Sept. 22, 1925. **1,554,614**

R. C. ALLEN

TURBINE BLADING

Filed Sept. 13, 1922

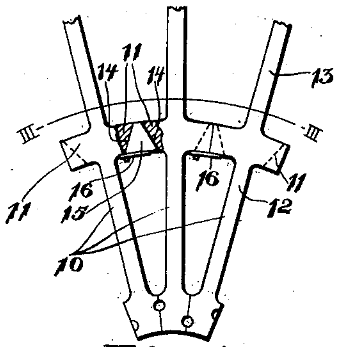


Fig:1.

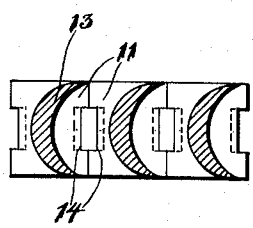


Fig:2.

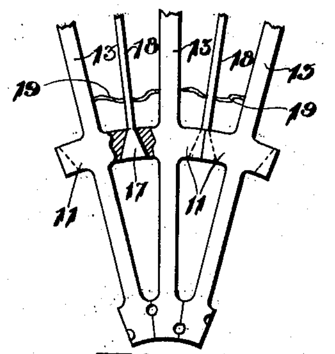


Fig:3.

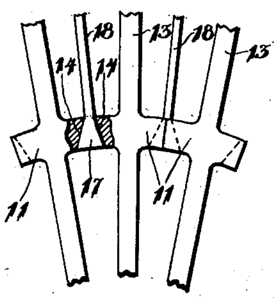


Fig:4.

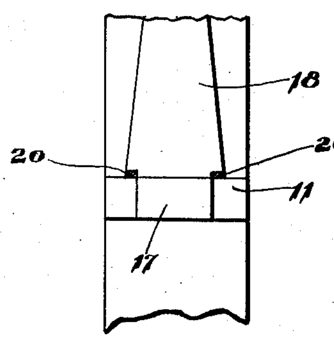


Fig:5.

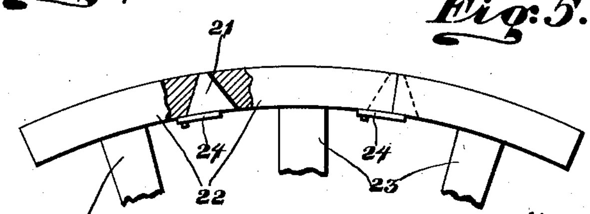
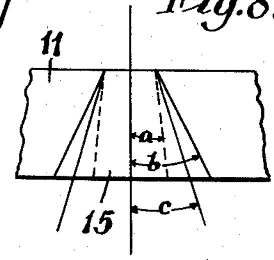


Fig:6.

Fig.8.



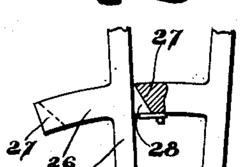


Fig:7.

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UNITED STATES PATENT OFFICE.

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TURBINE BLADING.

Application filed September 13, 1922. Serial No. 588,069.

To all whom it may concern:

Be it known that I, ROBERT C. ALLEN, a citizen of the United States, and a resident of Essington, in the county of Delaware and State of Pennsylvania, have invented a new and useful Improvement in Turbine Blading, of which the following is a specification.

My invention relates to turbine blades having lateral projections which define shrouds or deck partitions and it has for its object to provide wedge members in connection with the projections which shall assure the maintenance of a tight shroud or partition at all times, thereby limiting blade vibration, and in particular which shall permit of compensating movements taking place when the rotor and blading undergo disproportionate deformation.

A further object of my invention is to provide wedge elements of the character referred to with blade elements which shall serve the double purpose of increasing the mass which is effective under centrifugal force to maintain the wedge elements tight and of abstracting energy from motive fluid passing through the blading.

