No. 726,032. PATENTED APR. 21, 1903.

C. G. CURTIS.
ELASTIC FLUID TURBINE.
APPLICATION FILED JUNE 13, 1900.

NO MODEL.

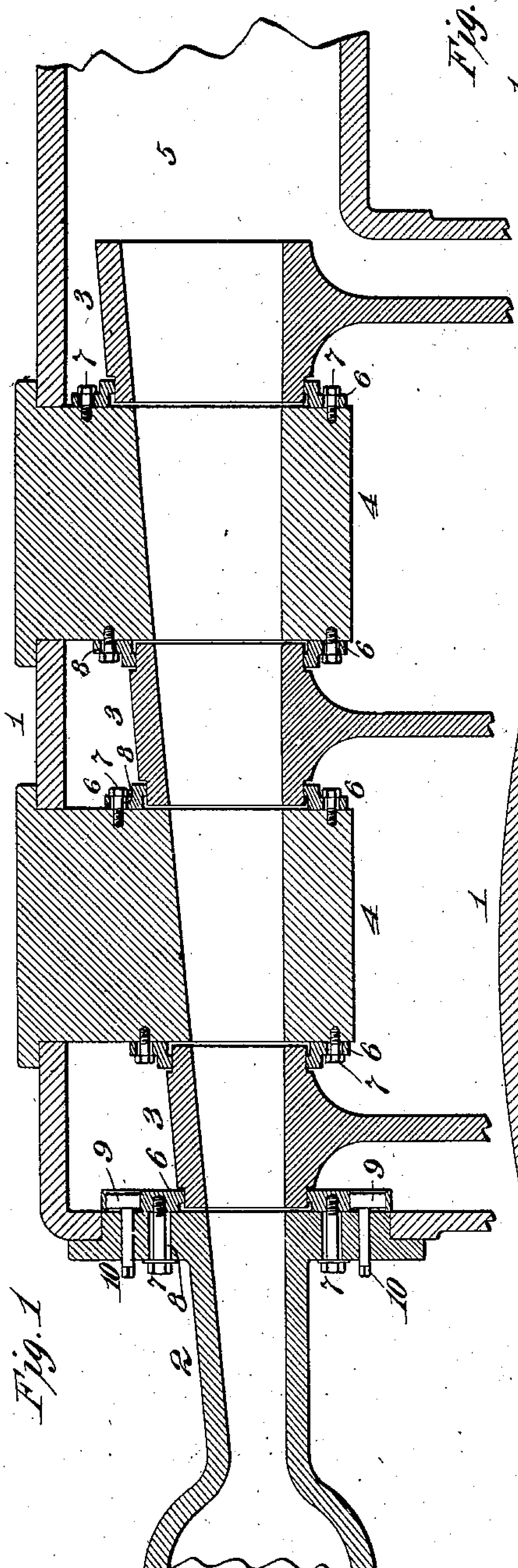

Fig. 1

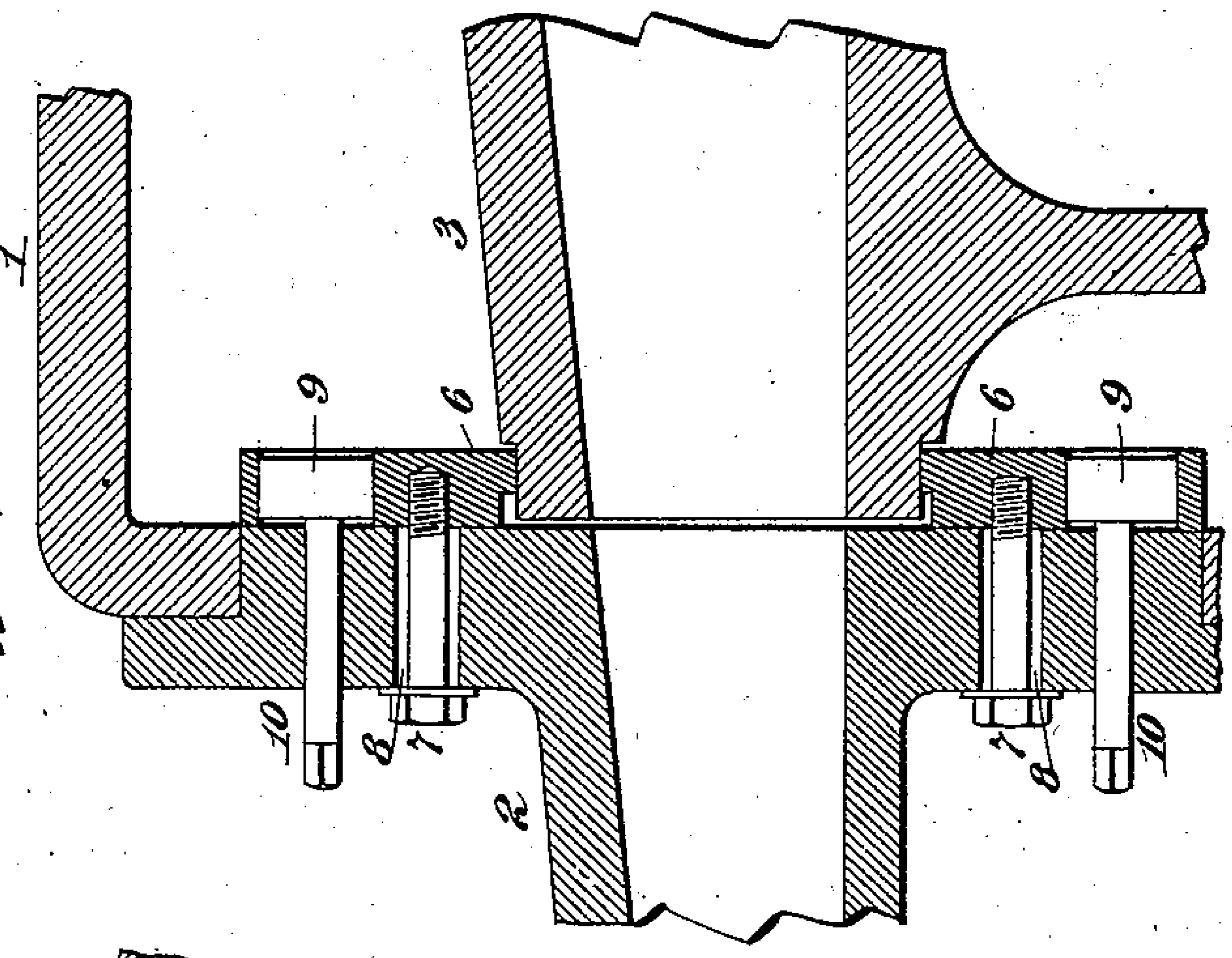

Fig. 2

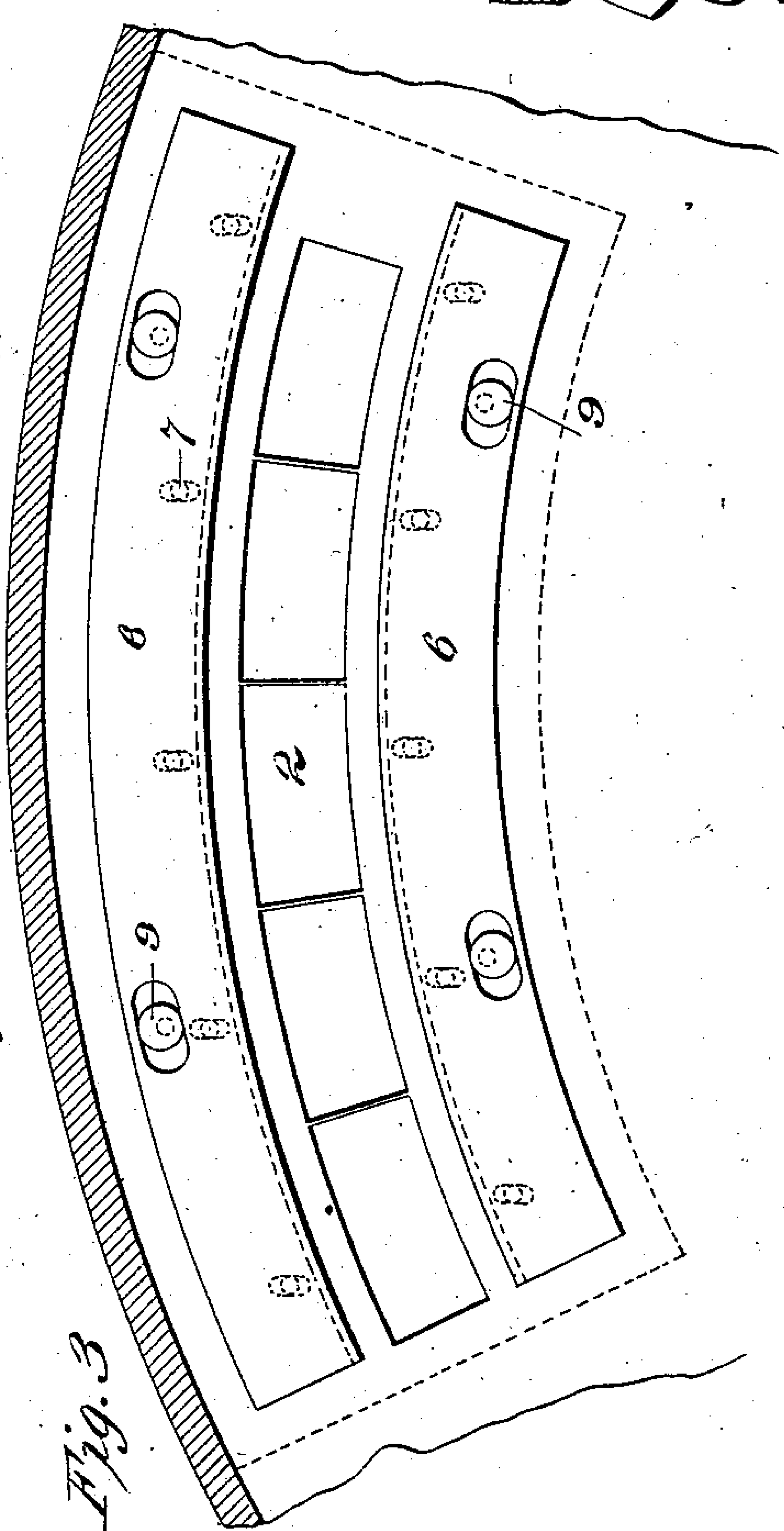

Fig. 3

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UNITED STATES PATENT OFFICE.

CHARLES G. CURTIS, OF NEW YORK, N. Y., ASSIGNOR, BY MESNE ASSIGNMENTS, TO CURTIS STEAM TURBINE COMPANY, A CORPORATION OF WEST VIRGINIA.

ELASTIC-FLUID TURBINE.

SPECIFICATION forming part of Letters Patent No. 726,032, dated April 21, 1903.

Application filed June 13, 1900. Serial No. 20,133. (No model.)

To all whom it may concern:

Be it known that I, CHARLES G. CURTIS, a citizen of the United States, residing in the borough of Manhattan, city of New York, State of New York, have invented a certain new and useful Improvement in Elastic-Fluid Turbines, of which the following is a description.

My present invention relates to means for reducing the leakage at the clearances of elastic-fluid turbines, and particularly in that class of turbines disclosed by my Patent No. 