

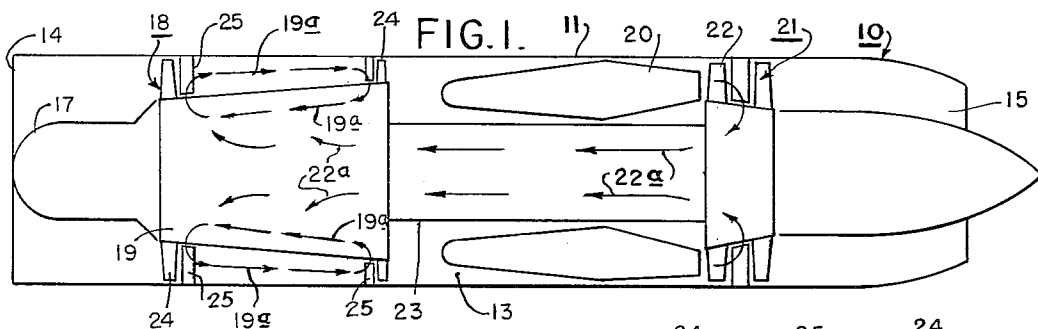
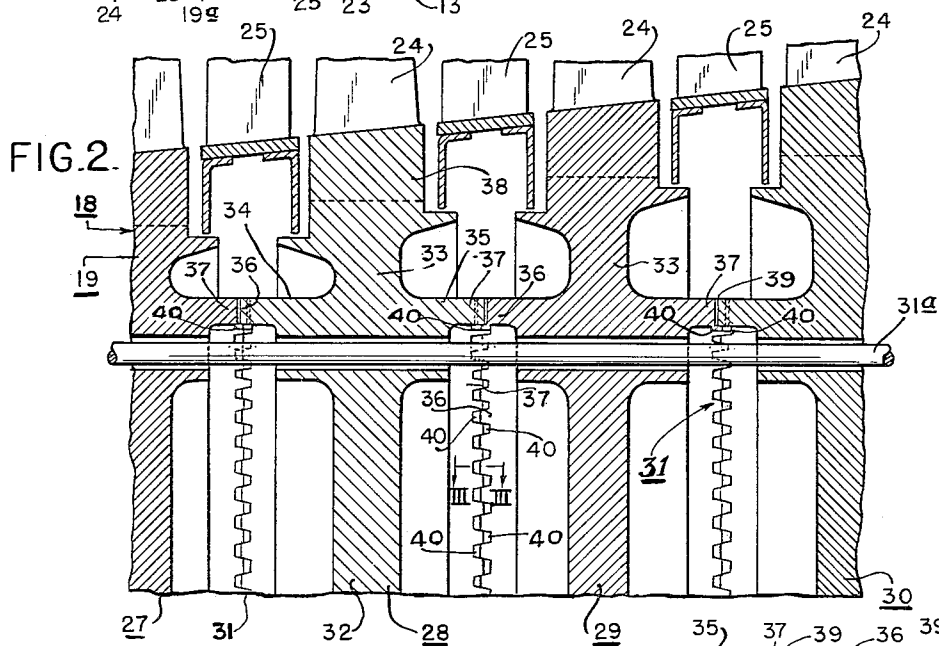
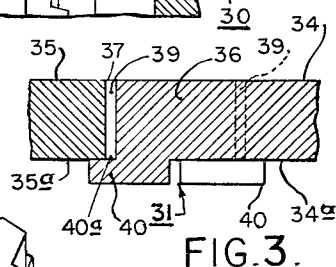
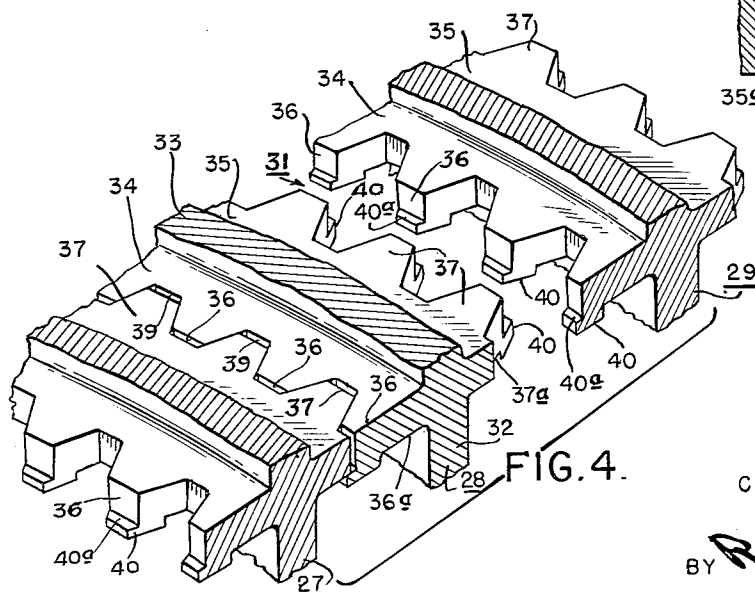
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ELASTIC FLUID MACHINE

