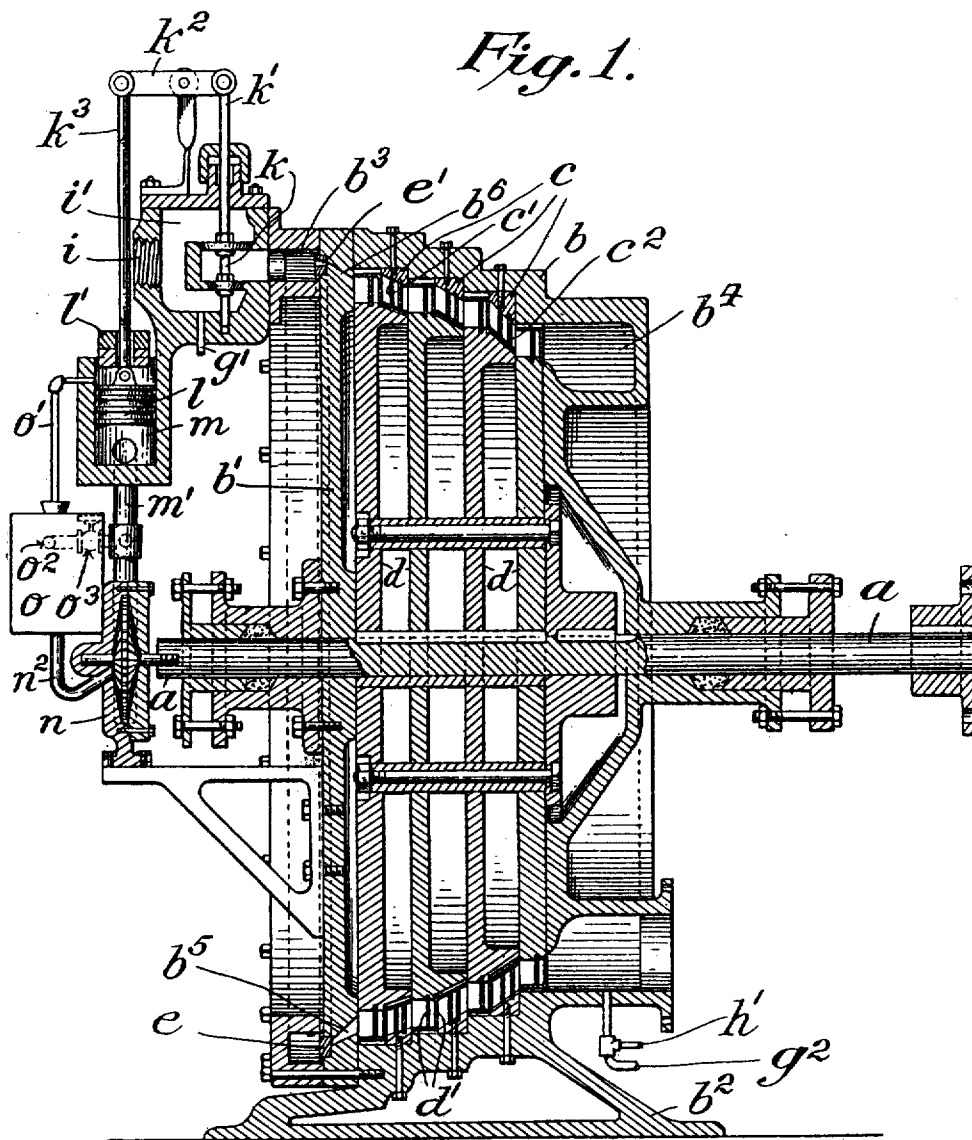


W. J. CARTWRIGHT.
ELASTIC FLUID TURBINE.
APPLICATION FILED JULY 6, 1907.

933,693.

Patented Sept. 7, 1909.
3 SHEETS—SHEET 1.



