Nov. 9, 1926. 1,606,029

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BLADE FASTENING

Filed March 6, 1925

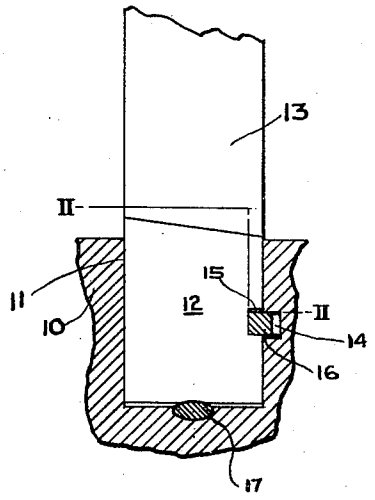


Fig.1.

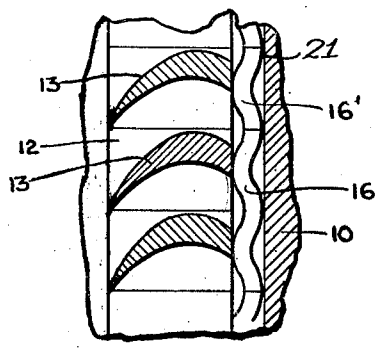


Fig.2.

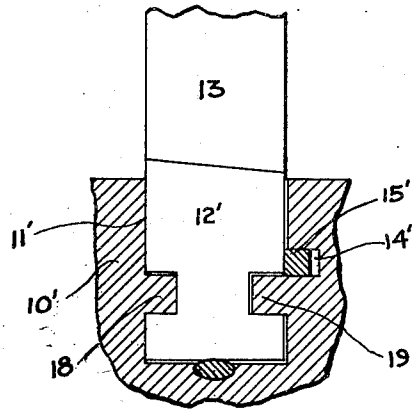


Fig.3.

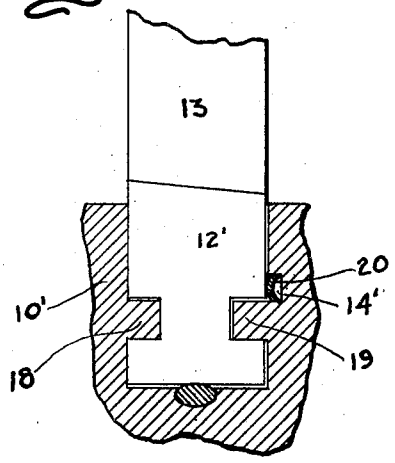


Fig.4.

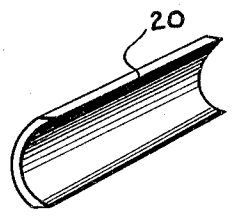


Fig.5.

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UNITED STATES PATENT OFFICE.

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BLADE FASTENING.

Application filed March 6, 1925. Serial No. 13,659.

My invention relates to blade fastening means for use in turbines and it has for its object to provide apparatus of the character designated which shall be effective to tightly retain blades in place over long periods of time and under widely varying temperature conditions, it being more specifically adapted for use in connection with blades having a relatively high coefficient of linear expansion when mounted in blade-holding slots formed of material having a relatively low coefficient of linear expansion.

In the accompanying drawing, Fig. 1 is a sectional view of a portion of a blade-holding member embracing a blade root and constructed in accordance with one form of my invention, the mounting shown being particularly adapted for the mounting of fixed blades; Fig. 2 is a top view, partially in section and partially in elevation, of a portion of the blade row taken on the plane II—II in Fig. 1 and more clearly indicating the arrangement of the packing means of Fig. 1; Fig. 3 is a view similar to Fig. 1 and illustrating a blade mounting structure particularly adapted for moving blades; and Fig. 4 is a view similar to Fig. 3 but showing an alternative form of packing member, the latter being shown more fully in Fig. 5.

In the construction of elastic fluid turbines, it is usual to form the blade-holding members of cast iron or steel and it has been proposed to employ blades of relatively large size formed from material having a relatively high coefficient of expansion such, for example, as phosphor bronze. When blades of this character are fastened by rigid packing means in slots formed in material having a relatively low coefficient of expansion, such as iron or steel, it will be obvious that upon heating the structure, the relatively great coefficient of expansion of the blade material tends to crush the packing means, repeated heating and cooling resulting in loosening up the entire packing structure.

In accordance with the present invention, I employ packing means so formed as to have an appreciable amount of resilience, whereby the blade root may expand and contract to a greater degree than the material of the blade-holding member without crushing the packing material and without eventual loosening of the entire packing structure.

Referring to the drawing for a more detailed understanding of my invention, I show a portion of the casing or stator of a steam turbine at 10 in Fig. 1, this member being provided with a slot 11 in which is placed the root 12 of a blade 13.

A small slot 14 is formed in the side wall of the main slot 11 and directly opposed thereto is a notch 15 in the blade root.

A packing member 16 of serpentine shape, as more clearly shown in Fig. 2, is inserted in the space formed by the slot 14 and the notches 15 in successive blades, the pitch of the convolutions in the member 16 being the same as the blade pitch so that a hump of the packing member rests against each blade root, bearing against the slot wall being secured intermediate the adjacent blade roots of a row, as indicated at 21.

