

Sept. 25, 1962

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STEAM TURBINES

3,055,634

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2 Sheets-Sheet 1

Fig. 1

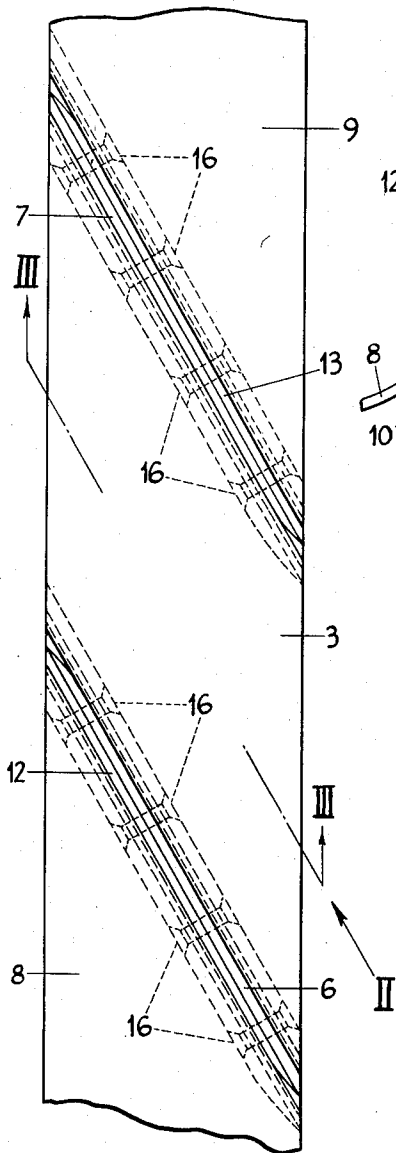


Fig. 2

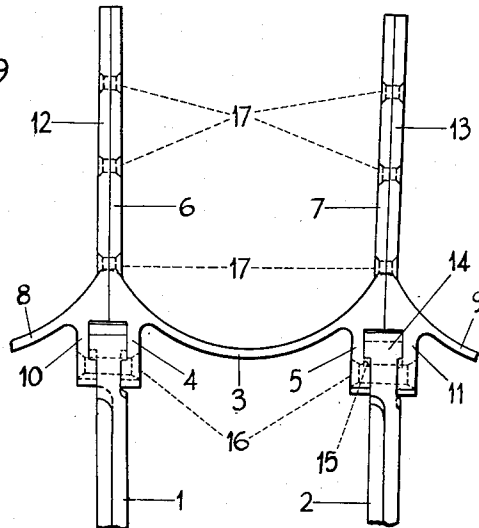
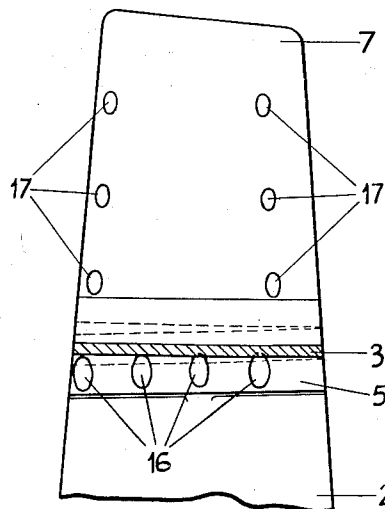


