J. WILLIAMSON.

METHOD OF BLADING TURBINES.

APPLICATION FILED JULY 19, 1915.

1,269,144.

Patented June 11, 1918.

3 SHEETS SHEET 1.

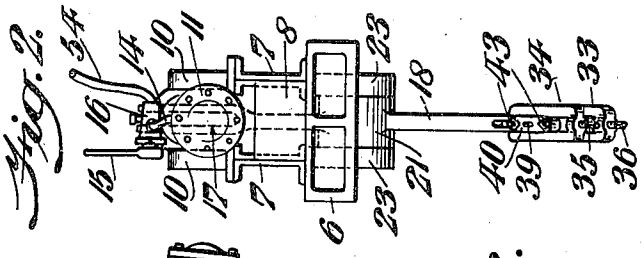


Fig. 2.

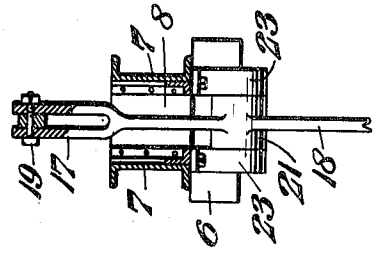


Fig. 3.

Fig. 1.

WITNESSES

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3 SHEETS—SHEET 2.

Fig. 4.

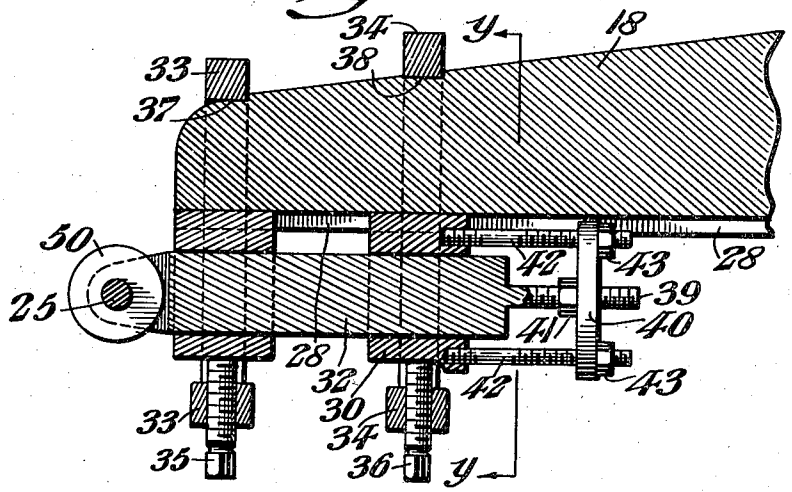


Fig. 5

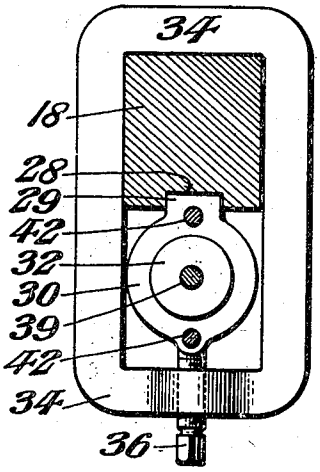


Fig. 6

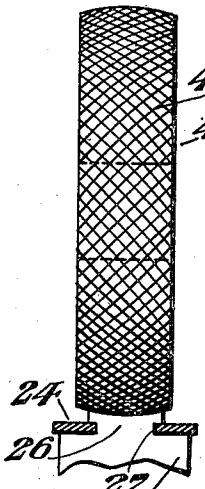


Fig. 7.

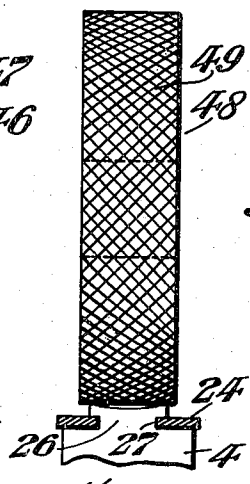


Fig. 8.

