May 20, 1924. 1,494,781

C. GILSON

BLADE FASTENING

Filed May 31, 1921

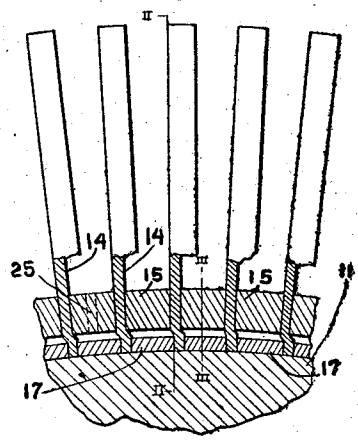


Fig. 1.

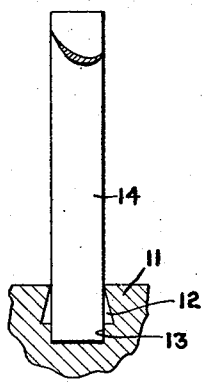


Fig. 2.

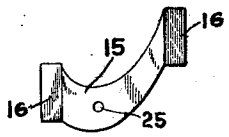


Fig. 4.

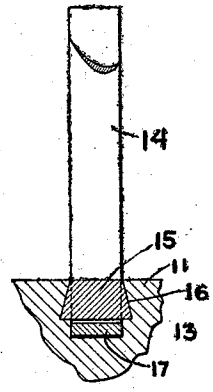


Fig. 3.

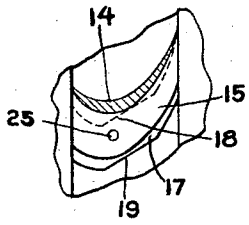


Fig. 6.

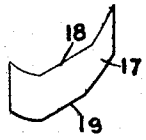


Fig. 5.

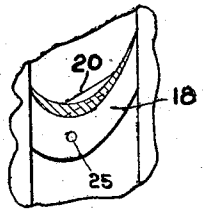


Fig. 7.

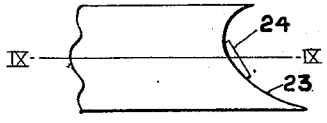


Fig. 8.

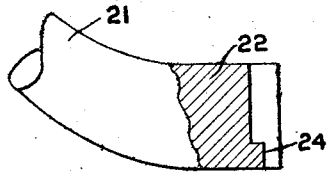


Fig. 9.

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UNITED STATES PATENT OFFICE.

CHRISTIAN GILSON, OF HOMEWOOD, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA.

BLADE FASTENING.

Application filed May 31, 1921. Serial No. 473,971.

To all whom it may concern:

Be it known that I, CHRISTIAN GILSON, a citizen of the United States, and a resident of Homewood, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Blade Fastenings, of which the following is a specification.

My invention relates to fastening means for the blades of steam turbines and similar structures and it has for its object to provide apparatus of the character designated which shall permit the use of blades of uniform cross-section throughout; and which shall so securely fasten these blades that a greater force is required to pull them out than is required for the actual disruption of the blade. A further object of my invention is to provide blade fastening means which shall be simple and inexpensive in construction and readily inserted during the assembly of a turbine.

Referring to the accompanying drawing for a more detailed understanding of my invention, I show a side view of a portion of a blading row in Figure 1, partially in section and partially in elevation; Figures 2 and 3 are views, partially in section and partially in elevation, taken transversely of the structure shown in Figure 1 and on the planes II—II and III—III, respectively; Figure 4 is a top plan view of the main or locking wedge or packing piece employed in my blade fastening means; Figure 5 is a top plan view of the lower or supplemental packing piece; Figure 6 is a top view, partially in section and partially in elevation, of a blade together with a main and a supplemental packing piece as assembled prior to driving; and Figure 7 is a similar view of the structure shown in Figure 6 after the completion of the driving operation; Figure 8 is a top plan view of a special tool employed in driving home the packing pieces of the previous figures; and Figure 9 is a side view, partially in section and partially in elevation of the tool shown in Figure 8, being taken on the plane IX—IX.

In the mounting of blades in steam turbines and similar structures, it is essential that the mounting means shall securely hold the blade in position, not only against the direct pull of centrifugal force but also against the loosening effects of long continued vibration and of heating and cooling. It has been proposed hitherto to mount blades by upsetting the lower end of the root thereof and by hooking this upset portion under a packing piece engaging in an undercut slot or groove on the spindle or cylinder of the turbine, as the case may be. Blade fastenings of this character have given extremely good results in service but experience has shown that the upsetting operation on individual blades is a somewhat expensive process, requiring careful manipulation and workmanship for the best results.

In accordance with the present invention, I provide blades of uniform cross-section throughout, that is to say, they are cut directly from blade stock without any upsetting operation and I mount these blades between main packing pieces engaging in an under-cut slot, the main packing pieces being similar to those of the prior art.

