Feb. 7, 1967 V. S. MUSICK 3,302,925

DIAGONAL COVER PIECE FOR TURBINE BUCKET

Filed Jan. 17, 1966

FIG. 1

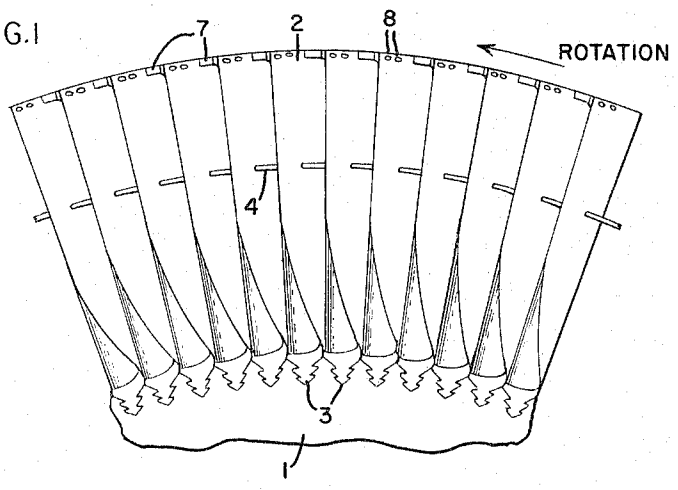


FIG. 2

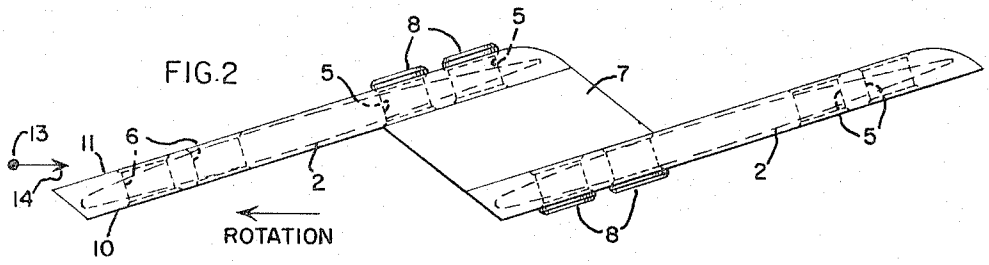


FIG. 4

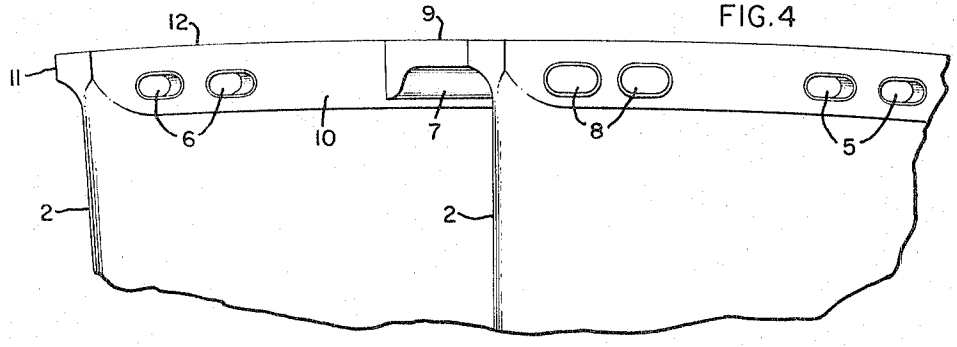
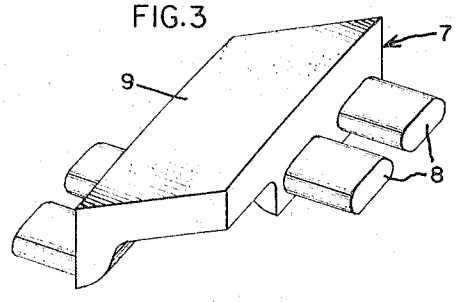


FIG. 3



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DIAGONAL COVER PIECE FOR TURBINE BUCKET

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This invention relates generally to turbo-machinery rotors and more particularly to an improved lashing or tying construction for turbine rotor buckets.

Adjacent turbine blades or buckets are normally connected together by some form of cover band around their outer periphery to confine the working fluid within a well defined path so as not to spill outwardly past the ends of the buckets, and also to increase the rigidity of the buckets. It is also a normal practice to provide longer turbine buckets with one or more tie wires which lash the buckets together around circumferences which are intermediate the bucket root and tip circumferences. These lashings serve to provide greater rigidity and are used on groups of blades or buckets spanning an arc of usually not more than 30°. It has been impracticable in the prior art to lash the buckets together around their 360° perimeter because prior art lashings have generally been of a single band or strip of material. Thermal expansion and contraction, and tensile strain of the rotor buckets due to centrifugal force have made it impossible to use such a single 360° lashing.

Accordingly, it is an object of the present invention to provide an improved turbine bucket cover piece which will serve also as a lashing or tie wire, thus eliminating one tie wire from the steam path permitting improved steam flow.

Another object is to provide an improved turbine bucket cover piece with which turbine buckets may be lashed together in a 360° unified whole to add rigidity to the buckets and dampen vibration.

Another object is to provide an improved turbine bucket lashing member which will serve also as a shroud or cover piece to confine steam flow in its axial passages and impede radial flow.

Other objects, advantages and features of the present invention will become apparent from the following detailed description of an embodiment thereof taken in connection with the accompanying drawing.

