

UNITED STATES PATENT OFFICE.

HERBERT T. HERR, OF MERION, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA.

TURBINE-BLADE FASTENING.

Application filed May 10, 1921. Serial No. 468,412.

To all whom it may concern:

Be it known that I, HERBERT T. HERR, a citizen of the United States, and a resident of Merion, in the county of Montgomery and State of Pennsylvania, have invented a new and useful Improvement in Turbine-Blade Fastenings, of which the following is a specification.

My invention relates to blade fastening means as employed in steam turbines, and it has for its object to provide apparatus of the character designated, which shall be peculiarly adapted for use with turbine rotors of the disc type, permitting the fastening of blades thereto by a simple, inexpensive and rugged means with a smooth overall contour in the finished product, the blades at the same time being readily removable for repair or replacement.

With these and other objects in view, I have illustrated my invention in the accompanying drawing in which Figure 1 is a side view, partially in section, of a turbine in which blades are employed according to my invention and Figure 2 is a detailed sectional view of a portion of a rotor disc using my specific method of attachment.

It has been proposed in the past, particularly where turbine blades are to be mounted on the periphery of the rotor disc, to provide the blades with inwardly extending tangs overlapping with outwardly extending flanges or other members on the disc, pins being driven through these overlapping members to attach the blade to the rotor disc, these pins being disposed parallel to the axis of rotation of the disc. Inasmuch as two or more rows of blades are in general mounted upon the same disc, it has followed that these pins could not be readily driven out, inasmuch as the inner ends thereof have necessarily been sealed and, furthermore, the combined effect of vibration and of centrifugal force has caused the pins to work loose, releasing the blades.

In accordance with the present invention, I cause the pins to be directed away from the axis of rotation in the direction of driving so that the action of centrifugal force thereupon causes them to remain in their seats, and furthermore, both ends of the pins are thus exposed so that they may be readily driven out in case of blade removal. This and other advantages will be more manifest

in view of the subjoined detailed description.

Referring to Figure 1, a portion of a turbine of the well known combination type is shown comprising a rotor or spindle 10, a casing 11, reaction blading 12 and two rows of impulse blading 13, steam being directed through the latter from a steam nozzle 14. Two rows of blading 13, 13' are mounted on a disc 15 and fixed impulse blades 16 project therebetween in a manner well known in the art. Referring to Figure 2, it will be noted that the disc 15 is provided with a central flange 17 of relatively low height but of relatively great width and with two annular flanges 18, 18 on one side thereof and with two annular flanges 19, 19 on the other flange thereof, these latter flanges being of relatively greater height than the central flange 17 but of relatively less thickness or width.

The blade 13 is provided with three tangs 20, 20, 20 of a length equal to the height of the flanges 18, 18 and the blade 13 is seated upon the flanges 18, 18 so that these tangs extend to the bottoms thereof, causing a full overlapping engagement between the blade 13 and the flanges 18. A pin 21 is driven through suitable openings in the flanges 18, 18 and tangs 20, 20 so as to firmly attach the blade 13 to the disc 15. The pin 21 is preferably driven toward that tang of the blade 13 which is nearest the central flange 17 and, inasmuch as the holes in the respective members are all directed outwardly and away from the disc 15, it follows that the pin 21 can not move back from its driven position except against the centrifugal force.

In like manner the blade 13' is provided with tangs 22, 22 and with a pin 23, this pin also being disposed further from the disc 15 at its inner end than at its outer end. Preferably the pins 21 and 23 are slightly tapered and the holes in which they are driven slightly reamed so that the pins are substantially precluded from further movement in the direction of driving and neither pin can move out in service, against the direction of driving, because of the action of centrifugal force.

Each pin is directed outwardly to such an extent that its inner end is exposed over the top of the root portion of the adjacent

blading in the other row so that any pin may readily be driven out by the insertion of a rod as indicated by the dotted line 24, it being borne in mind that the rotor blading is separated from the stationary blading for this operation.

From the structure described, it will be apparent that the flanges 18 and the tangs 20 constitute what may be termed tongue-and-groove connections between the rotor and the axial-flow blading 13, 13'. Also, the pins 21 and 23 are inclined to the plane of rotation so that a component of centrifugal force is effective to hold the pins out in position. In so far as the connection of the blading to the rotor is concerned, it is obvious that any form of connections of the blading and of the rotor which are suitable for the use of pins for holding the blading in place may be used.

Not only are there these advantages of ready removal and of pin retention by centrifugal force but also it should be noted that the area of each pin that is in shear at the abutting faces of a tang and of a flange is not a circle, assuming a round pin, but is rather an ellipse, this resulting in the development of great shear resistance, it being obvious that the normal shearing strength is in general less than the shearing strength in a given member of any other character.

Turning now to the consideration of the bending moments arising when it is attempted to move any of the blades laterally, as by steam pressure, it will be noted that the outer tang 20 is firmly pinned against the flange 18 and not only pinned but hooked, both by the disposition of the pin and by the enlarged head thereof, assuming that the pin 21 is tapered. In like manner the inner tang 20 cannot bend because it is firmly engaged between the inner flange 18 and the flange 17. Thus the entire overlapping-interengaging portions of the disk 15 and of blades 13 and 13' are joined together in a homogeneous mass, well adapted to withstand strains of any character which are imposed thereupon.

While I have shown my invention in a plurality of forms, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various other changes and modifications without departing from the spirit thereof, and I desire, therefore, that only such limitations shall be placed thereupon as are imposed by the prior art or as are specifically set forth in the appended claims.

What I claim is:

1. In a turbine blade structure, a rotor disc provided with annular radial flanges, blade members provided with tangs adapted to seat within said flanges, and pins passing through said flanges and tangs for the attachment of said blades to said rotor member, said pins being disposed at an angle with

respect to the axis of rotation of said rotor disc.

