C. E. SEARCH.

STEAM TURBINE.

APPLICATION FILED AUG. 15, 1914. RENEWED NOV. 15, 1915.

1,187,451.

Patented June 13, 1916.

2 SHEETS—SHEET 1.

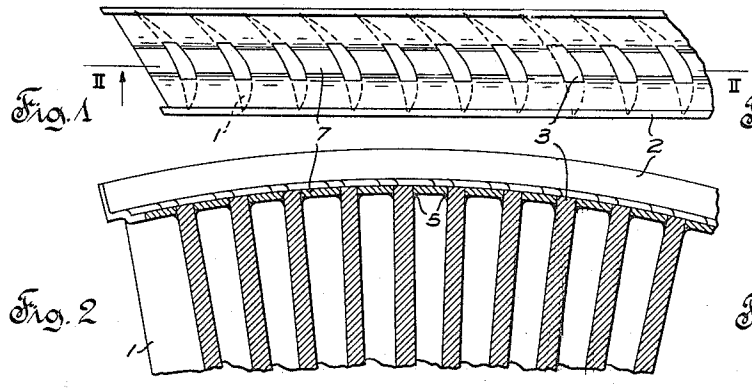


Fig. 1

Fig. 2

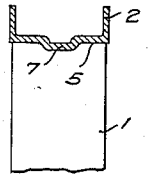


Fig. 3

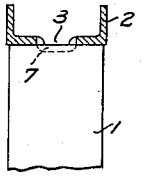


Fig. 4

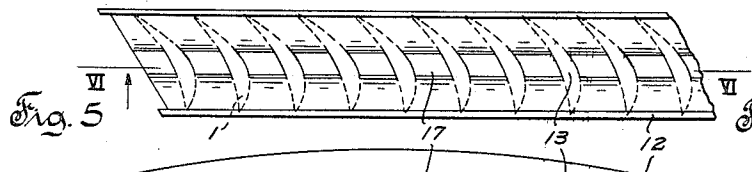


Fig. 5

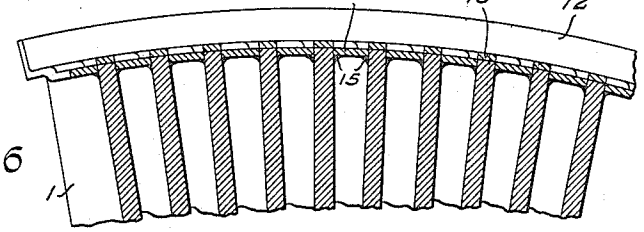


Fig. 6

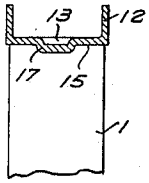


Fig. 7

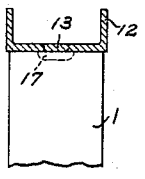


Fig. 8

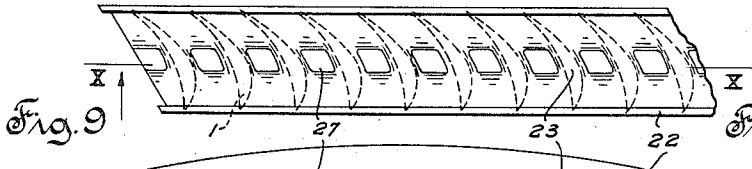


Fig. 9

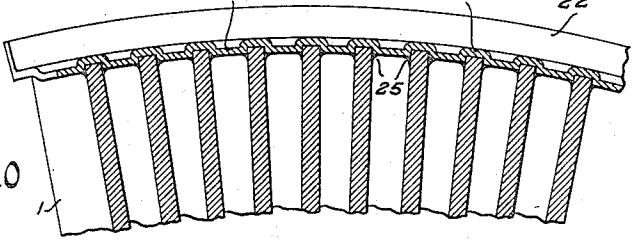


Fig. 10

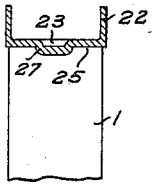


Fig. 11

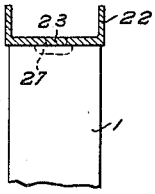


Fig. 12

Witnesses

Rob. E. Stoll.

