No. 821,051. PATENTED MAY 22, 1906.

J. L. MOORE.

STEAM TURBINE.

APPLICATION FILED OCT. 18, 1905.

2 SHEETS—SHEET 1.

Fig. 1.

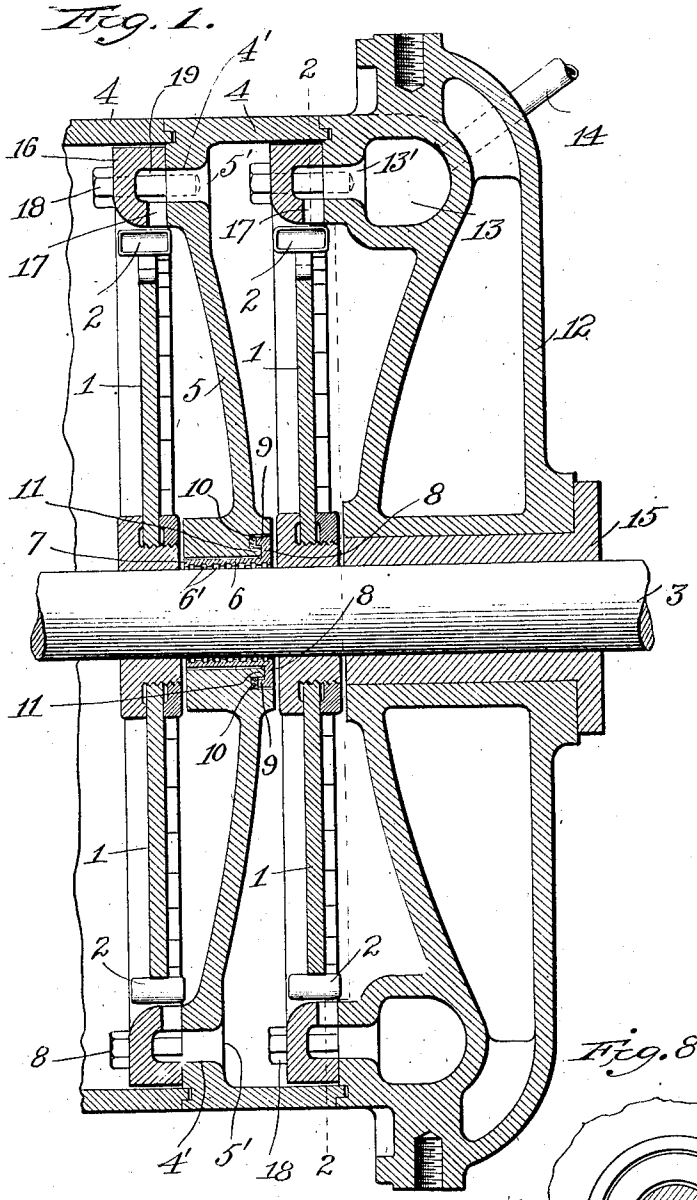


Fig. 3.

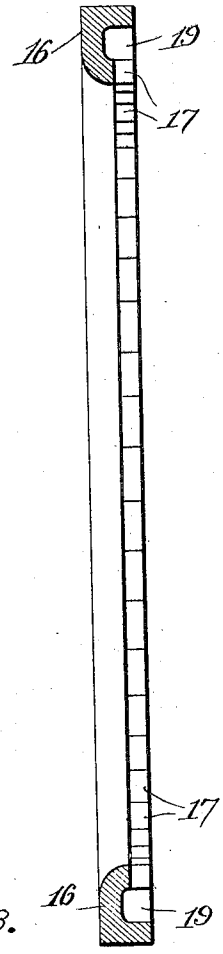
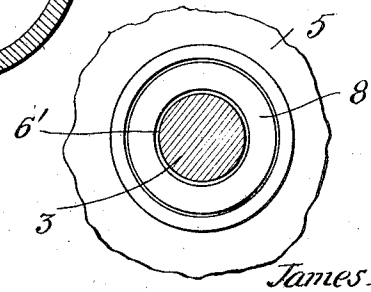


Fig. 8.



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2 SHEETS—SHEET 2.

