The cross-sectional form of the blades or vanes 16 is shown in detail in FIGURES 2 to 5. The full line figures illustrate the cross sectional shape of the modified rotor in accordance with the present invention and the broken line indicates the form of the blades on a conventional radial flow turbine rotor. It will be noted that the rotor blades are the same at the radially outer portion of the rotor, but, as the radially inner portion of the rotor is approached, the rotor blades thicken compared with those of a conventional turbine rotor, whereby the cross-sectional area of the flow passage defined between them is decreased.

Indicated on FIGURE 6 is an area C, defined within a broken outline, this area indicating that in which the vanes 16 are thickened to provide the decrease in cross-sectional area which enables a constant decrease in area to be obtained. Thus, the thickening of the vanes shown in FIGURES 2 to 5 is achieved by thickening the vanes in the area C, the remaining parts of the vanes being left at their original thickness, i.e. that shown, for example, in FIGURE 2.

Referring now to FIGURE 7, the curved graph A indicates the variation in flow area of the flow passages defined between adjacent vanes on a typical conventional turbine, i.e. that having vanes in accordance with the broken outline shown in FIGURES 2—5. It will be noted that the flow passages commence with an area of approximately 2.5 square inches which increases to nearly 3.5 square inches and then decreases to somewhat less than 2 inches adjacent the outlet to the rotor. It will be appreciated that such a variation in cross-sectional area discourages smooth flow of fluid through the rotor and creates turbulence and thus loss in efficiency.

The linear graph B indicates the flow passage characteristic with a rotor in accordance with the present invention, i.e. having blades 16 in accordance with the full line arrangement shown in FIGURES 2—5. It will be appreciated that the thickening of the vanes 16 adjacent the radially inner portion of the rotor decreases the cross-sectional area of the flow passages adjacent the radially inner portion of the rotor, and thus the substantial increase in cross-sectional area indicated by graph A is reduced and the linear form of graph indicated at B is produced. With such a form it will be appreciated that the decrease in cross-sectional area of each flow passage in a downstream direction is constant, and thus smooth flow of the fluid is obtained.

It will be appreciated that the flow characteristics of a radial flow rotor in accordance with the present invention are greatly enhanced compared with those of a conventional radial flow rotor.

It will be appreciated that the invention is not restricted to use in a radial flow turbine, but may, for example, be employed in a radial flow compressor. The fluid in this case will flow radially outwardly and thus the flow passages between adjacent vanes will effectively increase at a substantially constant rate in a downstream direction.

We claim:

1. A radial flow rotor having an inlet and an outlet adjacent opposite axial ends and vanes extending from the inlet to the outlet and defining flow passages therebetween, said axial ends of said radial flow rotor having different

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diameters; each of said vanes having radially inner portions thicker than radially outer portions thereof; and each of said vanes, when measured at a constant radius with respect to the axis of rotation of the rotor, increasing in thickness with increasing distance from the end of the smaller diameter of said rotor so that each of said flow passages has an effective flow cross-sectional area varying at a substantially constant rate from the inlet to the outlet of said rotor,

2. A radial flow rotor as claimed in claim 1 in which said effective flow cross-sectional area of each of said flow passages decreases at a substantially constant rate from the inlet to the outlet of said rotor.

3. A radial flow rotor as claimed in claim 1 in which

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the effective flow cross-sectional area of each of said flow passages increases at a substantially constant rate from the inlet to the outlet of said rotor.

References Cited

UNITED STATES PATENTS

2,621,851	12/1952	Voysey	230—134
2,819,012	1/1958	Atkinson	230—134
3,032,315	1/1962	Birmann	230—134

FOREIGN PATENTS

1,150,392	8/1957	France.
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