W. H. Lieber

Inventor

C. E. Search

By

Attorney

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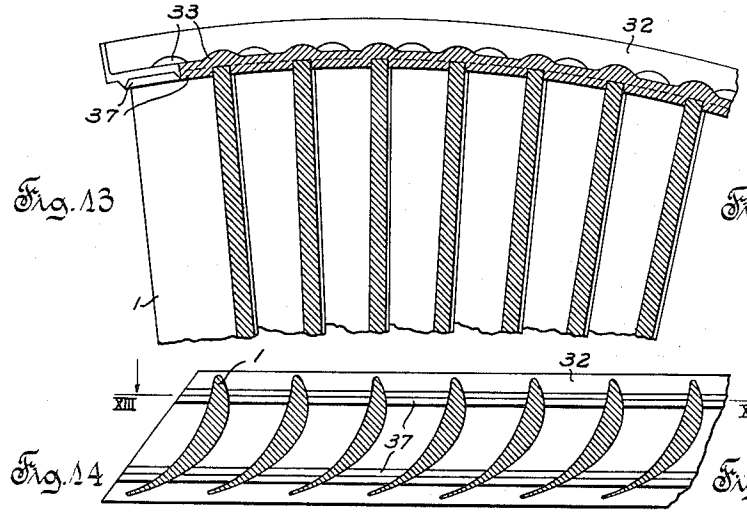


Fig. 13

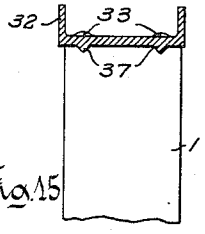


Fig. 15

Fig. 14

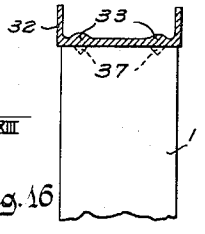


Fig. 16

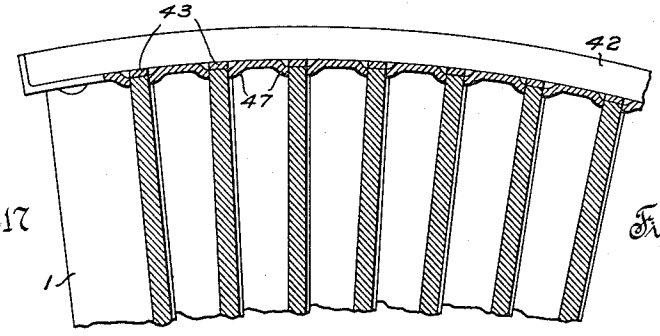


Fig. 17

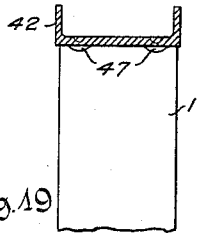


Fig. 19

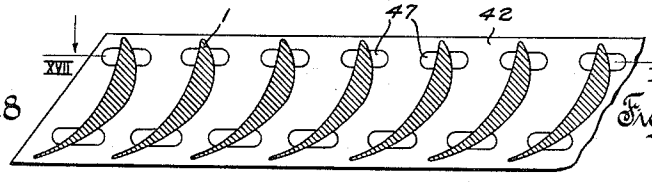


Fig. 18

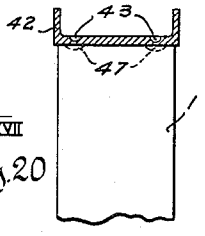


Fig. 20

Witnesses

Rob. E. Stoll.

W. H. Lieber

Inventor

C. E. Search

By

Attorney.

UNITED STATES PATENT OFFICE.

CHARLES EDWIN SEARCH, OF MILWAUKEE, WISCONSIN, ASSIGNOR TO ALLIS-CHALMERS MANUFACTURING COMPANY, OF MILWAUKEE, WISCONSIN, A CORPORATION OF WISCONSIN.

