Feb. 10, 1959 G. NEUMANN 2,873,088

LIGHTWEIGHT ROTOR CONSTRUCTION

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Fig. 1.

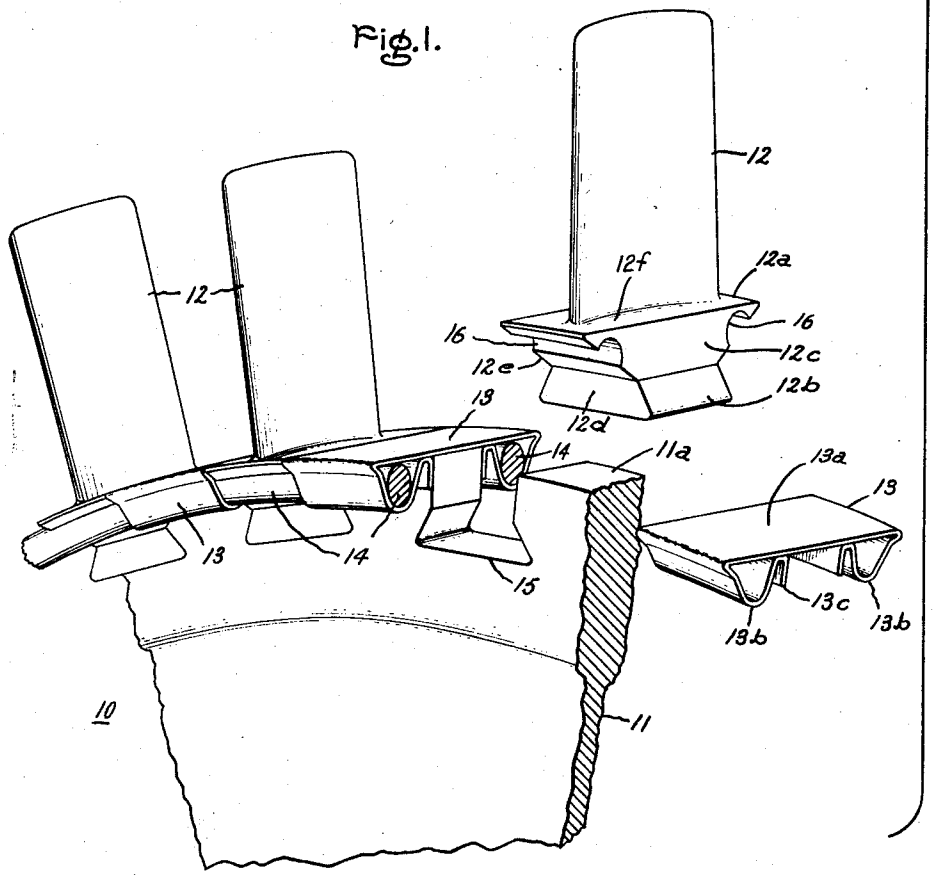
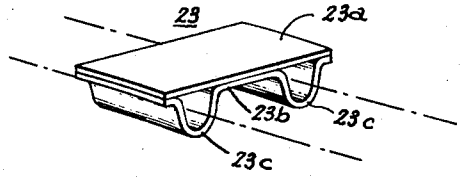


Fig. 2.



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2,873,088

LIGHTWEIGHT ROTOR CONSTRUCTION

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The present invention relates generally to turbomachines and more particularly to the platform filler structure between rotor blading of compressors, turbines and the like.

Blading used in such machines comes with either a wide blade base platform or a narrow blade base; with the former type a continuous circumferential surface is formed on the rotor disk periphery, while the bases of the latter type do not contact each other, so that the resulting gaps between adjacent blading must be filled by platforms, which are part of the rotor disk rim, to form a substantially continuous surface.

During operation of the machines, the means of blading attachment, such as a fir-tree or a dovetail construction or rivets, are subjected to forces of considerable magnitude, due largely to the weights of the blade airfoils and of the blade bases, especially in the former type. When narrow base blading is used, the rotor disk rims suffer considerable high local stresses, caused by the use of integral platforms to fill the gaps between adjacent blading.

