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LOCKING MEANS FOR TURBINE OR COMPRESSOR BLADING

Filed July 1, 1960

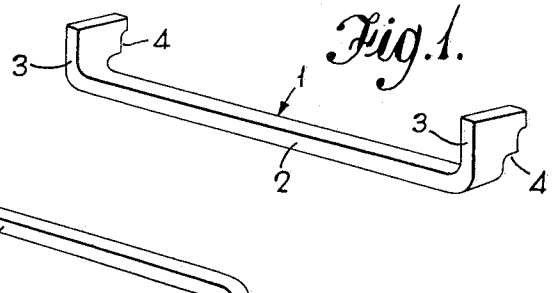


Fig. 1.

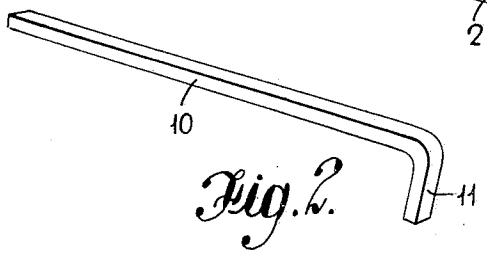


Fig. 2.

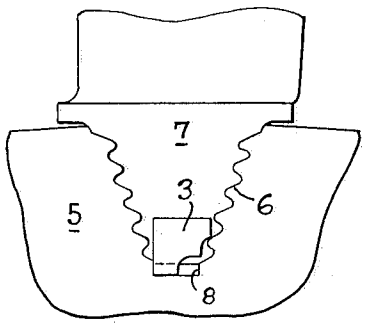


Fig. 3.

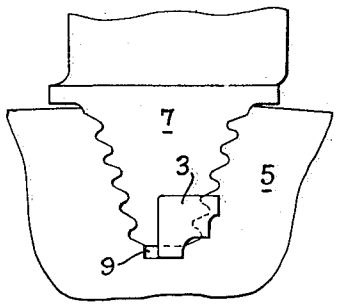
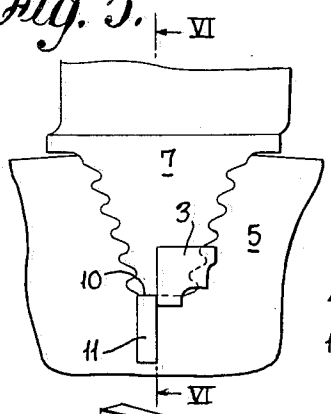


Fig. 4.

Fig. 5.



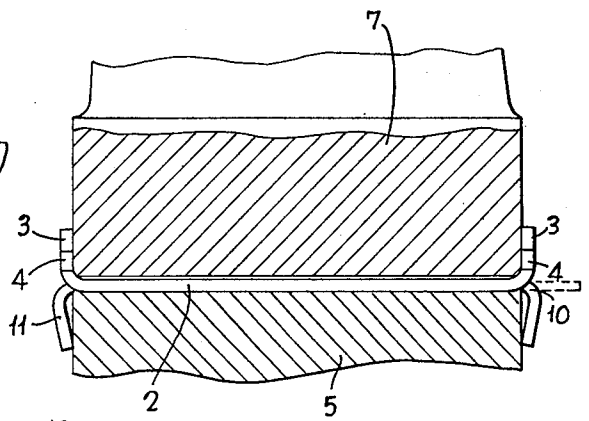


Fig. 6.

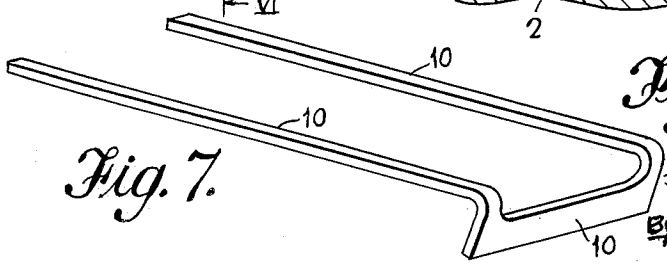


Fig. 7.

INVENTORS
JOHN ARTHUR BOYLE
JOHN GEORGE GARNETT
By Norris & Bateman
ATTORNEYS

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LOCKING MEANS FOR TURBINE OR COMPRESSOR BLADING

John Arthur Boyle, Sale, and John George Garnett, Winton, Eccles, England, assignors to Associated Electrical Industries Limited, London, England, a British company

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6 Claims. (Cl. 253—77)

This invention relates to means for locking in position the blades of turbine type machines or compressors to prevent their movement in an axial direction, of the kind in which the blades have an axial root fixing in slots or grooves around the periphery of the rotor or equivalent retaining body, the slot being formed with an overhanging shoulder or shoulders preventing removal of the blade from its slot in a radially outward direction. Such a blade attachment assembly is herein referred to as "of the shoulder type" and is exemplified by the well-known fir-tree assembly.

