No. 777,432. PATENTED DEC. 13, 1904.

C. O. RICHTER.

STEAM TURBINE.

APPLICATION FILED AUG. 17, 1904.

NO MODEL.

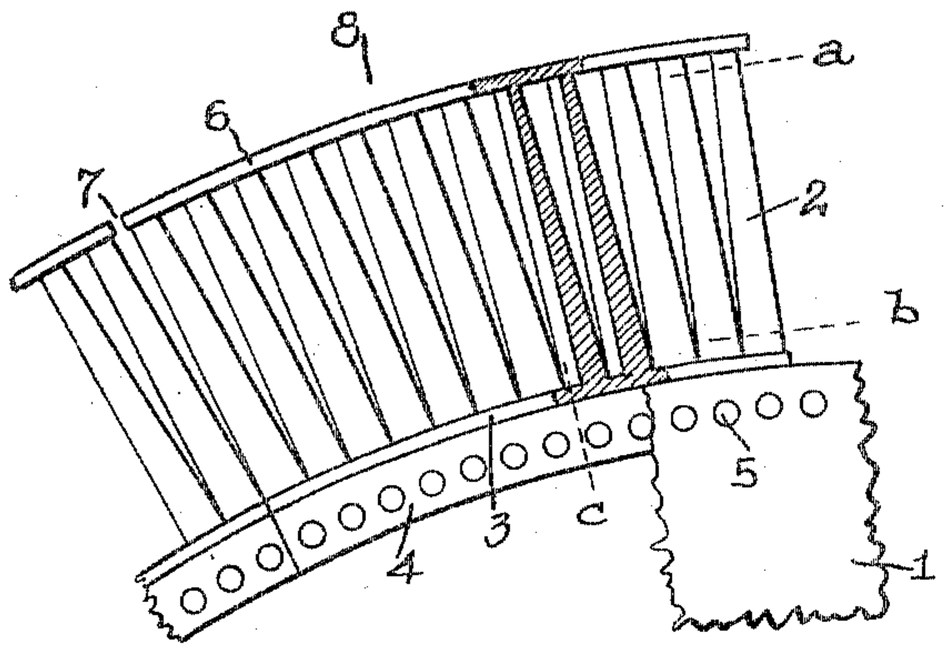

FIG. 1.

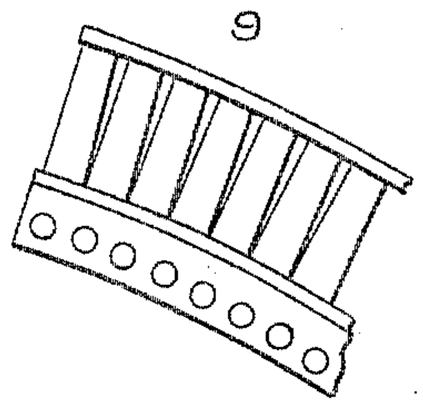

FIG. 2.

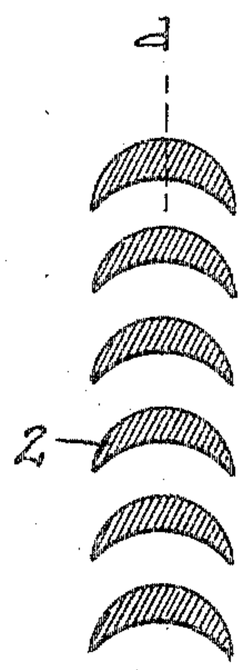

FIG. 4.

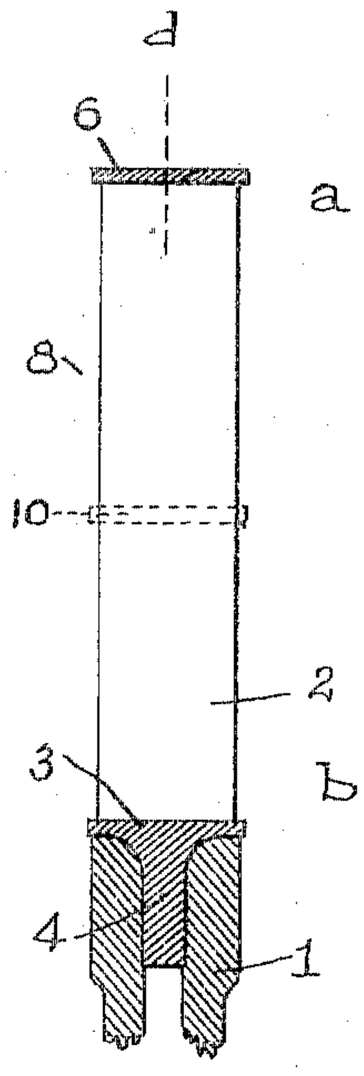

FIG. 3.

