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2,431,249

SECURING PROJECTIONS TO ROTORS

Filed July 11, 1944

2 Sheets-Sheet 1

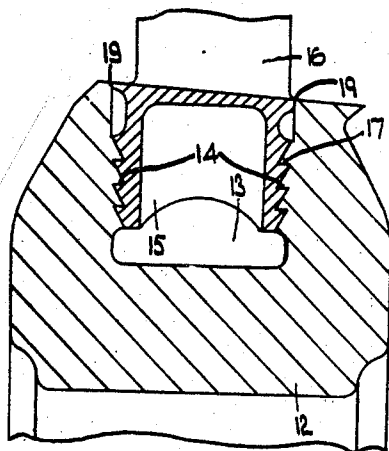


FIG. 5

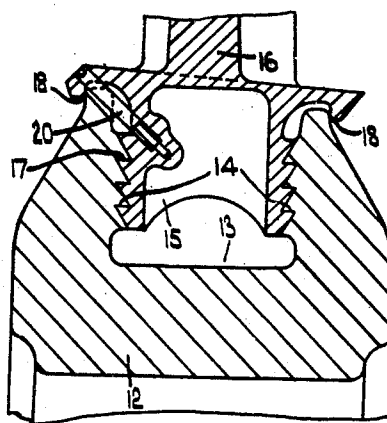


FIG. 6

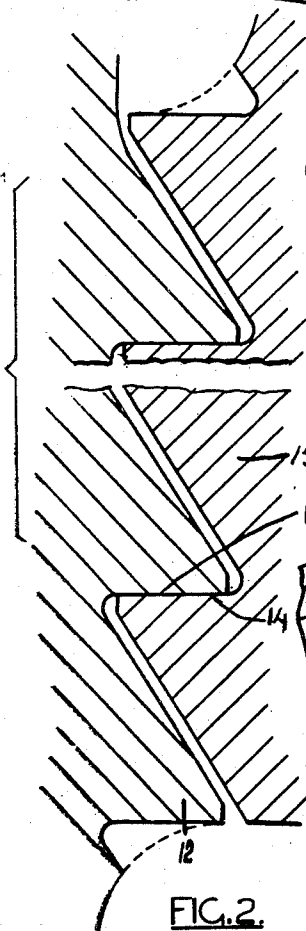


FIG. 2

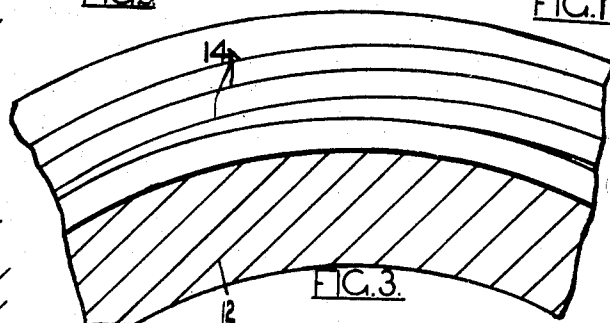


FIG. 3

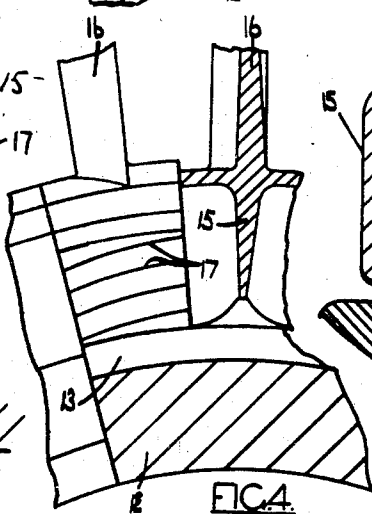


FIG. 4

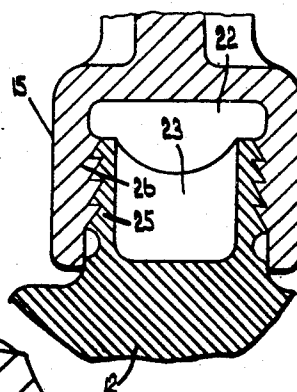


FIG. 7

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2 Sheets-Sheet 2

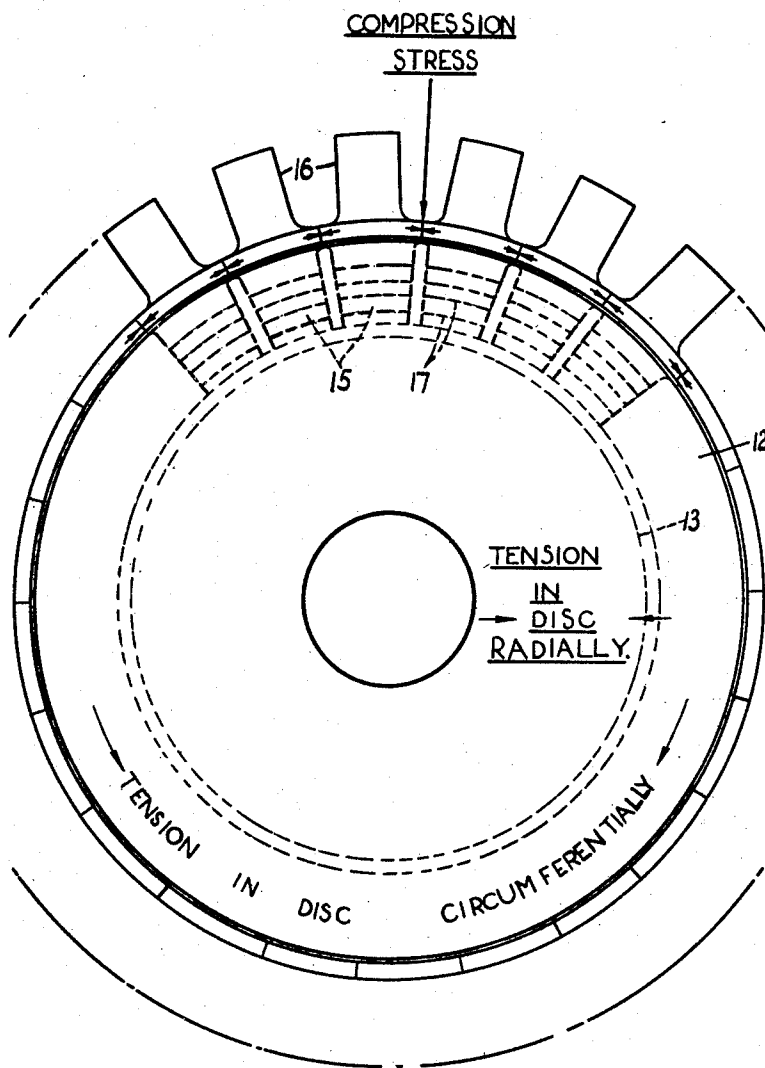


FIG. 7

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UNITED STATES PATENT OFFICE

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SECURING PROJECTIONS TO ROTORS

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1 Claim. (Cl. 29—156.8)

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This invention relates to drums, wheels or other rotors such as carry a ring of projections, for example, blades, arms, buckets, cutters or the like, and, although not limited in this respect, the invention is particularly applicable to a turbine and especially to an internal-combustion turbine plant for jet-propulsion purposes.

U. S. patent specification No. 2,240,742 in the name of Allen, discloses a turbine rotor having a peripheral groove in which is secured a ring of turbine blades, the groove having, on one radial face at least, a spiral screw-thread struck about the axis of the rotor, and the roots of the blades have corresponding spirally-formed teeth such that the blades can be screwed into the groove until they bottom on the groove, thus to be located radially and circumferentially. Alternatively, the groove may be in the roots of the blades.

I have found, in practice, that it is an extremely difficult production operation to arrange for the respective spiral screw-threads to be accurate as well as the radially-inner ends of the blade roots relatively to the bottom of the groove, so much so that the proposed method of assembly is in my opinion without utility, or impracticable. It is the main object of the present invention to obviate this defect whilst using the spiral screw-thread idea, which has undoubted advantages.

