Aug. 9, 1927. 1,638,648

H. R. TROTTER ET AL

TURBINE BLADE FASTENING

Filed Aug. 13, 1923

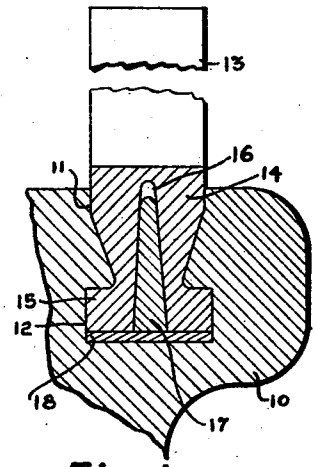


Fig. 1.

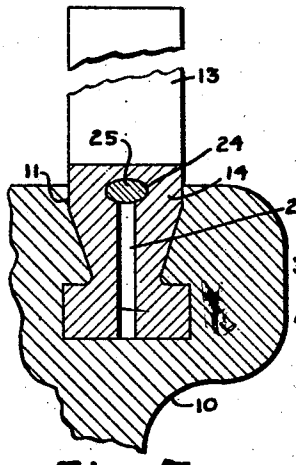


Fig. 3.

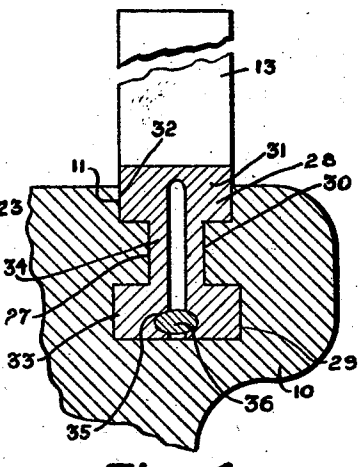


Fig. 4

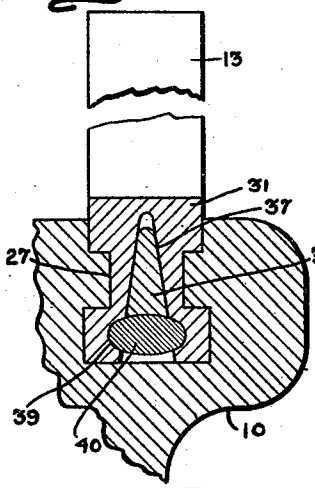


Fig. 5.

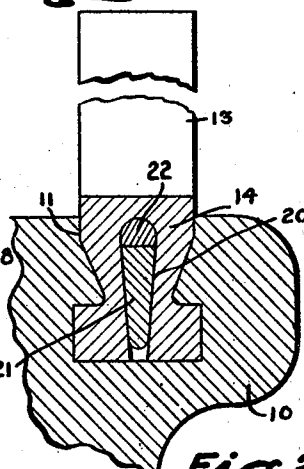


Fig. 2.

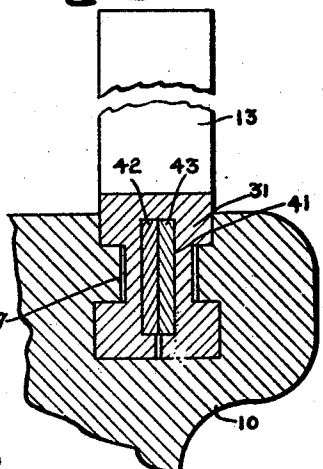


Fig. 6.

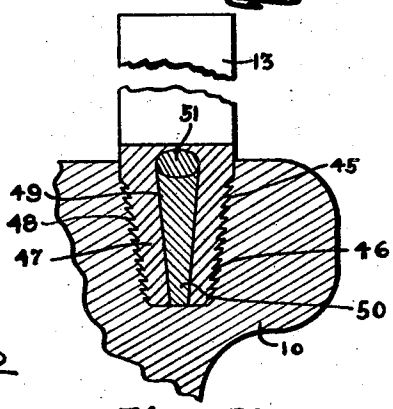


Fig. 7.

WITNESSES:

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UNITED STATES PATENT OFFICE.

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TURBINE-BLADE FASTENING.

Application filed August 13, 1923. Serial No. 657,211.

Our invention relates to turbines and more particularly to apparatus for securing the blades thereof to a blade-carrying element and it has for its object to provide apparatus of this character which shall assure a strong and durable fastening of the blades without any undue stressing of the blade root portions.

