No. 850,200. PATENTED APR. 16, 1907.

K. AHLQUIST.

TURBINE BUCKET AND NOZZLE.

APPLICATION FILED NOV. 28, 1905.

2 SHEETS—SHEET 1.

Fig. 1.

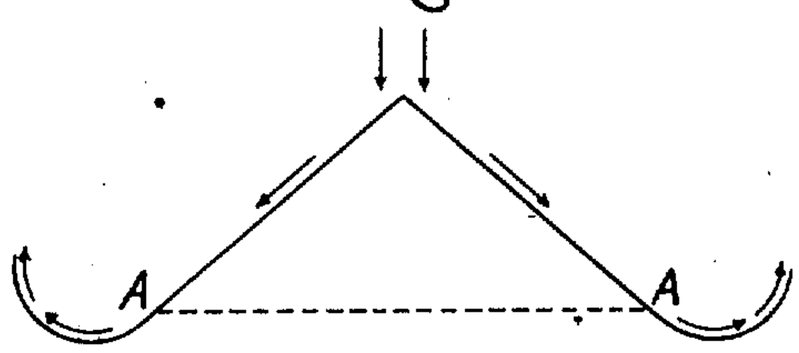

Fig. 2.

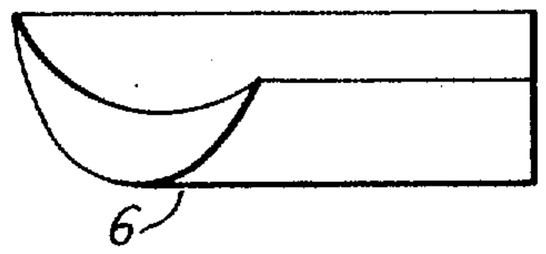

Fig. 3.

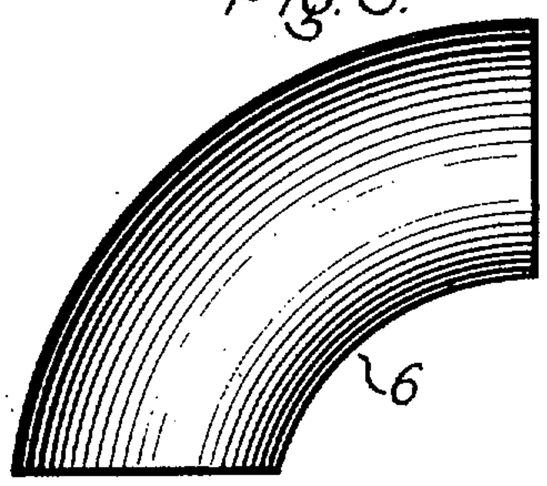

Fig. 4.