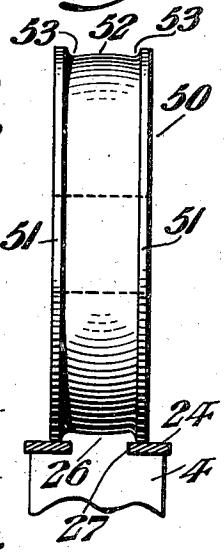


Fig. 9.

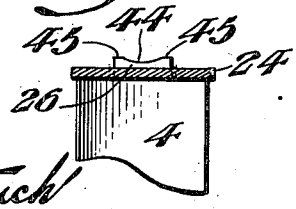
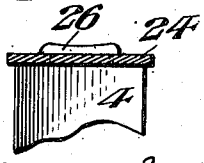


Fig. 10.



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3 SHEETS—SHEET 3.

Fig. 11.

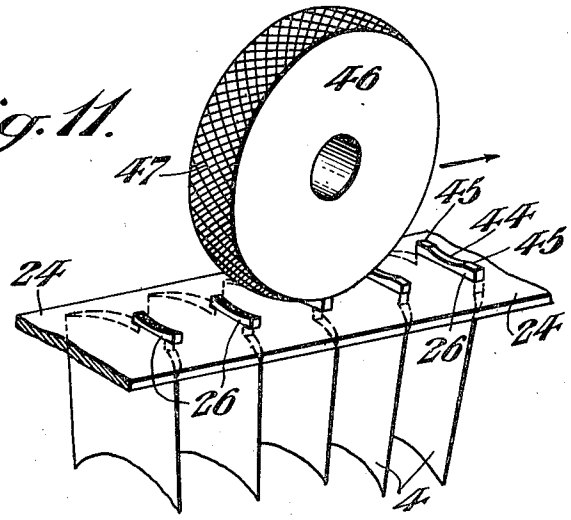


Fig. 12.

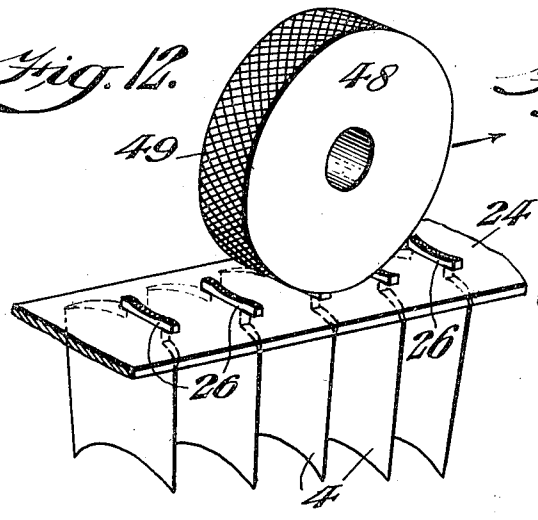
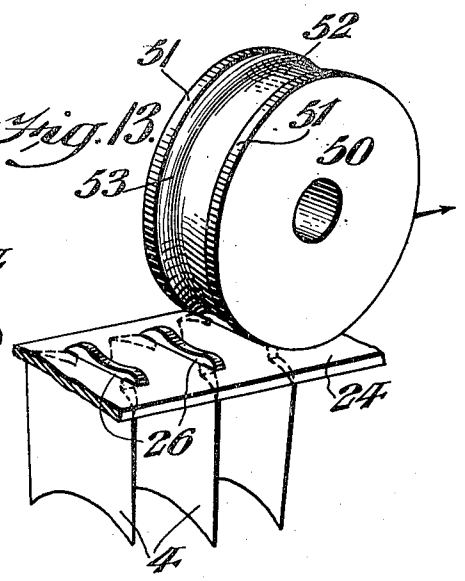


Fig. 13.



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METHOD OF BLADING TURBINES.

1,269,144. Specification of Letters Patent. Patented June 11, 1918.

