July 14, 1925. 1,545,495

H. HOLZWARTH

BUCKET FOR TURBINES

Filed Aug. 23, 1921

Fig. 1.

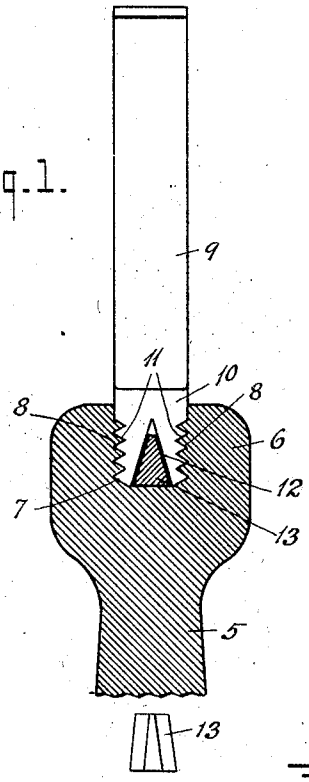


Fig. 2

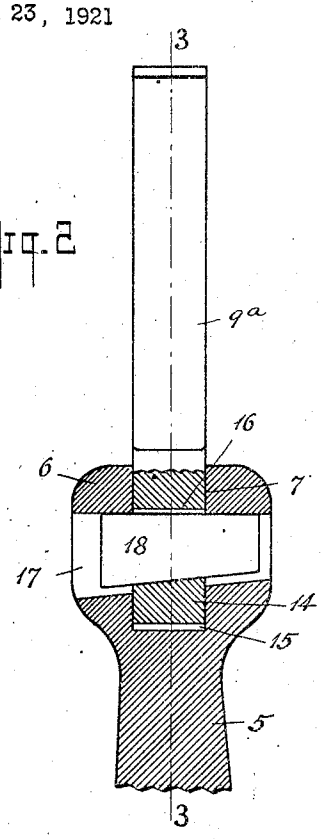


Fig. 3.

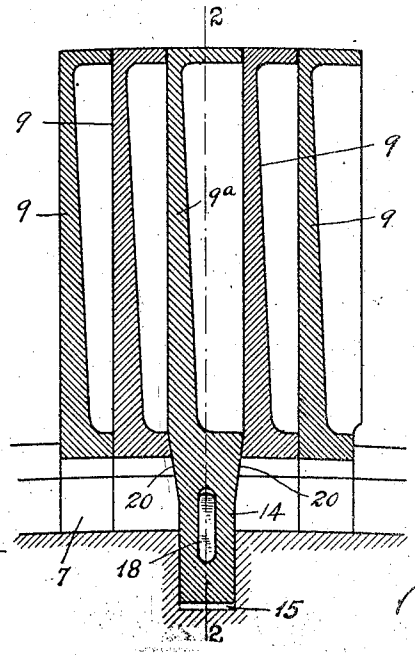
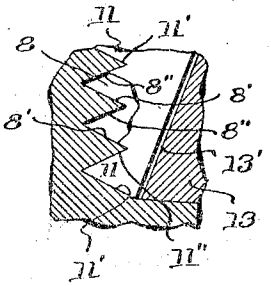


Fig. 4.



WITNESS

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UNITED STATES PATENT OFFICE.

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BUCKET FOR TURBINES.

Application filed August 22, 1921. Serial No. 494,644.

To all whom it may concern:

Be it known that I, HANS HOLZWARTH, a citizen of Germany, and resident of Mulheim, Germany, have invented certain new and useful Improvements in Buckets for Turbines, of which the following is a specification.

My invention relates to turbines and more particularly to gas or explosion turbines and has for its object to provide a novel and improved means of connecting the buckets thereof with the turbine wheel or rotor. Other more specific objects of the invention will appear from the description hereinafter and the features of novelty will be pointed out in the appended claims.

In the accompanying drawing, which illustrates examples of my invention without defining its limits, Figure 1 is a diagrammatic, sectional view showing the rim of the rotor and a bucket or blade connected therewith in my novel and improved manner; Fig. 2 is a similar view of another form of my invention on the line 2—2 of Fig. 3, the latter being a section on the line 3—3 of Fig. 2, and Fig. 4 is a detail view of a portion of Fig. 1, on an enlarged scale, with parts broken away.