STEAM-TURBINE.

1,187,451. Specification of Letters Patent. Patented June 13, 1916.

Original application filed February 9, 1914, Serial No. 818,156. Divided and this application filed August 15, 1914, Serial No. 856,984. Renewed November 15, 1915. Serial No. 62,073.

To all whom it may concern:

Be it known that I, CHARLES EDWIN SEARCH, a citizen of the United States, residing at Milwaukee, in the county of Milwaukee and State of Wisconsin, have invented a certain new and useful Improvement in Steam-Turbines, of which the following is a specification.

This invention relates to steam turbines and more particularly to means for securing the shroud to the blade ends and for properly positioning the blades at one end.

An object of the invention is to provide a blade structure for steam turbines and similar devices which is simple and light in construction, efficient in operation, and which possesses the requisite amount of rigidity and strength, especially to withstand vibration.

One of the more specific objects of the invention is to provide a very light longitudinally corrugated shroud having formed thereon means for properly spacing and angling single-surfaced blade ends, the shroud being secured to the blade ends by fusion of metal.

Another object is to provide a simple method of forming the means for positioning the blade ends by forming positioning surfaces on the corrugation in such a way as to coact with the working faces of the blades longitudinally to a considerable extent.

This application is a division of application Serial No. 818,156, filed February 9, 1914.

The expression "single-surfaced end" as used herein is intended to apply to a blade end which is free of any projection or recess abruptly interrupting the continuity of the end surface of the blade. The expression therefore includes blade ends having surfaces which are either plane or curved, these surfaces being either perpendicular or oblique relative to the edges of the blade.

It has heretofore been proposed to fasten a shroud to the ends of turbine blades by forming tenons at the ends of the blades which were passed through holes in the shroud and were riveted over at their protruding ends. It has also been proposed to fasten a light shroud to the ends of blades by fusion of metal, for instance by brazing, the blade ends having been properly positioned by forming projections thereon and inserting these projections in holes formed in the shroud. An objection to both of these prior blade positioning constructions is that considerable blade stock is wasted in forming the tenons or projections at the blade ends. Another objection to the riveted-over fastening is that because of the local fastening of the shroud to the blade ends, the shroud base must of necessity be made considerably heavier, thus increasing the stress on the fasteners due to centrifugal force and also increasing the cost of construction. With the device of the present invention these objections are eliminated. In addition, the corrugation of the shroud of the present invention combined with its fastening to the blade ends by fusion of metal makes the shroud in the completed structure very much stiffer and stronger.

A clear conception of several embodiments of the invention may be had by referring to the drawing accompanying and forming a part of this specification in which like reference characters designate the same or similar parts in the various views.

Figure 1 is a plan view of a fragment of one form of shroud attached to a plurality of blades. Fig. 2 is a transverse vertical section through fragments of the shroud and blades disclosed in Fig. 1, the section being taken along the line II—II of Fig. 1 looking in the direction of the arrow. Fig. 3 is a transverse vertical section through the shroud disclosed in Fig. 1, showing the same attached to a fragment of a blade, the section being taken at a portion of the shroud between successive blades. Fig. 4 is a transverse vertical section through the shroud disclosed in Fig. 1, showing the same attached to a fragment of a blade, the section being taken at one of the working faces of the blade. Fig. 5 is a plan view of a fragment of another form of shroud attached to a plurality of blades. Fig. 6 is a transverse vertical section through fragments of the shroud and blades disclosed in Fig. 5, the section being taken along the line VI—VI of Fig. 5. Fig. 7 is a transverse vertical section through the shroud disclosed in Fig. 5, showing the same attached to a fragment of a blade, the section being taken at a portion of the shroud between successive blades. Fig.