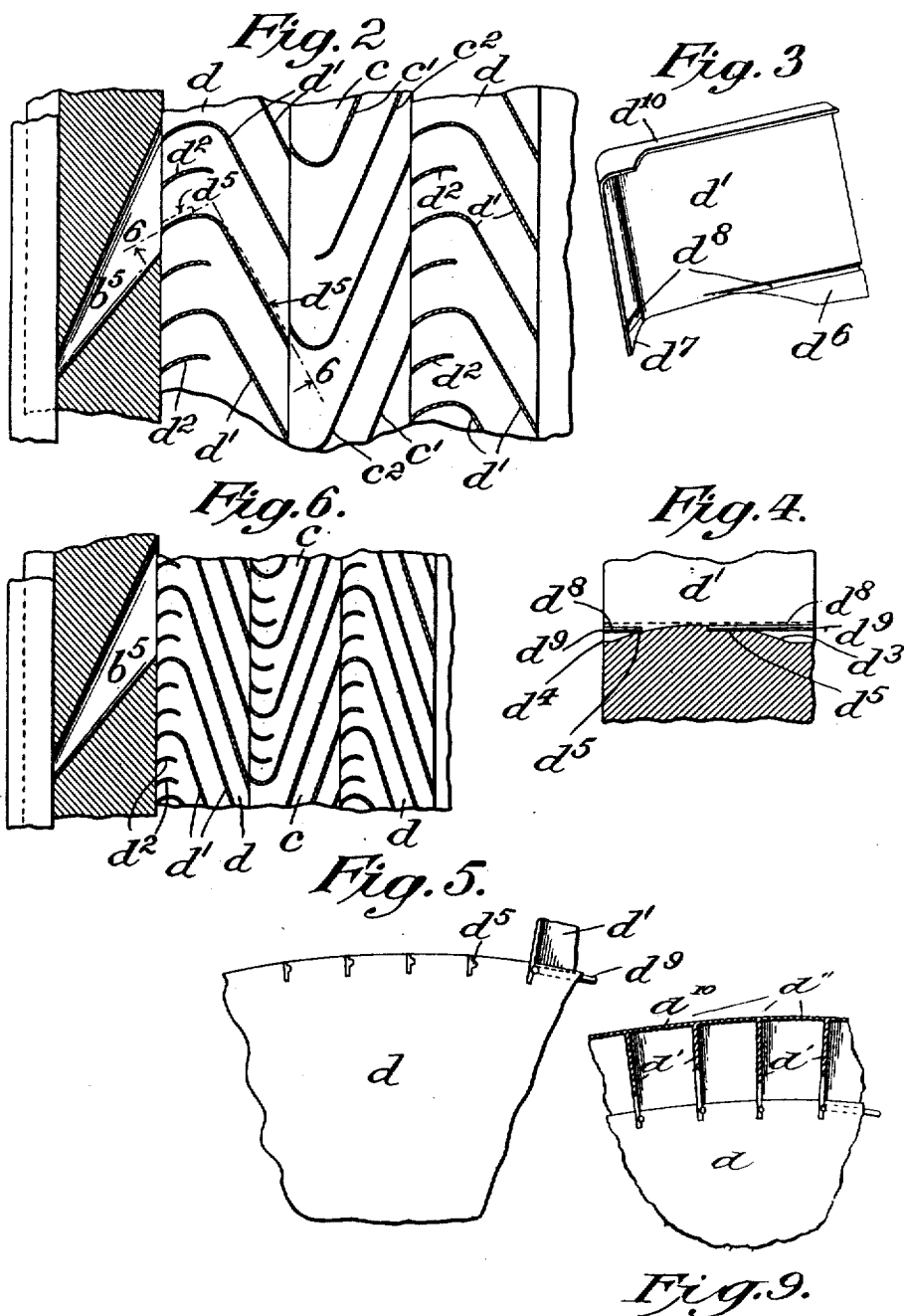
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3 SHEETS—SHEET 3.

Fig. 8.

