July 12, 1960 R. E. GINGRAS 2,944,787

COMPRESSOR BLADE LIMIT STOPS

Filed March 20, 1957

FIG. 1

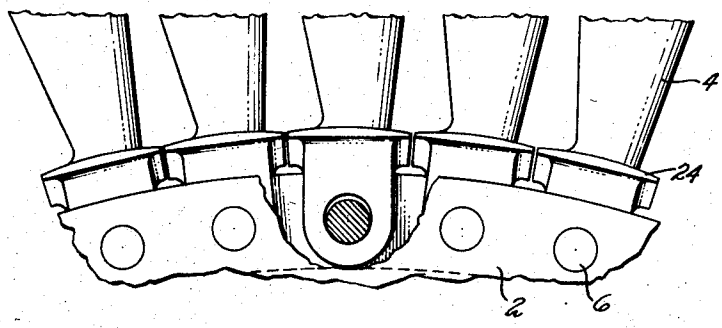


FIG. 2

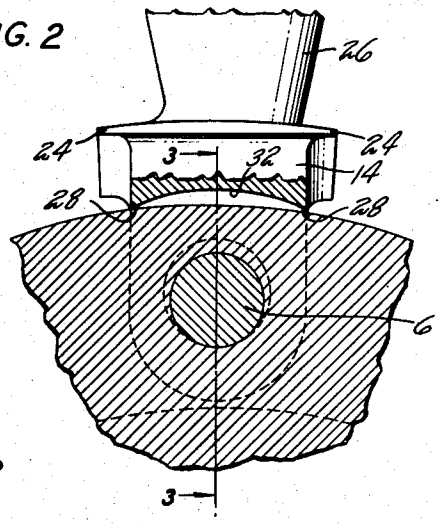
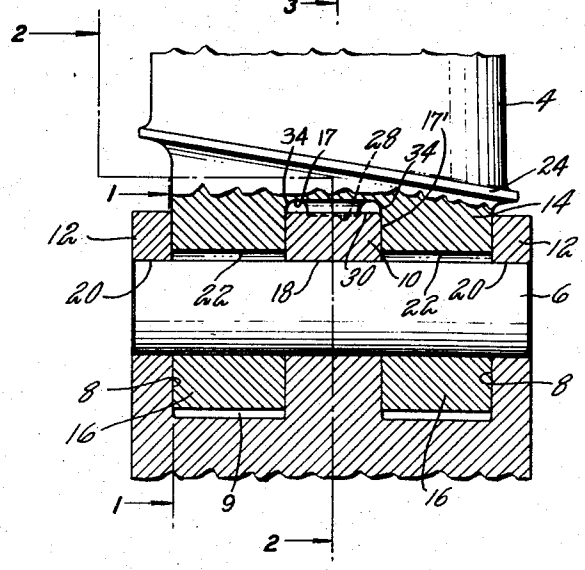


FIG. 3



INVENTOR
RICHARD E. GINGRAS
BY Charles Allen
ATTORNEY

United States Patent Office 2,944,787 Patented July 12, 1960

2,944,787

COMPRESSOR BLADE LIMIT STOPS

Richard E. Gingras, Agawam, Mass., assignor to United Aircraft Corporation, East Hartford, Conn., a corporation of Delaware

Filed Mar. 20, 1957, Ser. No. 647,436

4 Claims. (Cl. 253—77)

This invention relates to rotors for compressors or turbines and especially to an arrangement for supporting the blades of each row of blades on its respective disc where each blade is mounted for rocking movement on the disc.

One feature of the invention is an arrangement for limiting the pivotal movement of the blade from its normal substantial radial position with respect to the disc. Another feature is the arrangement of the stops which limit the pivotal movement of the blade such that the stops are an integral part of the blade structure and engage with an integral part of the disc structure.

Other features and advantages will be apparent from the specification and claims, and from the accompanying drawings which illustrate an embodiment of the invention.

Fig. 1 is a fragmentary side view of a disc with a series of blades mounted thereon.

Fig. 2 is an enlarged view partly in section as indicated by the line 2—2 of Fig. 3.

Fig. 3 is a sectional view substantially along the line 3—3 of Fig. 2.

The disc 2 which may be used in either a compressor or a turbine of the axial flow type has a row of blades 4 attached to and projecting from its periphery. Each blade is held to the disc by an axially extending pin 6 which in the arrangement shown permits pivotal movement of the blade structure about the axis of the pin.