8 is a transverse vertical section through the shroud disclosed in Fig. 5, showing the same attached to a fragment of a blade, the section being taken at one of the working faces of the blade. Fig. 9 is a plan view of a fragment of still another form of shroud attached to a plurality of blades. Fig. 10 is a transverse vertical section through fragments of the shroud and blades disclosed in Fig. 9, the section being taken along the line X—X of Fig. 9. Fig. 11 is a transverse vertical section through the shroud disclosed in Fig. 9, showing the same attached to a fragment of a blade, the section being taken at a portion of the shroud between successive blades. Fig. 12 is a transverse vertical section through the shroud disclosed in Fig. 9, showing the same attached to a fragment of a blade, the section being taken at one of the working faces of the blade. Fig. 13 is a transverse vertical section through fragments of still another form of shroud and blades, the section being taken along the line XIII—XIII of Fig. 14. Fig. 14 is a transverse sectional view through a plurality of blades having attached thereto a fragment of the shroud as disclosed in Fig. 13, the section being taken near the blade ends. Fig. 15 is a transverse vertical section through the shroud disclosed in Fig. 13, showing the same attached to a fragment of a blade, the section being taken at a portion of the shroud between successive blades. Fig. 16 is a transverse vertical section through the shroud disclosed in Fig. 13, showing the same attached to a fragment of blades, the section being taken at one of the working faces of the blade. Fig. 17 is a transverse vertical section through fragments of still another form of shroud and blades, the section being taken along the line XVII—XVII of Fig. 18. Fig. 18 is a transverse sectional view through a plurality of blades having attached thereto a fragment of the shroud as disclosed in Fig. 13, the section being taken near the blade ends. Fig. 19 is a transverse vertical section through the shroud disclosed in Fig. 17, showing the same attached to a fragment of a blade, the section being taken at a portion of the shroud between successive blades. Fig. 20 is a transverse vertical section through the shroud disclosed in Fig. 17, showing the same attached to a fragment of a blade, the section being taken at one of the working faces of the blade.

While the figures of the drawing in each case disclose rotor or movable blading of a parallel flow turbine of the Parsons type, it is to be understood that the invention is equally applicable to stator or stationary blading, as well as to other types of turbines. The shroud in each case is made very light and is provided with parallel side walls for the purpose of facilitating machining of the assembled structure, in order to secure a close fit between the shroud and the stationary turbine casing. This invention is not, however, limited to channel shaped shrouds. The blades 1 in each of the disclosures have single-surfaced ends and are secured to suitable foundation segments in the usual manner.

Referring specifically to Figs. 1, 2, 3 and 4, the channel shaped shroud 2 is formed of stock having a continuous longitudinal corrugation or projection 7 near the mid portion thereof. This corrugation or projection 7 may be formed by distortion of shroud stock normally having either a cylindrical or plane base portion, but is preferably formed during the manufacture of the shroud stock, either by rolling or drawing, and forms a continuous longitudinal arch on the shroud which greatly enhances the stiffness of the shroud stock. In order to provide means for positioning, that is, properly spacing and angling the blade ends, the shroud 2 is provided with a series of punched holes 3 passing transversely therethrough at the corrugation or projection 7 to form recesses in the projection. The surfaces of two opposite walls of the holes 3 conform to the contour of the working faces of the blades, and coact therewith longitudinally to a considerable extent. The holes 3 are formed by means of a die which is of a projected width equal to the maximum width of the projection 7. After the recesses in the projection 7 have been formed by the formation of the holes 3, the shroud 2 is applied to the single-surfaced blade ends and is united thereto by fusion of metal, either by soldering, brazing, welding or in any other way. In the drawings the union has been made by brazing, the added fusible material being represented as a fillet 5 adjacent the ends of the blades.

