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TURBINE BUCKET WHEEL

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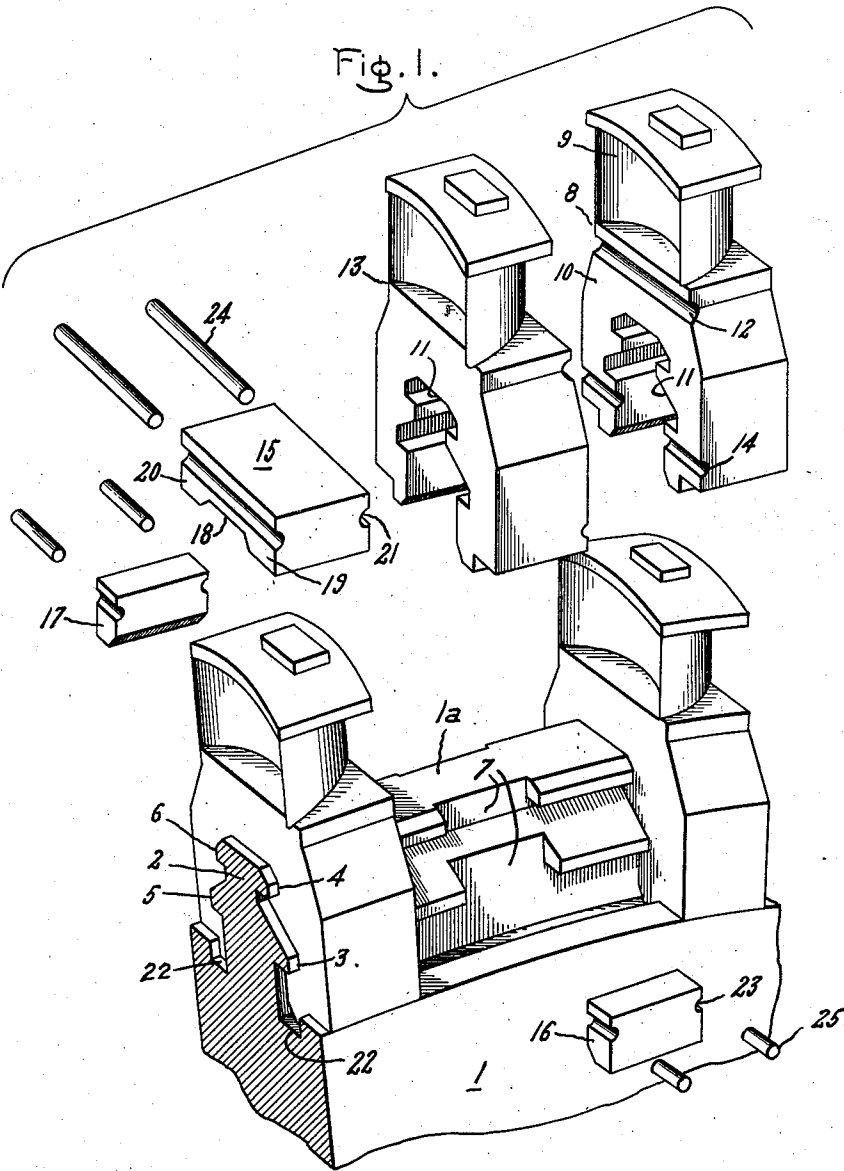
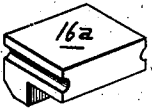


Fig. 4.



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TURBINE BUCKET WHEEL

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3 Claims. (Cl. 253—77)

This invention relates to bucket wheels with dovetail type fastenings such as are used in turbo-machines subjected to high temperatures and pressures. The novelty resides particularly in an improved notch block assembly for closing the "notch opening" in a circumferential dovetail through which the buckets are inserted into position on such a bucket wheel.

A typical bucket wheel embodying the invention comprises a disk element and a row or rows of buckets secured to the disk element by a dovetail connection between a base portion of each bucket and the rim of the wheel.

