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TURBINE BLADING

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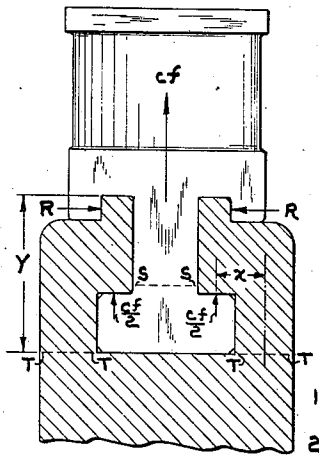


FIG. 1.

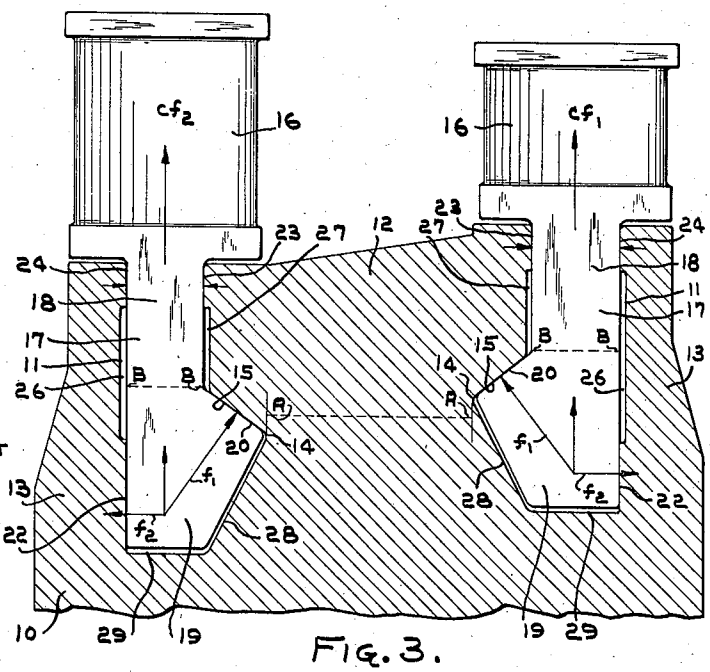


FIG. 3.

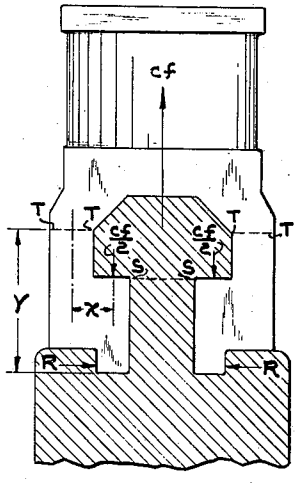


FIG. 2

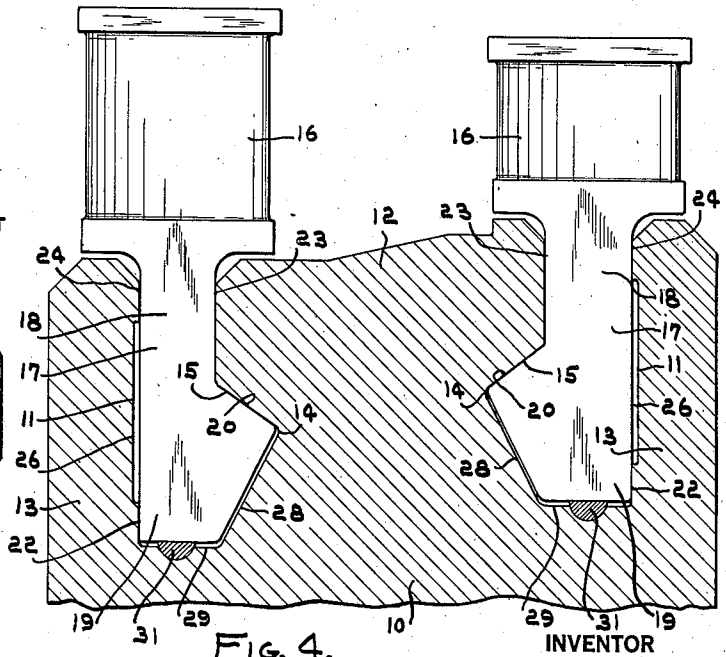


FIG. 4.

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TURBINE BLADING

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6 Claims. (Cl. 253—77)

The invention relates to turbine blading and it has for its object the provision of an improved type of blade fastening.