Various methods of locking have been proposed, for example caulking, also various arrangements of locking plates located between the blade root and the slot and bent up at the ends so as to engage the sides of the blade root and slot. British patent specification No. 691,380 describes a simple arrangement effective for small machines which comprises a locking device made up of strip metal which is disposed at the bottom of the slot and is longer than the length of the slot, the extending ends of the strip having lateral extensions, which are bent about a transverse line of the strip to closely engage adjacent end faces of the blade root and the body portion on a side of the slot. Such locking plates have however not been found satisfactory in the designs and manufacture of locking means for large heavy blades. The cross sectional area in such cases has to be designed for robustness with consequent loss of flexibility necessary to permit of full close contact against the faces of the retaining body; this area of strip material required to hold the blades from movement in an axial direction creates difficulty in closing as a final operation of assembly.

According to the present invention a locking means for a blade attachment assembly of the shoulder type including an axially extending groove at the bottom of the slot beneath the blade root comprises a U-shaped retaining plate and a locking plate located side by side in the bottom of the slot and filling the space between the walls of the groove and the tip of the blade root, the retaining plate being formed of a flat bar of the same length as the blade root and slot with an upstanding leg at each end arranged to contact the sides of the blade root and the retaining body, one leg of the U having a profile such that, when fitted over the tip of the blade root, the U-shaped plate is capable of axial insertion into the slot, without fouling the retaining shape of the slot wall, the width of the bar being such as to leave a gap along the side of the groove when placed therein, and the locking plate extending along the gap between the bar and one side of the groove to hold the bar against the opposite side of the groove with the legs overlying the blade root and retaining body, the ends of the locking plate being formed (e.g. bent over) so as to engage the sides of the retaining body and prevent axial movement therein.

With the use of the locking means according to this invention, the component which prevents axial movement of the blade is no longer locked in position in the retaining body by deformation of a stressed portion. It can therefore be produced by direct mechanical means as a preformed unit and be designed for robustness since the requirement for sufficient flimsiness to bend close against

the body by hand is now removed. The locking plate still has to be closed by hand but, as the construction has removed all axial stress from this plate, its cross-sectional area can be appropriately designed or the necessity for full closing contact on to the retaining wheel or body be removed.

The invention may be better appreciated from a consideration of the following description of the accompanying drawings which refers specifically to blades and slots having a fir-tree serrated shape, but the invention is applicable to any shape where the blade is prevented from moving outwards radially by the action of any undercut surface providing an overhanging shoulder.

In the drawings FIG. 1 is a perspective view of a preformed U-shaped retaining plate, FIG. 2 is a similar view of a preformed locking plate, FIGS. 3–5 illustrate successive stages in the assembly of a blade in a slot with the locking means of FIGS. 1 and 2 and FIG. 6 is a view on the line 6—6 of FIG. 5. FIG. 7 is a modified form of FIG. 2.

As shown in FIG. 1, the retaining plate **1** comprises a rectangular bar **2** with upstanding legs **3** at each end forming a member of generally U-shape. FIG. 2 shows a locking plate **10** made of strip material which may be preformed by bending one end **11** out of the plane of the strip.

The retaining body is depicted in axial end view in FIGS. 3–5 as part of a turbine or compressor rotor **5** with a slot **6** for receiving a blade root **7** of fir-tree shape. The inner end or bottom of the slot terminates in a groove **8** in which the bar **2** of plate **1** is located.

The retaining plate **1** is designed so that the inner faces of the legs **3** are spaced apart by a distance which will allow them to fit over the ends of the blade root **7**, as best seen in FIG. 6. The width of the legs when viewed lengthwise of the bar **2** is sufficient to allow one side to overlie the body **5** when the bar is against one side of groove **8**, as seen in FIGS. 4 and 5. The width of the bar **2** is such as to permit of circumferential movement of the bar to one side of the groove and provide a gap **9** at the other side, as shown in FIG. 4. The overhanging side of one at least of the legs **3** (the right hand side in FIGS. 3–5) is given a profile **4** such that the plate **1** may be slid axially along the slot **6** clear of the serrated retaining shape thereof. FIG. 1 shows both legs cut away at **4**, thus enabling either end of the plate to be inserted into the slot.

With the foregoing construction the retaining plate may be made sufficiently robust and of material strong enough to withstand the axial stresses set up due to any tendency of the blade root to move in the slot, whilst the locking plate can be of lighter construction, since no axial force is applied to it, enabling it to be readily bent over by hand against the side of the rotor body **5**.

On assembly the U-shaped plate **1** is first fitted over the tip of the blade root with the legs lying along the ends of the root without protruding laterally over the serrations. The assembled blade and plate are then inserted axially into the slot **6** in the retaining body (FIG. 3) and the U-shaped plate is then moved in a circumferential direction to the rotor so that the base of the plate contacts one side of groove **8** and the shaped legs of the plate overhang the sides of the body **5** as shown in FIG. 4. Thus as the blade root is contained within the legs of the U-shaped plate and as the plate overhangs the sides of the rotor body, the blade is prevented from having axial movement.