In the usual arrangement of this kind, the circumferential shoulder portions of the dovetail rim are cut away at least at one location defining a "notch opening" through which the buckets are inserted radially and slid circumferentially along the rim during assembly.

The buckets are held in place on the rim by a notch closing means usually consisting of a "notch bucket" comprising a base and blade portion, or a "notch block." The notch closing means also serves to fill out the contour of the wheel.

When the centrifugal forces acting on the bucket wheel are not very large relative to the high-temperature strength of the materials used for buckets and rotors, a notch bucket or solid notch block in the notch opening proves very satisfactory. However, in modern high-temperature turbines it is no longer possible to employ a notch bucket or heavy notch block because of the reduced strength of the materials at high temperatures. Accordingly, a heavy notch closing means results in an undesirable encroachment on design margins and safety factors. In addition, the heavier notch closing means requires that pins or rivets be driven through the wheel rim to aid in holding the notch block or bucket on the bucket wheel. This type of connection weakens the disk member in those areas containing the rivet or pin holes and the resulting stress concentrations introduce the possibility of cracks developing in the highly stressed areas around the holes through the wheel. If such cracking should develop, the entire wheel or rotor must be replaced or suitably modified to eliminate the cracked regions.

Accordingly, an object of this invention is to provide an improved notch-block arrangement for high-speed high-temperature turbines permitting a reduction in weight and resulting stresses in the bucket wheel rim at the place where the notch closing means is installed.

A further object is to provide a notch block assembly of utmost simplicity which can be quickly and easily locked in place in the bucket wheel, and which may readily be removed when it becomes necessary to repair or replace buckets.

A still further object is to lock the notch closing means to the bucket wheel without having to drill any holes through the wheel rim.

Other objects and advantages will become apparent from the following description taken in connection with the accompanying drawings, in which Fig. 1 illustrates an

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exploded perspective of a bucket wheel portion embodying the invention; Fig. 2 is a side view of a portion of a bucketed wheel showing the notch block assembly installed on the wheel; Fig. 3 is a sectional view taken along lines 3—3 of Fig. 2, and Fig. 4 is a modification of the lower notch block member.

Generally stated, the invention is practiced by providing a lightweight three-piece notch block assembly in the notch opening in the bucket wheel to prevent relative movement between the buckets and to lock them in place.

Referring first to Fig. 1, there is shown a perspective view of a disk member 1 having a grooved rim portion defining a dovetail 2. The dovetail of the rim forms shoulders 3, 4, 5, 6. These shoulders are cut away for a distance slightly greater than the dovetail thickness of bucket 8 to form notch opening 7. Bucket 8, comprises blade 9 and base portion 10, which latter defines a conjugate dovetail groove 11 of the same configuration as the rim dovetail 2. The thickness of the bucket dovetail is measured parallel to the circumference of disk member 1.

Referring now more particularly to Figs. 2 and 3, the notch opening is shown as being filled by a notch block assembly including members 15, 16 and 17. The upper notch member 15 defines a fork member comprising legs 19, 20 and recess 18. The length of member 15 measured in an axial direction relative to the disk member 1 is substantially less than the axial width of the bucket dovetails adjacent the notch opening, while the width of member 15 measured in a circumferential direction relative to the disk member 1 is substantially equal to the circumferential width of the notch opening 7. The width of the bucket dovetail is measured parallel to the axis of disk member 1. The notch block member 15 when inserted into the notch opening straddles the rim 1a of the disk member 1 and fills part of the cut-away portions of shoulders 4 and 6. The upper axially extending side surfaces of member 15 contacts the sides of the base portion of the adjacent buckets at substantially the top thereof.