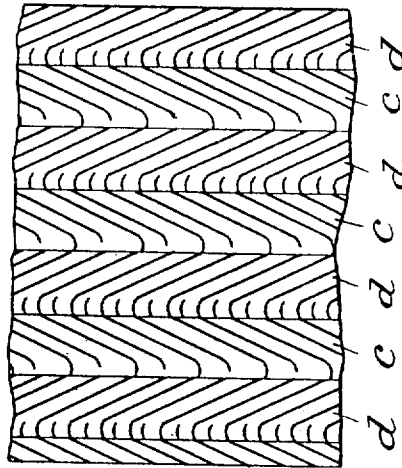
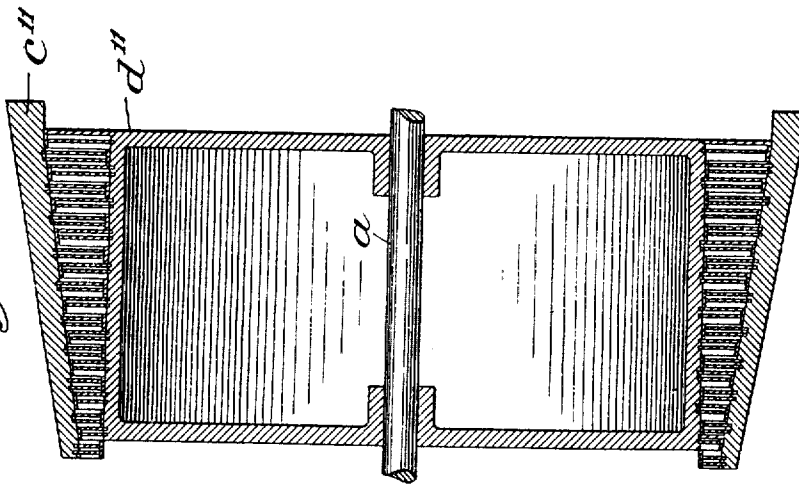


Fig. 7.



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UNITED STATES PATENT OFFICE.

WILLIAM J. CARTWRIGHT, OF NEW YORK, N. Y.

ELASTIC-FLUID TURBINE.

933,693.

Specification of Letters Patent.

Patented Sept. 7, 1909.

Original application filed March 27, 1907, Serial No. 364,942. Divided and this application filed July 6, 1907, Serial No. 382,459.

To all whom it may concern:

Be it known that I, WILLIAM J. CARTWRIGHT, a citizen of the United States, residing in the borough of Manhattan, of the city of New York, in the State of New York, have invented certain new and useful Improvements in Elastic-Fluid Turbines, of which the following is a specification, reference being had to the accompanying drawings, forming a part hereof, this application being a division of application Serial No. 364,942, filed March 27, 1907.

This invention relates to elastic fluid turbines of the type known as parallel-flow, in which the motive fluid flows through vane spaces or buckets in a direction generally parallel with the axis of the wheel. In such turbines it is desirable that the angle of the axis of the inlet portion of each moving bucket or vane space shall be relatively obtuse while the angle of the axis of the outlet or tail portion of each bucket or vane space shall be relatively acute, in order that the greater effect of impact of the fluid entering the vane spaces and the greater effect of reaction of the steam emerging from the vane spaces may be realized. As a result of this relation between the inlet and outlet portions of the vane spaces, the inlet portions are wider than the outlet portions and the possible effect of impact is lost by reason of the distance between the walls of the inlet portions.

It is the object of this invention to increase the efficiency of turbines of this type and to enable the effect of impact in such turbines to be more fully realized, and in accordance with the invention the inlet end of each of the moving buckets or vane spaces is subdivided by the insertion of one or more intermediate vanes, such intermediate vanes being shorter than the principal vanes, so that the outlet or tail portions of the buckets are not subdivided, there being no intermediate vanes between the tail portions of the principal vanes. In the stationary buckets or vane spaces the intermediate vanes, if used at all, being also shorter than the principal vanes are interposed between the tail portions of the principal vanes. By this means the advantages in turbines of the parallel flow type of more numerous surfaces for impact of the motive fluid as well as of successive impact of the motive fluid upon that which has already entered the bucket or

vane space, are fully realized, together with the advantages of a free flow of the motive fluid through the tail portions of the buckets or vane spaces and of the reactionary effect of the motive fluid issuing from such unobstructed tail portions.