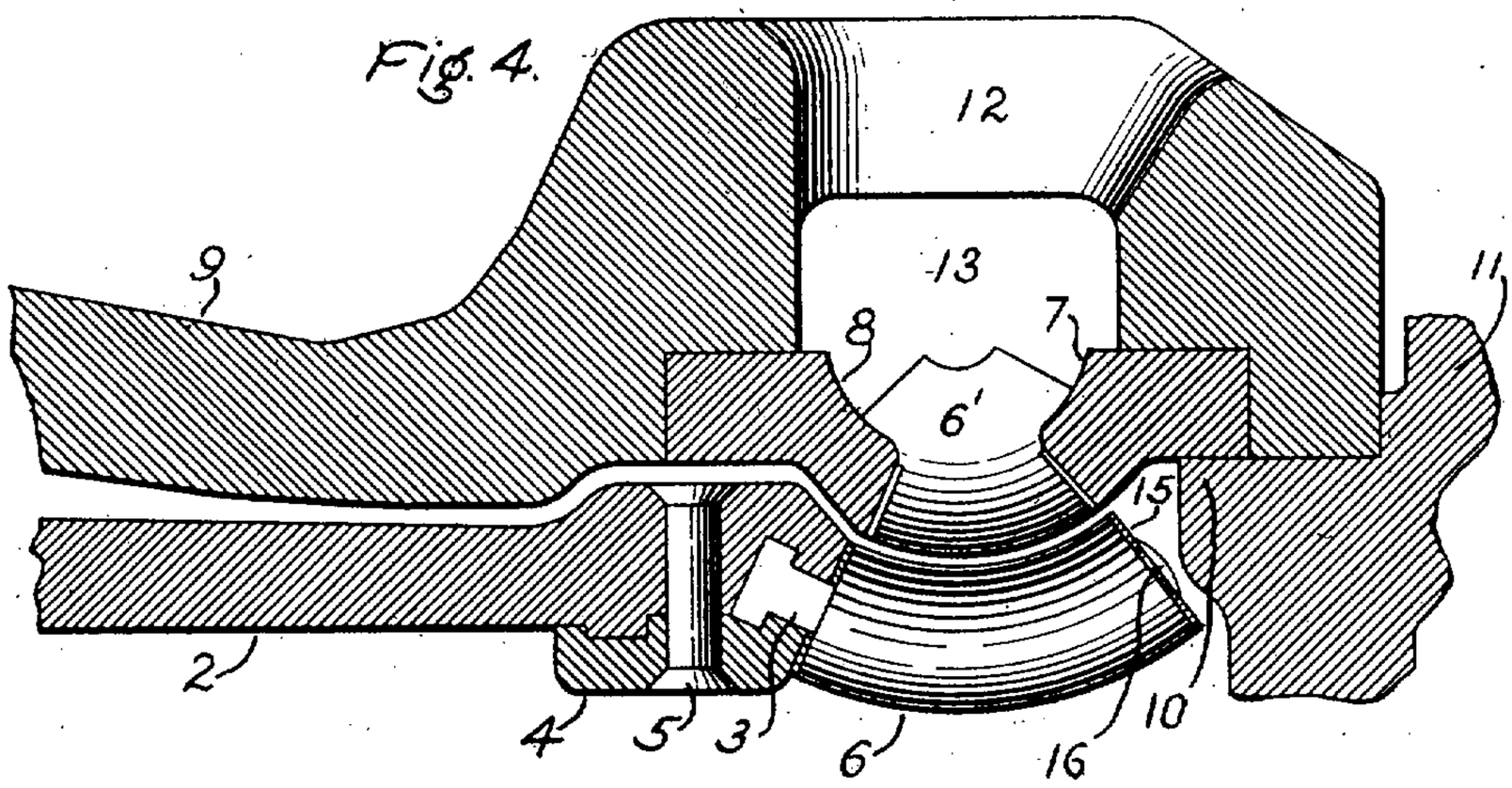

Fig. 5.

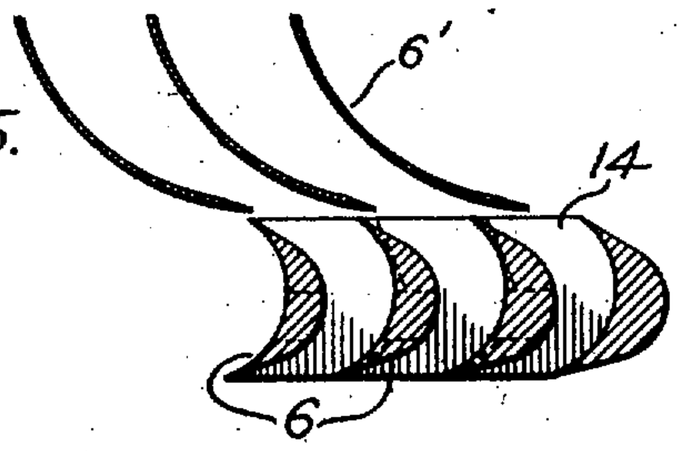

Fig. 6.

Fig. 7.

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2 SHEETS—SHEET 2.

Fig. 8.