Fig. 2.

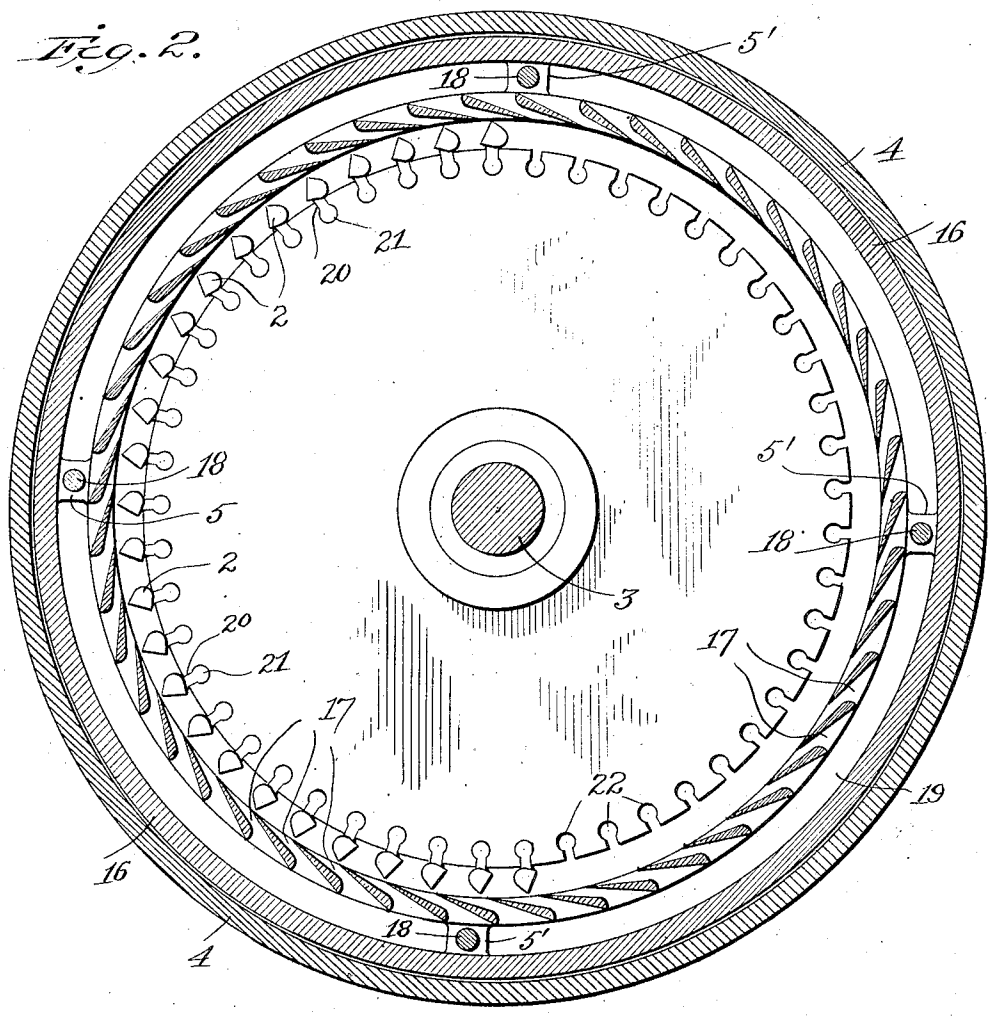


Fig. 4.

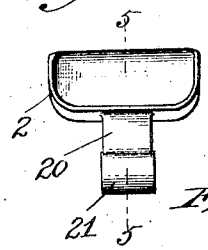


Fig. 5.

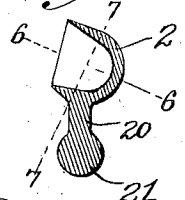


Fig. 6.

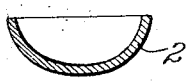
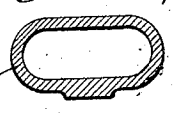


Fig. 7.



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UNITED STATES PATENT OFFICE.

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STEAM-TURBINE.

No. 821,051. Specification of Letters Patent. Patented May 22, 1906.