Application filed July 19, 1915. Serial No. 40,680.

To all whom it may concern:

Be it known that I, JAMES WILLIAMSON, a citizen of the United States, residing at Newport News, county of Warwick, State of Virginia, have invented a new and useful Method of Blading Turbines, of which the following is a specification.

My present invention consists of a novel method of blading turbines whereby the turbine blades may be securely fixed with respect to the shroud bands so that all the blades will be uniformly secured in place.

It further consists of novel means for exerting pressure on the ends of the turbine blades to cause them to be compressed and expanded over the shroud band.

It further consists of a novel apparatus for causing the forming tools to travel in a path concentric with the turbine grooves and the shroud band.

It further consists of a novel construction and arrangement of forming tools.

It further consists of novel means for securing the forming tool with respect to its driving means and novel means for effecting the adjustment of said tool relatively to the driving means and the turbine blades.

For the purpose of illustrating one manner of carrying out my invention in practice, I have shown in the accompanying drawings one form of apparatus which can be advantageously employed, although it is of course to be understood that the order in which the various steps of my method may be carried out as well as the instrumentalities employed may vary widely in practice and that many different types and forms of construction may be employed in accordance with my invention.

Figure 1 represents a sectional elevation of an apparatus for blading turbines, embodying my invention, and by means of which my invention may be carried out, said apparatus being illustrated in assembled position with a turbine casing.

Fig. 2 represents an end elevation of the apparatus in detached position.

Fig. 3 represents a section on line *x*—*x* Fig. 1.

Fig. 4 represents a longitudinal section showing more clearly certain details of construction.

Fig. 5 represents a section on line *y*—*y* Fig. 4.

Figs. 6, 7 and 8 represent, respectively, front elevations of different rollers employed, in conjunction with a section of the shroud band and a turbine blade as it appears after being acted upon by the rollers.

Fig. 9 represents a sectional view of a shroud band, and an assembled turbine blade with its tenon as it appears before rolling.

Fig. 10 represents a sectional view, similar to Fig. 9, but shows the tenon of the turbine blade as it appears when the rolling operation is completed.

Figs. 11, 12 and 13 represent, respectively, in perspective and diagrammatically, the manner in which the different steps of the operation take place.

Similar numerals of reference indicate corresponding parts in the figures.

Referring to the drawings.

In order to illustrate a practical manner of carrying out my invention, I have illustrated the same as corresponding in some particulars with the construction shown and broadly claimed in one of my prior applications for Letters Patent of the United States Serial No. 352,712, filed by me on the 23rd day of July 1914, for a machine for blading turbines, but it is to be understood that such construction is illustrative only and that my novel method may be utilized in conjunction with any other forms of construction.

1 designates a turbine casing having the grooves 2 therein with which the outer ends of the turbine blades are adapted to interlock and in order that such blades may be readily inserted into the groove, I provide a desired number of lateral openings 3 communicating with such grooves. 4 designates the turbine blades and 5 designates the distance pieces which are preferably assembled with respect to the grooves in the manner set forth in my prior application to which I have hereinabove referred.

Supported on the turbine casing 1 are beams 6, which carry the bars or angles 7, which latter are connected by the plates 8. 9 designates angle bars carried by the bars 7 and forming therewith a support for the brackets 10 which latter are connected thereto in any desired manner. Journaled in the brackets 10 are the trunnions of a motor 11 on which is mounted a reciprocatory piston 12, and admission of motive fluid to and exhaust from opposite ends of the piston 12 through the conduits 13 and 14 is controlled by means of a manually actuated handle 15

carried by a valve mechanism 16. This valve mechanism for convenience of illustration is shown as being carried by the casing of the motor 11 but it will of course be understood that this may be located at any desired place. The rod of the piston 12 extends between the forked end 17 of a lever 18 and is secured thereto by means of a fastening device 19, illustrated as consisting of a bolt and a nut, the bolt passing through one of the apertures 20 which are located at different points on the forked end 17 in order to vary the path through which the outer end of the lever 18 travels. The lever 18 is provided with a hub 21 through which passes a shaft 22 carried by brackets 23 secured to the bars 7 in any desired manner. The shaft 22 is preferably located, as is apparent, on the horizontal axis of the turbine casing 1 so that the end of the lever 18 will travel in a path substantially concentric with the turbine groove.