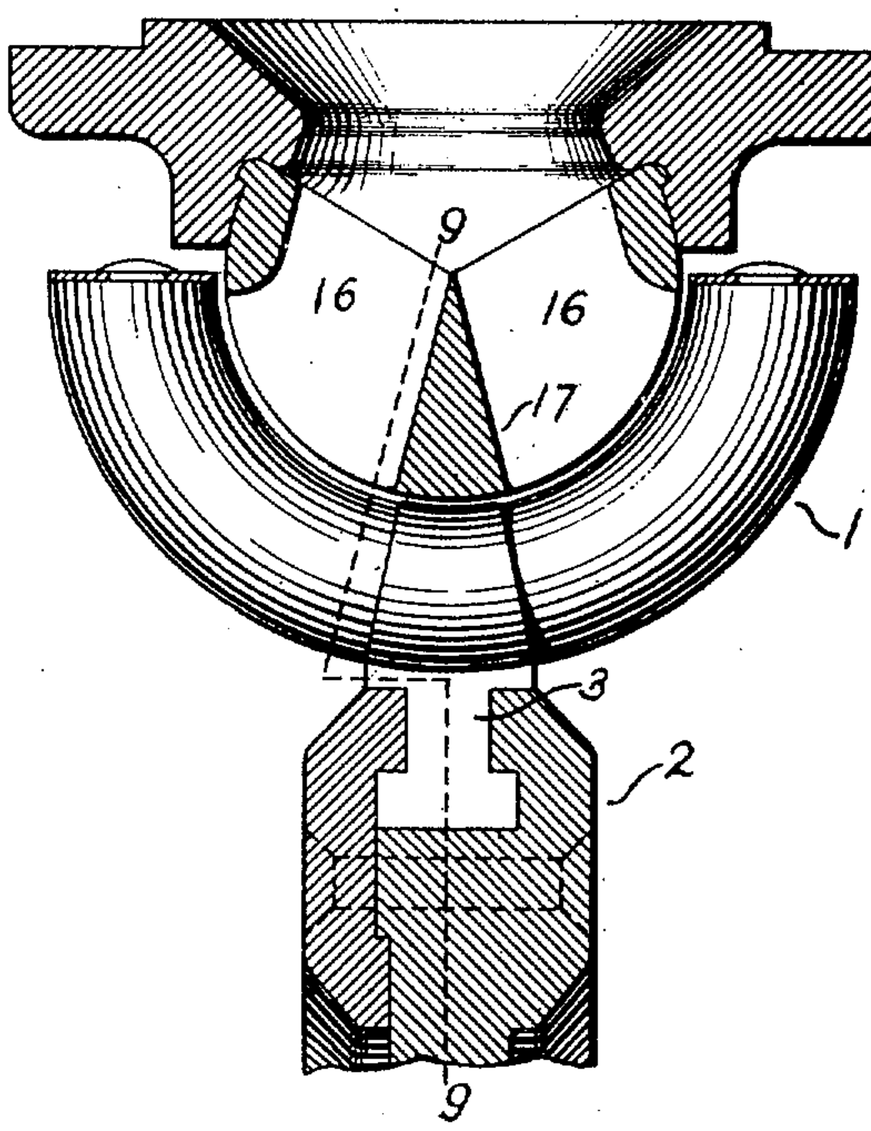
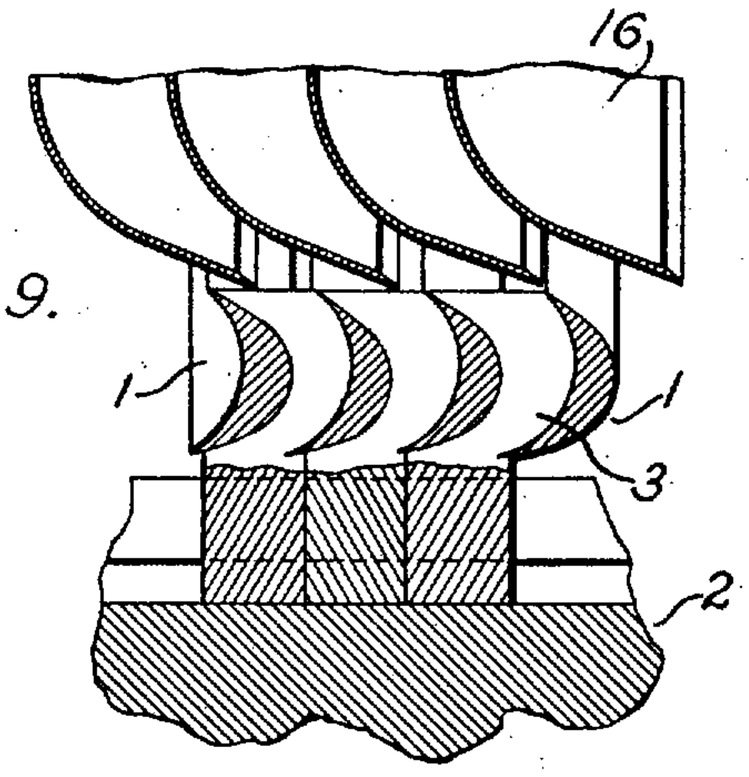


Fig. 9.