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1

2,741,454

## ELASTIC FLUID MACHINE

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5 Claims. (Cl. 253—39)

This invention relates to rotors for elastic fluid machines more particularly to rotors for multi-stage axial flow compressors, turbines and like machines and has for an object to provide an improved rotor of this type. It is especially, though not exclusively, applicable to aviation gas turbine engines in which light weight, sturdy construction and good efficiency characteristics are important requirements.

It is generally realized in the art that in elastic fluid machines having rotor assemblies formed by stacked discs, for example, multi-stage axial flow compressors, part of the pressurized gases in the high pressure stages leak through small spaces between adjacent discs to the lower pressure stages. Since, in an aviation gas turbine machine, the blading and discs comprising the lower pressure stages of the compressor section are usually made of aluminum alloys or similar light metal whose maximum working properties are reduced at high temperatures, such gas leakage leads to premature failure of the discs or blading.

Various arrangements have been proposed to eliminate the above recirculation of hot gases through the lower pressure stages by provision of sealing members interposed between the stacked discs. However, these arrangements generally require additional parts, involve additional assembly labor and increase cost of manufacture.

In view of the above, it is another object of the invention to provide, in a rotor comprised of stacked discs, an improved sealing arrangement adding little or no cost to the manufacture, yet entirely adequate to obviate recirculation of hot gases between stages.

A further object is to provide an improved sealing arrangement for a rotor assembly comprised of stacked discs having interlocking clutch teeth.

A more specific object is to provide, in a disc of the above type having interlocking clutch teeth, sealing means integral therewith for closing the spaces between the teeth when interlocked.

The above and other objects are effected by the invention as will be apparent from the following description taken in connection with the accompanying drawings, forming a part of this application, in which:

Fig. 1 is a diagrammatic axial view, with parts in section, of a typical aviation gas turbine, illustrating the problem which is solved by the present invention;

Fig. 2 is a detailed fragmentary axial section, taken on a large scale, of a stacked disc compressor rotor embodying the invention;

Fig. 3 is an enlarged sectional view taken on line III—III of Fig. 2; and

Fig. 4 is a fragmentary perspective view of a plurality of the discs shown in Fig. 2.

The present invention may be utilized in the construction of axial flow elastic fluid machines wherein the rotors are formed by a plurality of stacked discs having annular series of interlocking clutch teeth. Rotor construction of this type is well known in the art and is widely utilized in construction of aviation gas turbine machines. A typical stacked disc rotor construction is shown in

2

Pedersen et al. Patent No. 2,650,017 issued August 25, 1953 and assigned to the assignee of the present invention.

In view of the above state of the art and to clearly present the problem incurred by recirculation of high pressure gases, Fig. 1 of the drawing illustrates merely the schematic arrangement of a typical aviation gas turbine engine to which the invention is applicable.

Referring to Fig. 1 in detail, there is shown an aviation gas turbine engine 10 of the turbojet type comprising a cylindrical outer casing structure 11 defining the outer periphery of an annular fluid flow passageway 13 which extends axially through the power plant from an annular air inlet opening 14 to a rearwardly disposed discharge nozzle 15. The elements of the power plant are arranged in axial alignment, thus minimizing the frontal area and drag incident to forward motion of the aircraft (not shown) in which the turbojet is installed.

The main elements of the engine include a front fairing member 17, housing auxiliary control and starting apparatus (not shown) a multi-stage axial flow compressor 18 having a rotor assembly 19, annular combustion apparatus 20, and a multi-stage turbine 21 having a rotor assembly 22 which is operatively connected to the compressor rotor 19 through the medium of a tubular shaft 23 disposed interiorly of the combustion apparatus.