For attachment of the blade to the disc, the latter has radial grooves 8 in the periphery of the disc to form a centrally positioned radially extending flange 10 and outer flanges 12 spaced from the center flange and parallel to it. The blade structure 4 includes a root portion 14 having inwardly projecting tangs or ribs 16 which in an axial direction are spaced apart to straddle the center flange 10 and each of which is wide enough in an axial direction to substantially fill the space between the center flange and the outer flange 12. The flanges 10 and 12 which are thus intermeshed with the tabs on the root have aligned openings 18 and 20, respectively, which receive the pin 6, the latter being preferably a tight fit in these openings to hold the pin axially in position. The blade root 14 has corresponding aligned openings 22 in the tangs 16 which receive the pin and which are preferably a loose fit around the pin to provide for rocking movement of the blade structure on the pin. The tangs are so dimensioned as to provide for radial clearance between the disc and blade root both at the bases 17 of the ribs 16, that is to say, the base of the slot 17′ between the ribs 16 and at the bases 9 of the grooves 8 between the ribs 10 and 12 to permit this rocking movement.

Although the loose fit for the blade root on the pin need be only enough to permit the root to turn on the pin, it is desirable to make the openings 22 substantially larger than the pin such that there is a radial freedom of movement for the blade root with respect to the disc. This arrangement results in a rocking movement of the root on the pin without any sliding movement between

the pin surface and the cooperating surfaces of the openings 22.

Each blade has circumferentially extending projections 24 between the airfoil portion 26 of the blade structure and the base 14. These projections form inner shroud elements which align with similar elements on adjacent blades and are closely spaced from each other as shown. The assemblage of these shroud elements forms an inner shroud ring defining the inner wall of the gas path through the device.

With the blade mounted for rocking movement about the pin, it will be apparent that when the disc is spinning the blade structure tends to extend directly radially of the disc except for the gas forces acting on the blade and except for rotative forces applied between the disc and the blade. Under certain conditions, the forces acting on the blade structure tend to cause its pivotal movement about the pin 6 to a point beyond the permissible limit for blade rocking. To prevent each blade from rocking too far, stops 28 are formed centrally of the blade root in a position to engage with the outer periphery 30 of the central flange 10. With this arrangement, rocking movement beyond a predetermined angle is effectively prevented without the need for any added structure in the device.

One problem that is overcome is the possibility that the inner shroud elements or projections 24 may overlap one another as a result of nonsymmetrical pivotal movement of the adjacent blades and prevent return of the blades to the desired substantially radial position. The stops limit the movement of the blade about the supporting pin so that interference between adjacent blades or adjacent blade shroud elements will not occur. Another condition that exists during starting or stopping of the rotor is the extent of rocking movement occurring at slow speeds when the centrifugal load on the blades is very small as compared to the weight of each blade.

These stops 28 may be formed, for example, by forming an arcuate recess 32 within the blade root on a radius smaller than the radius of the periphery of the disc which, as shown, effectively prevents contact between any part of the blade root with the periphery of the flange 10. At the ends of the recesses 32, the narrow stop surfaces 28 are cut either at right angles to the blade axis or on an arc substantially the same as that of the outer radius of the disc. These stop surfaces 28 are defined by terminating the recess 32 just short of the ends of the slot 17′, that is short of the substantially radial end surfaces of each blade root. With the stops located and arranged as shown, very accurate control of the clearance between the stops and the cooperating disc surface is possible such that the extent of blade rocking is precisely determined. For more effective stops, the blade root has circumferentially extending grooves 34 formed adjacent to each of the tangs 16 with these grooves having a radial dimension slightly larger than the outer radius of the disc to prevent any contact between the disc and the blade structure at this point. The stops 28 are circumferentially spaced apart on each blade to as great an extent as possible in order to make the stops as precise and effective as possible.

It is to be understood that the invention is not limited to the specific embodiment herein illustrated and described, but may be used in other ways without departure from its spirit as defined by the following claims.

I claim:

1. In a turbine rotor, a disc having a plurality of flanges on its periphery and a row of openings extending axially through said flanges, a plurality of blades projecting outwardly from the disc and having roots at their inner ends with projecting ribs intermeshing with the

flanges on the disc, said ribs defining a slot therebetween, the ribs for each blade having aligned openings therein in alignment with the openings in the flanges, a pin for each blade positioned in said aligned openings in the flanges and ribs, said pin and openings being of such dimension that the pin is tight in the disc flanges and loose in the openings in the ribs and said blade and disc having radial clearance between the flanges and the bases of the ribs for rocking movement of the blade on its associated pin and circumferentially spaced stop means carried by the root at the base of and between the ribs thereon in a position to engage the disc for limiting the extent of rocking movement of the blade in either direction from a substantially radial position, said stop means being defined by a recess at the base of the slot between the ribs, said recess terminating short of the ends of the slot to form short stop elements engageable with the periphery of the disc flange between the ribs.

