Nov. 12, 1940. E. L. ROBINSON 2,220,914

ELASTIC FLUID TURBINE BUCKET WHEEL

Filed July 30, 1938

Fig. 1.

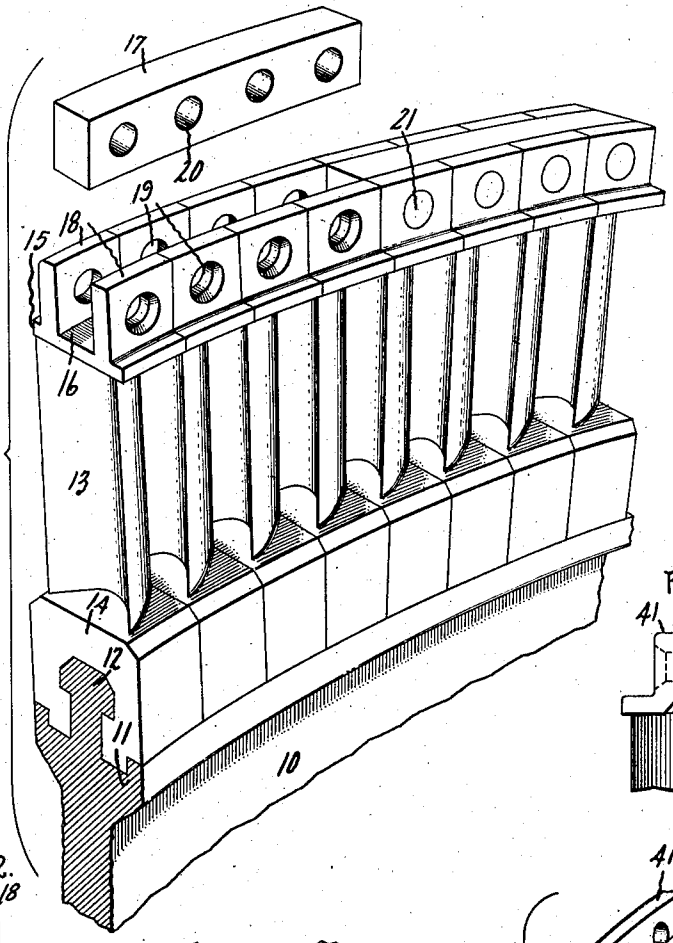


Fig. 6.

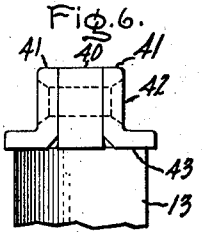


Fig. 2.

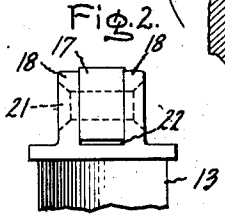


Fig. 3.

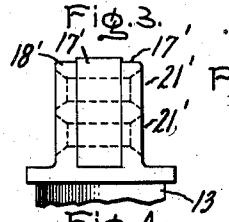


Fig. 4.

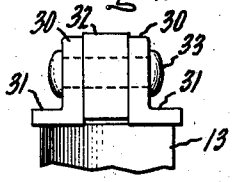


Fig. 5.

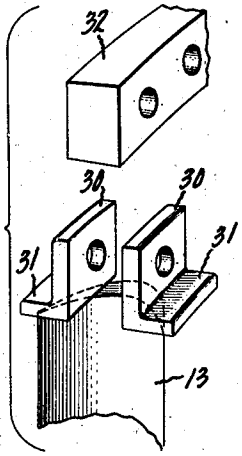
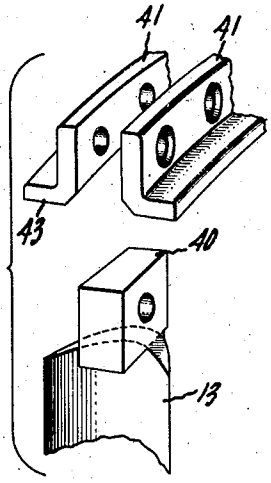


Fig. 7.