The compressor rotor 19 is provided with a plurality of series of annularly disposed rotating blades 24 which cooperate with a plurality of series of stationary diaphragm blades 25 to pressurize incoming air to a relatively high absolute pressure value.

In operation, the turbine rotor 22 drives the compressor rotor 19 by means of the shaft 23, whereupon air is drawn in through the inlet opening 14, is pressurized as it passes through the multiple stages of the compressor 18, is then directed into the combustion apparatus 20 where it is mixed with fuel and heated by ignition thereof in a well known manner to provide hot motive gases which are expanded through the turbine 21 to drive the same, and are then emitted through the discharge nozzle 15 in the form of a propulsive jet.

Referring to Fig. 2, it will be seen that the rotor 19 is formed of a series of discs 27, 28, 29 and 30 held in assembled relation by means of a plurality of elongated bolts 31 (only one shown) passing through openings in the discs. As thus far described, leakage paths exist between the inter-faces of adjacent discs, so that as the incoming air is pressurized by the succeeding higher and higher stages of the compressor, some of the pressurized air passes through the leakage paths between adjacent high pressure stage discs and recirculates through the rotor 19 as indicated by the arrows 19a to a lower pressure stage and are then drawn back into the air stream through leakage paths between adjacent discs in the low pressure stages of the rotor. Although a number of such recirculation air paths may develop in the rotor, only two have been shown. However, it will be understood that such recirculation may occur between any two stages with a resulting loss in efficiency.

A more serious aspect of the situation resides in the fact that when the highly pressurized air in one of the high pressure stages is recirculated back to a lower pressure stage, heat damage to the discs and blading of the first stages may occur. This is due to the natural phenomenon occurring upon pressurization of air or other elastic fluid which causes the fluid to be highly heated when pressurized. This phenomenon is especially serious in aviation engines, since the low pressure stage discs, in the interest of lightness, are made of aluminum alloys or other similar alloys whose maximum working properties are reduced at high temperatures and may be damaged by the above-mentioned highly heated recirculating fluids.

A similar situation may exist in the turbine 21 when its

rotor 22 is made of similarly stacked discs and since the tubular shaft 23 may have leakage paths therethrough communicating with the turbine rotor 22 and the compressor rotor 19, such gases as indicated by arrows 22a may ultimately find their way to the compressor rotor and ultimately pass through the leakage paths between the discs thereof to rejoin the air stream flowing through the stages, with resulting over-heating and damage to the discs and blading thereof.

Referring to Figs. 2, 3 and 4 in detail, especially Fig. 2, there is shown a fragmentary axial sectional view of the rotor 19, wherein the discs 27, 28, 29 and 30 are provided with the novel sealing means for preventing recirculation of the fluids illustrated by the arrows of 19a and 22a in Fig. 1. The discs 27, 28, 29 and 30 although varying in diameter and other dimensional aspects may be provided with identical locking and sealing means generally indicated 31. Hence, only the disc 28 will be described in detail.

The disc 28 has a central web-like disc portion 32 encompassed by an enlarged peripheral rim portion 33 having a pair of annular flanges 34 and 35 extending in opposite axial directions relative to each other and provided with annular series of clutch elements or teeth 36 and 37, respectively. The rim 33 is further provided with an outer annular portion 38 within which the rotatable blades 24 are received. Adjacent of and directly downstream of the rotatable blades 24 are disposed the stationary diaphragm blades 25.

The teeth 36 and 37 are of generally isosceles trapezoidal form and are arranged in concentric face-to-face alignment with the mating teeth of adjacent discs 27 and 29 so that the teeth interengage therewith and lock the discs together to form the unitary rotor assembly 19. To insure that the teeth 36 and 37 are maintained in engagement with each other, the bolts 31 passing through openings in the discs are drawn tightly by means of nuts (not shown) provided at the ends thereof.

Although the teeth 36 and 37 are machined by precision methods and held to very small tolerances, nevertheless, when they are in engagement with each other a series of small spaces 39 exist between the ends of the teeth 37 and the recesses between the teeth 36. These spaces 39 extend radially inwardly the entire tooth width and heretofore have created the leakage paths mentioned.

