

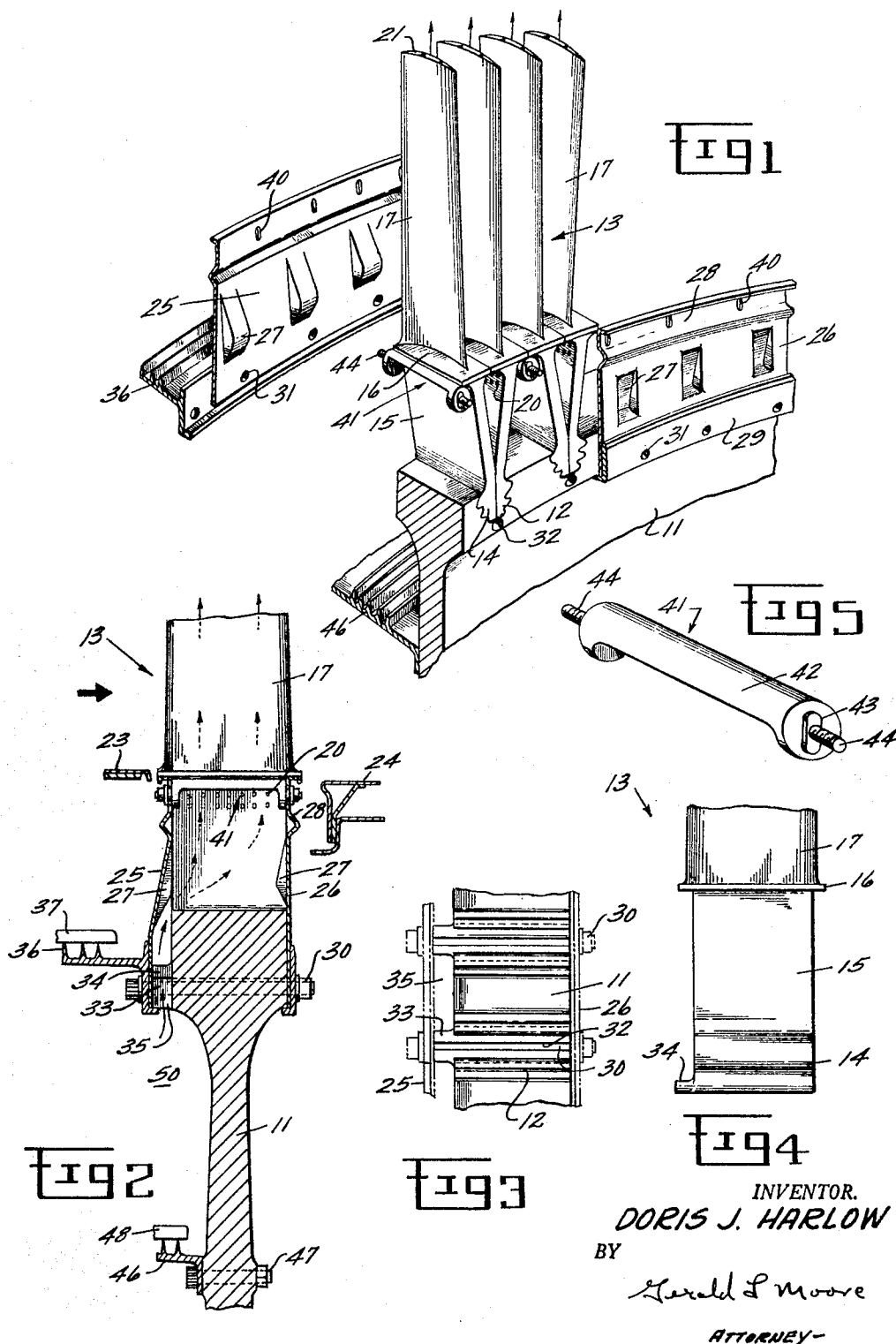
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TURBOMACHINE ROTOR ASSEMBLY

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TURBOMACHINE ROTOR ASSEMBLY

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3 Claims. (Cl. 253—39.15)

This invention relates to a turbomachine rotor assembly and more particularly to a lightweight assembly with provision for air cooling and blade damping.