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ELASTIC FLUID TURBINE BUCKET WHEEL

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Application July 30, 1938, Serial No. 222,225

3 Claims. (Cl. 253—77)

The present invention relates to elastic fluid turbine bucket wheels and more particularly to arrangements for covering and tying together the outer ends of the buckets.

In turbine bucket wheel construction, adjacent buckets or blades are usually connected together by some form of a cover or shroud band attached to the ends of the buckets to confine the operating fluid within the working passage and to prevent it from spilling outwardly past the ends. Because of the relatively great tangential force exerted by the operating fluid against the buckets, particularly in the high pressure stages, a certain amount of bending of the individual buckets takes place which is accompanied by a corresponding distortion of the cover band between adjacent buckets. This is particularly pronounced in turbines of the partial admission type. This distortion of the cover band together with the centrifugal force, due to the wheel rotation, acting outwardly on the cover band and the force exerted by the operating fluid acting directly against the surface of the cover band stresses the attaching means as well as the band itself. In elastic fluid turbines designed not only for high speed operation but also for modern high pressures and temperatures, the combined forces acting upon the cover band are very large. The usual form of covers consisting of a single tie member riveted onto the bucket ends has proved incapable of withstanding such stresses under severe operating conditions.

It is an object of this invention to provide a new and improved turbine bucket wheel shrouding arrangement of increased strength capable of withstanding extreme operating conditions.

A further object is to produce a new and improved turbine bucket cover arrangement by which a large portion of the loading stress is distributed to the adjacent buckets on both sides of the one being acted upon by the operating fluid, while a relatively small percent of the total load is carried by the tie member.

For a consideration of what I believe to be novel and my invention, attention is directed to the following description and the claims appended thereto taken in connection with the accompanying drawing.

In the drawing, Fig. 1 represents a section of a turbine bucket wheel in perspective provided with a cover according to my invention; Fig. 2 is a fragmentary elevation illustrating a detail of the cover shown in Fig. 1; Fig. 3 is a fragmentary elevation illustrating an alternative arrangement of the invention disclosed in Figs. 1 and 2; Figs. 4 and 5 are views illustrating another modification of the invention; while Figs. 6 and 7 illustrate a still further modification.

Referring to Fig. 1 of the drawing, 10 indicates the web of the wheel disk or rotor and 11 the grooved rim thereof which on opposite sides is provided with annular shoulders defining a dovetailed portion 12 for retaining the buckets 13 thereon. The bucket blades are curved and have thin inlet and outlet edge portions and thick intermediate portions. The bucket bases 14 are provided with a grooved slot defining an inverted dovetail for cooperatively fitting over the rim of the rotor substantially as shown. This bucket fastening means forms what is commonly termed the inverted dovetail type of fastening and in itself is well-known in the art and typical of bucket wheels in connection with which my present invention may be carried out. It is understood, of course, that the buckets may be secured to the rotor in any other suitable manner.

According to my invention, the buckets 13 are each provided with relatively rigid cover portions 15 substantially bridging the space between the adjacent buckets at the outer ends thereof. These cover portions prevent the operating fluid from escaping outwardly past the ends of the buckets and absorb the outward pressure which would otherwise be directed against the cover band or tying means. It is preferred that the cover portions be formed integrally with the buckets and be so dimensioned that the facing surfaces of adjacent covers substantially abut with each other around the periphery of the wheel, although it may be desirable to provide suitable clearance to allow necessary thermal and elastic strains to take place without giving rise to accompanying stresses. The cover portions 15 together form a continuous band with edge portions projecting axially beyond the inlet and outlet edges respectively of the bucket blades. In a turbine these projecting edge portions are in cooperative relation with similar bands of adjacent diaphragms.