According to the invention, a method of securing projections against one another round the periphery of a rotor involves providing a screw-thread on one face at least of a peripheral groove provided either in the rotor or in the roots of the projections (when properly assembled), such screw-thread being in the form of a spiral struck about the axis of the rotor, providing a corresponding screw-thread either on the roots of the projections (when properly assembled) or on a peripheral flange of the rotor, as the case may be, the roots being adapted to be received in the groove of the rotor or the flange being adapted to be received in the groove of the roots, as the case may be, and screwing the roots to the rotor with the projections circumferentially spaced from one another until they abut one another with a relatively-large pressure in a circumferential direction, whereby they are positioned in a radial direction solely by the interaction of the two spiral threads, being positioned circumferentially by friction resulting from the deformation of the coating threads when the roots engage one another with the relatively-large circumferential pressure.

Preferably, the final screwing of the roots to

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the rotor is effected while the grooved element (i. e., the rotor or the roots, as the case may be) is at a materially higher temperature than the coating element (i. e., the roots or the rotor, as the case may be) so that the circumferential pressure will be reached when the parts are at substantially the same temperature.

Preferably, too, the coating spiral threads have axial clearance from one another, axial location being elsewhere provided. The terms "axial clearance" and "axial location" are applied to the blade roots with respect to the axis of the rotor.

For a steam turbine the "relatively-large" circumferential pressure may be of the order of from 5 to 10 tons per square inch, and higher for an internal-combustion turbine, for example, up to 20 tons per square inch. The circumferential pressure will fall to something like half its value at very high speeds, due to deformation of the rotor under the centrifugal forces.