In turbomachinery, and primarily in axial flow gas turbines for use in aircraft, it is well known to manufacture the rotor wheel and blades separately and provide means for mounting the blades about the periphery of the wheel. However, it is necessary in such an assembly to provide means for sealing against the axial flow of gas between the adjacent blade shanks or that portion of the blade which does not extend directly into the gas flow passageway. This is necessary to prevent leakage of a portion of the primary gas flow around the passageway through which the vane portion of the blades extend; said leakage would thereby reduce the efficiency of the rotor assembly. One manner of doing this in the past has been to form integral with the blade shanks peripheral extending flanges which when all the blades are assembled about the rotor wheel, serve to prevent this axial gas flow past the shank portions of the blade. However, such an assembly serves to decrease the flexibility of the blade shanks and thereby introduces additional vibrational problems not present with the use of flexible blade shanks.

Also, where the rotor assembly is subjected to high temperature gas flow as is the case with a turbine assembly, it is necessary to provide for cooling fluid circulation through the rotor assembly to cool the blades. Similarly such assemblies have served to stiffen the blade shanks where the structure is formed integral with the blade as described heretofore, or has at times consisted of providing fluid passageways internal to the blade shanks which greatly increased the manufacturing problems and also served to weaken the blade shanks.

A very beneficial assembly would be one which provides for the mounting of blades about the periphery of the rotor wheel and seals against axial gas flow past the blade shanks while not limiting the flexibility of the blades in any manner. Additionally, the assembly should be one which provides for fluid cooling of the blade assembly with a minimum of internally formed passages in the rotor wheel and blades and, if possible, rather than merely not introducing any new vibrational problems within the assembly, would additionally provide means for damping what vibrations might exist between the blades utilized. All these functions preferably should be performed by the simplest and most easily manufactured and assembled rotor assembly.

It is accordingly one object of this invention to provide a lightweight turbomachine rotor assembly.

It is another object of this invention to provide a lightweight turbomachine rotor with an integrated assembly providing means for damping vibration within the blade assembly, and if necessary, means for cooling the rotor blades.

According to one embodiment of the invention there is provided a turbomachine rotor assembly comprising a rotor wheel having a plurality of blades circumferentially spaced about the periphery and extending in a radial direction. These blades include a shank, vane portion and a platform therebetween, with the vane portion having internal cooling passages opening to the outside of the blade and connecting with a fluid passage leading from the exterior of the blade shank. Flat baffle plates extending from the rotor wheel to the blade platform are located on each side of these blade shanks to prevent axial flow

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of gas past the blade shanks and to form with the blade shanks a cooling fluid passageway. One baffle is spaced from the rotor wheel in a manner to allow cooling fluid from the exterior to flow between the rotor wheel and the baffle into the chamber formed by the baffles and blade shanks and subsequently into the internal cooling passages in the blade vane portion. The baffles are connected at the edge adjacent the blade platforms by loosely attached damper pins extending axially between the blade shanks; said pins are forced by centrifugal force against the joints between adjacent blade platforms to seal the joints and, additionally, to damp vibrations between the adjacent blades. Other bolt fasteners may be inserted at the dovetail bases of the blades to both hold the baffle plates in position adjacent the rotor wheel and hold the blades in axial position on the rotor wheel.

The invention will be further understood and its various objectives, features and advantages more fully appreciated by reference to the appended claims and the following detailed description when read in conjunction with the accompanying drawing, wherein:

In the drawing:

FIG. 1 is a partially exploded perspective view showing the entire rotor assembly,

FIG. 2 is a side plan view partially in section of the rotor assembly,

FIG. 3 is a top plan view of the rotor wheel with the baffle members in phantom,

FIG. 4 is a side plan view of the shank and dovetail portion of a rotor blade, and

FIG. 5 is an enlarged perspective view of the damper pin.

Referring now primarily to FIGS. 1 and 2, therein is illustrated a rotor wheel 11 having dovetail slots 12 circumferentially spaced about the periphery. These slots are of the usual "Christmas-tree" shape which are well known and widely used for positioning and attaching rotor blades radially around the rotor wheel periphery. Extending radially from the rotor wheel and attached to the rotor wheel at the dovetail slot are rotor blades 13 which include a base portion 14, shank portion 15, a platform 16 and a vane portion 17. The base portion 14 of a blade forms one half of the cooperating structure to conform to the dovetail opening 12 in the rotor wheel and the blades are positioned in pairs or "Siamese-twin" manner about the rotor. This method of attaching the blade is more fully described in U.S. Patent 2,990,156, Marshall, et al. and provides the advantages of allowing centrifugal force to impart a moment on the blades that are paired to force them together and damp vibrations therebetween while simplifying the overall attachment of the blades.