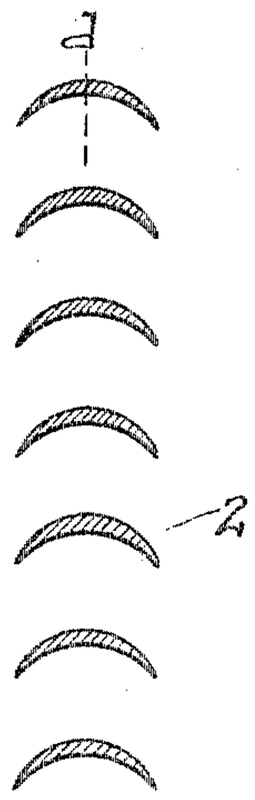

FIG. 5.

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No. 777,432. Patented December 13, 1904.

UNITED STATES PATENT OFFICE.

CHARLES O. RICHTER, OF HAMILTON, OHIO, ASSIGNOR TO THE HOOVEN, OWENS, RENTSCHLER COMPANY, OF HAMILTON, OHIO.

STEAM-TURBINE.

SPECIFICATION forming part of Letters Patent No. 777,432, dated December 13, 1904.

Application filed August 17, 1904. Serial No. 220,997. (No model.)

To all whom it may concern:

Be it known that I, CHARLES O. RICHTER, a citizen of the United States, residing in Hamilton, Butler county, Ohio, (post-office address care The Hooven, Owens, Rentschler Company, Hamilton, Ohio,) have invented certain new and useful Improvements in Steam-Turbines, of which the following is a specification.

There is a well-known class of steam-turbines in which a multiplicity of buckets or vanes project radially from a disk secured upon the turbine-shaft. The vane construction is rather light, and an original and a maintained accuracy of construction is of high importance. One system of construction heretofore employed has consisted in forming the vanes either separately or in groups and securing their heels to the disk, a tire being then applied tightly to the periphery of the vanes. This construction required extreme care in assembling and extraordinary care in subsequently handling the completed wheels when out of the turbine-case. It is well understood that any kind of a wheel—a vehicle-wheel, for instance—when under inward radial strain from an encircling tire tends to dish if its periphery is deflected laterally, and in case deflection is unsymmetrical then the tendency to dish is concentrated at one or more points irregularly, causing a buckling of the wheels. The wheel of a steam-turbine if constructed upon the plan above mentioned may be accurately made and may be satisfactory while in the turbine; but if the wheel be removed from the casing and handled without extraordinary care a side strain is likely to be imposed at one or more points irregularly on the rim of the wheel, resulting in its permanent buckling. A buckled turbine-wheel is a very discouraging sort of an affair. The danger of buckling becomes greater the greater the radial projection of the vanes from the disk. Even aside from the evils referred to in connection with the above-mentioned plan of construction and even disregarding the extraordinary care required in handling the wheels the construction has been found very expensive.

It is the purpose of my invention to overcome the mentioned defects and to economically produce a rotator of a steam-turbine not liable to become buckled under any ordinary conditions of use or handling.

My invention will be readily understood from the following description, taken in connection with the accompanying drawings, in which—

Figure 1 is a side elevation, part section in the plane of line *d*, of one of the vane-sections associated with a portion of another section and with a portion of one of the exemplifying-disks; Fig. 2, a side elevation of a portion of one of the vane-sections, illustrating the vanes of lesser length than those illustrated in Fig. 1; Fig. 3, a radial section of a disk-section in the plane of line *c;* Fig. 4, a tangential section of vanes in the plane of line *b*, and Fig. 5 a tangential section of vanes in the plane of line *a*.

In the drawings, 1 indicates the ordinary disk employed in the construction of the rotator of a steam-turbine, the disk in the present case being compound—that is to say, formed of two members adapted to clamp the vane-shanks between them, it being immaterial to a realization of my invention whether the disk straddle the vane-shank or the vane-shank straddle the disk; 2, a series of vanes projecting radially, or substantially radially, from the periphery of the disk, these vanes being illustrated as having a usual cross-sectional form; 3, a shank-strip united with the heels of a group of the vanes, the group in the present case being illustrated as comprising twelve vanes and the construction illustrated being the preferable one, in which the vanes are cast integrally with the shank-strip; 4, a shank united with and projecting inwardly from the shank-strip to serve in securing the group of vanes to the disk, the construction illustrated providing, as before stated, a disk of compound construction engaging each side of the vane-shank; 5, rivets engaging the disk members and the vane-shank and unifying the group of vanes with the disk; 6, a tire-segment permanently secured to the outer ends of the group of vanes pertaining to a given one of the shank-strips, the given group of vanes thus comprehending

in one structure the vanes, the shank-strip, the shank, and the tire-segment; 7, a gap between the ends of contiguous tire-segments, this gap being of sufficient extent to insure against influential contact between the tire-segments; 8, one of the vane-sections considered as a whole; 9 in Fig. 2, a vane-section differing from that illustrated in Fig. 1 only in that the vanes are of less radial length whereby with a given diameter of disk a rotator of lesser diameter may be produced, and 10 in Fig. 3 the position of the tire-segment relative to the shankwork when the vanes of reduced length are employed.