Thus, with the invention, location is effected by the tensional and compressive deformations of the two spiral threads, respectively—i. e., by an elastic deformation which is large compared with the irregularities of the machined teeth of the blade roots, whereas in the U. S. specification aforesaid, or in other constructions where the blade roots are let into individual shaped recesses in the rotor, the elastic deformation of the locating surfaces is small compared with the irregularities of the machined root surfaces.

In the accompanying drawings:

Figure 1 is a fragmentary section, taken in a plane in which the axis of the rotor lies, of a turbine blade secured to the rotor according to the invention;

Figure 2 is a similar but smaller fragmentary view, and to a larger scale;

Figure 3 is a fragmentary view in cross-section through the rotor, with the blades removed;

Figure 4 is a fragmentary elevational and part-cross-sectional view showing one blade in elevation and the next in section;

Figure 5 is a view, similar to Figure 1, showing a blade having a root of slightly different form;

Figure 6 is a view, also similar to Figure 1, showing an inverse method of securing a blade to a rotor; and

Figure 7, which is an axial elevation of a complete turbine disc but with only some of the blades fully shown, is a diagram showing the stresses.

In the construction of Figures 1 to 4, and also in that of Figure 5, the rotor 12 has a peripheral

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groove 13 with parallel radial faces in which fine-pitch, spiral screw-threads 14 are cut, and opposite faces of the root 15 of a blade 16 have corresponding spiral teeth 17 cut therein. In machining the teeth of the roots, the blades should be assembled in a ring, the blades extending radially with their roots abutting one another, and the spiral screw-thread machined whilst they are in this position. Care should be taken to number or otherwise mark each blade as the spiral teeth on different blades will be different, and it is only by arranging the roots in the correct order that they can subsequently be correctly screwed into the groove 13 of the rotor.

As shown by Figure 2, the screw-threads have axial clearance, and I provide axial location (with respect to the rotor) in the construction of Figures 1 to 4 solely at the places marked 18, 18, i. e., internally of the flange of the blade root. The construction of Figure 5 differs from that of Figures 1 to 4 mainly in that axial location is provided at 19, 19 at the outer end of the rotor groove. A locating dowel 20 (Figure 1) may be inserted as a safety precaution after assembly, but in our opinion it will not be required.

It will be seen from Figures 1 to 5 that the only radial engagement effected between the blade roots and the rotor is through the interacting spiral screw-thread. As stated, the grooved element, i. e., the rotor in this case, may be heated to a predetermined temperature, for example, 70° C. or 100° C., when the blade roots are to be screwed into it; and if the latter be screwed up tightly (i. e., to abut one another), when the parts have again reached the same temperature the radial contraction of the spiral screw-thread of the rotor acting on the spiral screw-thread of the roots of the blades will draw the latter radially inwardly to an extent in which each blade root bears on the adjacent blade roots with a predetermined circumferential pressure. That is to say, the rotor will be placed in tension both circumferentially and radially and the ring of blade roots in compression circumferentially, as shown by Figure 7. Otherwise complicated machinery may be necessary to screw up the blade roots to a sufficient circumferential pressure—i. e., if heat is not used. Initially heating the rotor to 200° C. will produce a circumferential pressure of about 20 tons per square inch when the parts are at the same temperature.

In this way the blade roots are radially located and it is impossible for them to work loose, assuming that they are never subsequently at temperatures materially lower than that of the rotor.

In the modification of Figure 6 it will be ob-

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served that the groove 22 is provided in the blade roots 15, the groove receiving the flange 23 of the rotor 12, and, as before, radial location is provided solely by the interaction of the two spiral screw-threads 25, 26.

Figures 3 and 4 show a multi-start spiral. In Figure 7 the spiral is intended to be a single-start one.

What I claim as my invention and desire to secure by Letters Patent of the United States is:

A method of securing a built-up ring element to a rotor element, said ring element comprising a number of radially extending projections to be mounted against one another with their roots abutting one another in a circumferential direction, which involves providing a groove in one of said elements and a flange on the other element to be received in said groove with the groove so relatively deep that its bottom will not be reached by the inner end of the root when the root is in the home position in the groove, providing at least one of the faces of said flange and the adjacent face of the wall of said groove with corresponding spiral screw-threads struck about the axis of the rotor, screwing the roots to the rotor, with the projections circumferentially spaced from one another, until they abut one another with a relatively-large pressure in a circumferential direction, and with the inner ends of the roots spaced from the bottom of the groove to provide radial clearance between said elements except for the engagement of said spiral screw-threads whereby said projections are positioned in a radial direction solely by interaction of the two spiral threads, the step of screwing the roots to the rotor being carried so far as to deform the coating threads incident to the relatively great circumferential pressure of the roots upon one another.

FRITZ ALBERT MAX HEPPNER.

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