Application filed October 18, 1905. Serial No. 283,216.

To all whom it may concern:

Be it known that I, JAMES L. MOORE, a citizen of the United States, residing at Wellsville, in the county of Allegany and State of New York, have invented certain new and useful Improvements in Steam-Turbines, of which the following is a specification.

My invention relates to nozzles particularly adapted for compound steam-turbines, known more especially as the "multicellular" type and shown, for example, in the Patents No. 756,241, to Charles V. Kerr, dated April 5, 1904, and No. 798,105, dated August 29, 1905.

The objects of my invention are, first, to construct a nozzle which consists of a series of nozzle-openings arranged on a ring which is made separate and independent from the castings forming the turbine; second, to construct a nozzle-ring, as above indicated, whereby the nozzle-openings may be quickly and cheaply formed in the edge of the ring by a milling-cutter and at the same time made of a more durable material than cast-iron, such as bronze or other composition, thereby insuring greater strength and less corrosion; third, to construct a nozzle-ring in which the nozzle-openings may be placed closer together, so that in case of a partial admission the motive fluid is admitted in a body and uniformly about the rotating element of the turbine; fourth, to construct a nozzle of a greater power by cutting more nozzle-openings in a given diameter of nozzle-ring of a turbine; fifth, to construct a series of removable nozzle-rings of the same diameter and having different number of nozzle-openings, whereby the capacity of a turbine may be readily and widely changed by removing one set of nozzle-rings and inserting others having more or less nozzle-openings; sixth, to so construct and arrange the nozzle-openings with respect to the buckets that there is nearly a completet reversal in the direction of the motive fluid within the buckets while flowing in a general direction parallel to the axis; seventh, to so proportion and design the single buckets which are attached to the periphery of the bucket-wheels so that the motive fluid which passes out the nozzle-openings of the nozzle-rings above referred to will enter into the buckets at one side, flow across the bucket in a highly-efficient manner with a minimum of friction, and issue from the same on the other side; eighth, other evident advantages and features of the specific construction and arrangement of the parts, which will hereinafter appear from the detailed description of the nozzle-ring and manner of construction and applying the same.

My invention consists of structural features and relative arrangements of elements, which will be hereinafter more fully and clearly described, and pointed out in the appended claims.

Referring to the two sheets of drawings, in which similar reference characters indicate the same parts in the several figures, Figure 1 is a central longitudinal section of two expansion-chambers, showing two of the nozzle-rings and buckets in operative position. Fig. 2 is a transverse section through the nozzle-opening on line 2 2 of Fig. 1. Fig. 3 is a transverse central section of the nozzle-ring removed from the turbine. Fig. 4 is a front elevation of one of the buckets removed from the bucket-wheel. Fig. 5 is a sectional view of a bucket, taken on line 5 5 of Fig. 4. Fig. 6 is a section of a bucket on line 6 6 of Fig. 5. Fig. 7 is a section of a bucket on line 7 7 of Fig. 5, and Fig. 8 is a fragmentary section showing an end view of the combined bushing and bearing.

In the drawings the same reference characters indicate the same parts throughout the several figures.

Referring to the drawings, 1 1 represent the bucket wheels or disks of the rotor element of the turbine, and 2 2 are the buckets on the periphery of the wheels.

3 is a rotary shaft passing centrally through the turbine-casing, to which the wheels 1 1 are suitably secured.

4 4 are the separable sections of the turbine-casing, which are fitted to each other and the ends of the cylinder by tongue-and-groove joints and held together by longitudinal bolts. (Not shown.) The outside portion of the casing may be provided with the usual lagging, as shown in the former patents hereinbefore referred to.

5 indicates one of the partitions separating one wheel or expansion-chamber from the other and is preferably made integral and connected at one end of its corresponding casing-section 4 by means of any number of webs 5′ 5′, placed diametrically opposite to

each other. The spaces between these webs form extended arcuate-shaped passages 4′ for conveying the motive fluid from one section to the next succeeding section or stage of expansion.