2. In a turbine blade structure, a rotor member provided with radially disposed members on the surface thereof, a blade provided with inwardly extending tangs inter-leaving with said radial members, and a fastening pin extending through said radial members and said tangs for attaching said blade to said rotor member, said pin having one end disposed at a greater distance from the axis of rotation of said rotor member than the other end.

3. In a turbine blade structure, a rotor member provided with radially disposed members on the surface thereof, a blade provided with inwardly extending tangs inter-leaving with said radial members, and a tapered fastening pin extending through said radial members and said tangs for attaching said blade to said rotor member, said pin having its small end disposed at a greater distance from the axis of rotation of said rotor member than the large end.

4. In a turbine blade structure, a rotor member provided with radially disposed members on the surface thereof, a blade provided with inwardly extending tangs inter-leaving with said radial members, and a tapered fastening pin extending through said radial members and said tangs for attaching said blade to said rotor member, said pin having its small end disposed at a greater distance from the axis of rotation of said rotor member than the large end, and said large end being seated in one outside tang and the remaining outside tang being restrained from bending by engagement with a portion of said rotor member.

5. In a turbine blade structure, the combination with a rotor member provided with "N" radial extensions on the surface thereof, a blade provided with "N+1" inwardly extending tangs interleaved with said radial extensions so that each radial extension is embraced by two tangs, and a fastening pin extending through said tangs and extensions for attaching said blade to said rotor member, one end of said pin being disposed nearer the axis of rotation of said rotor member than the remaining end, and means on said rotor member for positively engaging the end of the tang in which said remaining end is disposed.

6. In a turbine blade structure, the combination with a rotor member provided with "N" radial flanges on the surface thereof, a blade provided with "N+1" inwardly extending tangs interleaved with said radial flanges so that each radial flange is embraced by two tangs, and a fastening pin extending through said tangs and flanges for attaching said blade to said rotor member, one end of said pin being disposed nearer the axis of rotation of said rotor member than

the remaining end and means on said rotor member for positively engaging the end of the tang in which said remaining end is disposed.

7. In a turbine blade structure, the combination with a rotor member provided with "N" radial extensions on the surface thereof, a blade provided with "N+1" inwardly extending tangs interleaving with said radial extensions so that each radial extension is embraced by two tangs, and a tapered fastening pin extending through said tangs and extensions for attaching said blade to said rotor member, the large end of said pin being disposed nearer the axis of rotation of said rotor member than the small end thereof, and means on said rotor for positively engaging the inward end of the tang in which said small end is disposed.

8. In a turbine blade structure, the combination with a rotor member with "N" radial extensions on the surface thereof, a blade provided with "N+1" inwardly extending tangs interleaved with said radial extensions so that each radial extension is embraced by two tangs and a tapered fastening pin extending through said tangs and extensions for attaching said blade to said rotor member, the large end of said pin being disposed nearer the axis of rotation of said rotor member than the small end thereof, and means on said rotor for positively engaging the inward end of the tang in which said small end is disposed.

9. In a turbine, the combination of a rotor, axial-flow blading carried thereby, and pins inclined to the plane of rotation for holding the blading to the rotor.

10. In a turbine, the combination of a rotor, axial-flow blading carried thereby, tongue-and-groove connections between the blading and the rotor, and pins inclined to the plane of rotation and passing through said connections for holding the blading in place.

11. In a blade-mounting structure, the combination with a rotor member having a central annular flange of relatively great width and of relatively little height, of an annular flange disposed on each side of said central flange and having relatively greater height and lesser width with respect thereto, a blade seated upon each side flange and having inwardly extending tangs embracing the same and extending substantially to the bottom thereof, the ends of the tangs between said side flanges and said central flanges being tightly embraced therebetween, and pins passing through the tangs of each blade and said side flanges, said pins having their ends adjacent said central flange disposed

further from the axis of rotation than the remaining ends.

12. In a blade-mounting structure, the combination with a rotor member having a central annular flange of relatively great width and of relatively little height, of an annular flange disposed on each side of said central flange and having relatively greater height and lesser width with respect thereto, a blade seated upon each side flange and having inwardly extending tangs embracing the same and extending substantially to the bottom thereof, the ends of the tangs between said side flanges and said central flange being tightly embraced therebetween, and having said ends adjacent said central flange terminating outside the periphery thereof.

13. In a blade-mounting structure, the combination with a rotor member having a central annular flange of relatively great width and of relatively little height, of an annular flange disposed on each side of said central flange and having relatively greater height and lesser width with respect thereto, a blade seated upon each side flange and having inwardly extending tangs embracing the same and extending substantially to the bottom thereof, the ends of the tangs between said side flanges and said central flanges being tightly embraced therebetween, and tapered pins passing through the tangs of each blade and said side flanges, said pins having their small ends disposed in the tangs adjacent said central flange and further from the axis of rotation of said rotor member than the larger ends thereof.

14. In a blade-mounting structure, the combination with a rotor member having a central annular flange of relatively great width and of relatively little height, of an annular flange disposed on each side of said central flange and having relatively greater height and lesser width with respect thereto, a blade seated upon each side flange and having inwardly extending tangs embracing the same and extending substantially to the bottom thereof, the ends of the tangs between said side flanges and said central flanges being tightly embraced therebetween, and tapered pins passing through the tangs of each blade and said side flanges, said pins having their small ends disposed in the tangs adjacent said central flange and further from the axis of rotation of said rotor member than the large ends thereof, said small ends lying outside the periphery of said central flange.

In testimony whereof, I have hereunto subscribed my name this 2nd day of May, 1921.

HERBERT T. HERR.