Referring specifically to Figs. 5, 6, 7 and 8, the channel shaped shroud 12 is formed of stock having a continuous longitudinal corrugation or projection 17 near the mid portion thereof, this corrugation being formed as indicated hereinabove. The means for positioning, that is, properly spacing and angling the blade ends, is produced by providing a series of recesses extending transversely across the corrugation or projection 17. These recesses are formed by shearing the metal of the projection 17 and simultaneously forcing the sheared portions 13 located in line with the blade ends, back into alinement with the normal base of the shroud 12. The recesses are thus formed with opposite walls having surfaces conforming to the contour of the working faces of the blades 1 and coacting therewith longitudinally to a considerable extent. After the recesses have been formed in the projections 17, the

shroud 12 is applied to the single-surfaced blade ends and is united therewith by fusion of metal as indicated hereinabove. In the drawing this union has been indicated as having been accomplished by brazing, the added fusible material being represented by fillets 15 adjacent the ends of the blades 1. The shearing of the metal of the projection 17 is not, however, to be considered as perforating, as this term is intended to apply only to the form of shroud disclosed in Figs. 1 to 4 inclusive.

Referring specifically to Figs. 9, 10, 11 and 12, the channel shaped shroud 22 is formed of stock which primarily has a continuous longitudinal corrugation or projection 27 near the mid portion thereof. This corrugation is again preferably formed as indicated hereinabove. The means for positioning the blade ends consists of a series of transverse recesses in the projection 27, these recesses being formed by forcing back the portions 23 of the projection 27 so as to bring the same into alinement with the normal base of the shroud 22. The recesses are thus formed with opposite walls having surfaces conforming to the contour of the working faces of the blades 1 and coacting therewith longitudinally to a considerable extent, but not to the same degree as in the forms hereinabove described. After the recesses have been formed, the shroud 22 is applied to the single-surfaced blade ends and is united thereto by fusion of metal, the added fusible material being represented as fillets 25 adjacent the ends of the blades 1.

Referring specifically to Figs. 13, 14, 15 and 16, the channel shaped shroud 32 is formed of stock having a pair of substantially parallel continuous longitudinal projections 37 extending along the blade side thereof. These projections 37 are preferably formed during the manufacture of the shroud stock either by rolling or drawing the shroud strip with the continuous projections thereon. The means for properly positioning the blade ends are produced by forming a series of recesses in the projections 37. The recesses are formed with opposite walls having surfaces conforming to the contour of the working faces of the blades 1 and coacting therewith longitudinally to a considerable extent. The recesses in the projections 37 are formed by forcing back the metal of the projections wherever it is desired to have a recess, permitting the metal so displaced from the projections to build up in the form of low, spread-out mounds or projections 33 on the outer side of the shroud base. After the recesses have been properly formed in the projections 37, the shroud 32 is applied to the single-surfaced ends of the blades and is united thereto by fusion of metal as indicated hereinabove. This construction has the advantage that the backing die used in forming the recesses does not necessarily have to be reached in order to permit feeding forward of the shroud stock which is secured to an intermittently fed support. In this case the shroud stock will spring sufficiently to permit the dislocation of the mound from the stationary backing die. It is preferable, however, to recede the backing die for this purpose.

Referring specifically to Figs. 17, 18, 19 and 20, the channel shaped shroud 42 is formed of stock having a surface on the blade side thereof comprised of rectilinear transverse elements. The means for properly positioning the blade ends are produced by first locally distorting the shroud base to form projections 47 on the blade side thereof, after which the portions of the projections 47 in line with the blades are restored to form recesses at the desired portions thereof, by forcing back the portions 43 of the projections 47 to bring these portions 43 into re-alinement with the shroud base. The recesses are formed with opposite walls having surfaces conforming to the contour of the working faces of the blades 1 and coacting therewith longitudinally to a considerable extent. The shroud 42 after recessing is applied to the single-surfaced ends of the blades 1 and is united thereto by fusion of metal as indicated hereinabove.