Referring to the illustration, 5 represents the wheel or rotor of a turbine, and 6 the peripheral rim thereof; the latter is formed with a circumferential recess 7, the opposite, radial walls of which are provided with a plurality of grooves 8. The bucket or blade 9 which may be of any suitable and well known form is constructed with a continuing stem or foot 10 on the opposite sides or flanks of which a plurality of teeth 11 are located, said teeth being constructed to fit into the grooves 8, as will appear more fully hereinafter. The stem or foot 10 is formed with a slit 12 which converges from the free end of said foot and has its apex pointed toward the outer end of the bucket or blade 9. The arrangement further includes a wedge 13 adapted to fit the slit 12 and to rest with its base upon the bottom of the recess 7; both the slit 12 and wedge 13, in addition to tapering toward the free outer end of the bucket or blade 9, are wedge-shaped in a direction tangential to the rotor 5 or, more specifically, the bottom of the recess 7 thereof.

In existing steam turbines the steam jet generally operates in a constant and continuous manner without interruption and the generated pressure upon the individual buckets or blades is generally relatively slight. In gas or explosion turbines, on the contrary, the energy which is liberated by an explosion is effective, as a jet of gas, upon the bucket or blade for only a very short period of time. Altogether, only about one tenth of a second is available for such operation. Immediately thereafter the driving effect from a given explosion chamber ceases as the latter must be cooled with air and then loaded with a fresh charge of explosive mixture. The buckets or blades of explosion turbines are therefore subjected to relatively short but powerful blows as the result of successive explosions. The accompanying high temperatures (400 to 450° C.) restrict the constructor's choice to only a limited number of different materials for all parts of the turbine. Because of this, the construction of the stem or foot of the bucket or blade, which must be of great strength, is of especial consequence.

With steam turbines of existing construction it is amply sufficient if the buckets or blades of the first series are secured, by means of their stems or feet, against the generated, centrifugal force. It was, therefore, possible, for these reasons, to construct the blades of such steam turbines from drawn bars and to insert them into profiled recesses, with spacing members inserted between each two buckets or blades and to fasten the whole in place with light hammer blows, or the spacing members and buckets could be taken together, the bucket and its stem or foot being forged or otherwise constructed in one piece, and the bucket stem or foot again placed in recesses of the turbine wheel or rotor and fixed in place. In the case of steam turbines, arrangements are also known in which the bucket stem is slitted from below and the bucket is pressed from above to spread apart the two sides or flanks of the bucket stem and thus provide a constant safety against the generated centrifugal force. In addition with steam turbines, arrangements exist in which a wedge or the like is driven in to press the flanks of the bucket stem or foot sideways against the turbine rotor or wheel.

But all of these arrangements, satisfactory as they may be for steam turbine operation, are useless for utilization in the op-

eration of gas turbines. These existing constructions of the bucket stems, as stated, take into consideration only the centrifugal force which is generated; under the effect of generated blows and high bucket pressures they give and yield. In such case, the buckets, as the blows are delivered, pound with the flanks of the stems or feet against one another and against the rotor and thereby become loose. These slight vibrations against each other and against the rotor become constantly greater and finally result in breakage of the buckets or blades. In all existing constructions of the bucket stems the permanent tension against the periphery or rim of the rotor and against adjoining buckets or blades is missing. Without this permanent tension the buckets or blades, when subjected to short blows, as in the operation of internal combustion turbines, must become loosened.