The member 15 is locked in place in the bucket wheel by key means between the member 15 and the buckets adjacent the notch opening. The locking means between the notch member 15 and each of the buckets adjacent the notch opening being identical, only the locking means between member 15 and one of the adjacent buckets will be described here. The key means consists of cooperating recesses 12 and 21 in the base portion 10 of bucket 8 adjacent the notch opening and the notch block member 15 respectively, and key 24 for insertion into said recesses. The cooperating recesses 12 and 21 are located in a radial direction beyond the rim 1a of the disk member, and runs in a direction substantially perpendicular to the face of the disk member and parallel to the axis thereof.

The buckets disposed on the bucket wheel are sometimes subjected to tangential vibration, and to restrain the buckets adjacent the notch opening against tangential movement relative to the disk member it is required to locate in the notch opening adjacent the base of the dovetail additional supporting means for the buckets. In accordance with the present invention, the additional supporting means for the buckets adjacent the notch opening comprise notch blocks 16, 17, inserted in the disk member at the base of the dovetail.

Since the notch block members 16, 17 are identical in shape, location, and installation, only one has reference numerals applied thereto. In the preferred embodiment as shown in Figs. 2 and 3, the notch member 16 is rectangular in shape and located in a circumferential groove 22 defined by the disk member.

The axial and circumferential dimensions of member 16 are substantially equal to the axial width of groove 22 and circumferential dimension of notch opening 7 respectively. The radial dimension of member 16 is substan-

tially equal to the distance between the bottom of groove 22 and the under surface of shoulder 3. For ease of assembly, however, the axial length of the lower notch member above the groove 22 may be increased, as disclosed at 16a in Fig. 4, so that its outer face matches the face of the wheel rim.

Notch block member 16 is locked in place in the notch opening 7 by key means similar to that used to lock member 15 to the bucket wheel. The key means for locking the member 16 to the buckets 8, 13 adjacent the notch opening being the same only the locking means between member 16 and one of the adjacent buckets will be described. The key means comprises cooperating recesses 14, 23 in the bucket base 10 and notch block 16 respectively and key 25 for insertion into the cooperating recesses 14, 23 to lock the bucket 8 and notch block against movement relative to each other.

It will be realized by those skilled in the art that radial displacement of the notch block assembly is prevented by the key means above described locking the assembly to the buckets 8, 13 adjacent the notch opening 7, and axial displacement of the assembly is prevented by the interengagement between the disk member 1 and notch block members 15, 16 and 17 respectively. The keys are retained against axial displacement relative to the bucket wheel by peening the buckets 8, 13 and the notch closing members over the ends of the keys as illustrated at 26.

The bucket wheel is assembled in the following manner:

The buckets 8 are inserted radially through the notch opening 7 and slid to the left or right along the rim of disk member 1. After all the buckets are located on the wheel, the notch opening is then closed by the notch block assembly embodying my invention. The two lower notch blocks 16, 17 are inserted radially into the grooves 22 defined by the disk member 1 at the base of the dovetail. These blocks are then locked to the buckets 8, 13 adjacent the notch opening by inserting the keys 25. The key assembly may be constructed after the notch closing means is inserted in the bucket wheel as, for instance, by drilling the cooperating recesses 14, 23 as one hole and then inserting the dowel pins 25. Then the upper notch piece 15 is inserted in the notch opening with the legs 19, 20 straddling the rim portion 1a which fits into recess 18. The member 15 is then locked to the buckets adjacent the notch opening by adding the keys 24, which are located radially outward beyond the rim 1a of the disk member 1.

The keys are then fixed in place by peening an adjacent portion of the buckets 8, 13 and the notch block members over the ends of the keys.

Thus it will be seen that the invention provides a lightweight notch opening filling means requiring no holes in the highly-stressed disk member, and which can be quickly and easily installed in the bucket wheel, and readily removed by drilling away the peened-over portions when it is necessary to repair or replace buckets.

While two embodiments of the invention have been described in detail herein, it will be obvious to those skilled in the art that changes and substitutions of equivalents might be made. For example, the notch block assembly may be attached to the adjacent buckets by "grub screws" or other mechanical equivalents of the dowel pins 24. In addition this invention is also applicable to dovetails having either a greater or lesser number of "shoulders." It is, of course, desired to cover by the appended claims all such modifications as fall within the true spirit and scope of the invention.