In accordance with the present invention, each of the teeth 36 and 37 is provided with a tab portion 40 disposed at the inner portion thereof and extending axially therefrom a distance greater than the space 39. As shown in Fig. 4, the tabs 40 lie within the confines of the tooth side faces so that full engagement between the mating teeth is not hampered in any way. The tabs 40 terminate short of the bases 36a and 37a of the teeth 36 and 37, respectively, to provide clearance permitting full lapping engagement between the tabs and the adjacent flanges of the adjacent discs. It will be noted that the inner faces 34a and 35a of the flanges 34 and 35, respectively, are arcuate. In similar manner, the sealing faces 40a of the tabs 40 are of arcuate shape and of the same curvature as the flange faces 34a and 35a.

The discs 27, 28, 29 and 30 are stacked together in a simple manner by movement thereof towards each other in axial direction whereupon the mating teeth 36 and 37 interengage each other and the sealing tabs 40 lap into engagement with the adjacent flanges 34 and 35, respectively, a depth sufficient to block the space 39. Since the cooperating surfaces 34a and 35a of the flanges and 40a of the tabs are of the same contour, a seal of high order is thereby attained and recirculation of fluids therethrough is obviated.

The tabs 40 preferably are formed integral with the discs and may easily be provided by simple machine techniques with no additional cost in manufacture other than modification of existing tools for forming the con-

tours of the flanges 34 and 35 prior to machining of the teeth. The thickness of the tabs and the axial length thereof is not critical and may be varied to suit the amount of lapping engagement desired. Also, with this sealing arrangement it is not essential to attempt to maintain the clearance space 39 between the interlocked teeth to a minimum value.

It will now be seen that with this arrangement a simple sealing means is provided for a stacked disc rotor assembly having interlocking clutch teeth for maintaining the discs centered and for transmitting torque. Since the tabs are formed integrally with the discs, assembly of the discs is no more involved than that of the interlocking discs utilized in the prior art. Also, since the sealing tabs 40 are in lapping engagement with the flanges they are not damaged or altered upon assembly and may be used repeatedly after dis-assembly of the rotor for inspection and servicing without material change in their sealing properties.

It must also be pointed out that although the tabs 40 are disposed in a manner to form a seal with the inner surfaces of the flanges 34 and 35, they may be provided on the outer surfaces of the teeth with equal ease of manufacture and assembly.

While the invention has been shown in but one form, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various changes and modifications without departing from the spirit thereof.

What is claimed is:

1. A rotor assembly for an elastic fluid machine comprising a plurality of stacked components having annular flanges projecting axially in opposite directions and arranged in concentric face-to-face alignment, said flanges having axially-extending clutch teeth, said teeth being interengaged and means comprising tabs extending axially from the ends of said teeth and disposed in lapping engagement with adjacent flanges.

2. A rotor assembly for an elastic fluid machine comprising a pair of stacked components, each of said components having a projecting annular flange, said flanges extending towards and being arranged in concentric face-to-face alignment with each other, each of said flanges having an annular series of axially-projecting teeth, said series of teeth being interengaged to provide a clutch and defining a series of spaces adjacent the points of interengagement, and means integrally formed with said teeth for blocking said spaces, said means projecting axially beyond said teeth and disposed in lapping engagement with portions of the adjacent flanges.

3. A rotor assembly for an elastic fluid machine comprising a plurality of stacked components, each of said components having a pair of annular flanges extending in opposite directions and arranged in concentric face-to-face alignment with the flanges of adjacent components, each of said flanges having an annular series of axially-extending teeth, said teeth of adjacent face-to-face flanges being interengaged to provide a clutch and means integrally formed with said teeth for providing a fluid-tight seal between interengaging teeth, said means including tabs extending axially from said teeth and disposed in lapping engagement with portions of the adjacent flanges of the adjacent components.

4. The structure recited in claim 3 in which the teeth are of substantially isosceles trapezoidal form, and the tabs are displaced radially inwardly from the interengaging surfaces of the teeth and have arcuate outer faces engaging the inner faces of adjacent flange portions.

5. An integral disc for a rotor assembly of an elastic fluid machine comprising an annular flange portion extending in a direction parallel to the axis of the disc, said flange having an annular series of axially-extending teeth of substantially isosceles trapezoidal form and tabs disposed radially of and extending axially beyond the axial extremity of each tooth, said tabs having arcuately-

2,741,454

5

shaped faces adapted to lap the flange of an adjacent disc of similar form.

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