In my prior application to which reference has hereinbefore been made, the end of the lever 18 had fixed thereto a pressing tool by means of which the turbine blades and distance pieces were positioned in the grooves of the turbine casing. After this has been done, the shroud band 24 is placed in position with the tenons 26 of the turbine blades extending through apertures 27 in the shroud band. It has heretofore been customary to secure the shroud band with respect to the blades by having the operator hammer the end of the blades into engagement with the shroud band. This method involves a considerable amount of unnecessary time and expense and there is always a likelihood that the blades will not be uniformly secured to the shroud band. In order to overcome these defects of prior methods I have devised novel means for securing the ends of the turbine blades with respect to the shroud band, which can be employed in conjunction with the same machine which had previously been employed to effect the placement of the blades and distance pieces in their grooves.

Referring now more particularly to Figs. 1, 4 and 5, the lever 18 at its outer end is provided with the slots or keyways 28 which are adapted to receive the key 29 of the adjustable guides 30, two of which are employed in the present instance, and which are apertured to receive the rod 32. The outer end of the rod 32 is bifurcated, in order to receive a roller 50 mounted thereon by means of the pin 25. The guides 30 are fixed in position by means of yokes 33 and 34 which are provided with set screws 35 and 36, respectively, the inner end of which contact with the support 30 adjacent thereto. In the form illustrated the end portion of the lever 18 is cut away, as at 37 and 38, in order that the yokes will come into close engagement with the lever 18 and their relative movement during the rolling operation will be prevented. The rod 32 has connected thereto, or integral therewith as illustrated, a threaded rod 39 which passes through a cross bar 40 and is provided at one side of said cross bar with a nut 41.

42 designates rods fixed to the inner of said guides 30 in any desired manner, and their outer ends are threaded and pass through the cross bar 40 and are provided with nuts 43. By such construction the relative longitudinal adjustment of the working tool and the lever 18 may be readily effected by the proper manipulation of the nuts 41 and 43. The inner ends of the turbine blades have, as before stated, the inwardly projecting tenons 26, the inner faces of which are preferably provided with the central concave portions 44 which merge into the smooth faces 45 on opposite sides thereof. 46 designates a roll having a convex knurled periphery, as indicated at 47. 48 designates a second roller the outer periphery of which is level or on the same radius and is knurled, as indicated at 49.

The finishing roll seen in Figs. 1 and 8 and indicated by reference character 50 is provided on its outer periphery at the sides with the flanges or smooth surfaces 51 and a central convex face 52 which merges into the flanges 51 by means of the curved faces 53.

The operation of my novel machine for blading turbines and the manner in which my novel method is carried out in practice will now be readily understood by those skilled in the art and is as follows:—

The turbine blades 4 and distance pieces 5 are first placed in the groove 2 of the turbine casing and the shroud band 24 is placed in position so that the tenons 26 extend through the apertures 27 of the shroud band. The tenons of the turbine blade at this time appear as seen in Fig. 9. The operator now assembles the roll 46 with respect to the rod 32 provided therefor. The rod 32 is properly adjusted by means of the nuts 41 and 43. The operator now actuates the handle 15 in order to permit the motive fluid to pass from the inlet conduit 54, see Fig. 2, through the valve mechanism 16 to opposite ends of the piston 12, thereby imparting a reciprocatory movement to its piston rod. Since the piston rod is connected with the lever 18, the latter will be rocked on its fulcrum 22 and the roll 46 will engage the end faces of the tenons of the turbine blade and owing to the convex face at the periphery of the roll 46, the tenons will assume the formation seen in Figs. 6 and 11, whereby the tenons are caused to extend over and be compressed against the shroud band 24. This movement removes the faces 45 and causes the end of the tenon to have

a concave surface. The operator then removes the roll 46 and secures the roll 48 in position with respect to the roll support 32 and the piston rod and the lever 18 are actuated as before to cause the roll 48 to travel concentrically with the turbine groove and the shroud band and after the lever has been reciprocated a desired number of times the tenon 26 appears as seen in Figs. 7 and 12.