I further provide a straight slot in the bottom of the under-cut slot, the blades extending to the bottom thereof and I place supplemental packing pieces in this lower slot, these packing pieces being of such configuration as to slightly deform the blade section as they are driven home. This slight deforming causes the blades to engage positively under the main packing pieces and I find that the efficiency of the fastening thus provided is greater than 100% in that the blades pull in two before they can be extracted from their support.

Referring to the drawing for a more detailed understanding of my invention, I show a portion of a foundation piece at 11 in Figures 1, 2 and 3, this being either a portion of the cylinder or a portion of the spindle of a steam turbine. An under-cut slot or groove 12 is provided in the piece 11 and in the bottom thereof there is cut a further straight sided slot or groove 13 of a width substantially equal to the blade width. These two grooves together constitute what may be termed a compound fastening groove or slot.

Blades 14, 14, of uniform cross-section throughout, are inserted in the compound slot, reaching to the bottom of the lower slot 13, and main packing pieces 15, 15 are inserted therebetween, these packing pieces

extending to the bottom of the under-cut slot 12 and being provided with wedge-shaped sides, as indicated at 16 in Figures 3 and 4. The pieces 15 are roughly crescent shaped in plan view, as shown in Figure 4, but having blunt ends and are designed to fill the spaces between the adjacent blades and to maintain the blades in their proper operative position. The construction to this point is old and well understood in the art and requires no further explanation.

Supplemental packing pieces 17, 17 are placed in the lower groove 13 and the plan view of these pieces is shown in Figure 5. It will be noted that the general contour is that of a blunt-ended crescent, similar to the plan view of the members 15, except that flat spots 18 and 19 are provided on the concave and convex faces, respectively, for a purpose to be hereinafter more fully described.

Referring now to Figure 6, it will be noted that a blade 14 has a main packing piece 15 fitting snugly thereagainst, and underneath the packing piece 15 is seen a supplemental packing piece 17, which does not fit snugly against the convex face of the blade 14 because of the flat portion 18, this being the condition of the blade assembly prior to driving the parts home.

Figure 7 shows the position of the parts after they have been driven home and it will be noted that the respective ends of the member 17 now coincide with the respective ends of the member 15, these two members being of identical contour except for the flat spots 18 and 19 on the member 17. It will further be noted that the flat portion 18 of the member 17 has been forced against and into the blade structure to such an extent as to deform the blade and cause a portion thereof to protrude, as indicated at 20. This deforming is clearly indicated at the roots of the blades in Figure 1.

In the carrying out of my invention, it is advisable to employ a suitable tool for driving home the packing pieces, and such a tool is illustrated in Figures 8 and 9, wherein a handle 21 carries a driving head 22 provided with a face 23 conforming in its shape to the backs of the main packing pieces 15 but also provided adjacent its lower edge with a driving tongue or lug 24, as clearly shown in Figure 9.

In the driving home of the packing pieces, they are first assembled, as shown in Figure 6, and the driving tool is then so placed that the tongue 24 bears against the flat face 19. Under these conditions, all the driving force is exerted against the supplemental packing piece 17 until the blade is deformed to the desired extent, when the curved driving face 23 comes into contact with the back of the main packing piece 15. By this means it is at all times assured that the unflattened convex face of the supplemental packing piece 17 shall always be directly in line with the convex face of the packing piece 15, all as is desirable for securing a uniform and rigid spacing of the blade members.

It should further be noted that the shearing engagement of the blade between the main and supplemental packing pieces forces the main packing piece upward into firm wedging engagement with the walls of the under-cut slot and forces the supplemental piece downward into engagement with the bottom of the slot, thus firmly solidifying the entire blade mounting structure.

A small hole 25 may be drilled through each main packing piece so that subsequent to assembly, the inspector may insert a wire therethrough and assure himself that all the supplemental packing pieces have been inserted.

It will be obvious to those skilled in the art that my invention is susceptible of various modifications, as in causing the deforming portions 18 and 19 to take other shapes; such for example, as a hump at the point 18 and a hollow at the point 19, but I do not consider such modifications as these to depart from the spirit of my invention. It is extremely desirable, however, that all blade-deforming portions of the members 17 shall be located near the central portion thereof and that the ends of the members 17 shall conform in contour to the corresponding portions of the member 15, so that the blade edges shall not be distorted from their proper position.

While I have shown my invention in but one form, 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 assembly, locking packing means for a blade comprising an upper member and a lower member of equivalent blade-supporting cross-section in planes normal to the longitudinal axis of the blade but with their traces in said planes of dissimilar configuration.