It is old in the art to provide a turbine blade which has a substantially T-shaped root portion fitting in a similarly shaped groove of a blade-carrying element. It has been proposed to associate wedges with various portions of the T-root portion in order that the latter may be firmly engaged in its groove. It is the object of our invention not only to assure a better connection with this type of fastening, but also with other types of fastening hereinafter shown and described. In general, we provide a blade root portion which is divided or bifurcated longitudinally of the blade and well toward the top of the groove so as to provide relatively long arms which may be spread by appropriate wedge means in order that the root portion may be firmly engaged in its groove without undue stressing or flexure of any of the parts of the root, thereby assuring a good fastening and the preservation of the strength of the root portion. The wedges for spreading the arms of the root portions may be effective either longitudinally of a blade or transversely with respect thereto. Also, a compound wedge means may be employed, in which case, one wedge means may be effective longitudinally of the blade and the other wedge means may be effective transversely of the blade in order to render the first wedge means effective or the elements of the compound wedge means may be both effective transversely of the blade root portion. With any of the types of wedges referred to, a uniform spreading of the root portion so as to firmly engage the latter with the blade holding groove is assured.

Apparatus made in accordance with our invention is illustrated in the accompanying drawings, forming a part of this application, in which Fig. 1 is a sectional detail view showing a T-form of blade connection with compound wedges; Fig. 2 shows a similar root connection with a different arrangement of wedges; Fig. 3 is a view similar to Fig. 1 but showing a single transverse wedge; Figs. 4, 5 and 6 show countersunk T-form blade connections with different types of wedge means for spreading the root portions; and Fig. 7 is a detail view of a serrated type of connection with wedge means for spreading the blade root portion.

Referring now to the drawings for a better understanding of our invention, in Fig. 1, we show a blade-carrying element 10, which may be the rotor or the stator of a steam turbine or like apparatus, having a blade groove 11 with lateral recesses 12 at the bottom thereof. A blade 13 has a root portion 14 provided with lateral projections 15 which fits in the groove 11. The root portion 14 is divided or bifurcated so as to provide an intermediate recess 16 having inclined walls extending from the bottom end of the blade root portion adjacent to the top of the blade groove 11 and having inclined walls for the reception of a wedge 17, which is effective longitudinally of the blade in order to spread the root portion to firmly engage the sides of the blade holding groove 11. In Fig. 1, the wedge 17 is forced upwardly in order to spread the root portion in the manner stated by means of a second wedge 18, which is located in the bottom of the blade holding grooves 11 and which when driven in the direction of extent of the blade root 11 not only forces the wedge 17 up in the manner stated, but also, cooperates to force the projections 15 tightly up into contact with the top walls of the recess 12.

The wedges 17 and 18 of Fig. 1 may be duplicated, thereby facilitating manufacture and assembly.

Fig. 2 shows a blade groove 11 and a blade root portion 14 which is similar to those shown in Fig. 1. In this view, the blade root 14 is provided with an intermediate recess 20 having walls which converge downwardly, the recess extending from the bottom of the root portion well toward the top thereof. A wedge 21 has inclined sides and fits the converging sides of the recess 20; and, a second wedge 22 cooperates with the wedge 21 above the latter for forcing the wedge 21 downwardly in order to spread the root portion and to obtain a uniform firm engagement thereof with the blade holding groove 11.

In Fig. 3, we show a blade holding groove 11 and a blade root portion 14 which are similar to those shown in Fig. 1. In this view, however, the root portion 14 is bifurcated or divided in order to provide a transverse recess 23 having a portion 24 at the top thereof with inclined walls extending transversely of the blade 13 or in the direction of extent of the blade holding groove 11 for the reception of a wedge 25 which is driven in the direction of the blade groove in order to spread the root to firmly engage the latter with the blade holding groove.

In Fig. 4, we show a slightly modified form of blade groove and blade root. Instead of having a blade root with sides which converge toward the lateral projections 15, as in Figs. 1, 2 and 3, in this view, we show what may be termed a countersunk I-form of connection. The blade holding element 10 of the turbine is provided with a recess 27 having an upper parallel sided portion 28 connected to a lower parallel sided portion 29 by a parallel sided portion 30, so that, in general outline, these portions of the recess taken together are I-shaped in cross section. The blade 13 is provided with a root 31 having side portions 32 and 33 fitting respectively in the portions 28 and 29 of the recess 27 and with a connecting neck portion 34 which fits the neck portion 30 of the recess. The blade root portion 31 is divided or bifurcated so as to provide an intermediate recess extending from the bottom of the root portion well toward the top thereof; and in the bottom, this recess is provided with inclined walls 35 which are inclined transversely or in the direction of the blade groove 27 for the reception of a wedge 36, which is driven in the direction of said blade groove in order that the root portion 31 may be spread to firmly engage the blade holding groove.