6 is one of the combined bushings and bearings about the shaft 3, which is seated in the central shaft-opening 7 of the partition or division-wall 5. The bushing or bearing 6 is provided on its inner cylindrical wall or face with a series of rectangular annular grooves 6′, which are not provided with a lubricant, but are able to collect such water as may pass along the shaft and by forming eddy-currents provide sufficient resistance for the motive fluid to reduce its leakage to a very small or negligible amount. A sufficient clearance is provided between the shaft and the inner or smaller side of the grooves 6′, so that only the shaft will rotate, and the combined bushing and bearing 6 will be held to its seat by the difference of pressure between the expansion-chambers. By this construction and arrangement it has been found that the shaft will rotate practically without touching the bushing and will be separated from it and packed by a filling of the motive fluid.

8 is a narrow collar made integral with one end of the bushing 6 and is provided with an annular flange 9, which is seated in a corresponding recess 10, the bottom of which recess may be provided with the usual fibrous material for packing.

11 is a circular ridge forming the inner wall of the recess 10 or the outer edge of the central opening 7 of the partition or division-wall 5. The outer end of this circular ridge 11 is V-shaped in cross-section, so as to present a blunt knife-edge to the bottom face of the circular channel within the inner side of the collar 8, thereby assisting to make a fluid-tight joint between the bushing 6 and division-wall 5 when pressed against said wall by the preponderating fluid-pressure, as above indicated.

The bushing 6 is made slightly smaller in its outer diameter than the central opening 7 in the partition 5, so as to provide a clearance in order not to disturb the proper alinement of the axis 3 in its bearings should the centers of the opening 7 in the partitions 5 not exactly correspond with that of the axis of the shaft 3.

12 is a cored casting which forms the steam end of the cylinder and is provided with a motive-fluid chest 13, provided with any pipe connection 14, leading to a source of motive-fluid pressure, and the arc-shaped openings or ports 13′, leading to the first series of nozzle-openings, to be hereinafter described.

15 is any suitable bushing surrounding the shaft at the section where it passes through the end casting 12.

16 16 are the nozzle-rings, which are preferably made of bronze or other hard metallic composition of annular form and U-shaped in cross-section. The inner side or portion of the U-shaped section is provided (see Fig. 2) by cutting with a milling-cutter or other suitable tool with a series of rectangular-shaped passages 17, which form the nozzle-openings for the passage of the motive fluid from one expansion-chamber to the next. The said nozzle-rings are attached by means of bolts 18 18 or other suitable means engaging the webs 5′ 5′, so that the circular recess or depression 19, formed in the annulus of the U-shaped cross-section, is made to register with the arc-shaped passages 4′ in the partition-wall 5 or ports 13′, leading from the chest 13.

From the foregoing arrangement and construction it will be seen that I have formed a compact and cheap construction for providing a uniform and proper distribution of the motive fluid to a rotary bucket-wheel, as used in this type of turbines.

The single-cup buckets 2, as shown in detail in Figs. 2 to 7, are provided with a shank 20, which has at its lower end an enlargement 21 of cylindrical form adapted to fit in a corresponding recess 22 in the periphery of the wheel 1. The curvature of the walls forming the inside of the bucket, as indicated in Figs. 5 and 6, and the inclination of the nozzle-passages in the nozzle-rings with respect to the path described by the buckets are such that the motive fluid is reversed in direction, thereby efficiently imparting its velocity and energy to the rotor element of the turbine with the minimum of friction between the motive fluid and the walls of the buckets.

As is customary with turbines employing double-cup buckets on the wheel, the motive fluid issues from both the sides of each of the buckets, while in the single-cup bucket and arrangement herein described the motive fluid is at all times on the opposite side of the bucket from which it enters, thereby avoiding the exhaust from the buckets passing across the face of the bucket wheel or disk in order to get to the next series of nozzle-passages, as in the case of the double-cup buckets.

From the foregoing description of my invention it will be seen that the nozzle-rings can be easily manufactured of the same size of any suitable metal and with a different number of nozzle-passages, and when it is desired to vary the capacity of the turbine all that is necessary to do is to remove the said rings and quickly substitute others having the required number of passages without changing the construction or relation of the other parts of the turbine. Also, if so desired, the same turbine may have nozzle-rings with a different number of nozzle-passages in order to properly and uniformly distribute the torque in the different expansion-chambers or along the rotary shaft.

