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STEAM TURBINES

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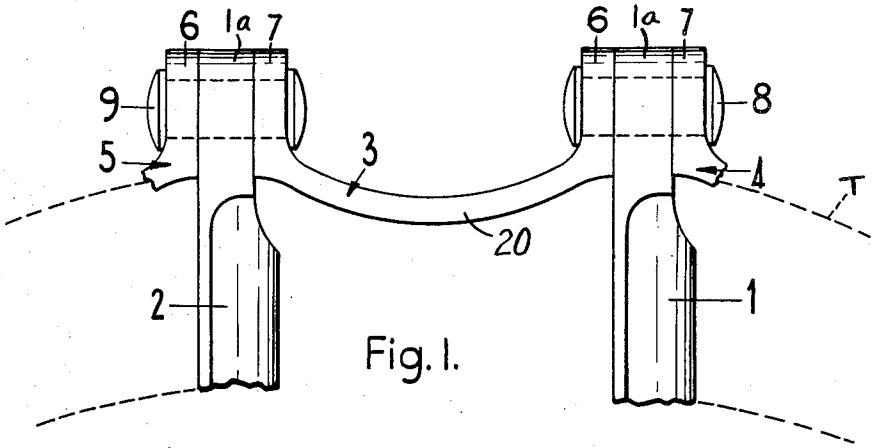


Fig. 1.

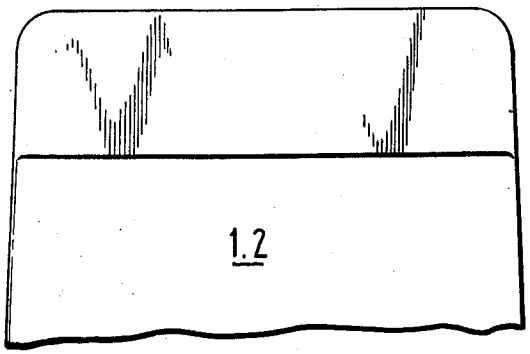


Fig. 2.

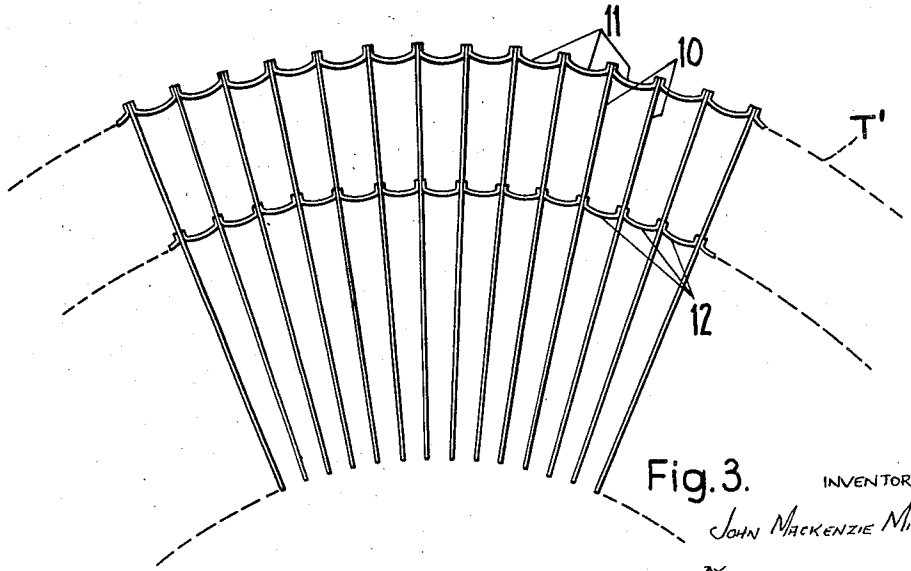


Fig. 3.

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STEAM TURBINES

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2 Claims. (Cl. 253—77)

This invention relates to steam turbines of the axial flow type. In large turbines of this type, the turbine wheels in the low pressure stages are large and with high centrifugal forces coming into play at the wheel peripheries where the pitch of the turbine blade tips is also large, difficulties are experienced in providing a satisfactory coverband or shrouding band construction for the blade tips or ends. One object of the present invention is the provision of a turbine wheel having a coverband or shrouding band construction which overcomes many of the difficulties encountered in the past.

Another difficulty which is experienced with long turbine blades is that of providing an efficient means of raising the fundamental frequency of blade vibration and a subsidiary object of the invention is the provision in a turbine wheel of a stiffening ring construction which overcomes or substantially reduces this difficulty.

The main and subsidiary objects of the invention are achieved by the use of members of arched or bowed construction placed one between each pair of adjacent turbine blades, the members being arched or bowed radially inwardly so that the centrifugal force acting on the members causes them to tend to lengthen and exert end thrusts on the blades.

In order that the invention may be clearly understood, two constructions of turbine wheel in accordance with the invention will now be described by way of example with reference to the three fiures of the accompanying drawings in which Figure 1 shows a side view of part of the first turbine wheel in accordance with the invention, said view showing the ends of two adjacent blades with the special coverband member in accordance with the invention between them, and parts of the adjacent members, Figure 2 is a view showing the undrilled tip section of a blade, and Figure 3 shows on a reduced scale a side view of part of the second construction of turbine wheel.