The blades include internal air passages (not shown) in the vane portions 17 which connect with cooling fluid passages passing through the platform 16 and open external of the blade shanks at openings 20. As denoted by the arrows in FIG. 2, cooling fluid may enter the openings 20 and flow outward through the shank and platform portions of the blades to subsequently flow through the vane internal passages and be expelled in any convenient manner as by openings 21 at the extreme outer end of the vane.

As in normal turbomachines, only the vane portion 17 of the blades extends into the primary gas flow of the turbomachine and duct walls extend closely adjacent to the platform of the blade to contain this primary gas flow. Such duct walls are illustrated in part by the wall portions 23 and 24 of FIG. 2 with a similar wall (not shown) at the outer extremity of the blade forming the primary gas flow passageway. It is necessary however to seal between adjacent blade shanks in the area between the platform and the rotor wheel to prevent gas passage past the joint between the wall portion 23 and the platform 16 and then between the blade shanks and lower the efficiency of the

machine as well as allowing hot gases to cause corrosion, etc., of the rotor assembly. To seal this shank area, baffle plates 25 and 26 are fastened in some suitable manner as by bolting on the upstream and downstream sides of the blade shanks as illustrated to prevent such gas leakage. These baffle plates include indented portions 27 and a grooved portion 28 which serves to stiffen the baffle walls and allows for thermal expansion in a radial direction to prevent the introduction of high thermal stresses. The baffles are fastened to the rotor wheel edge by bolt fasteners 30 passing through openings 31 in the baffles and openings 32 in the rotor wheel with baffle 25 abutting projections 33 on the rotor wheel 11 which serve to space the inward edge of the baffle from the wheel as will be explained hereinafter.

Turning now to FIG. 4 briefly, there is illustrated a side view of the shank and base portion of a blade with the base portion including a projection 34 extending in an axial direction normal to the blade axis. This projection as illustrated in FIG. 2 is such that when the bolt 30 is inserted and a nut is attached the baffle 26 is drawn tightly against the rotor wheel and the baffle 25 is drawn against the ends of the projection 33 on the rotor wheel and these projections 34 thereby allowing a space 35 between the baffle and wheel, the purpose of which will be further discussed hereinafter. Also a rotating seal member 36 may be attached by this bolt 30 which extends in an axial direction and forms a labyrinth seal with a stationary seal member 37 for the purpose of sealing against air passage from the rotor axis area out toward the rotor periphery.

The outer edges of the baffle plates 25 and 26 include elongated openings 40 which are located in the same radially extending plane as the joint between adjacent pairs of blade platforms and spaced radially inward therefrom. A damper pin 41 which is better illustrated in FIG. 5 is inserted so as to extend between baffle plates and hold the plates against axial deflection. This damper pin 41 consists of a half cylindrical mid portion 42, a shoulder 43 which is slightly smaller than the openings 40 in the baffle plates and a screw threaded projection 44 at each end. When the damper pins are inserted to extend axially between the baffle plates, the rounded portion 42 fits adjacent the joint between adjacent blade platforms 16 with the shoulders 43 extending through the openings 40 in the baffle plates. When a nut is tightened on each end of the damper pin, it tightens against the shoulder 43 so as to allow a loose fit between the damper pin and the baffle plates while still providing axial support to these baffle plates.

By allowing a loose fit between the damper pin and baffle plates, during operation the damper pin is forced radially outward by centrifugal force and presses tightly against the adjacent blade platforms thereby tightly sealing the joint between these platforms to prevent gas leakage. In addition, this close rubbing contact between adjacent blade platforms serves to damp vibration or relative movement of these platforms and thereby serves to provide a more integrated overall blade assembly.

In addition, a rotating seal member 46 may be bolted by bolt 47 extending through the rotor wheel which co-operates with a stationary member 48 to form with the rotating seal member 36 a chamber 50 within the rotor assembly. When cooling air is introduced into this chamber, it may be of sufficient pressure to cause its flow into the opening 35 or it may be radially accelerated by the rotating rotor assembly so as to be centrifuged outward along the rotor wheel 11 and thereafter enter the opening 35 formed between the baffle 25 and the rotor wheel. As denoted by the arrows, this cooling air may then flow between the rotor wheel and baffle into a fluid passageway formed by the blade shanks 15 and the baffle plates 25 and 26 along with the blade platforms 16 to subsequently enter the openings 20 in the blades opening into that passageway and flow thereafter into the inner cooling passageways of the vanes 17 to cool the vanes when they are

subjected to high temperature gases of the primary gas flow, this flow being aided by the centrifuging action of the rotating assembly.