The complete vane-sections, each comprising its vanes, tire-segment, shank-strip and shank, is integrally cast, preferably in phosphor-bronze, and such machining is then done upon it as the construction may require. The shank-strips or shanks abut at their ends, so that when vane-sections are assembled with the disk to form a complete rotator the vane-sections will form a complete abutting circular series at the periphery of the disk. The tire-segments do not abut, but stand away from each other. The result of this construction is that the series of vanes comprehended in a vane-section gets substantial support from its attachment to the disk and the outer ends of the vanes give support to each other through the medium of the tire-segment, the several vane-sections being in firm union at the inner ends of the vanes, while free at their outer ends. A rotator may be thus constructed with accuracy and economy.

If in the course of any handling of the rotator when out of the turbine-casing any extraordinary side strain comes upon a given vane-section, it may deflect that section laterally either as a whole or at one of its ends independent of its other end; but in case of such irregular deflection within a single vane-section it is at perfect liberty to restore itself to normal position when the strains are removed. Again, such lateral deflection on the part of a given vane-section to which strains may be applied will obviously be quite without disturbing influence on contiguous vane-sections. The rotator as a whole is therefore free from liability to become buckled under any ordinary or even extraordinary conditions, and a maintained accuracy of rotator may thus be relied upon.

Attention is particularly called to the longitudinal cross-section of the individual vanes, as seen in Fig. 1. Their concave faces are preferably on curves uniform throughout the length of the vane, and the innermost portion of the concavity is preferably radial to the rotator; but the convex face of the vane, which is the face moving forward when the rotator is in motion, is not concentric with the concave face nor is the wall of the vane of equal thickness throughout its length. On the contrary, the wall tapers, being thickest at its base. The result is that the vanes have tapering bodies well rooted to the shank-strip at their larger ends. This form yields lightness of construction along with superior strength for each individual vane and with a well-braced system as between the several vanes of a section and the parts with which they are united. For vane-sections with shorter vanes, as indicated in Fig. 2, the dimensions at the base of the vanes and all of the dimensions of the retained portions of the vanes remain the same, as in the case of the longer vanes; but the vanes being shorter the effect is as if the vanes of Fig. 1 had their outer portions cut off to bring about the proper length, a tire-segment being then provided in the new radial position.

I claim as my invention—

1. In a rotator for a steam-turbine, the combination, substantially as set forth, of a circumferential series of substantially radial vanes arranged in groups, a shank-strip united with the heels of the vanes of each group, the length of the shank-strips being such that they will abut when the groups are assembled to form a rotator, and a tire-segment united to the outer extremities of the vanes of each group, the lengths of the tire-segments being such that their ends will be free of each other when the vane-sections are assembled to form a rotator.

2. In a rotator for a steam-turbine, the combination, substantially as set forth, of a circumferential series of substantially radial vanes arranged in groups, each vane having its wall tapering with its heel end the larger, a shank-strip united with the heels of the vanes of each group, the length of the shank-strips being such that they will abut when the groups are assembled to form a rotator, and a tire-segment united to the outer extremities of the vanes of each group, the lengths of the tire-segments being such that their ends will be free of each other when the vane-sections are assembled to form a rotator.

3. In a rotator for a steam-turbine, the combination, substantially as set forth, of a circumferential series of substantially radial vanes arranged in groups, a shank-strip united with the heels of the vanes of each group, the length of the shank-strips being such that they will abut when the groups are assembled to form a rotator, a shank united with and projecting inwardly from the shank-strip and adapted for engagement with a disk, and a tire-segment united to the outer extremities of the vanes of each group, the lengths of the tire-segments being such that their ends will be free of each other when the vane-sections are assembled to form a rotator.

4. In a rotator for a steam-turbine, the combination, substantially as set forth, of a circumferential series of substantially radial vanes arranged in groups, a shank-strip united with the heels of the vanes of each group, the

length of the shank-strips being such that they will abut when the groups are assembled to form a rotator, a shank united with the shank-strip centrally of its width and projecting inwardly and adapted to engage between the two members of a compound disk, and a tire-segment united to the outer extremities of the vanes of each group, the lengths of the tire-segments being such that their ends will be free of each other when the vane-sections are assembled to form a rotator.

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