Means are also provided for connecting or tying a group of adjacent buckets together. While in the drawing I have shown groups of four buckets tied together, it is obvious that any suitable number may be included in a group. The outer surface of each cover portion is provided with a circumferentially extending slot 16 so located that it aligns with the adjacent ends of the slots formed in the adjacent covers thereby defining a continuous circumferential slot adapted to receive one or more tying members 17. The side

walls 18 of the slot form spaced-apart extensions projecting upwardly from the cover surface. The slot is preferably rectangular in configuration so that the inner or facing surfaces of the side walls 18 lie in planes parallel with the plane of the disk. The tying members 17 are also preferably rectangular in cross-section so as to cooperatively fit into the slot 16, the plane side faces thereof substantially engaging with the slot side walls. The opposite side walls or extensions 18 are provided with aligned holes 19 and the tying members 17 with suitably spaced holes 20 so that pins 21 may be extended therethrough to secure the tying members in the slot. The pins 21 may be secured in position in any suitable manner such as by peening the ends thereof as shown.

The tying members may be secured to the extensions 18 so as to allow relative pivotal movements therebetween permitting the ends of the buckets tied together to deflect in the radial plane under the impulse of the operating fluid. As shown in Fig. 1, a single pin 21 is provided through the extensions 18 of each bucket and the tie member 17, the pin lying substantially parallel with the axis of the wheel. As illustrated more clearly in Fig. 2, the tie member 17 is supported in the slot between the extensions 18 slightly above the base of the slot by a small clearance 22. This arrangement will allow limited rocking or flexing movements of the outer ends of the buckets.

In certain stages of the turbine, it may be desirable to connect the outer ends of the buckets rigidly together so as to preclude the deflection thereof under the impulse of the operating fluid. As shown in Fig. 3, the depth of the slot, or the length of the extensions 18', is such as to accommodate a plurality of pins 21' therethrough and through the tie member 17'. The tie member 17' is further snugly seated against the base of the slot as distinguished from the provision of a clearance corresponding to 22 as shown in Fig. 2. By this arrangement relative movements between the extensions of any one bucket and the tie member are precluded and the ends of adjacent buckets are thereby substantially rigidly fixed.

In this modification of the invention, Figs. 1–3, inclusive, the tie member is substantially protected by the cover portions 15 from the outward force of the operating fluid flowing through the working passage between adjacent buckets. The cover portions also directly absorb and transmit a considerable amount of the circumferential stress to the adjacent buckets. By ruggedly proportioning the dimensions of the slot, the side walls or extensions, the tie member, and the pins, the remaining stresses may be carried by such parts with little danger of failure, even under the most severe of operating conditions.

In Figs. 4 and 5 is shown a second modification of the invention in which the circumferential slot provided in the bucket covers, extends all the way therethrough to the upper ends of the buckets. As in the first described modification, the slot side walls or extensions 30, and the cover portions 31 are preferably integrally formed with the buckets 13, and are of such width as to substantially bridge the space between the outer ends of adjacent buckets, although suitable clearance for thermal and elastic expansions may be provided. The tie member 32 secured between the extensions 30 by the pins 33 is exposed on its under side to the force of the operating fluid flowing through the working passage, but because this side is relatively narrow as regards its height, as viewed in Fig. 4, it is capable of withstanding relatively high pressures without being unduly stressed thereby.

In Figs. 6 and 7 is illustrated a modification similar to that last described except that the integral extensions or portions 40 are centrally disposed with respect to the ends of the buckets 13. These portions are so aligned as to form a substantially continuous peripheral rim around the outer ends of the buckets. As in the case of the covers 15 of the first modification and the portions 30 and 31 of the second modification, they may act to distribute part of the bucket loading to adjacent buckets. The tie members in this instance comprise a pair of similar right angle straps 41 which are secured as by pins 42 upon opposite sides of the portions 40. The lower flanges 43 of the tie members together with the lower edge of the spacer member 40 act as covers to prevent the escape of operating fluid past the ends of the buckets.

It is understood that the tie members of the last two described modifications may be secured to the integral extensions in the two alternative manners as described in connection with the first modification. That is, a single pin may be used as shown in Fig. 2 whereby relative pivotal movements may take place between the bucket ends and the tie members, or a plurality of pins may be used as shown in Fig. 3, in which case the bucket ends will be rigidly secured to the tie members.