The operator then removes the roll 48 and secures in position the finishing roll 50 which is reciprocated, in a similar manner to that already described, to cause the tenon to receive the formation seen in Figs. 8, 10 and 13, from which it will be apparent that the tenon is rolled or swaged over the shroud band in such a manner that the turbine blade is firmly and uniformly connected therewith. The operative faces of the rolls travel in a path concentric with the shroud band of the turbine groove and the center of the circle is on the horizontal axis of the turbine casing. The roll can be adjusted so that it will travel on circles formed by different radii by adjusting the nuts 41 and 43, as is evident. The length of stroke of the lever may be adjusted by varying the point of attachment of the piston rod with the bifurcated end of the lever 18.

It will now be apparent that in carrying out my novel method I exert pressure against the outer face of the tenon of the blade to cause such tenon to be compressed over the shroud band, such roller having a convex outer periphery. I then subject the tenon to the action of a roll having its outer periphery formed on a common radius and during the operation of such roll the side portions only of the outer face of the tenon are acted upon. I then subject the tenon to the action of a finishing roll having a smooth outer periphery conforming to the finished shape of the tenon and acting on the entire outer face and the sides of the tenon to give the finished formation to the tenon.

It will be apparent from the foregoing that by the use of my novel method and apparatus for blading turbines that the turbine blades will be uniformly connected with the shroud band with great rapidity and economy over the methods heretofore employed.

Attention is directed to the fact that in accordance with my invention it is unnecessary to slot or cut into the ends of the tenons which would tend to weaken the construction and I am enabled to act upon the entire outer face of the tenon to cause it to be expanded in both a circumferential and a lateral direction and firmly compressed against the shroud band. I prefer to have the rolls free to revolve but if desired they may be fixed and adjusted to bring a new surface into operation as they become worn.

It will be apparent from the foregoing that the roll is rotatably mounted at the end of a lever so that it travels in a circular path having the lever axis as its center and the roll may be adjusted in order to vary the radius of said circular path. The piston rod may be connected to the lever at different radial points in order to vary the stroke of the lever.

It will now be apparent that I have devised a novel and useful method of blading turbines which embodies the features of advantage enumerated as desirable in the statement of the invention and the above description, and while I have, in the present instance, shown and described preferred embodiments thereof which will give in practice satisfactory and reliable results, it is to be understood that the same are susceptible of modification in various particulars such as will come within the scope of the appended claims without departing from the spirit or scope of the invention or sacrificing any of its advantages.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent, is:—

1. The method of blading turbines, which consists in assembling the turbine blades with the casing and shroud band with the ends of the blades passing through the shroud band, exerting a pressure against the entire inner periphery of the blades, then exerting a pressure against only opposite portions of the inner periphery of the blades, then exerting a pressure against the inner periphery of the blades and simultaneously therewith forming the side walls of the inner ends of the blades.

2. The method of blading turbines, which consists in assembling the turbine blades in a groove of the casing with the inner ends of the blades passing through a shroud band, and successively subjecting the inner ends of the blades to the rolling action of a convex roll, a level roll, and a finishing roll.

3. The method of blading turbines, which consists in assembling the turbine blades in a groove of the casing with the inner ends of the blades passing through a shroud band, and successively subjecting the inner ends of the blades to the rolling action of a convex roll, a level roll, and a finishing roll by reciprocating said rolls in a path concentric with a turbine groove.

JAMES WILLIAMSON.

Witnesses:
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WILLIAM BURLINGHAM.