Fig. 3



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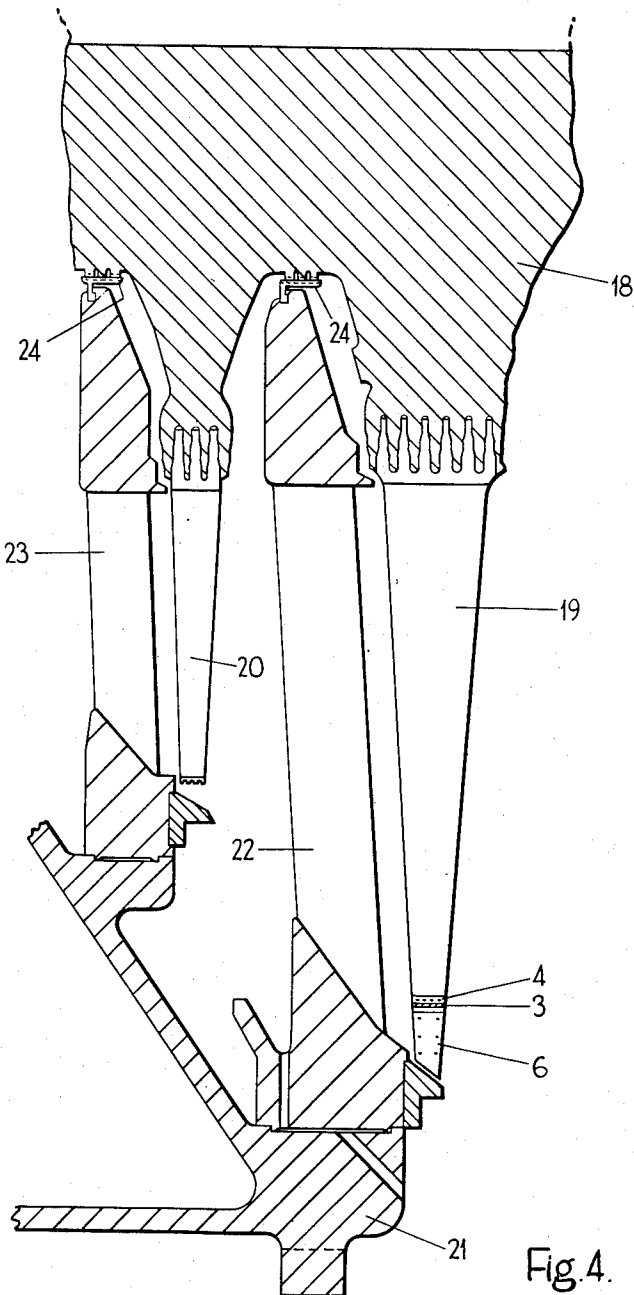


Fig. 4.

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5 Claims. (Cl. 253—77)

This invention relates to steam turbines of the axial flow type and is more particularly concerned with the low pressure stages of the turbines.

In a condensing steam turbine, the steam gradually cools during its expansion through the blading and in the last few stages the steam becomes wet.

When the percentage of water by weight exceeds about 5%, there is a tendency for the water to separate into discrete droplets, and since these are more dense than the surrounding steam, they tend to leave the fixed blades with low velocity.

In consequence, the velocities of the droplets relative to the moving blades are not correctly aligned with the inlet angles and impact occurs between the water droplets and moving blades.

When the peripheral speed of the blading is high, as is always the case in large modern turbines, the result of the impact is that the material at the inlet edges of the moving blades is gradually eroded away, necessitating replacement of the rather expensive blading. A common means of reducing the erosion is to fit "erosion shields" which comprise a strip of hard material attached to the inlet edges of the blades by brazing. The disadvantage of this technique is that the heating associated with brazing tends to impair the mechanical properties and corrosion resistance of the blading and detachment of shields can occur.

It is an object of the present invention substantially to overcome the problems arising out of the condensation of water droplets, and to provide a turbine wheel which does not necessitate the use of "erosion shields" as now employed.

According to the present invention, a turbine wheel for a steam turbine of the axial flow type comprises a shaft, a plurality of blades radiating from said shaft, a coverband secured to the free ends of the blades and of unitary form between each pair of said blades, and blade tips extending outwardly from said coverband, said blade tips being integral with and supported solely by said coverband.

The members forming the coverband may comprise a plurality of arched-beam like members and each end of said member may provide half a blade tip. Mating half blade tips may be secured together by common rivets, and common rivets may be used to secure the members to the blades.

The tips of the blades may be made of a harder material than the body of the blades, and the tips may derive their rigidity from the members forming the coverband.

In order that the invention may be readily understood, one construction of a turbine wheel will now be described by way of example with reference to the four figures of the accompanying drawings in which FIGURE 1 shows a plan view of part of the turbine wheel including two of the blades, FIGURE 2 shows a side view of the blades shown in FIGURE 1 viewed in the direction of the arrow II, FIGURE 3 is a side view of one blade taken on the line III—III in FIGURE 1 and FIGURE 4 shows in part section the last two stages of a large turbine in which the turbine wheel of the fixed stage as replaceable tips.

Referring now to the drawings, the turbine wheel com-

prises a plurality of identical blades projecting radially from a common hub and being joined at their free ends by arched coverband members. Since all the blades are identical only two are shown in the drawings as 1 and 2 and these are joined at their free ends by a coverband member comprising an arch 3 having two small inwardly projecting flanks 4, 5 one at each end of the arch 3 and two outwardly projecting flanks 6, 7. The blades 1, 2 have on their other sides similar coverband members comprising arches 8, 9 having inwardly projecting flanks 10, 11 and outwardly projecting flanks 12, 13 respectively, the arches 8, 9 connecting the blades 1, 2 to the adjacent blades not shown.