The forces and stresses in rotor disks due to high speed of rotation are decreased considerably by reducing the weight of the blade with integral platform, which in turn results in a reduction of disk rim web thickness, or by reducing the rim width and by eliminating the disk platform structure.

Furthermore, stresses within the blading are reduced considerably by a more elastic installation of blading in the disk rim and introduction of dampening action from the locking means used.

The object of my invention is to provide an improved rotor construction which is simpler and less expensive to manufacture and more readily repairable.

Another object of the invention is to provide an improved lightweight rotor which can be operated at higher speeds than conventional rotor structure.

Still another object of the invention is to provide an improved lightweight rotor structure which results in large economies in weight and use of critical materials.

A further object of the invention is to provide an improved lightweight rotor structure for a turbomachine in which the life of the blading is increased.

A still further object of the invention is to provide turbomachine blading with integral platforms produced with a great economy in machining time.

Another object of my invention is to provide a means for locating blading on a rotor disk without causing local high stress concentrations.

These and other objects of the invention will become more apparent by reference to the following description taken in conjunction with the accompanying drawing, which illustrates preferred embodiments of my invention and in which:

Fig. 1 is a partly exploded isometric view of my improved lightweight rotor structure; and

Fig. 2 is an isometric view of a modification of my sheet metal platform filler.

In accordance with the illustrated embodiments of my disclosure, I accomplish the objects of my invention by replacing heavy metallic blade or rotor disk platform structures with separate sheet metal platform fillers.

In the drawing, a section of a turbomachine is disclosed generally at 10, comprising a relatively lightweight, large diameter rotor disk 11, blading 12 and lightweight sheet metal platform spacers or filler pieces 13, held in assembled relationship by retaining wires 14 disposed on opposite sides of rotor disk 11.

The periphery or rim 11*a* of disk 11, carries grooves of either a fir-tree or dove-tail configuration, as shown at 15, to receive blading 12 having a base 12*a* with a form corresponding to the groove in the disk rim. The width of the disk rim has been narrowed to be strong enough only to support the blading, lightweight platform fillers and retaining wires when in assembled relationship, so that the web thickness of the disk also has been reduced accordingly, because of the lessened centrifugal stresses due to smaller rim weight.

Base 12*a* has two pairs of opposed surfaces 12*d* and 12*e* which define radially extending surfaces outlining the tenon or toe portion 12*b* and the substantially parallel faces 12*c* of bases 12*a*. The height of the surfaces 12*c* cause the top or platform 12*f* of base 12*a* to protrude beyond the rim 11*a* to the extent of the thickness of the sheet metal platform spacers 13 to provide in assembled relationship therewith, a smooth aerodynamic platform outer surface between adjacent blading. The two pairs of opposed surfaces 12*b* and 12*c* define axially extending faces which outline (1) the parallel faces 12*d*, adjacent the toe portion 12*b*, and (2) the outwardly flaring platform supporting faces 12*e*, each of which latter faces extend beyond the dimensions of the axial width of the rim 11*a* and which contain a semi-round groove 16 substantially parallel to the platform 12*f* of base 12*a*.

My preferred embodiment of platform filler 13 is constructed from a single piece of sheet metal bent inwardly away from platform surface 13*a* to form on the inner side thereof, substantially parallel channels 13*b* and wheel rim gripping flanges 13*c*, which are formed by reentrant bending of the ends of the sheet metal defining the channels and serve to hold the platform filler in position on the disk rim prior to final assembly of the lightweight rotor, which follows by the insertion of proper size retaining wires 14 through the channels 13*b* of the platform filler sections 13 and against the aligned grooves 16 in the base of the blades 12. The flanges 13*c*—13*c* span the rotor rim 11 so as to resiliently engage the sides of the wheel 11. In this manner, not only are the blades connected to the sections or spacers 13 and locked in position and prevented from moving axially but the retaining wires prevent radial spacer movement and provide a dampening action to increase the life of the blading. The ends of the retaining wires are fastened together in some appropriate manner. When a retaining wire is removed for repairs of individual blading, it is replaced easily if damaged in removal. For better efficiency, the bent over edges of the fillers defining the leading and trailing edges thereof should approximate the corresponding edges of the outwardly flaring faces 12*e*.