The invention will be more fully described hereinafter with reference to the accompanying drawings in which, for purposes of illustration and explanation of the nature of the invention, there is shown a practical embodiment thereof.

In the drawings—Figure 1 is a view in vertical central section of a steam turbine which embodies the invention. Fig. 2 is a detail view, illustrating on a larger scale the construction and arrangement of the buckets or vane spaces. Fig. 3 is a detail view in perspective of one of the principal vanes removed from the turbine wheel. Fig. 4 is a detail view in section on the irregular plane indicated by the line 6—6 of Fig. 2. Fig. 5 is a detail view showing, on a smaller scale than the three preceding figures, a portion of the turbine wheel with one of the vanes, to further illustrate the preferred manner of mounting the vanes on the wheel. Fig. 6 is a view similar to Fig. 2 but showing a slightly modified arrangement of the vanes. Fig. 7 is a view in longitudinal central section of a portion of a turbine of a different type from that shown in Fig. 1, but having the present improvements applied. Fig. 8 is a detail view, somewhat diagrammatic in its nature, illustrating more particularly the arrangement of the buckets or vane spaces of the turbine shown in Fig. 7. Fig. 9 is a detail view, partly in elevation and partly in section through the vanes at the right hand of the intermediate vanes of one of the wheels shown in Fig. 2, illustrating the union of the vanes.

In the embodiment of the invention illustrated in the drawings the shaft *a* of the turbine is mounted to rotate in suitable bearings supported by the body *b* and head *b'* of a generally circular casing which is shown as mounted upon a suitable base *b''*. The body *b* is preferably stepped or successively reduced in diameter from the annular inlet or feed chamber *b³* which is secured to and forms a part of the head *b'*, to the annular exhaust chamber *b⁴*. To the inside of the casing body *b* are secured the rings *c* which support the stationary vanes *c'* and *c''*, which

form the stationary buckets or vane spaces, to be more particularly described hereinafter. To the shaft a are secured rotating turbine wheels d , d' , to which are secured the vanes d' , d^2 which form the moving buckets or vane spaces through which the motive fluid flows in a general direction parallel with the axis of the wheel. Through the head b' are formed the nozzles b^5 , b^6 , through which the steam or other elastic fluid is admitted to the buckets of the first wheel d .

The buckets or vane spaces may be formed in any convenient manner, but preferably by milling into the rim of each wheel d two slots, as at d^3 and d^4 , one from each edge and at right angles to each other, or otherwise related to each other according to the form of the vane d' , a hole d^5 having been drilled alongside each slot. The vane d' , having received a suitable form by drop forging or drawing, as indicated in Fig. 3, is provided on its lower edge with flanges d^6 and d^7 which fit into the slots d^3 and d^4 respectively, each flange being grooved, as at d^8 , to receive a locking pin d^9 which is driven into the groove or hole d^5 and the groove d^8 to hold the vane securely in position. Each vane d' may also be provided on its upper edge with a flange d^{10} which can be brazed or welded to the next vane as indicated at d^{11} in Fig. 9 to further strengthen the construction. The intermediate vanes d^2 may be seated in slots in the rim of the wheel and secured by pins in the same manner as the principal vanes d' . When all of the vanes have been assembled in the wheel and properly brazed or otherwise integrally united the wheel may be placed in a lathe and turned down to a smooth surface and properly balanced. The stationary vanes c' and c^2 may be secured in the stationary rings c in a similar manner.

As shown in Fig. 2 but one intermediate vane d^2 is interposed between two adjacent principal vanes, dividing the total vane space and doubling the number of vanes for impact of the steam. In Fig. 6 two intermediate vanes d^2 are shown as interposed between two adjacent principal vanes d' , dividing the vane space in thirds and trebling the number of vanes for impact of the steam. As shown in both Figs. 2 and 6, the improved wheels are arranged to cooperate with expansion nozzles b^5 of the ordinary type, while in Figs. 7 and 8, the improvement is shown as applied to a parallel-flow turbine in which expansion nozzles are not employed. All of the buckets are shown as carried by a single wheel d^{11} and all of the stationary vanes by a single shell c^{11} . Various other arrangements of revolving buckets or vane spaces and stationary vane spaces with relation to each other and with relation to the nozzles might be devised to embody this part of the invention by which in a par-

allel-flow turbine, with the angle of the axis of the inlet portion of each bucket or vane space relatively obtuse and the angle of the axis of the outlet portion relatively acute, an increased number of blades is afforded for impact of the motive fluid while the free flow of the fluid through the tail portions of the buckets is not restricted.