The inwardly projecting flanks 5 and 11 of the arches 3 and 9 abut over the end of the blade 2 and around the end of the blade. A hammer-head and socket joint is formed by an enlarged portion 14 at the end of the blade 2 which locates in a recess 15 formed by the mating of the two flanks 5 and 11. Rivets pass through holes in the flanks 5, 11 and the blade 2 to hold the coverband securely to the blade. The blade 1 is secured to the flanks 4 and 10 in a similar manner.

The outwardly projecting flanks 6, 12 and 7, 13 abut respectively to form the tips of the blades 1 and 2, and these tips are shaped so that they present the correct profile to the steam issuing from the previous set of fixed blades. Holes are provided in these outwardly projecting flanks and rivets 17 pass through these holes to secure the abutting pairs of flanks together.

Referring more particularly to FIGURE 4, the turbine has a rotor 18 to which are attached the blades of the final turbine wheel 19 and the penultimate turbine wheel 20. Attached to the housing 21 of the turbine are the diaphragms carrying the fixed turbine blades 22, 23 and these diaphragms are provided with seals 24 at their point of contact with the rotor 18.

Since water erosion of the turbine blades is usually confined to the outer region of the blades on account of the tendency of the dense water droplets to centrifuge outwards, it is evident that the tips of the blades 1 and 2 formed by the pairs of flanks 6, 12 and 7, 13 will be the most likely portion of the blades to be eroded. To resist this tendency for increased erosion of the blade tips the outwardly projecting flanks can be fabricated from a material having a high resistance to erosion, which material however may not be suitable for constructing the whole of the blade.

One advantage of this construction of the blade tips is that when the tips eventually become eroded they can be replaced by replacing the coverband around the periphery of the wheel. The blade tips need not necessarily be formed as two halves but could be formed singly if so desired.

Another advantage is that the connection between the blade and the tip is both highly resistant to radial pull and at the same time is flexurally stiff, without being too massive. Further stiffening of the tip is obtained at high speeds from the forces exerted by the arches themselves, the action of these arches is more fully described in British patent specification No. 770,528.

I claim:

1. A turbine wheel for a steam turbine of the axial flow type, said wheel comprising: a shaft, a plurality of blades radiating from said shaft, a coverband secured to the free ends of the blades and of unitary form between each pair of said blades, and blade tips extending outwardly from said coverband, said blade tips being integral with and supported solely by said coverband.

2. A turbine wheel for a steam turbine of the axial flow type, said wheel comprising: a shaft, a plurality of blades radiating from said shaft, a coverband secured to the free ends of the blades and including a plurality of

3

unitary members arched radially with respect to said shaft and each extending between a pair of adjacent blades, and blade tips formed integrally with and supported solely by said unitary members and extending outwardly from said coverband.

3. A turbine wheel for a steam turbine of the axial flow type, said wheel comprising: a shaft, a plurality of blades radiating from said shaft, a coverband secured to the free ends of the blades and including a plurality of unitary members radially arched with respect to said shaft and each extending between a pair of adjacent blades, and blade tips, each consisting of abutting integral extensions of the ends of two adjacent ones of said unitary members, said blade tips extending outwardly from and being solely supported by said coverband.

4. A turbine wheel for a steam turbine of the axial flow type, said wheel comprising: a shaft, a plurality of blades radiating from said shaft, a coverband secured to the free ends of the blades and including a plurality of unitary members radially arched with respect to said shaft and each extending between a pair of adjacent blades, and blade tips, each consisting of an integral extension of one of said unitary members at one of its ends, said

4

blade tips extending outwardly from and being solely supported by said coverband.

5. A turbine wheel for a steam turbine of the axial flow type, said wheel comprising: a shaft, a plurality of blades radiating from said shaft, a coverband secured to the free end of each blade by a riveted hammerhead and socket joint, said coverband including a plurality of unitary members radially arched with respect to said shaft and each extending between a pair of adjacent blades, and blade tips, each consisting of abutting integral extensions of the ends of two adjacent ones of said unitary members, said blade tips extending outwardly from and being solely supported by said coverband.

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