This and other objects are effected by the invention as will be apparent from the following description and claims taken in connection with the accompanying drawing forming a part of this application, in which:

Figs. 1 and 2 are diagrammatic views showing conventional types of blade fastenings; and,

Figs. 3 and 4 are detail sectional views showing the improved type of fastening.

With blade fastenings of the straddle-T type, whether the disc straddles the root, Fig. 1, or the root straddles the disc, Fig. 2, the centrifugal force is concentric with the neck sections S—S, but is eccentric to the sections T—T. A bending moment

$$\frac{cf}{2} \times X$$

where cf is the centrifugal force of the blade, would be exerted on each section T—T but for the straddle connection at R, which exerts a bending moment $R \times y$, on section T—T. The force R, however, is statically indeterminate depending upon the flexibility of the tension arm T—T and the initial clearance or press fit at R, and it cannot relieve the entire tension arm T—T of bending stresses.

With the improved root construction, statically indeterminate bending stresses in the tension members are avoided, the necessity for an accurately-fitting straddle is eliminated, and, for a given space, lower stresses on account of centrifugal and steam forces are encountered. The improved fastening is particularly applicable to impulse blades where there are two rows of blades on a disc or rotor, as shown in Figs. 3 and 4. The fastening resembles Fig. 2, the T head being a part of the rotor, except that a blade is attached to each of the tension arms T—T.

Referring to Fig. 3, the blade disc or rotor 10 has a pair of grooves 11 defined by an intermediate flange 12 and outer flanges 13. The intermediate flange 12 is undercut at each side, as indicated at 14, to provide overhanging bearing surfaces 15 which are inclined outwardly and toward the outer flanges 13.

The blades 16 have roots 17 designed to fit the grooves, each root having a neck portion 18 and an inner portion 19 enlarged at one side. The enlarged portions have surfaces 20 inclined conformably to the surfaces 15.

The outer flanges 13 are provided with bearing or abutment surfaces 22 for engagement with the inner ends of the roots so that, in operation as hereinafter pointed out, forces applied to each blade are effectively resisted by the cooperative action of the bearing surfaces 20 and 22. Also, the intermediate and outer flanges are provided with opposed bearing surfaces 23 and 24, respectively, for engagement with the necks near the top of the grooves, these surfaces being effective to hold the blades in position at lower speed.

Preferably, each groove 11 is radial and undercut at one side and the outermost wall is relieved, at 26, to provide the inner and outer bearing surfaces 22 and 24 and the inner wall is shown as being relieved, at 27 in Fig. 3, to provide a bearing surface 23 spaced from the overhanging bearing surface 15. Furthermore, the grooves are relieved at 28 and 29. Thus, the engagement of the walls of each groove with a root is restricted to the opposed radial bearing surfaces 23 and 24 near the top of the groove and to the inclined surface 15 and the radial surfaces 22 near the bottom of the groove.

In Fig. 4, showing a particular application of the invention, the structure is fundamentally the same as that already described, except that the relief 27 between the bearing surface 23 and the inclined surface 15 is omitted, and caulking or wedges 31 are associated with the inner ends of the roots to bring about initial firm engagement of the inclined surfaces 15 and 20 with the inner end of the root abutting the radial bearing surface 22.

In Figs. 3 and 4, the centrifugal force is concentric with tension sections B—B and with the tension sections A—A because of the equal, or nearly equal, centrifugal forces of the two rows of blades. The centrifugal force cf_1 is balanced by the components f_1 and f_2, which are statically determined by the simple force triangle. The component f_1 is directed normally with respect to the overhanging inclined bearing surface 15 and the component f_2 is directed normally with respect to the radial bearing surface 22. Thus, these components are opposed by the bearing surfaces 15 and 22, and a structure having such a disposition of bearing surfaces would be adequate to hold the root and resist forces applied to the blade in operation; however, I prefer to have the rotor flanges extend outwardly so as to provide the opposed bearing surfaces 23 and 24 near the tops of the grooves and to assemble the blades with a clearance or light press fit, at 23 and 24, to hold the blades in position at low speeds.

From the foregoing, it will be apparent that,

as compared to the ordinary straddle-T connection, the improved type of fastening has the following advantages thereover:

(1) Statically indeterminate bending stresses in tension members, hereinbefore referred to in connection with Figs. 1 and 2, are avoided.

(2) Because of the arrangement and connection of cooperating surfaces for holding the blade to the rotor, the necessity for accurate fits, such as heretofore required for the straddle connection, is avoided.