It can be seen that by this assembly a lightweight rotor construction is afforded because of the unique use of complementing lightweight parts which serve multiple functions in providing an integrated blade assembly with cooling fluid passageways. In addition, this assembly is easily manufactured and assembled with a minimum of readily interchangeable and replaceable parts to facilitate maintenance. Also, by the use of the unique baffle and rotor wheel cooling fluid passage, no small passages through the rotor wheel are utilized which might clog or otherwise increase the cost of the assembly. Furthermore, by the use of baffle plates of the type described heretofore, the aerodynamic losses of the rotor assembly are decreased and the blade shanks are flexible thereby decreasing any vibration which might be caused by otherwise stiff shanks.

Certain preferred embodiments of the invention have been described and illustrated by way of example in the foregoing, but many modifications will occur to those skilled in the art and it therefore should be understood that the appended claims are intended to cover all such modifications as follow in the true spirit and scope of the invention.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. A rotor assembly for an axial flow turbomachine, comprising
 - a rotor wheel,
 - a plurality of blades having shank and vane portions with a platform therebetween,
 - said blades positioned to extend radially from said rotor wheel with the shank portions attached to said wheel and adjacent platforms abutting,
 - first and second baffle plates positioned on the upstream and downstream sides of said blade shanks respectively to prevent the axial flow of gas between said shanks,
 - said baffle plates including radially extending slots adjacent where said platforms abut,
 - damper pins supported from said slots and connecting said plates in a manner to allow limited radial movement of said pins and hold said plates in position,
 - said damper pins positioned to rub against the joint formed by adjacent blade platforms to seal said joint and damp vibrations between adjacent blades,
 - said blades having internal cooling fluid passages opening into chambers formed by the blade shanks and baffle plates,
 - and means to introduce cooling fluid into these chambers for circulation through said blades.
2. A rotor assembly for an axial flow turbomachine, comprising
 - a rotor wheel,
 - a plurality of blades having shank and vane portions with a platform therebetween,
 - said blades positioned to extend radially from said rotor wheel with the shank portions attached to said wheel and adjacent platforms abutting,
 - first and second baffle plates positioned on the upstream and downstream sides of said blade shanks respectively to prevent the axial flow of gas between said shanks,
 - said baffle plates having radially extending openings adjacent where said platforms abut,
 - said first baffle plate being axially spaced from said rotor wheel,
 - damper pins supported in said openings and connecting said plates, in a manner to allow limited radial movement of said pins and also hold said plates in position,
 - said damper pins positioned to rub against the joint

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formed by adjacent blade platforms to seal said joint and damp vibrations between adjacent blades, said blades having internal cooling fluid passages opening into chambers formed by the blade shanks and baffle plates,

and means to introduce cooling fluid to flow between said first baffle plate and said rotor wheel for circulation through said blade internal cooling fluid passages to cool said blades.

3. A rotor wheel assembly for an axial flow turbomachine, comprising
- a rotor wheel,
 - a plurality of blades having shank and vane portions with a platform therebetween,
 - said blades positioned to extend radially from said rotor wheel with the shank portions attached to said wheel and adjacent platforms abutting,
 - a first baffle plate positioned to extend radially from said platforms to said wheel to prevent flow of gas between said blade shanks from an axial direction,
 - said rotor wheel having projections on the radial surface to axially space the inner edge of said first baffle plate,
 - a second baffle plate positioned to extend radially from said platform to said wheel on the other side of said blade shanks,
 - said first and second baffle plates including radially slotted portions,
 - dampers supported from said slotted portions and

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connecting said first and second baffle plates to hold these plates in position, said damper pins connecting said plates in a manner to allow some radial movement of said pins with respect to said plates, said damper pins positioned against the joint formed by adjacent blade platform to seal said joint and damp vibration between adjacent platforms, said blades having internal cooling fluid passages opening external to the blades at said blade shanks, and means to introduce cooling fluid to flow between said first baffle plate and said rotor wheel for circulation through said blade internal cooling fluid passages.

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