The locking plate **10** is next inserted axially into the gap **9** between the other side of the groove **8** (i.e. the left side in FIGS. 4 and 5) and the side of the part **2** of the plate **1**. The plate **10** is then locked in position by forcing

the end that is not preformed against the side of the body 5 as seen at the right hand side of FIG. 6. Obviously if the locking plate is a flat unbent strip, both ends will be bent over. It will be seen from FIG. 5 that the plate 10 prevents the bar 2 from moving in the groove so that the axial movement of the assembly is prevented.

Since no axial force is applied to it the plate 10 is only required to be of nominal thickness, though it will usually be of the same thickness as the U-shaped plate 1, so as to leave as little clearance as possible between it and the tip of the blade root.

One advantage of the method of locking described above is that the blades can be inserted along the length of the groove in either direction and this is necessary in certain cases of blade profiles having a large angle of twist from root to tip.

Another advantage is that it facilitates the assembly of blades in a solid gashed rotor having a number of retaining discs or wheels on one spindle, each of which has grooves for the retaining of blades; another additional advantage is that the main U-shaped retaining plate is not expendable on reblading, as only the cheaper locking plate will have to be renewed when the blades are replaced.

It will be appreciated that modifications of the construction illustrated may be made without departing from the scope of the invention described herein. For example the preformed locking plate may consist of two or more legs connected at one end by a yoke, the plate being shaped to suit the radius of the bottom of the slots with the legs spaced apart a distance equal to the pitch of the slots so as to fit beneath the blade roots. With this form the yoke may lie in the plane of the legs or it may be bent as in the case of a single strip. A suitable type of preformed plate with two legs 10 connected by a yoke 12 bent at an angle to the legs is illustrated in FIG. 7. In some cases it may be sufficient for one leg only of the plate 1 to be profiled, the other being for example rectangular. However profiling both legs enables the plate to be inserted into the slot from either side of the body. In a further modification both sides of the leg(s) may be profiled, permitting circumferential movement in the slot in either direction during assembly.

Although in the foregoing the invention has been described with particular reference to axially directed slots, it is understood that it may equally well be applied to assemblies with a skew-axial fixing.

What we claim is:

1. In combination, a rotor body having an axially extending slot in its periphery, a blade having a root fitting in said slot and radially retained therein by an attachment of the shoulder type, the slot and root having co-operating portions spaced apart radially thereby forming an axially extending groove at the bottom of the slot beneath the blade root, and means for retaining the root in axial position in the slot including a preformed U-shaped retaining plate and a locking plate extending side by side through said groove, said retaining plate being formed of a flat bar of the same length as the blade root and slot with an upstanding leg at each end arranged to contact the sides of the blade root and the rotor body, one leg of the U having a transverse dimension smaller than that of said slot and a profile such that, when said U-shaped plate is fitted over the tip of the blade root, said root and plate together are capable of axial insertion into the slot without said plate fouling the retaining profile of the slot wall, the bar being narrower than the groove so as to leave a gap extending along the side of the groove when placed therein, and the locking plate extending along the gap at one side of the groove to hold the bar against the opposite side of the groove with the legs overlying a part of the blade root and of the rotor body, the ends of the locking plate in the assembly being angularly disposed to engage the sides of the rotor body and prevent axial movement therein.

2. The combination claimed in claim 1, in which both said retaining plate legs are profiled on the same side to conform substantially with the retaining profile of said slot wall.

3. The combination claimed in claim 2, in which said legs are additionally profiled in like manner on their other sides thereby providing a plate of symmetrical form.

4. The combination claimed in claim 1, in which said locking plate consists of a plurality of legs connected at one end by a yoke, the plate being shaped to suit the radius of the bottom of the slots with the legs spaced apart a distance equal to the pitch of the slots so as to fit beneath the blade roots.

5. The combination claimed in claim 4, in which the said yoke is bent substantially at right angles to the legs so as to lie against the side of the rotor body.

6. In combination, a rotor having an axial surface slot of uniform width, a blade having a root of the same axial length as said slot axially inserted into said slot, cooperating interlocking formations on said root and in said slot radially retaining the blade on the rotor, said slot being of such depth as to provide an axial groove beneath the root, a preformed U-shaped retainer plate having a bar narrower than the groove axially extending along said groove and end legs bridging the opposite sides of the rotor and blade root, at least one of said legs being profiled to enable axial insertion of the blade root and retainer plate together in assembly into said rotor slot, and said retainer plate bar being shiftable circumferentially of the rotor in said groove after the blade root and retainer plate together have been axially inserted into the slot to locate said legs to bridge the root and rotor sides, and a locking plate extending axially along said groove beside said bar, said locking plate having at least one straight end prior to assembly for insertion endwise into said groove after the blade root and retainer plate have been installed on the rotor to occupy remaining groove width and retain said bar against displacement circumferentially of the rotor, and both locking plate ends extending in the assembly to engage the rotor sides and prevent axial displacement of the locking plate.

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