(3) For given limitations of space, the improved root construction provides for lower stresses in the fastening due to centrifugal and steam forces.

While the invention has been shown in two 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 it is desired, therefore, that only such limitations shall be placed thereupon as are specifically set forth in the appended claims.

What is claimed is:

1. In a turbine, a rotor and a row of blades carried thereby, said rotor having first and second flanges defining a blade groove which is undercut at the second flange side to provide a bearing surface which overhangs the groove bottom and which is inclined outwardly and toward the first flange, said second flange being relatively thicker in an axial direction than the first flange, each blade having a root provided with an inner enlarged portion and the enlarged portion having a surface inclined conformably to said inclined bearing surface for engagement with the latter, and said first flange having a bearing surface adjacent to the bottom of the groove for engagement with the root with the inclined surface of the enlargement engaging said inclined bearing surface.

2. In a turbine, a rotor and a row of blades carried thereby, said rotor having first and second flanges defining a blade groove which is undercut at the second-flange side to provide a bearing surface which overhangs the bottom of the groove and which is inclined outwardly and toward the first flange, said second flange being relatively thicker in an axial direction than the first flange, each blade having a root provided with an inner enlarged portion having a surface inclined conformably to said inclined bearing surface for engagement therewith, and said first and second flanges having opposed bearing surfaces adjacent to the top of the groove for engagement with the root and said first flange having a bearing surface adjacent to the bottom of the groove for engagement with the root with the inclined surface of the enlargement engaging said inclined bearing surface.

3. In a turbine, a rotor, and a pair of rows of blades carried thereby, said rotor having a pair of outer flanges and an intermediate flange defining a pair of blade grooves which are undercut at the intermediate-flange sides to provide bearing surfaces which overhang the groove bottoms and which are inclined outwardly and toward the outer flanges, the blades having roots provided with inner enlarged portions having surfaces which are inclined conformably to said inclined bearing surfaces for engagement therewith, and said outer flanges having bearing surfaces for engagement with the roots near to the groove bottoms with the inclined surfaces of the enlargements thereof engaging said inclined bearing surfaces.

4. In a turbine, a rotor; a pair of rows of blades carried thereby; said rotor having a pair of outer flanges and an intermediate flange defining a pair of blade grooves which are undercut at the intermediate-flange sides to provide bearing surfaces which overhang the groove bottoms and which are inclined outwardly and toward the outer flanges, the blades having roots provided with inner enlarged portions having surfaces which are inclined conformably to said inclined bearing surfaces for engagement therewith, and said outer flanges having bearing surfaces for engagement with the roots adjacent to the bottoms of the grooves; and caulking cooperating with the inner ends of the roots for tightening the blades in the grooves with the inclined surfaces of the enlarged portions engaging the inclined overhanging surfaces of the intermediate flange and with surfaces opposite to the inclined surfaces and adjacent to the bottoms of the grooves engaged by the outer flanges.

5. In a turbine, a rotor, and a pair of rows of blades carried thereby, said rotor having a pair of outer flanges and an intermediate flange defining a pair of blade grooves which are undercut at the intermediate-flange side to provide bearing surfaces which overhang the groove bottoms and which are inclined outwardly and toward the outer flanges, the blades having roots provided with inner enlarged portions having surfaces which are inclined conformably to fit inclined bearing surfaces for engagement therewith, said outer flanges having bearing surfaces for engagement with the roots with the inclined surfaces of the enlargements thereof engaging said inclined bearing surfaces, and said flanges having opposed bearing surfaces at the tops of the grooves for engagement with opposed sides of the roots.

6. In a turbine, a rotor; and a pair of rows of blades carried thereby; said rotor having a pair of outer flanges and an intermediate flange defining a pair of blade grooves, said intermediate flange being relatively thicker in an axial direction than the outer flanges, said intermediate flange having its sides undercut to provide bearing surfaces which overhang the groove bottoms and which are inclined outwardly and toward the outer flanges, the blades having roots provided with inner enlarged portions having surfaces which are inclined conformably to said inclined bearing surfaces for engagement therewith, said outer flanges having bearing surfaces for engagement with the roots near the bottoms of the grooves with the inclined surfaces of the enlargements thereof engaging said inclined bearing surfaces, and the intermediate and outer flanges having opposed bearing surfaces for engagement with opposite sides of the roots at the tops of the grooves; and caulking cooperating with the inner ends of the roots to obtain a tight fit of the roots with respect to the grooved overhanging inclined surfaces and the surfaces opposed thereto adjacent to the groove bottoms.

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