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H. P. DAHLSTRAND

2,350,310

BLADE SHROUDING

Original Filed Sept. 12, 1940

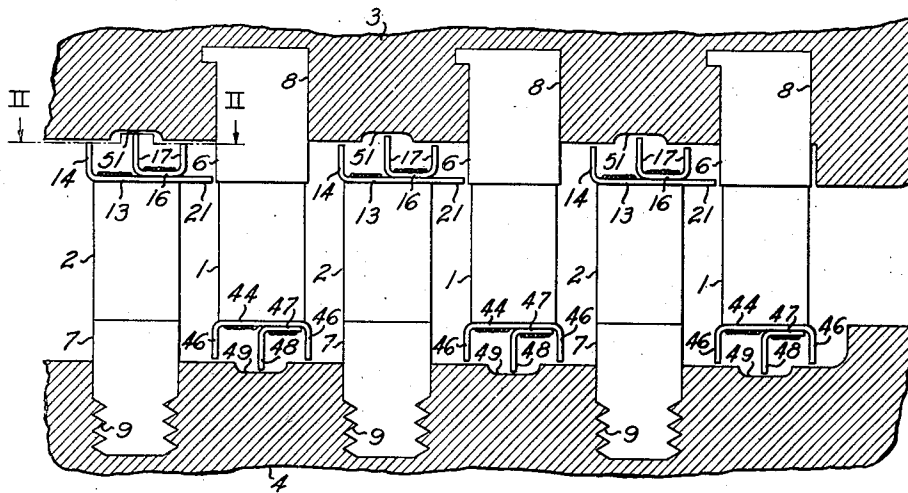


Fig. 1

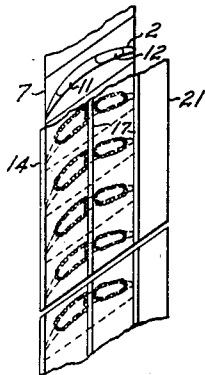


Fig. 2



Fig. 4

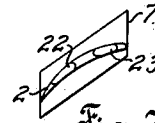


Fig. 7

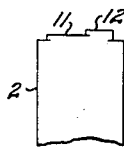


Fig. 3

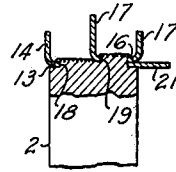


Fig. 5

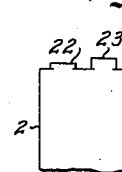


Fig. 6

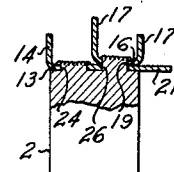


Fig. 8

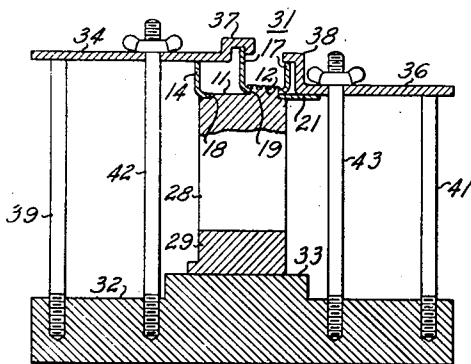


Fig. 10

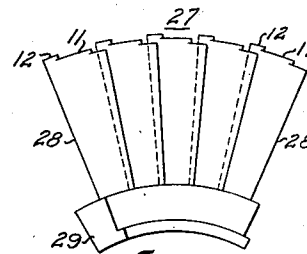


Fig. 9

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UNITED STATES PATENT OFFICE

2,350,310

BLADE SHROUDING

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Original application September 12, 1940, Serial
No. 356,411. Divided and this application No-
vember 16, 1942, Serial No. 465,672

5 Claims. (Cl. 253-77)

This invention relates to blade shrouding and more particularly to a built-up shroud and seal structure for the tip portions of turbine blades; the method of constructing same being fully disclosed and claimed in applicant's copending application Serial No. 356,411, filed September 12, 1940, of which this application is a division.

The primary object of this invention is to provide an improved built-up shroud and seal structure for turbine blades which is extremely durable and cheap to manufacture.