2. In a turbine rotor, a disc having a plurality of flanges on its periphery and a row of openings extending axially through said flanges and being circumferentially spaced on the disc, a plurality of blades projecting outwardly from the disc and having roots, each root having spaced inwardly extending ribs thereon to intermesh with the flanges on the disc, the ribs for each blade having aligned openings therein in alignment with the corresponding openings in the flanges, a pin for each blade positioned in said aligned openings in the flanges and ribs, the dimensions of the pin and the openings being such that the pin is tight in one set of openings and smaller in diameter than the other set of openings to be loose therein such that the blade may pivot with respect to the disc on the pin, said blade root and said disc having radial clearance at the periphery of the flanges to provide for rocking movement of each blade on its associated pin, and circumferentially spaced stops integral with the root in circumferentially spaced relation to each other, said stops being located axially between the spaced ribs on the blade root and being in radial alignment with the periphery of one of the flanges on the disc for engagement with said flange by rocking movement of the blade in either direction from a substantially radial position, said stop means being defined by a recess at the base of the slot between the ribs, said recess terminating short of the ends of the slot to form short stop elements engageable with the periphery of the disc flange between the ribs.

3. In a turbine rotor, a disc having a plurality of radial flanges on its periphery including a central flange and outer flanges spaced axially therefrom, said flanges having circumferentially spaced axially extending aligned openings therein, a plurality of blades projecting outwardly from the disc and each blade having a root for attachment of the blade to the disc, each root having a pair of spaced ribs thereon to fit over the central flange on the disc and to be received between the outer flanges, said pair of ribs having aligned openings therein, one in each rib, in a position to align with one set of the axially aligned openings in the disc flanges, a pin for each blade positioned in said aligned openings in the ribs and flanges, said pin being substantially the diameter of the

flange openings and thus being a tight fit in said flange openings, and said pin being smaller in diameter than the rib openings and thus being a loose fit in the rib openings, the rib openings being larger in diameter than the flange openings for the same pin, said root ribs being deep enough radially to provide radial clearance between the root and the peripheries of the flanges, such that the blade is free to rock on the pin, and spaced stops spaced apart circumferentially on the balde root and positioned axially of the root so as to align radially with the periphery of the central flange and to engage said central flange by movement of the blade on the pin from its substantially radial position, said stop means being defined by a recess at the base of the slot between the ribs, said recess terminating short of the ends of the slot to form short stop elements engageable with the periphery of the central disc flange.

4. In a turbine rotor, a disc having a plurality of radial flanges on its periphery including a central flange and outer flanges spaced axially therefrom, said flanges having circumferentially spaced axially extending aligned openings therein, a plurality of blades projecting outwardly from the disc and each blade having a root for attachment of the blade to the disc, said blades being circumferentially spaced on the disc, and adjacent blades having inner shroud elements on the roots of the blades extending circumferentially into closely spaced relation to each other, each root having a pair of spaced ribs thereon to fit over the central flange on the disc and to be received between the outer flanges, said pair of ribs having aligned openings therein, one in each rib, in a position to align with one set of the axially aligned openings in the disc flanges, a pin for each blade positioned in said aligned openings in the ribs and flanges, said pin being substantially the diameter of the flange openings and thus being a tight fit in said flange openings, and said pin being smaller in diameter than the rib openings and thus being a loose fit in the rib openings, the rib openings being larger in diameter than the flange openings for the same pin, said root ribs being deep enough radially to provide radial clearance between the root and the peripheries of the flanges, such that the blade is free to rock on the pin, and spaced stops spaced apart circumferentially on the blade root and positioned axially of the root so as to align radially with the periphery of the central flange and to engage said central flange by movement of the blade on the pin from its substantially radial position, said stop means being defined by a recess at the base of the slot between the ribs, said recess terminating short of the ends of the slot to form short stop elements engageable with the periphery of the central disc flange.

References Cited in the file of this patent

UNITED STATES PATENTS

2,326,145	Kroon	Aug. 10, 1943

FOREIGN PATENTS

302,953	Great Britain	Dec. 21, 1928
468,846	Canada	Oct. 17, 1950
667,979	Great Britain	Mar. 12, 1952