The operation of the invention is as follows:

Referring to Fig. 1, the motive fluid passes from the steam-chest 13, through the ports 13′ and recess 19, to the passage-ways 17 in the nozzle-ring, striking the buckets 2 on the wheel in such a direction that the velocity of the motive fluid is imparted to the wheel, thereby rotating the shaft 3. The motive fluid in striking the buckets is turned back on itself in a direction almost opposite from that of the original or striking direction, whence it passes into a second chamber, which acts as a motive-fluid chest for the succeeding stage of expansion. The motive fluid again passes through arcuate-shaped ports 4′, recess 19 to and through a series of similarly-arranged nozzle-passages 17 17, against another set of buckets, and so on until the last stage of expansion to the final exhaust, as illustrated and described in the patents referred to above and need not herein be further described for a clear understanding of the operation and use of the present invention.

From the foregoing description of the structural features, mode of assembling the different parts, and manner of operation it will be readily seen that I have devised a turbine in which all the objects recited in the statement of invention are carried out, the parts of the turbine are easily and cheaply manufactured, its capacity readily changed, and the smooth and efficient running of a turbine is easily effected.

Various changes may be made in the specific construction of the nozzle-ring and its mode of being supported and secured in the turbine, and while I have shown my preferred form I do not care to limit myself to these specific arrangements, as they could be modified in many ways without departing from the spirit of my invention and accomplish the same results.

Having now fully described my invention, what I claim as new, and desire to secure by Letters Patent, is as follows:

1. A multicellular compound turbine comprising a cylinder composed of separable and independent sections for the several stages of expansion of the motive fluid, a vertical partition or wall within each section and secured thereto by separated webs thereby forming arcuate-shaped ports or passage-ways between the inner side of each of the sections and the periphery of the partitions, removable and independent nozzle-rings, an annular recess or groove in one of the flat faces and near the periphery of each of the nozzle-rings, said recess corresponding or registering with the arcuate-shaped ports in one of the vertical partitions, nozzle-passages in the rings and connecting the annular recesses with the centers of the nozzle-rings, means for securing or holding the nozzle-rings against the vertical partition, a rotary shaft passing centrally through each of said sections and partitions, a wheel or disk within each chamber formed by the separable sections and fixed to the shaft, and a row of single-cup buckets on the periphery of each wheel or disk.

2. A multicellular compound turbine comprising a cylinder composed of separable and independent sections for the several stages of expansion of the motive fluid, a vertical partition or wall within each section and secured thereto by separated webs thereby forming arcuate-shaped ports or passage-ways between the inner side of each of the sections and the periphery of the partitions, removable and independent nozzle-rings, an annular recess or groove in one of the flat faces and near the periphery of each of the nozzle-rings, said recess corresponding or registering with the arcuate-shaped ports in one of the vertical partitions, nozzle-passages in the rings and connecting the annular recesses with the centers of the nozzle-rings, means for securing or holding the nozzle-rings against the vertical partition, a rotary shaft passing centrally through each of said sections and partitions, a wheel or disk within each chamber formed by the separable sections and fixed to the shaft, and a row of single-cup buckets on the periphery of each wheel or disk, the inner walls of the cups and their relation to the nozzle-passages being such that the motive fluid passes into the cups on one side of the bucket-wheel and across their interior and issues from the other side of the bucket-wheels.

3. In a multicellular compound turbine, a nozzle-ring of U-section with a series of passages cut in the radially inner edge of said section and means for holding said nozzle-ring in position in said turbine.

4. A multicellular compound turbine composed of a series of separable and independent sections, a rotary shaft passing through each of said sections, a wheel or disk fixed to said shaft within each chamber formed by adjacent sections, a series of buckets fixed to the rim of each disk, and a removable nozzle-ring of U-section held to successive sections of said turbine in position to deliver the motive fluid tangentially to said series of buckets.

In testimony whereof I affix my signature in presence of two witnesses.

JAMES L. MOORE.

Witnesses:
C. V. KERR,
CLAUDE R. SCOTT