Another object of this invention is to provide an improved shroud and seal structure for turbine blades in which the shroud and seal structure is formed from a plurality of stampings which are welded together and to the blade tip to form an integral shroud and seal structure having at least three sealing flanges.

The invention accordingly consists of the various features of construction, combinations of elements and arrangements of parts as more fully pointed out in the appended claims and in the detailed description, in which:

Fig. 1 is a partial sectional view of a turbine spindle and stator having coacting blades embodying the invention;

Fig. 2 is a plan view of a portion of a moving blade row taken on line II-II of Fig. 1 with a part of the shroud structure broken away;

Fig. 3 is a side view of the top portion of one of the blades shown in Fig. 2 with the shroud removed;

Fig. 4 is a plan view of the blade shown in Fig. 3;

Fig. 5 is a side view, partly in section, of the type of blade shown in Figs. 3 and 4 with the shroud and sealing means attached thereto;

Fig. 6 is a side view of the top portion of a blade illustrating a modified construction;

Fig. 7 is a plan view of the blade shown in Fig. 6;

Fig. 8 is a side view, partly in section, of the type of blade shown in Figs. 6 and 7 with the shroud and sealing means attached thereto;

Fig. 9 is a perspective view of a segmental group of blades with the shroud removed; and

Fig. 10 is a vertical section illustrating apparatus for temporarily holding the shroud and sealing structure on a blade or on a group of blades preparatory to welding the structure thereto.

Referring to Fig. 1 of the drawing, it is seen that the invention is shown as applied to the stationary and moving blades 1 and 2, respectively, of a turbine structure comprising a stator 3 and a

rotor 4. The individual blades 1 and 2 are provided with conventional root or base portions 6 and 7, respectively, which are removably secured in circumferentially extending grooves 8 and 9 in the stator and rotor, respectively, in the usual manner. The manner in which the blades are secured in the turbine structure forms no part of this invention, and since any desired form of securing means may be used, a further description in this connection is not necessary for a complete understanding of the present invention.

Referring to Figs. 2-5 inclusive, it is seen that the tip portions of the blades 2 are shaped to provide a stepped projection comprising a relatively short portion 11 which is made approximately equal in length to the thickness of the shroud member to be secured to the blade tip and a relatively long portion 12 which is made approximately equal in length to twice the thickness of the said shroud member. The shrouding and sealing means comprises a first member having a base or shroud portion 13 and an upstanding sealing flange 14 and a second channel shaped member having a base or web portion 16 of less width than the base portion 13 of the first member and presenting when mounted on the tip portion of a blade a pair of laterally spaced upstanding sealing flanges 17. The base portion 13 of the first member is provided with an opening 18 adapted to snugly receive the stepped projection and the base member 16 of the second member is also provided with an opening 19 adapted to snugly receive the relatively long portion 12 of the said projection. The width of the base portion 13 of the first member is such that when the first member is positioned on the blade tip as shown in Fig. 5, an edge portion of said base member extends beyond and overhangs the edge of the blade, thereby providing a laterally extending sealing flange 21.

The dimensions of the first and second members, the arrangement of the openings 18 and 19 therein, respectively, and the dimensions and the arrangement of the stepped projection are such that when the first and second members are positioned on the tip portion of a blade in the order named, the shrouding and sealing means are arranged as shown in Fig. 5. The thickness of the base or web portion 16 of the second member is substantially the same as the thickness of the base or shroud portion 13 of the first member. Consequently, since the length of the portions 11 and 12 of the stepped projection is approximately equal to the thickness and to twice the thickness of the shroud portion 13, respec-

tively, it should be obvious that when the first and second members are positioned on the blade as shown in Fig. 5, the top of the portion 11 will be nearly flush with the top surface of the base or shroud portion 13 and the top of the portion 12 will be nearly flush with the top surface of the base or web portion 16. Therefore, when the first and second members are thus positioned on the blade tip, all that remains to be done in order to obtain a permanent structure is preferably to weld or otherwise secure the base portions of the first and second members to the juxtapositioned portions 11 and 12 of the stepped projection as indicated in Figs. 1, 2 and 5. When the first and second members are dimensioned to span a series of blades as indicated in Fig. 2, the said members are positioned on and welded or otherwise secured to the blades after they have been mounted on the turbine rotor or stator. Any suitable means may be employed for holding said members in their proper assembled relation during the welding operation and in this connection apparatus somewhat similar to that shown in Fig. 10 has been found entirely satisfactory.