Apparatus embodying features of my invention is illustrated in the accompanying drawings, forming a part of this application, in which Fig. 1 is a fragmentary detail view showing a plurality of blades of a row with my tightening wedges applied thereto; Fig. 2 is a sectional view taken along the line II—II of Fig. 1; Fig. 3 is a detail view, similar to Fig. 1, but showing blade elements carried by the tightening wedges; Fig. 4 is a detail view, similar to Fig. 3, but having a different type of means for limiting inward movement of the wedge and blade elements; Fig. 5 is a face view of the blading shown in Fig. 4; Fig. 6 is a detail view showing my tightening wedge mechanism applied to blade tip shrouding; Fig. 7 is a detail view showing a modified form of shroud and wedge construction; and Fig. 8 is a diagrammatic view illustrating a feature of my invention.

With turbine blading having shrouds or partitions, more particularly with relatively tall blading, difficulty has been encountered due to crushing or ruinous deformation of the shroud or partition elements taking place in consequence of disproportionate or unequal rates of expansion of the rotor and of the blading. When steam is turned on, in starting, the blading heats up and expands much more rapidly than the massive spindle, with the result that any tight or continuous partition or shroud tends to be crushed. In accordance with my invention, the shroud or partition is provided with wedge means so that its length may at all times be that required by the physical condition of the blading and the spindle.

Referring now to the drawings for a more detailed description of my invention, in Fig. 1, I show a plurality of blades 10 of a row provided with intermediate abutments or shroud elements 11 which serve to brace the blades and to define inner and outer decks of blade elements 12 and 13.

The shroud elements 11 are provided with inclined and complementary recesses 14 which define outwardly-converging spaces to receive wedge elements 15. The angle of inclination of the recesses and of the wedges is greater than the angle of rest for a purpose to be described. Any suitable means may be provided for limiting inward movement of the wedges 15 after they are assembled; for example, in Fig. 1, I show spring elements 16, carried on the inner sides of shroud elements 11 for this purpose.

With the assembly of blading and wedge elements of this type, should expansion of the blading take place in operation, due to any cause, the wedge elements 16 will move out under the influence of centrifugal force to maintain a tight fit in the recesses, thereby serving to provide a firm bracing structure for the blades at all times. In this way, vibration of the blades, permitted by the shroud elements becoming spaced apart due to expansion or stretching of the blades, is avoided. On the other hand, with a contraction of the blade structure, the wedge elements 16 move inwardly due to the fact that the angle of inclination of the faces thereof is greater than the angle of rest. The springs 16, or any suitable equivalent thereof serve to limit inward movement of the wedges so that the latter may be maintained in place at all times. Furthermore, with unequal or disproportionate expansion of the rotor and the blading, the wedge construction permits of compensating movement taking place to maintain a tight shroud without liability of the shroud being crushed or deformed.

The above mentioned action is best illustrated by reference to Fig. 8 in which the shroud elements 11 and wedge 15 are shown drawn to a larger scale. In the drawing, the angle of the surface of the wedge 15 and the shroud elements 11 is indicated at b, the angle of rest at c and an angle smaller than the angle of rest at a. If the angle of the surface of the wedge 15 and the shroud element 11 were equal to the angle a it is obvious that when the blading expands and the wedge is moved outwardly by centrifugal force, assuming a new position, it will remain in the new position upon contraction of the blading, entailing crushing of the material. By making the angle of the two surfaces equal to the angle b, and greater than the angle c, upon contraction of the blading structure the wedge 15 moves inwardly.

In Figs. 3 to 5, inclusive, I show wedge elements 17 which fit in converging spaces defined by the inclined recesses 14 and which carry blade elements 18 interposed between the outer deck blade elements 13. The blade elements 18 are preferably smaller than the outer deck blade elements 13, and they serve the double purpose of increasing the effective mass subject to centrifugal force to urge the wedge elements 17 tightly in place between the shroud elements 11 and of abstracting energy from motive fluid passing through the upper deck.

In Fig. 3, I show springs 19 connected to the outer deck blade elements 13 and to the wedge-carried blade elements 18 for the purpose of limiting inward movement of the wedges 17 and the blade elements carried thereby.