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UNITED STATES PATENT OFFICE.

KARL AHLQUIST, OF RUGBY, ENGLAND, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

TURBINE BUCKET AND NOZZLE.

No. 850,200. Specification of Letters Patent. Patented April 16, 1907.

Application filed November 28, 1905. Serial No. 289,453.

To all whom it may concern:

Be it known that I, KARL AHLQUIST, a subject of the King of Sweden, residing at Sunnyside, Clifton Road, Rugby, England, have invented certain new and useful Improvements in Turbine Buckets and Nozzles, of which the following is a specification.

The present invention relates to the construction of turbine buckets and nozzles, and has for its object to improve their construction whereby the efficiency of elastic-fluid turbines can be improved.

The invention is particularly applicable to the lower pressure stages, where heretofore it has been difficult, if not impossible, to obtain a satisfactory and at the same time a relatively small exit angle without interfering with the economy of operation.

The invention is also useful in connection with stages of higher pressure in a multistage turbine and single-stage turbines.

In the accompanying drawings, which illustrate embodiments of my invention, Figure 1 is a diagram showing the principle upon which the buckets are constructed. Fig. 2 is an end elevation of a bucket. Fig. 3 is a plan of the same. Fig. 4 is a sectional view showing the buckets in place on a wheel, together with a suitable form of nozzle. Fig. 5 is a developed view of the buckets and nozzle shown in Fig. 4. Figs. 6 and 7 are detail views of the plates situated between the inner ends of the buckets and their support. Fig. 8 is a slight modification wherein the wheel or other support is provided with two rows of buckets, and Fig. 9 is a sectional view on line 9 9 of Fig. 8.

Each bucket is crescent-shaped in cross-section; but the sharpened edges instead of being straight are curved, usually, but not necessarily, in the arc of a circle, the inlet edge being shorter than the outlet edge. The buckets are provided with suitable bases or shanks and are arranged in a row around the periphery of the turbine-wheel or other support. The nozzle or stationary element for admitting fluid to the buckets comprises suitable closely-associated passages separated by segmental and curved partitions, the delivery edges of which are curved concentrically with the inlet edges of the buckets. These buckets may be considered as being formed from a cone having a gutter round its curved edge. Such a cone is represented in section in Fig. 1. Consider a bucket of this shape arranged upon the periphery of a wheel and a jet of fluid directed axially on the apex of the cone. Then this jet will spread symmetrically round the cone and be deflected round the inside of the gutter, leaving it everywhere at the same angle to the axis of the cone. In order that the purpose of this invention may be fulfilled, the curve of the gutter should be such that this angle is as small as possible. If now the cone is assumed to be cut away at right angles to its axis along a line A A below the level of the rim of the gutter, a channel-shaped ring will remain, having curved inner and outer surfaces, and if a quarter-segment is cut from this ring a blade of the form above described will be obtained having concentric circular edges, the inlet edge being shorter than the delivery edge. Figs. 2 and 3 show such a blade in elevation and plan, respectively.

In Fig. 4 a blade 6 of the form described is shown in position on the turbine-wheel 2. The blade is attached to a shank 3, which is held in a groove in the wheel by the clamping-piece 4 and rivets 5. The fluid stream is given the proper direction for impingement by means of a nozzle having partitions 6′, which have the form of a portion of a conical surface. These nozzle-partitions may be held in place by clamping-pieces 7 and 8, secured to the nozzle support or diaphragm 9. The portion 7 of the nozzle is seated in an annular shoulder formed in the diaphragm and is firmly held in place between the diaphragm and the shoulder 10 on the inside of the wheel-casing 11. The portion 8 of the nozzle is seated in an annular shoulder formed on the diaphragm and is suitably held in place by bolts or rivets. The inner and outer portions of the diaphragm are secured together by strong radial ribs 12, and between said ribs and the receiving ends of the nozzle-partitions is an annular chamber 13, which serves to equalize the pressure of the steam or other elastic fluid delivered to the nozzle-sections.