In Fig. 5, we show a blade holding groove 27 and a blade root portion 31 which are similar to corresponding parts shown in Fig. 4, the only difference being in the type of wedge means employed. In this view, we show the root portion 31 provided with an intermediate recess 37 having walls which converge upwardly and longitudinally of the blade to receive a wedge 38. Near the bottom of the blade the recess 37 is provided with walls 39 which converge transversely of the blade root portion or in the direction of the blade root 27. A wedge 40 fits between the walls 39 and it is driven home in the direction of the blade groove 27 in order to force the wedge 38 upwardly and to assist in spreading the blade root portion.

In Fig. 6, we show a further modified type of wedge means for a form of blade connection each as shown in Figs. 4 and 5. In this view we show a blade root portion 31 which is divided or bifurcated to provide a complemental recess 41 for the reception of the elements 42 and 43 of a compound wedge of a type well-known in the art. In this form of our invention, the blade root portion is spread in order to firmly engage the blade root 27 by relative displacement of one wedge portion 42 with respect to the other portion 43. Such displacement resulting in an increase in the effective width of the wedge construction and consequent spreading of the arms of the bifurcated root portion.

In Fig. 7, we show a modified type of root connection which employs a wedge construction somewhat like that already described in connection with Fig. 2. In this view, we show a blade-carrying element 10 having a blade groove 45 whose walls converge downwardly and which are provided with serrations 46. The blade 13 is provided with a converging root portion 47 having lateral serrations 48 for engagement with the serrations 46 of the blade groove 45. The root portion 47 is divided or bifurcated in order to provide an intermediate recess 49 which extends from the bottom of the root portion well toward the top thereof. The recess 49 converges downwardly and a wedge 50 fits therein. A second wedge 51 is arranged above the wedge 50 and when it is driven home it forces the wedge 50 downwardly in order to spread the root portion 47 to firmly engage it with the sides of the blade holding groove.

From the apparatus shown and described in connection with the various modifications already referred to, it will be apparent that we have provided wedge means cooperative with a blade root portion which is so divided that the force of the wedge is distributed on the portions of the root to avoid concentrated stresses at any place. In this way, all of the root portion is effective in the same manner contemplated to hold the blade in place. Since each root portion is divided or bifurcated substantially throughout its length it is possible to secure the requisite deflection of the arms without undue stressing at any point. Also, as ample deflection may be provided with our construction, it is possible to provide blade roots which are sufficiently smaller than the blade holding grooves to assure of easy assembly, the subsequent wedging operations being depended upon to secure spreading of the root portions in order to firmly engage the blade holding groove at all holding points.

While we have shown our 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 we desire, therefore, that only such limitations shall be placed there-

upon as are imposed by the prior art or as are specifically set forth in the appended claims.

What we claim is:

1. In a turbine, the combination of a blade-carrying element having a blade groove therein with lateral recesses, a blade having a root portion with lateral projections to fit the groove and being divided longitudinally so as to provide an intermediate recess having walls inclined longitudinally of the blade, wedge means fitting the inclined walls of said recess, and second wedge means for driving the first wedge means longitudinally of the blade.

2. In a turbine, the combination of a blade-carrying element having a blade groove with lateral recesses, a blade having a root portion with lateral projections for fitting the blade groove and being divided in a longitudinal direction so as to provide a recess having walls inclined longitudinally of the blade, a wedge located in the recess, and a second wedge effective in the direction of extent of the blade groove and transversely of the blade for forcing the first wedge into the recess longitudinally of the blade to spread the blade root portion in order that the latter may firmly engage the blade groove.

3. In a turbine, the combination of a blade-carrying element having a blade groove with lateral recesses, a blade having a root portion with lateral projections for fitting the blade groove and being divided in a longitudinal direction so as to provide a recess having walls inclined longitudinally of the blade, a wedge located in the recess, and a second wedge bearing on the first-mentioned wedge and forcing it longitudinally of the blade into tighter engagement with the inclined walls of the recess.

4. In a turbine, the combination of a blade carrying element having a blade groove therein with a lateral recess, a blade having a root portion with a lateral projection to fit the groove and being divided longitudinally so as to provide an intermediate recess having walls extending substantially longitudinally of the blade and inclined relatively to each other, wedge means fitting the inclined walls of the recess, and second wedge means separate from the first wedge means for driving the first wedge means longitudinally of the blade.

5. In a turbine, the combination of a blade carrying element having a blade groove therein with a lateral recess, a blade having a root portion with a lateral projection to fit the groove and being divided longitudinally so as to provide an intermediate recess having walls extending substantially longitudinally of the blade and inclined relatively to each other, wedge means fitting the inclined walls of the recess, and second wedge means separate from the first wedge means effective when driven transversely of the blade for driving the first wedge means longitudinally of the blade.

In testimony whereof, we have hereunto subscribed our names this 2nd day of August 1923.

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HENRY F. SCHMIDT.