In Fig. 5, I show a different means for limiting inward movement of the wedges 17 and the blade elements 18 carried thereby. In this view, the root of the blade portion 18 overhangs the shroud elements 11 and caulking 20 is inserted therebetween. In operation, the caulking will give sufficiently to provide for the necessary clearance for movement of the wedge elements 17 in order to limit vibration of the blades.

In Fig. 6, I show wedge elements 21 which are interposed between the shroud elements 22 arranged at the tips of the blades 23, inward movement of the wedge elements 21 being limited by any suitable means, such as by springs 24. The wedge construction shown in this view operates similarly to that shown in Fig. 1, already referred to.

In Fig. 7, I show a modified form of shroud constructon which may be used in any of the modifications heretofore described. In this view, I show each blade element 25 provided with a single shroud or partition element 26, having an inclined recess 27 to receive wedge 28 which fits in the recess and against an adjacent blade in order to maintain a tight shrouding structure.

From the foregoing, it will be apparent that I have devised shrouding for turbine blades which is particularly useful in connection with tall blading and which shrouding is maintained automatically tight at all times to limit vibration, regardless of any stretching of the blades or disproportionate expansion of the blades and the rotor, in order to limit vibration.

While I have shown my invention in but five 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. The combination of a row of turbine blades, shrouding members between adjacent blades in a row, said members having opposed and abutting faces provided with seats, one of which is inclined, and a wedge fitting the seats.

2. The combination of a row of turbine blades, bracing means between adjacent blades in a row, said bracing means having opposed faces provided with inclined seats, and outwardy-tapering wedges fitting the seats.

3. The combination of a row of turbine blades, bracing means for the blades, and outwardly-tapering wedge means cooperating with the bracing means to keep the blading tight, the angle of inclination of the wedge faces being greater than the angle of rest.

4. The combination of a row of turbine blades having bracing members between adjacent blades, said members having lateral and inclined seats defining outwardly-converging spaces and wedges fitting the spaces.

5. The combination of a row of turbine blades having bracing members between adjacent blades, said members having lateral and inclined seats defining outwardly-converging spaces, wedges in the spaces, and means for limiting inward movement of the wedges.

6. The combination of a row of turbine blades, intermediate and laterally-extending deck members on the blades defining inner and outer decks of blade portions and provided with inclined faces which define outwardly-converging spaces, and wedge members in the spaces.

7. The combination of a row of decked turbine blades having deck-defining members provided with inclined surfaces and outwardly-tapering wedge elements fitting the surfaces, the angle of inclination of the wedge and surfaces being greater than the angle of rest.

8. The combination of a row of blade elements, intermediate projections on the blade elements having inclined seats which define outwardly-converging spaces, wedge elements in the seats and fitting the spaces, and means cooperating with the wedge elements for limiting inward movement thereof.

9. The combination of a row of blade elements, intermediate projections on the blade elements defining inner and outer decks of blade portions and provided with opposed and inclined recesses defining outwardly-converging spaces, wedge elements fitting the spaces, and blade elements carried by the thin ends of the wedge elements and interposed between the outer deck blade portions.

10. The combination of a row of blade elements, intermediate projections on the blade elements defining inner and outer decks of blade portions and provided with opposed and inclined recesses defining outwardly-converging spaces, wedge elements fitting the spaces, blade elements carried by the thin ends of the wedge elements and interposed between the outer deck blade portions, and means cooperating with the latter blade elements for limiting inward movement of the wedge elements.

11. The combination of a row of blade elements, intermediate projections on the blade elements defining inner and outer decks of blade portions and provided with opposed and inclined recesses defining outwardly-converging spaces, wedge elements fitting the spaces, blade elements carried by the thin ends of the wedge elements and interposed between the outer deck blade portions, the latter blade elements extending beyond the lateral edges of the wedge elements over the sides of the projections, and caulking means cooperating with the latter blade elements and with the projections for limiting inward movement of the wedge elements.

In testimony whereof, I have hereunto subscribed my name this 7th day of September, 1922.

ROBERT C. ALLEN.