2. In a turbine blade assembly, locking means for a blade comprising an upper wedge member abutting against the blade in a face conforming to the normal blade face and a lower member abutting against the blade in a face not conforming to the normal blade face, said lower member being forced against the blade to deform the same.

3. In a turbine blade assembly, locking means for a blade comprising an upper member abutting against the blade in a face

conforming to the normal blade face and a lower member in general conforming to the blade shape but less concave in its concave face than the convex surface of the blade and less convex in its convex face than the concave face of the blade.

4. In a turbine blade assembly, locking means for a blade comprising an upper member abutting against the blade in a face conforming to the normal blade face and a lower member in general conforming to the blade shape but having a blade-engaging concave face differing in contour from the convex blade face and having a blade-engaging convex face similarly differing in contour from the concave blade face.

5. In a turbine blade assembly, the combination with a foundation member provided with a compound groove formed of an upper groove with undercut sides and a lower groove in the bottom thereof having straight sides, said lower groove conforming to the blade width, of a series of blades inserted in said compound groove and spaced apart by main packing pieces having wedging sides adapted to engage the walls of said undercut groove, and supplemental packing pieces between said blades and lying in said lower groove, said supplemental pieces being so shaped as to deform said blades when driven home.

6. In a turbine blade assembly, the combination with a foundation member provided with a compound groove formed of an upper groove with undercut sides and a lower groove in the bottom thereof having straight sides, said lower groove conforming to the blade width, of a series of blades inserted in said compound groove and spaced apart by main packing pieces having wedging sides adapted to engage the walls of said undercut groove, and supplemental packing pieces between said blades and lying in said lower groove, said supplemental pieces having convex and concave faces for engaging the concave and convex faces, respectively, of the immediately adjacent blades but the respective degrees of convexity and concavity of the packing piece faces not conforming accurately to the corresponding degrees of concavity and convexity of the coating blade faces, whereby, when said supplemental packing pieces are driven home, said blades are slightly deformed and thereby locked beneath said main packing pieces.

7. In a turbine blade assembly, the combination with a foundation member provided with a compound groove formed of an upper groove with undercut sides and a lower groove in the bottom thereof having straight sides, said lower groove conforming to the blade width, of a series of blades inserted in said compound groove and spaced apart by main packing pieces having wedging sides adapted to engage the walls of said undercut groove, and supplemental packing pieces between said blades and lying in said lower groove, said supplemental pieces having convex and concave faces for engaging the concave and convex faces, respectively, of the immediately adjacent blades, the respective blade-engaging faces of said supplemental packing pieces being provided with flat portions adjacent the centers thereof, whereby, when said supplemental packing pieces are driven home, said blades are slightly deformed and caused to be locked beneath the respective main packing pieces.

8. A packing piece for use in a turbine blade assembly having a general crescent shape, a convex edge conforming, in general, to the concave face of the blade to be mounted and the concave edge conforming, in general, to the convex face of the blade to be mounted, said convex edge, however, being slightly cut away over a portion of its length, from the true corresponding blade shape and said concave edge correspondingly protruding beyond the true corresponding blade shape over a portion of its length.

9. A packing piece for use in a turbine blade assembly having a general crescent shape, the convex edge conforming, in general, to the concave face of the blade to be mounted and the concave edge conforming, in general to the convex face of the blade to be mounted, said convex edge, however, having a flat portion adjacent its center and said concave edge having a corresponding flat portion adjacent its center.

10. A compound packing unit for use in a turbine blade assembly comprising a main upper packing piece of a general crescent shape having wedging sides for engagement in a locking groove and a supplemental lower packing piece also having a general crescent shape and conforming to the contour of said main packing piece throughout its major portion but departing from said contour in a minor portion.

11. A compound packing unit for use in a turbine blade assembly comprising a main upper packing piece of a general crescent shape having wedging sides for engagement in a locking groove and a supplemental lower packing piece also having a general crescent shape and conforming to the contour of said main packing piece adjacent its limbs but departing from the contour of said main packing piece adjacent its center.

12. A compound packing unit for use in a turbine blade assembly comprising a main upper packing piece of a general crescent shape having wedging sides for engagement in a locking groove and a supplemental lower packing piece also having a general crescent shape and conforming to the contour of said main packing piece but having less concavity in the central portion of its concave face and less convexity in the central

portion of its convex face than the corresponding portion of the respective faces of said main packing piece.

13. The method of assembling turbine blades in a blade mounting comprising main packing pieces conforming accurately to the blade shapes and engaging in an undercut slot and further comprising supplemental packing pieces under said main packing pieces not conforming accurately to the blade shapes which comprise inserting said elements in a suitable mounting slot and forcing said supplemental packing pieces into such predetermined relation to said main packing pieces that the blades are deformed thereby and caused to engage under the immediately adjacent main packing pieces.