Inasmuch as the packing member 16 must be inserted at a given point on the casing and driven around through the slot to its point of final use, it will be obvious that the member 16 cannot be formed out of sections having undue length. I have illustrated in Fig. 2 the use of a member having a length equivalent to the pitch of two blades and I have also shown a member 16′ having a length equal to the pitch of one blade, either form operating satisfactorily when driven into final position and the lengths actually employed being determined by the conditions of the design.

In order to further enhance the rigidity of the blade fastening, I may employ the usual end packing shown at 17.

In the mounting of a blade in the rotor structure of a turbine, it is necessary to provide for centrifugal stresses which are not encountered in a fixed blade and accordingly, as shown in Fig. 3, I provide a slot 11′ in a blade-holding member 10′, said slot being provided with overhanging portions 18 and 19 in the walls thereof so as to provide an undercut portion at the base of the slot 11′. The blade root 12′ is correspondingly notched so as to engage in the undercut slot, all as is well-known and understood in the art, and the blade slot 11′ is further provided with a packing groove 14′ in the wall thereof immediately above the member 19. A packing member 15′ is inserted in the slot 14′ for a function similar to that explained in connection with Fig. 1. It is preferable to place the packing means above the dovetailed interolck inasmuch as the

rigid holding of the blade near its point of emergence from the holding member diminishes the bending strains on the reduced neck portion of the blade, thus increasing the life thereof.

In the form of my invention shown in Figs. 4 and 5, the blade is mounted similarly to the manner shown in Fig. 3 but, instead of using a serpentine packing member as illustrated in Fig. 2, I may employ a packing member of crescent shaped cross-section as clearly shown in perspective at 20 in Fig. 5.

Having thus described the arrangement of apparatus embodying my invention, the operation is as follows:—

The blades being formed of phosphor bronze or other material having a higher coefficient of expansion than the iron or steel forming the blade-holding means, tend to expand more than the slot upon an increase in temperature and to also contract more than the slot upon a decrease in temperature. With the form of packing shown either in Fig. 2 or in Fig. 5, the points of bearing against the blade root are not directly opposite the points of bearing against the side wall of the slot so that the packing member is permitted to be deformed under pressure and to reassume its original shape upon the removal of such pressure. Thus, the packing means hold the blade root in firm engagement with the slot throughout constantly recurring temperature changes over long periods of time.

While I have shown my invention in several 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. In a turbine, the combination of blade-holding structure having a blade-root groove, one side wall of said groove being provided with a slot, a row of blades having root portions fitting in the groove, and means in said groove resiliently urging said blade root against the opposite side wall of the groove.

2. The combination defined in claim 1 wherein the blade root has interlocking engagement in the groove in a plane normal to the blade axis for retaining the blade root in the groove.

3. In a turbine, the combination of blade-holding structure having a blade-root groove, one side wall of said groove being provided with a slot, a row of blades having root portions fitting in the groove, and resilient packing means in said slot for forcing said blade root against the opposite side wall of the groove.

4. The combination defined in claim 3 wherein the blade root has interlocking engagement in the groove in a plane normal to the blade axis for retaining the blade root in the groove.

5. In a mounting for turbine blades, a blade-holding member, a turbine blade, a slot in the blade-holding member adapted for the reception of the blade root and a packing member tightly fitting between the blade root and one side wall of the slot, the points of contact of said packing member against said blade root being spaced away from direct opposition to the points of contact of said packing member against said slot wall, whereby the resilience of said packing member is effective in a lateral direction to force said blade root against the opposite side wall of the slot.

6. In a mounting for turbine blades, the combination with a blade-holding member having an undercut slot therein, of a blade provided with an enlarged root for engaging in said slot and a packing member tightly fitting between the blade root and one side wall of the slot, the points of contact of said packing member against said blade root being spaced away from direct opposition to the points of contact of said packing member against said slot wall, whereby the resilience of said packing member is effective in a lateral direction to force said blade root against the opposite side wall of the slot.

7. In a turbine, the combination with a blade-holding member having a given coefficient of linear expansion and provided with a blade-holding slot, of a blade disposed in said slot and having a greater coefficient of linear expansion, and packing means disposed between the blade root and one side wall of the slot and adapted to maintain tight engagement between said blade root and the opposite slot wall under varying temperature conditions.

8. In a turbine, the combination of blade-holding structure having a blade-root groove, a row of blades having root portions fitting in the groove, said groove and said root portions being provided with registering lateral slots, and a resilient packing member in the slots for holding the blades in place with respect to said structure, the resilience of said packing member being effective in a lateral direction to force the blades against the opposite wall of the groove.

9. The combination of a turbine blade, a blade-holding member having a slot therein for the reception of the blade root, registering slots in meeting walls of the blade root and the first-mentioned slot, and a resilient packing member enclosed by said registering slots, said packing member locking the blade

against outward movement and also forcing said blade root against the opposite wall of the first-mentioned slot.

10. The combination described in claim 9 and a packing member between the bottom of the first-mentioned slot and the bottom of the blade root.

11. The combination of a turbine blade, a blade-holding member having a slot therein for the reception of the blade root, an inwardly facing shoulder in one side wall of the slot and an outwardly-facing shoulder in the adjacent wall of the blade root, and a packing member disposed between said walls and between said shoulders, thereby locking said blade root in the slot, said packing member also being formed to resiliently hold the blade root against the opposite wall of the slot.

In testimony whereof, I have hereunto subscribed my name this eleventh day of February, 1925.

HERBERT T. HERR.