According to the present invention the fastening of the buckets or blades is accomplished in such a manner that the stem or foot of the bucket or blade slitted and provided with profiled sides or flanks, is secured through the medium of a wedge which sets upon the bottom of a circumferential recess of the rotor and is driven into place in the direction of said recess; that is to say, the wedge 13, with its base resting upon the bottom of the recess 7 in the rotor rim 6 is driven into the slit 12 in a direction tangential to the rotor and thus presses the flanks of the stem 10 sideways. In this manner large, transverse pressures and also large, radial pressures are exerted against the bucket stem or foot. By means of the transverse pressures the teeth 11 are firmly pressed into the grooves 8 while through the medium of the radial pressures the bucket is pressed outwardly in the direction of the centrifugal force which is subsequently generated, to press the flanks or sides of the teeth 11 against the contiguous surfaces of the grooves 8. In this way the entire bucket or blade is placed under tension relatively to the rim of the rotor and, through the described arrangement, is maintained under tension, during the operation of the turbine, against any bucket pressures, bucket pushing, bucket blows or centrifugal effects upon said buckets which may be generated. Instead of an individual wedge for each bucket, a wedge common to a plurality of buckets may be used.

It will be noted that the two surfaces or flanks of each of the teeth 11 are inclined in opposite directions, that is, the flank 11′ nearer the center or axle of the rotor is inclined inwardly from the tip of the tooth toward the wedge, while the outer flank 11″ of the tooth is inclined outwardly. The corresponding walls 8′, 8″, of the grooves 8 are also inclined in opposite directions from the tip of the tooth toward the wedge. Furthermore, it will be noted that the outer flanks 11″ of the teeth 11 (and the corresponding outer surfaces 8″ of the grooves 8) are inclined outwardly at a smaller angle than the sides of the wedge 13, so that the said outer flanks and the adjacent side surfaces 13′ of the wedge 13 converge outwardly, that is to say, away from the axis of the turbine. Both of these features contribute to hold the bucket stem 10 firmly within the recess of the rotor rim 6.

The wedge is constructed of material which is relatively harder than the bucket stem and drives the toothed flanks thereof into the grooves of the rotor rim and warrants a minimum of strains upon the flanks of the teeth from outside forces. To maintain this advantage in the case of high driving temperatures, the wedge must be protected against the direct influence of the jet temperature; that is, the bucket stem or foot must be relatively high and the wedge must be located in its lower, protected portion. Accordingly, the advance or taper of the wedge is so arranged that the pressure exerted upon the bucket by the jet forces said bucket upon the wedge.

In some instances, additional security may be obtained by utilizing the arrangement shown in Figs. 2 and 3. In this case, locking buckets or blades 9^a are located at intervals and are provided with extensions 14 which project through the recess 7 and into pockets 15 extending radially inward therefrom at the proper points. The extensions 14 are provided with slots 16 adapted to register with slots 17 in the rim 6, through which wedges 18 are forced so as to extend transversely to the recess 7, as shown in Fig. 2; the opposite sides of the extensions 14 diverge outwardly in engagement with correspondingly formed surfaces of adjacent buckets or blades 9, as shown at 20 in Fig. 3. With this arrangement the wedges, by bearing against the walls of the slots 16 and 17, draw the bucket 9^a inwardly toward the centre of the rotor 5 and clamp it in place and at the same time cause the surfaces 20 to exert a clamping action upon the adjacent buckets or blades 9, whereby the rigidity of the connection between the latter and the rotor is still further increased.

In this way the blade or bucket ring or series is interrupted less often than has, up to the present time, been the case, and a greater number of blades or buckets may be included in a ring which, particularly in large gas turbines, is of special advantage.

Various changes in the specific forms shown and described may be made within the scope of the claims without departing from the spirit of my invention.

I claim:

1. In an internal combustion turbine, the

combination of a rotor having a circumferential recess provided with a plurality of grooves in its opposite radial walls, a bucket, a stem on said bucket having a tapering slit and provided with teeth arranged to fit said grooves and a wedge adapted to rest upon the bottom of said circumferential recess and to fit into said slit, the latter and said wedge being tapered in radial directions and in a direction tangential to said rotor whereby said teeth are pressed transversely into said grooves and the outer flanks of said teeth are radially pressed against the opposite walls of said grooves in the direction of the centrifugal force generated when the turbine is in operation.

2. In an internal combustion turbine, the combination of a rotor having a circumferential recess provided with a plurality of grooves in its opposite radial walls, a bucket, a stem on said bucket having a tapering slit and provided with teeth arranged to fit said grooves and means within said recess whereby said teeth are pressed transversely into said grooves and the outer flanks of the teeth are radially pressed against the opposed walls of said grooves in the direction of the centrifugal force generated when the turbine is in operation.