With the type of shroud 2 disclosed in Figs. 1 to 4 inclusive, there are practically no local projections extending from the shroud stock and tending to produce any undesirable retardation of the turbine rotor. In the form of shroud 32 disclosed in Figs. 13 to 16 inclusive, the mounds 33 are so low and spread-out as to produce substantially no retardation of the turbine rotor. The form of shroud 42 disclosed in Figs. 17 to 20 inclusive, would produce substantially no retardation to the rotation of the rotor as there are no local projections extending outwardly from the normal base of the shroud. The forms of shroud 32, 42, shown in Figs. 13 to 20, inclusive, are especially applicable to the larger sizes of blading because of the increased distance between the limits of transverse contact between the positioning surfaces and one of the working faces of the blade.

It will be noted that with all of the constructions herein disclosed, a blade 1 having a single-surfaced end may be utilized thereby eliminating waste of blade stock. The shroud itself in each case is formed with spacing and angling means thereon. The fact that the shroud in each case is secured to the blade ends by fusion of metal together with the distortion of the shroud, also permits formation of a shroud strip which is very light in structure and which still possesses the requisite rigidity and strength. It should furthermore be noted that in each

case the shroud at a blade is formed with a recessed projection in contradistinction to the formation of a shroud with a series of projections leaving recesses between them for the blade ends, although here the original projection is in fact altered by the recessing to form divisional projections. In the form disclosed in Figs. 17 to 20 inclusive, the recessed projection at a blade is discontinuous with the corresponding recessed projection of an adjacent blade so there will be less tendency to produce eddying of the steam between the blades in this structure.

It should be understood that it is not desired to be limited to the exact details of construction shown and described except as required by the scope of the appended claims, for obvious modifications will occur to a person skilled in the art.

It is claimed and desired to secure by Letters Patent,—

1. In combination, a blade having a single-surfaced end, and a shroud having a recessed projection for positioning said blade, said shroud being secured to said blade at said recess.

2. In combination, a blade having a single-surfaced end, and a shroud having a recessed projection for positioning said blade, said shroud being secured to said blade at said recess by fusion of metal.

3. In combination, a plurality of blades each having a single-surfaced end, and a shroud having a projection serially recessed for positioning said blades, said shroud being secured to said blades at said recesses.

4. In combination, a plurality of blades each having a single-surfaced end, and a shroud having a projection serially recessed for positioning said blades, said shroud being secured to said blades at said recesses by fusion of metal.

5. In combination, a series of blades each having a single-surfaced end, and a shroud secured to the ends of said blades, said shroud having projections spanning the spaces between successive blades and said projections having surfaces coacting with side faces of said blades.

6. In combination, a series of blades each having a single-surfaced end, and a shroud secured to the ends of said blades by fusion of metal, said shroud having projections spanning the spaces between successive blades and said projections having surfaces coacting with side faces of said blades.

7. In combination, a series of blades each having a single-surfaced end, and a shroud secured to the ends of said blades by fusion of metal, said shroud having alined projections spanning the spaces between successive blades and said projections having surfaces coacting with side faces of said blades.

8. In combination, a blade, and a shroud having a recessed longitudinal corrugation provided with surfaces for positioning said blade, said shroud being secured to said blade at said recess.

9. In combination, a blade, and a shroud having a recessed longitudinal corrugation provided with surfaces for positioning said blade, said shroud being secured to said blade at said recess by fusion of metal.

10. In combination, a plurality of blades, and a shroud having a recessed longitudinal corrugation provided with surfaces for positioning said blades, said shroud being secured to said blades at said recesses.

11. In combination, a plurality of blades, and a shroud having a recessed longitudinal corrugation provided with surfaces for positioning said blades, said shroud being secured to said blades at said recesses by fusion of metal.

12. In combination, a plurality of blades, and an imperforate shroud having a recessed longitudinal corrugation provided with surfaces for positioning said blades, said shroud being secured to said blades at said recesses.

13. In combination, a plurality of blades, and an imperforate shroud having a recessed longitudinal corrugation provided with surfaces for positioning said blades, said shroud being secured to said blades at said recesses by fusion of metal.

In testimony whereof, the signature of the inventor is affixed hereto in the presence of two witnesses.

C. EDWIN SEARCH.

Witnesses:
G. F. De Wein,
W. H. Lieber.