The modification of the platform filler structure disclosed in Fig. 2 at 23 is a two piece, sheet metal structure comprising an outer parallelogram shaped platform section 23*a* welded to an inner section 23*b* similar in shape but formed with a pair of spaced parallel channels 23*c* for resilient mounting on the rotor and through which the retaining wires 14 are threaded to lock the blading 12 and platform fillers 23 in position on the disk rim, the bases of the blading 12 having grooves 16 as in the preferred embodiment.

It will be apparent to those skilled in the art that

applicant's novel rotor is of lightweight construction having a reduced rim width and web thickness, that lighter blading is required with the use of sheet metal platform spacers, that blade life is increased by more elastic mounting, and that repairs are greatly facilitated.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A platform filler for a rotor having blading spaced on the rim thereof, said filler comprising a sheet metal plane section defining an aerodynamic surface adapted to be inserted between adjacent blading and a pair of spaced channels on the opposing surface thereof, the ends of said plane section defining said channels comprising re-entrant flanges adapted to resiliently engage said rim.

2. A sheet metal platform filler for a rotor disk having rim spaced blading and comprising a plane section adapted to be inserted between adjacent blading thereby forming an aerodynamic surface therewith, a pair of spaced channels extending inwardly away from said plane section and adapted to span said rotor, the inner edges of the walls of said channels having re-entrant portions adapted to receive the rim portion of said disk between them whereby axial movement of said filler is restrained.

3. An integrated sheet metal platform filler for a rotor disk having a grooved rim carrying insertable blading comprising an outer plane section adapted to be inserted between adjacent blading for forming a smooth aerodynamic surface therebetween and an inner section having spaced grooves thereon joined to said plane section and forming channels therewith, said channels adapted to span said rotor disk when said filler is in operative position.

4. In combination, a rotor disk, blading and platform fillers having a smooth outer surface thereon, said disk having a relatively large diameter and a relatively narrow rim, said blading being attached to said rim and having a platform portion extending beyond the periphery thereof, and said platform fillers being disposed between said blading and fastened thereto by locking means extending around the periphery of said disk, said fillers thereby forming an aerodynamic surface between said blading, said fillers having resilient faces engaging opposite sides of the rotor disk rim.

5. In combination with a rimmed rotor disk having circumferentially spaced apart grooves in the rim portion and blading provided with bases which correspond in form to said grooves for fastening said blading to said rim, sheet metal platform fillers disposed between said blading having a platform section extending beyond the periphery of said disk when in operative position, said platform fillers being attached to the blading providing an aerodynamic surface therebetween and having channels on the surface opposite thereto and spaced to span the rim of said disk in resilient engagement therewith, said blading having parallel grooves on the base of said blading substantially in alignment with said channels, and means interconnecting said fillers and blading passing through said channels and engaging said grooves to form an integrated assembly.

6. In a lightweight rimmed rotor, the combination of a disk having spaced apart peripheral grooves extending across the width of the rim of said disk, blading having a base portion disposed in said grooves, said base portion having substantially parallel semi-round grooves located on opposite sides of the rim of said disk when in assembled relationship therewith, and filler pieces between said blading in close abutting relationship therewith to form smooth flow surfaces, said filler pieces having channels on their inner sides separated by the rim of said disk, the inner sides of said channels having re-entrant portions in resilient engagement with said rim, and means for fastening said blading and filler pieces to said disk comprising a retaining wire through said channels and engaging said base grooves.

7. In a turbomachine having a peripheral grooved rotor disk with insertable blading disposed in the grooves of said disk, said blading having bases containing semi-round grooves, separably removable spacing members fitting between adjacent blading on the periphery of said disk and forming an outer aerodynamic surface therewith, the spacing members having substantially parallel channels formed on the inner surfaces thereof, in combination with annular fastening means threaded through each of said channels and engaging the grooves in the bases of said blading to form an integrated assembly.

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