3. In an internal combustion turbine, the combination of a rotor having a circumferential recess provided with a plurality of grooves in its opposite walls, said rotor further having spaced, transverse slots communicating with said recess, a plurality of buckets, stems on said buckets provided with teeth arranged to fit said grooves, means whereby said teeth are pressed transversely into said grooves, locking buckets located at intervals between said first buckets and provided with slots in registry with said transverse slots, transverse wedges extending through said slots and co-operating surfaces on said locking buckets and contiguous buckets whereby the latter are clamped in place by the action of said transverse wedges.

4. In an internal combustion turbine, a rotor having a circumferential recess and transverse slots communicating therewith at intervals, said rotor further having radial pockets extending inwardly from said recess in registry with said slots, locking buckets, stems on said buckets extending through said recess and into said pockets and provided with slots in registry with said transverse slots and wedges extending through said slots to secure said locking buckets in position upon said rotor.

5. The combination of a rotor having a circumferential recess, a bucket having a stem fitted into said recess, said stem having a slit extending circumferentially of the rotor, and a wedge fitted into said slit and engaging the rotor within said recess, said wedge and said slit being tapered both outwardly from the central portion of the rotor and also circumferentially of the rotor, whereby the slit stem is pressed by said wedge both away from the center of the rotor and against the side walls of said recess.

6. The combination of a rotor having a circumferential recess, a bucket having a stem fitted into said recess, said stem having a slit extending circumferentially of the rotor, and a wedge fitted into said slit and tapered both circumferentially of the rotor and outwardly, to expand the slit stem against the side walls of said recess and also away from the center of the rotor.

7. The combination of a rotor having a circumferential recess, a bucket having a stem fitted into said recess, said stem having a slit extending circumferentially of the rotor, and a wedge fitted into said slit and tapered circumferentially of the rotor to expand the slit stem against the side walls of said recess.

8. The combination of a rotor having a circumferential recess having in its side a circumferential wedge-shaped groove, the surfaces of which are inclined inwardly and outwardly respectively, a bucket having a stem fitted into said recess and provided on its side with a circumferential wedge-shaped tooth, the flanks of which are inclined outwardly and inwardly respectively to fit the surfaces of said groove, and means for forcing said stem against the walls of said recess to drive the said tooth into said wedge-groove.

9. The combination of a rotor having a circumferential recess provided in its opposing sides with circumferential wedge-shaped grooves, each having one surface inclined inwardly and the other outwardly, a bucket having a split stem fitted into said recess, said stem being provided on each of its sides with circumferential wedge-shaped teeth each having one of its flanks inclined outwardly and the other inwardly to fit the respective surfaces of the corresponding groove, and a wedge fitted into said split bucket stem to force its teeth into said wedge-grooves.

10. The combination of a rotor having a circumferential recess provided in its opposing sides with circumferential wedge-shaped grooves, each having one surface inclined inwardly and the other outwardly, a bucket having a split stem fitted into said recess, said stem being provided on each of its sides with circumferential wedge-shaped teeth each having one of its flanks inclined outwardly and the other inwardly to fit the respective surfaces of the corresponding groove, and a wedge fitted into said split bucket stem to force its teeth into

said wedge-grooves, the inclined outer surface of a groove and the adjoining surface of said wedge converging outwardly.

11. The combination of a rotor having a circumferential recess and a transverse slot communicating with said recess, buckets provided with stems fitted into said recess, one of said buckets being a locking bucket having surfaces to force the adjacent buckets apart circumferentially upon a radial movement of the locking bucket, said locking bucket also having a slot to register with said slot of the rotor, and a transverse wedge adapted to be driven into said slots to force the locking bucket radially.

12. The combination of a rotor having a circumferential recess and a pocket communicating with said recess and extending therefrom toward the center of the rotor, buckets provided with stems fitted into said recess, one of said buckets being a locking bucket, extending into said pocket, and means for fastening said locking bucket.

In testimony whereof I have hereunto set my hand.

HANS HOLZWARTH.