The modified arrangement shown in Figs. 6-8, inclusive, in which like numerals are used to designate the same or similar parts, differs from that shown in Figs. 1-5, inclusive, in that the tip portion of the blade 2 is provided with two laterally spaced upstanding projections 22 and 23, and in that the base or shroud portion 13 of the first member is provided with two laterally spaced openings 24 and 26 adapted to snugly receive the projections 22 and 23, respectively. The length of the projection 22 is approximately equal to the thickness of the base or shroud portion 13 of the first member and the length of the projection 23 is approximately equal to the combined thickness of the base or shroud member 13 of the first member and the base or web portion 16 of the second member as best shown in Fig. 8. The first and second members comprising the shrouding and sealing means are positioned and held in position on the tip portions of the blades and welded thereto in exactly the same manner as set forth in connection with the description of Figs. 1-5, inclusive, and a repetition of this procedure is not deemed necessary for a complete understanding of the invention. The resultant structure affords all of the advantages with respect to assembly and strength inherent in the preferred construction shown in Figs. 1-5, inclusive, but is less desirable in that shaping space projections is more difficult and therefore more costly than shaping the stepped projection employed in the preferred construction.

Fig. 9 shows a unitary segmental blade group 27 in which the tip portion of each blade 28 is provided with a stepped projection comprising portions 11 and 12 similar to those shown in Figs. 3-5, inclusive. These segmental blade groups are formed in a known manner by casting or otherwise securing the blades 28 in a common base member 29 to form a unitary structure of the general form indicated. The base member 29 may be made in any desired or preferred shape in order to facilitate mounting and securing the segmental blade group on the turbine rotor or stator, and that shown is merely illustrative of a commercially practical construction. The shrouding and sealing means to be secured to each such group of blades is of course identical to that disclosed in connection with Figs. 1-5, inclusive, but in this construction, the first and second

members comprising the shrouding and sealing means are preferably secured to the individual groups before they are mounted on the turbine rotor or stator.

Fig. 10 illustrates a suitable jig or fixture 31 for holding the first and second members in their proper assembled relation on the tip portions of the blades 28 during the welding operation. The jig 31 comprises a base 32 having a portion 33 adapted to receive thereon the base member 29 of a segmental blade group, a pair of top members 34 and 36 having edge portions 37 and 38, respectively, adapted to coact with the flanges 14 and 21 of the first member and with the flanges 17 of the second member, spacing members 39 and 41, and clamping bolts 42 and 43 by means of which the top members 34 and 36 may be drawn toward the base 32, thereby firmly holding the first and second members in their assembled relation on the tip portions of the blades. The jig 31 is merely illustrative of a commercially practical construction adapted for carrying out the present invention with respect to segmental blade groups, and it should be understood that any other suitable jig or fixture may be used if it is so desired.

Referring again to Fig. 1, it is seen that the shrouding and sealing means applied to the stationary blades 1 differs from that employed on the moving blades 2 in that the first member is channel shaped and in that the second member is L-shaped. The web portion 44 of the first member constitutes the shroud portion and the channels 46 sealing flanges. The base member 47 of the second member is of less width than the web portion 44 of the first member and is adapted to be positioned on the base or web portion 44 of the first member so that the sealing flange 48 is disposed approximately midway between the channels 46 on the first member. The first and second members are positioned on the tip portion of the stationary blades and secured thereto in exactly the same manner as disclosed in connection with the moving blades 2 and therefore a further description in this connection is deemed unnecessary. In all modifications, the length of the centrally disposed sealing flange is preferably made higher than the height of the other sealing flanges and the opposed surfaces of the rotor and stator are provided with coacting grooves 49 and 51, respectively.