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

1. A turbo-machine bucket-wheel assembly comprising a disk member having an imperforate rim portion defining a circumferential dovetail, and a circumferential groove at the base of the dovetail on either side thereof, a row of buckets each having a base defining a conjugate dovetail groove adapted to engage the rim dovetail, the

rim also defining at least one notch opening extending radially across the rim portion defining the dovetail through which the buckets are inserted during assembly, and means located between buckets disposed adjacent the notch opening for closing the notch opening to prevent relative movement between the disk member and the buckets, said means including a fork member having legs disposed in the notch opening, a pair of similar rectangular members disposed in the portion of the circumferential grooves in radial alignment with the notch opening, the circumferential dimension of said fork and rectangular members being substantially equal to that of the notch opening, and cooperating axially extending key means interengaging the fork and rectangular members with the buckets adjacent the notch opening to prevent radial displacement of the fork and rectangular members relative to the disk member, the cooperating key means being disposed at a location radially beyond the imperforate rim of the disk member.

2. A high speed turbo-machine bucket-wheel assembly comprising a disk member having an imperforate rim portion defining a circumferential dovetail, and a circumferential groove at the base of the dovetail on either side thereof, a row of buckets each having a base defining a conjugate dovetail groove adapted to engage the rim dovetail, the rim also defining at least one notch opening extending radially across the rim portion defining the dovetail through which the bucket dovetails are inserted during assembly, and means located between buckets disposed adjacent the notch opening for closing the notch opening to prevent relative movement between the disk member and the buckets, said means including a fork member having legs disposed in the radially outer portions of the notch opening, a pair of similar generally rectangular members disposed in the portion of the circumferential grooves radially aligned with the notch opening, the circumferential dimension of the fork and rectangular members being substantially equal to that of the notch opening, the axial dimension of the fork member being no greater than the width of the dovetail bases of the buckets adjacent the notch opening, the axial dimension of said rectangular members being substantially equal to that of said grooves, and cooperating axially extending key means interengaging the fork and rectangular members with the buckets adjacent the notch opening to prevent radial displacement of the fork and rectangular members relative to the disk member, the cooperating key means being between the fork member and the adjacent buckets being disposed at a location radially beyond the imperforate rim of the disk member.

3. A high speed turbo-machine bucket-wheel assembly comprising a disk member having an imperforate rim portion defining a circumferential dovetail, and a circumferential groove at the base of the dovetail on either side thereof, a row of buckets each having a base defining a conjugate dovetail groove adapted to engage the rim dovetail, the rim also defining at least one notch opening extending radially across the rim portion defining the dovetail through which the bucket dovetails are inserted during assembly, and means located between buckets disposed adjacent the notch opening for closing the notch opening to prevent relative movement between the disk member and the buckets, said means including a fork member having legs disposed in the radially outer portions of the notch opening, a pair of L-shaped members one leg of which is disposed in the portion of the circumferential grooves in radial alignment with the notch opening, the circumferential dimension of the fork and L-shaped members being substantially equal to that of the notch opening, the axial dimension of the fork member being no greater than the width of the dovetail bases of the buckets adjacent the notch opening, the axial dimension of the leg of said L-shaped member disposed in the

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groove and that of the other leg of said L-shaped member being substantially equal to the width of the groove and the distance from the inside of the groove to the side of the disk member respectively, and cooperating axially extending key means interengaging the fork and L-shaped members with the buckets adjacent the notch opening to prevent radial displacement of the fork and L-shaped members relative to the disk member, the cooperating key means between the fork member and the adjacent buckets comprising dowel pins engaging axial recesses in abutting portions of the fork member and bucket and located radially beyond the imperforate rim

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of the disk member, whereby the highly stressed disk rim is not weakened by the key means.

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