Not only do the intermediate vanes afford additional surfaces for impact but as each pressure bucket or vane space passes the nozzle or the outlet of a stationary vane space, the motive fluid entering the succeeding bucket or vane space exerts an impulse like a blow upon the fluid which, having entered the preceding portion of the bucket or vane space, fills the tail portion of such bucket or vane space into which the several subsidiary inlets are merged. An additional driving impulse is thus secured and moreover the fluid in the tail portion of the vane space is driven out with an added impulse and a corresponding increase of reactionary effect is secured. It will be observed not only that the tail portion of the vane space is straight and of uniform width, facilitating the outflow of the motive fluid and avoiding retardation thereof, but as the area of the outlet is large the reactionary effect of the issuing fluid is greater than would be the case if the same area were divided by intermediate vanes in the tail portion in correspondence with the intermediate vanes in the inlet portion. There is, therefore, a distinct advantage, in this direction, in making the intermediate vanes short. Various other reasons for increase in efficiency due to the provision of the short intermediate vanes in the inlet or head portions of the buckets or vane spaces will readily suggest themselves in view of the explanation herein given, but it is not necessary to attempt to enumerate herein all of the incidental advantages.

I claim as my invention:

1. A parallel-flow turbine wheel having buckets or vane spaces with the angle of the inlet portion relatively obtuse and the angle of the outlet portion relatively acute and short intermediate vanes subdividing the inlet portions.

2. A parallel-flow turbine wheel having buckets or vane spaces with the angle of the inlet portion relatively obtuse and the angle of the outlet portion relatively acute and short intermediate vanes subdividing the inlet portions, the subsidiary inlets formed by the intermediate vanes merging into the tail portion of the corresponding vane space.

3. A parallel-flow turbine wheel having buckets or vane spaces with the angle of the inlet portion relatively obtuse and the angle of the outlet portion relatively acute and short intermediate vanes subdividing the inlet portions, the subsidiary inlets formed by

the intermediate vanes merging into the tail portion of the corresponding vane space, and the tail portion of each vane space being of uniform area in cross-section from the point of merger of the subsidiary vane spaces.

4. A parallel-flow turbine wheel having buckets or vane spaces with the angle of the inlet portion relatively obtuse and the angle of the outlet portion relatively acute and short intermediate vanes subdividing the inlet portions, the subsidiary inlets formed by the intermediate vanes merging into the tail portion of the corresponding vane space, and the tail portion of each vane space having straight and parallel sides.

5. In a parallel-flow turbine a carrying body having slots in its rim, each of said slots having a pin seat, vanes having flanges entered in said slots and grooved, and pins engaging said pin seats and grooves to retain the vanes, the edge of the outer portion of each vane being integrally united to the body of the next vane.

6. In a parallel-flow turbine having a plurality of turbine wheels, principal sta-

tionary vanes forming between successive wheels stationary buckets or vane spaces having the angle of the inlet portion relatively obtuse and the angle of the outlet portion relatively acute, and short intermediate vanes subdividing the inlet portions.

7. In a parallel-flow turbine the combination of a plurality of turbine wheels having buckets or vane spaces with the angle of the inlet portion relatively obtuse and the angle of the outlet portion relatively acute and short intermediate vanes subdividing the inlet portions, principal stationary vanes forming between successive wheels stationary buckets or vane spaces having the angle of the inlet portion relatively obtuse and the angle of the outlet portion relatively acute, and short intermediate vanes subdividing the inlet portions.

This specification signed and witnessed this 2nd day of July, A. D., 1907.

WILLIAM J. CARTWRIGHT.

Signed in the presence of—

W. B. GREELEY,
AMBROSE L. O'SHEA.