14. The method of assembling turbine blades in a blade mounting comprising main packing pieces conforming accurately to the blade shapes and engaging in an undercut slot and further comprising supplemental packing pieces under said main packing pieces, and conforming, in part, to the configuration of said main packing pieces but not conforming accurately to the blade shape, which comprises inserting said elements in a suitable mounting slot and forcing said supplemental packing pieces into alignment with the similarly shaped portions of the main packing piece, whereby the blade is deformed and thereby caused to positively engage beneath an adjacent main packing piece.

15. The method of assembling turbine blades of crescent-shaped cross-section in a blade mounting comprising main packing pieces of crescent shape conforming accurately to the respective blade faces and engaging in an undercut holding slot and further comprising supplemental crescent-shaped packing pieces underlying said main packing pieces and having limbs conforming accurately to the shape of the limbs of said main packing pieces but having less concavity at the center of the concave edge thereof, and less convexity at the center of the convex edge thereof than the corresponding portions of the main packing pieces which comprises assembling said elements in said slot and driving home said packing pieces with a tool having straight faces for engagement with the respective limb portions of said packing pieces, whereby the limbs of each supplemental packing piece are brought into alinement with the corresponding limb of the associated main packing piece, respectively, and said center portions of the supplemental packing pieces are caused to deform the respective blades to cause engagement thereof under the associated main packing pieces.

16. The method of assembling turbine blades of crescent-shaped cross-section in a blade mounting comprising main packing pieces of crescent shape conforming accurately to the respective blade faces and engaging in an undercut holding slot and further comprising supplemental crescent-shaped packing pieces underlying said main packing pieces and having limbs conforming accurately to the shape of the limbs of said main packing pieces but having less concavity at the center of the concave edge thereof and less convexity at the center of the convex edge thereof than the corresponding portions of the main packing pieces which comprise assembling said elements in said slot and driving home said packing pieces with a tool having straight faces for engagement with the respective limb portions of said packing pieces, and having an extension for engagement with the center portion of the supplemental packing piece, whereby said supplemental packing pieces are not caused to deform the respective blades for engagement under the associated main packing piece and whereby the limb portions of each supplemental packing piece are subsequently brought into alinement with the corresponding limb portion of the associated main packing piece by said straight tool faces.

17. In a blade mounting structure for turbines, the combination with a foundation member having an undercut slot of wedge-shaped packing pieces seated therein and engaging the blade roots and means beneath said packing pieces for deforming the blade roots in a circumferential direction, thereby resulting in outward movement of said wedge-shaped packing pieces into firm engagement with the walls of said undercut slot.

18. In a blade mounting structure for turbines, the combination with a foundation member having an undercut slot, of wedge-shaped packing pieces seated therein and engaging the blade roots and supplemental packing pieces beneath said main packing pieces, said supplemental packing pieces so deforming said blade roots as to cause an outward expansion forcing said wedge-shaped packing pieces into firm engagement with the walls of said undercut slot.

19. In a turbine, the combination of a foundation member having an undercut groove with a countersunk slot therein, a plurality of blades in the groove and slot, packing pieces in the groove, and packing pieces in the slot which, when driven home, result in deformation of the blade roots tending to force the first packing pieces upwardly into firm engagement with the sides of the undercut groove and tending to force the second packing pieces downwardly firmly into contact with the bottom of the slot.

20. In a turbine, the combination of a

foundation member having an undercut groove therein, a plurality of blades in the groove, wedge-shaped packing pieces in the groove and arranged between the blades, and other packing pieces arranged between the blades and below the first packing pieces for securing a circumferential deformation of the lower portions of the blade roots when the blading and packing pieces are assembled.

21. In a turbine, the combination of a foundation member having an undercut groove with a countersunk slot therein, a plurality of blades in the groove and slot, wedge-shaped packing pieces fitting the groove and having blade-engaging surfaces, and packing pieces in the slot for securing a circumferential deformation of the lower portions of the blade roots when the blading and packing pieces are assembled.

22. In a turbine, the combination of a member having a groove, a plurality of blades in the groove, upper packing pieces in the groove having surfaces which are conjugate to the blades, and other packing pieces below the first packing pieces which have blade-engaging surfaces differing in outline from the blade-engaging surfaces of the first packing pieces.

23. In a turbine, the combination of a member having an undercut groove, a plurality of blades in the groove, wedge-shaped packing pieces in the groove and between the blades and having surfaces which are conjugate to the blades, and other packing pieces below the first packing pieces and having blade-engaging surfaces which are dissimilar in outline to the blade-engaging surfaces of the first packing pieces.

In testimony whereof, I have hereunto subscribed my name this 24th day of May, 1921.

CHRISTIAN GILSON.