Fig. 5 shows a number of the buckets and nozzles in developed section. It will be noticed that the blades are arranged unsymmetrically with regard to a plane perpen-

dicular to the axis of the wheel, the fluid therefore having a greater incoming than outgoing angle. Plates 14 may be located between the wheel and the buckets in order to cover the opening into the groove in the wheel, which would otherwise be left. The shape of these plates is shown in Figs. 6 and 7, which represent one of the plates in plan and end elevation, respectively. The outer ends of the buckets are provided with a cover 15, which is secured in place by tenons 16, formed integral with the buckets. Other means for securing the buckets in place may be provided, if desired—such, for example, as bolts or screws entering the ends of the buckets.

Instead of forming the blades of a quarter-segment of the ring, as above described, they may consist of semicircular segments, which are mounted on the periphery of the wheel, so that they project equally on opposite sides of the plane of the wheel. Such an arrangement is shown in Fig. 8, where the bucket 1 is secured to the wheel 2, the nozzle-passages 16 in this case being in the plane of the wheel. The nozzle-passages are formed by partitions having the form of portions of the curved surface of a cone. To separate adjacent partitions, distance-pieces 17 are provided. In Fig. 9 the nozzles and blades are shown developed, the figure being a section along the line 9 9 in Fig. 8.

Among the advantages of the construction shown in Figs. 8 and 9 over that referred to in connection with the previous figures is the fact that the wheel is balanced as to thrust, that on one side being equal and opposite to that on the other side. The nozzle, being annular and located between and discharging to both sets of buckets, can be used to discharge steam or other elastic fluid in opposite axial directions from a given point, or the nozzle may be arranged, as in the present case, to discharge steam tangentially after the manner of the Stumpf turbine. However the parts are arranged, the advantages due to the improved bucket-angles and expansion of the bucket-spaces or passages are preserved.

By means of the construction described it will be seen that the exit-angle can be made small with respect to that of the entrance without causing any restriction in the passage between buckets in the direction of flow of the fluid. It is evident that this is due to the fact that the discharge edge of the bucket is much longer than the inlet edge. By curving the buckets in the manner shown the desired effect can be obtained with a minimum bucket-diameter.

In accordance with the provisions of the patent statutes I have described the principle of operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof; but I desire to have it understood that the apparatus shown is only illustrative and that the invention can be carried out by other means.

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

1. A bucket for a turbine, comprising a body portion having curved entrance and exit edges.

2. A bucket for a turbine, comprising a body portion having curved entrance and exit edges, the curve of the exit edge being of greater radius than that of the entrance.

3. A bucket for a turbine, comprising a body portion which is crescent-shaped in cross-section, with curved entrance and exit edges, the inlet edge being shorter than the exit, and the angle of entrance greater than the angle of exit.

4. In a turbine, the combination of a support, with a plurality of buckets mounted thereon, each bucket comprising a body portion having curved entrance and exit edges, the entrance edge being shorter than that of the exit, the buckets being so arranged on the support that the angle of entrance of the adjacent walls of the inlet side is greater than the angle on the exit side.

5. In a turbine, the combination of a support, a plurality of buckets having curved entrance and exit edges, and a shank for each bucket that is mounted in the support, the buckets being so disposed on the support that the angle of entrance for the fluid is greater than the angle of exit.

6. In a turbine, the combination of a support, buckets situated on opposite sides of the plane thereof, each bucket having curved entrance and exit edges, and a nozzle situated between and discharging against both rows of buckets.

7. In a turbine, the combination of a support, buckets situated on opposite sides of the plane thereof, each bucket being crescent-shaped in cross-section, with curved entrance and exit edges, and a nozzle situated between and discharging against both rows of buckets, the discharge ends of the nozzle being curved to correspond to the curvature of the inlet edge of the buckets.

8. In a turbine, the combination of a support having a groove, buckets having curved entrance and exit edges and arranged in rows which are situated on opposite sides of the plane of the support, shanks for the buckets which are located in said groove, means for securing the buckets in place, and nozzles concentric with said buckets.

9. In a turbine, the combination of a casing having an internal shoulder, wheel-buckets, a partition supported by the shoulder, and a nozzle carried by the partition and held between it and the shoulder.

10. In a turbine, the combination of a cas-

ing having an internal shoulder, wheel-buckets, a partition supported by the shoulder, a nozzle carried by the partition and comprising an inner and an outer member with portions between forming passages, the said outer member being held between the partition and the shoulder.

In witness whereof I have hereunto set my hand this 15th day of November, 1905.

KARL AHLQUIST.

Witnesses:
ERNEST HARKER,
SIDNEY GEO. WEBB.