From a consideration of the foregoing and the accompanying drawing, it should be obvious that in accordance with this invention the end of a blade or the ends of a group of blades can be readily shrouded and provided with an intermediate or centrally disposed upstanding and circumferentially extending sealing flange 17 (such a construction is impractical with blades having a centrally disposed tenon of the type heretofore employed) without in any manner weakening the connection between the end of the blade and the superimposed shroud and seal structure. In fact, the disclosed construction is much stronger than the tenoned constructions heretofore employed since, as clearly shown, a shroud and seal structure embodying the invention is secured or attached to the end of the blade by an effective bond area which is substantially equal to the area of the blade end, thereby materially reducing, and in some instances, entirely eliminating the cantilever effect produced by centrifugal force acting on the free edges of shroud and seal strips which are secured to the end of a blade by a centrally disposed tenon.

Shrouding and sealing structures with multiple spaced sealing flanges can be readily built up in accordance with this invention more cheaply than has heretofore been possible with the prior art methods and the structures produced in accordance with this invention have excellent physical properties with respect to stress resistance and with respect to corrosion and erosion resistance. The invention is applicable to all types of turbine blading with respect to which it is necessary to employ a shrouding and sealing means, and while the invention has been disclosed in connection with shrouding and sealing means adapted to span a series of blades, it should be understood that the invention is not in any manner limited to the exact mode of construction or to the exact constructions herein shown and described, as various modifications within the scope of the appended claims may occur to persons skilled in the art.

It is claimed and desired to secure by Letters Patent:

1. A blade structure embodying shroud and seal members comprising a blade having on one end thereof juxtapositioned short and long tenon portions, a first element disposed on said blade end and being apertured to receive and accessibly expose the end parts of said short and long tenon portions, a second element having a base portion superimposed on said first element, said base portion being apertured to receive and accessibly expose the end part of said long tenon portion and having a width sufficiently less than the width of said first element to leave exposed and accessible a part of the end of said short tenon portion, and means securing said first element and the base portion of said second element to the exposed and accessible end parts of said short and long tenon portions, respectively.

2. A blade structure embodying shroud and seal members comprising a blade having on one end thereof juxtapositioned short and long tenon portions, a first element disposed on said blade end and being apertured to receive and accessibly expose the end parts of said short and long tenon portions, a second element having a base portion superimposed on said first element, said base portion being apertured to receive and accessibly expose the end part of said long tenon portion and having a width sufficiently less than the width of said first element to leave exposed and accessible a part of the end of said short tenon portion, and weld metal fusibly uniting said first element and the base portion of said second element to the exposed and accessible end parts of said short and long tenon portions, respectively.

3. A blade structure embodying shroud and

seal members comprising a blade having on an end thereof adjacent one of its edges a first upstanding tenon portion and having on said end adjacent its other edge a second upstanding tenon portion of greater length than said first portion, a first element disposed on said blade end and being apertured to receive and accessibly expose the end parts of said short and long tenon portion, a second element having a base portion superimposed on said first element, said base portion being apertured to receive and accessibly expose the end part of said long tenon portion and having a width sufficiently less than the width of said first element to leave exposed and accessible a part of the end of said short tenon portion, and means securing said first element and the base portion of said second element to the exposed and accessible end parts of said short and long tenon portions, respectively.

4. A blade structure embodying shroud and seal members comprising a blade having on one end thereof a pair of spaced, upstanding tenon portions of different length, a shroud element disposed on said blade end and being apertured to receive and accessibly expose the end parts of said tenon portions, a seal element having a base portion superimposed on said shroud element, said base portion being apertured to receive and accessibly expose the end part of the longer one of said tenon portions and having a width sufficiently less than the width of said shroud element to leave exposed and accessible a part of the end of the short tenon portion, and means securing said shroud element and the base portion of said seal element to the exposed and accessible end parts of said short and long tenon portions, respectively.

5. A blade structure embodying shroud and seal members comprising a blade having on one end thereof an upstanding stepped projection having its lower step disposed adjacent one edge of said blade and having its higher step disposed adjacent the other edge of said blade, a shroud element disposed on said blade end and being apertured to receive and accessibly expose said projection, a seal element having a base portion superimposed on said shroud element, said base portion being apertured to receive and accessibly expose said higher step and having a width sufficiently less than said shroud element to leave exposed and accessible a part of the top of said lower step, and means securing said shroud element and the base portion of said seal element to the exposed and accessible parts of said lower and higher steps, respectively.

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