Referring now to Figure 1 of the drawings, the reference character T denotes a turbine wheel embodying the instant invention. Inasmuch as the wheel consists of a large number of identical turbine blades and coverband members, only the ends of two turbine blades and all of one coverband member are shown in Figure 1, thereby simplifying the drawings. Said two turbine blades **1** and **2** are linked by an elastic arched coverband member **3** and adjacent elastic arched coverband members **4** and **5** exactly similar to the member **3**, are provided connecting the turbine blades **1** and **2** with the next adjacent turbine blades (not shown). Each turbine blade has a tip **1***a*. The blades are radially extending and circumferentially spaced. The whole coverband of the turbine wheel consists entirely of a plurality of such coverband members one between each pair of adjacent blades. Each elastic arched coverband member **3**, **4** or **5** is of high strength steel and may be made by any convenient machining or other operation. The extremities of each elastic arched coverband member constitute radially outwardly extending end portions **6** and **7** and these end portions are connected by a radially inwardly arched span **20** so that the balance of each elastic arched coverband member between the end portions thereof entirely constitutes the aforesaid radially inwardly arched span **20**. Said span **20** of each said coverband member is of rectangular section. The end portions **6** and **7** of each coverband member have configurations which match the configurations of the tips **1***a* of the turbine blades between which the coverband member is disposed. The form of all the blade tips **1***a* is shown in Figure 2. The end portions **6** and **7** of all of said coverband members (see Figure 2) extend axially across the full widths of the tips **1***a* of the pairs of blades between which said members are disposed, so that said end portions are thereby parallel to the axis of the turbine wheel T. Common rivets **8** or **9** secure the arched coverband members **3**, **4** and **5** to the blade tips **1***a* and the curvature of each arched coverband member, e.g., the member **3** is radially inwardly so that when the turbine wheel T rotates, the centrifugal force acting on the arched central portion **20** of the coverband member develops end thrusts which are balanced by the end thrusts of adjacent coverband members **4**, **5**.

One advantage of this coverband construction is that it allows a larger span to be covered between adjacent blade tips **1***a* than is possible with the normal type of coverband which is essentially a beam. In the normal type, if the beam is made of sufficient radial thickness to bring the bending stresses within reasonable limits, the total centrifugal force of the system becomes large and attachment to the blade tips is difficult. Another advantage is that the end thrusts of the individual arched coverband members **3**, **4** and **5** developed by the elongation thereof exert no force on the rivets **8**, **9** and these are subjected to no bending action or tension by the coverband members. The coverband members have sufficient elasticity to accommodate temperature differentials between the various parts of the complete wheel T and any one blade can be removed simply by removing the two coverband members flanking it.

Similar arched members may be applied as auxiliary stiffening at a position part way along the lengths of the turbine blades, the arch construction of the members providing the same degree of support as they do if used at the periphery of a turbine wheel. Such a construction is illustrated in Figure 3, which is partly diagrammatic, and shows a side view of a portion of a wheel T'. Referring to this figure, the blades **10** have arched coverband members **11** of the nature shown in Figure 1 and auxiliary members **12** forming the auxiliary stiffening at a position radially inwards of the periphery of the wheel T'. The auxiliary members **12** are similarly shaped to the arched coverband members **11**, the blades **10** being suitably shaped and drilled to co-operate with the ends of the auxiliary members **12** which are riveted to the blades, and the auxiliary members **12** are arched radially inwards so that centrifugal action causes them to exert end thrusts on the blades **10**. The auxiliary members **12** take the place of the normal ring of lacing wires which are provided on long blades in order to raise the fundamental frequency of blade vibration. Such lacing wires suffer from certain disadvantages, one main disadvantage being that they are passed through holes in the blades and secured by brazing, the brazed joints having a limited life and the brazing process impairing the corrosion resistance of the blades themselves at and around the joints.

I claim:

1. In or for a turbine of the axial flow type, a turbine wheel comprising a plurality of radially extending circumferentially spaced blades each having a tip, and a cover band for said blades, said cover band consisting

entirely of a plurality of elastic arched members, each member being disposed between a different pair of adjacent blades and every pair of adjacent blades having one of said elastic arched coverband members located between the same, the extremities of each member constituting radially extending end portions and the balance of each of said members between said end portions entirely constituting a radially inwardly arched span, means rigidly securing the end portions of each of said members to the tips of the pair of blades between which it is disposed, the arched span of each of said members being symmetrical with respect to the radial line at the middle of the space between said pair of blades, the arched span of each of said coverband members being of rectangular section and thinner than the tips of said pair of blades so as to be elastic, and the end portions of all of said coverband members extending axially across the full widths of the tips of said pairs of blades and thereby being parallel to the axis of the turbine wheel, whereby as the turbine wheel rotates and the turbine blades elongate under centrifugal force, the elastic arched spans will flex symmetrically outwardly under centrifugal force and place each of said coverband members under compression so that each of said coverband members develops uniform end thrusts against the tips of the turbine blades and thereby uniformly tangentially brace said tips.

2. A combination as set forth in claim 1 wherein auxiliary stiffening means are provided part way along the lengths of the radially extending circumferentially spaced blades, said auxiliary stiffening means consisting entirely of a plurality of elastic arched members each of which is disposed between a different pair of adjacent blades and every pair of adjacent blades having one of said auxiliary elastic arched members located between the same, the extremities of each auxiliary member constituting radially extending end portions and the balance of each

of said auxiliary members between said end portions entirely constituting a radially inwardly arched span, means rigidly securing the end portions of each of said auxiliary members to the pair of blades between which it is disposed, the arched span of each of said auxiliary members being symmetrical with respect to the radial line at the middle of the space between said pair of blades, the arched span of each of said auxiliary members being of rectangular section and thinner than the tips of said pair of blades so as to be elastic, and the end portions of all of said auxiliary members extending axially across the full widths of said pairs of blades and thereby being parallel to the axis of the turbine wheel, whereby as the turbine wheel rotates the elastic arched spans of the auxiliary members will flex symmetrically outwardly under centrifugal force and place each of said auxiliary members under compression so that each of said auxiliary members develops uniform end thrusts against the turbine blades and thereby uniformly tangentially brace said blades at the end portions of said auxiliary members.

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