Briefly stated, the present invention is practiced in one form by turbine buckets each having a flange or cover piece extending from its tip near the trailing portion thereof to the tip of the next following bucket near the leading portion thereof. The cover piece is a separate element and has projections. The turbine buckets have transverse holes near the tips thereof. The cover piece projections are inserted into the holes and mechanically upset therein so as to join each bucket (at its tip trailing portion) to the next following bucket (at its tip leading porion).

In the drawing:

FIG. 1 is a partial elevation of a turbine stage embodying this invention.

FIG. 2 is a radially inward view of two buckets of the turbine stage of FIG. 1.

FIG. 3 is a perspective view of the cover piece of this invention.

FIG. 4 is an axial view of the two buckets shown in FIG. 2.

Referring now to FIG. 1, a typical environment of this invention is shown including a turbine rotor 1 of a low pressure steam turbine. The rotor 1 has buckets 2 mounted thereon by some form of dovetail 3 or other means not forming a part of this invention. In the area

intermediate the roots and tips of buckets 2 are tie wires 4 connecting the buckets in groups and adding greater rigidity and vibration resistance thereto. At the tips of buckets 2 are formed transverse holes 5 (see FIGS. 2 and 4) in the trailing portion of the tips, and transverse holes 6 in the leading portion of the tips. The surfaces of buckets 2 are modified at their tip portions such that the upstream and downstream bucket surfaces 10 and 11 respectively at the bucket tips are substantially planar, parallel to each other, and perpendicular to the bucket end surface 12. Transverse holes 5 and 6 are substantially perpendicular to surfaces 10 and 11. Between the trailing portion of each bucket tip and the leading portion of the next following bucket tip is mounted a cover piece 7 which acts as a spacing member and a lashing member between adjacent buckets, and also as a shroud member around the bucket periphery. As can be seen in FIG. 2, cover piece 7 covers a substantial portion of the radial opening between buckets 2. Cover piece 7 has projections 8 extending from its surfaces as shown in FIGS. 2 and 3 which fit within holes 5 and 6 in the turbine buckets as shown. The cover piece projections 8 are mechanically upset after being inserted into holes 5 and 6, thus enlarging the ends of the projections 8 and resulting in a secure fastening of cover piece 7 to turbine buckets 2.

Water droplets, represented by 13 in FIG. 2, sometimes appear in the steam path adjacent the stator nozzles. These droplets have relatively low absolute velocity and since the lower stage buckets 2 have a very high absolute velocity, the velocity of droplets 13 relative to buckets 2 is in the general direction represented by arrow 14. The resulting impinging action could be quite damaging to fitted parts. However, the projections 8 in holes 6 project through to the trailing surface of each bucket and hence are not in the path of impinging droplets 13. It should be pointed out here that the droplets present problems only relative to the upstream portions of buckets 2. The droplets have either picked up velocity or have been dissipated as they move further in an axial direction or downstream through the stage and are not an impingement problem relative to projections 8 in holes 5 at the trailing portion of each bucket.

The radially outer surface 9 of cover piece 7 is cylindrical coaxially with the rotor so as to permit closer tolerances and a smaller clearance between itself and the stator. The same is true of bucket and surfaces 12. Cover piece 7 is of such a thickness, greater than that of strips which are generally used as cover bands, as to give it the strength required for its function as a lashing member.

In operation, the cover pieces of this invention block the turbine buckets 2 apart while at the same time lashing them together at their extremities. The buckets are so blocked and lashed without interruption through the 360° of their periphery. This construction thus provides improved rigidity and resistance to vibration as compared to prior art lashings in which discrete groups of turbine buckets, usually embracing not more than about 30°, are lashed together.

Since the lashings and the rotor shroud are incorporated in the same cover piece, there is less disturbance to steam flow than there would be if a second tie wire were used at a circumference radially inward of the shroud.

The cover member of this invention covers a substantial area as seen radially and thus provides a measure of sealing against radial steam flow spilling out of the passage between adjacent buckets.

Thus it will be appreciated that a turbine bucket cover member has been provided which acts as a lashing as well as a sealing shroud, eliminating a tie wire from the

steam path and permitting improved flow. The cover piece of this invention also allows a unified 360° turbine wheel with greater rigidity and improved vibration characteristics.

It will occur to other of ordinary skill in the art to make modifications of this invention which will remain within the concept and scope thereof and will not constitute patentable departure therefrom. Accordingly, it is intended that the invention be not limited by the details in which it has been described but that it encompass all within the purview of the following claims.

What is claimed is:

1. A turbomachine rotor assembly comprising a plurality of rotor buckets on a shaft, each of said buckets having an enlarged tip portion and two separate cover pieces fastened thereto at its tip portion and extending from the trailing portion and the leading portion of said bucket tip portion to the leading and trailing portions of adjacent bucket tip portions respectively, said cover pieces mutually lashing and spacing said buckets, said cover pieces and said buckets together defining an outer surface which is substantially cylindrical and coaxial with said rotor.

2. A turbomachine rotor assembly according to claim 1 in which said turbine buckets define holes transversely through the tip portions thereof and said cover pieces include projections, said projections extending within said holes and fixed relative thereto.

3. A turbomachine rotor assembly comprising a plurality of rotor buckets on a shaft and a plurality of cover pieces,

(a) each of said buckets having parallel planar surfaces on the upstream and downstream tip portions thereof,

(b) each of said buckets defining a plurality of transverse holes between said planar surfaces,

(c) one of said cover pieces extending between adjacent rotor buckets connecting the trailing portion of one bucket with the leading portion of the next following bucket,

(d) said cover pieces having projections extending therefrom and fixed within said holes,

(e) said cover pieces and said buckets together defining an outer surface which is coaxial with said rotor and substantially cylindrical.

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