Thus, with my invention I have accomplished an improved construction and arrangement of bucket covers and tie means for covering and tieing together a row of bucket blades which have inner ends secured to the rim of a bucket wheel disk. Each of the several embodiments shown in the drawing and described above has a plurality of buckets with bucket cover and tie means including members on opposite sides at the outer ends of the blades, which members are L-shaped in cross section. The bases of the L's extend axially beyond the inlet and outlet edges respectively of the blades and the legs of the L's of each blade are spaced and parallel to each other. The legs of each of a group of blades are connected by bar members 17 engaging adjacent faces of the legs. Either the L-shaped members or the bar-shaped member is integrally formed with the ends of the blades, while the other member or members are separately formed and bridge a plurality of blades. In other words, one kind of the members are integrally formed with the blades and the other kind of the members are separately formed. In the arrangement of Fig. 1 each blade has an end portion integrally formed with two L-shaped members 18, whereas in the arrangement of Fig. 7, for instance, each blade has an end portion integrally formed with a bar member. In the arrangement of Figs. 1 to 3 the legs of the L-shaped members are united by an intermediate portion so that this intermediate portion together with the base portions of the legs form a continuous band.

Looking at the invention as shown in Figs. 1 to 3 from still another viewpoint, it will be found that the cover portions integrally formed at the outer ends are essentially U-shaped with the base of the U adjacent the ends of the blades and the legs of the U defining a channel for receiving a tie member. The base portion of the U is extended in opposite directions to project beyond the edges of the bucket blades. The radial pro-

jections of the legs are located inside the connecting lines of the outer edges of the blades, that is, the legs are axially spaced from and located between the thin inlet and outlet edges of each blade. With such an arrangement the overall axial distance between the legs is less than the width of the outer portions of the blades. This is important because in this manner the heavy leg portions and the heavy tie bar are supported by the thick intermediate blade portions and not by the thin edge portions of the blades.

Having described the principle of operation of my invention together with the apparatus which I now consider to represent the best embodiment thereof, I desire to have it understood that the apparatus shown is only illustrative and that the invention may be carried out by other means.

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

1. Axial flow elastic fluid turbine bucket wheel comprising a disk having a rim, a row of circumferentially spaced bucket blades extending radially from the disk and having inner ends secured to the rim, and tie means for the outer ends of the blades, said tie means including members on opposite sides at the outer ends of the blades, said members being L-shaped in cross section with the bases of the L's extending axially beyond the inlet and outlet edges respectively of the blades and the legs of the L's extending parallel to each other, bar members engaging adjacent faces of the legs and means securing the bar members to the legs, one kind of the L-shaped and bar members being integrally formed with the ends of the blades and the other kind of the members are separately formed and bridge a plurality of blades.

2. Axial flow elastic fluid turbine bucket wheel comprising a disk having a rim, a row of circumferentially spaced bucket blades extending radially from the disk and having inner ends secured to the rim, and bucket cover and tie means including a member having at least one portion L-shaped in cross section and integrally formed at the outer end of each bucket with the base of the L extending axially beyond the edge of the bucket blade and the leg of the L axially spaced from and located between the inlet and outlet edges of the blade, and a bar bridging a group of blades and secured to each L-shaped member of the group.

3. Axial flow elastic fluid turbine bucket wheel comprising a disk having a rim, a row of circumferentially spaced bucket blades extending radially from the disk and having inner ends secured to the rim, and bucket cover and tie means including a cover member for each bucket blade integrally formed with the outer end thereof, the cover members being U-shaped in cross-section with the bases of the U's forming a continuous band having edges projecting axially beyond opposite edges of the blades and legs extending radially outward from the outer surfaces of the bases and being spaced inward from the corresponding edges of the blades, and a tie bar located between and secured to the legs.

ERNEST L. ROBINSON.