566,968, dated September 1, 1896, wherein the velocity of the elastic fluid is fractionally abstracted by directing it two or more times successively against moving buckets. In turbines of this character the pressure is not entirely converted into velocity by the expansion-nozzle; but some pressure above that of the exhaust is retained in the elastic fluid at the point of delivery by the nozzle to the first set of revolving buckets and also to a less extent at subsequent clearances, resulting in leakage. Leakage of the elastic fluid is obviously reduced by making the clearances between the moving and stationary elements of the turbine as small as possible. In practice, however, and especially in turbines of large diameter, it is found impossible to make the revolving parts run perfectly true on their side faces or, if constructed to run true, to remain true during use, and it is also desirable and practically essential that more or less end play of the shaft carrying the revolving buckets should be permitted. Hence in operation the revolving parts of the turbine necessarily have more or less lateral movement toward and away from the stationary parts, increasing and decreasing the width of the clearances and permitting a serious leakage of the elastic fluid thereat.

The object of my present invention is to provide means whereby this leakage may be very materially reduced.

It is a fact that the cylindrical surfaces of the revolving parts of an elastic-fluid turbine, between which the revolving buckets are located, when once made true will remain approximately true in use, and this is so independently of the end play of the shaft. I utilize this fact by constructing the turbine so that the meeting sides of the stationary and revolving elements of the turbine shall overlap each other on lines concentric with the axis of rotation, whereby the clearances will be transferred from the side faces of the parts to the cylindrical surfaces. Owing to the high velocity of the revolving parts in turbines of this character, it is not practicable to use ordinary forms of packing between the moving and stationary surfaces. In order to reduce the width of the clearances, which are transferred from the side faces to the cylindrical surfaces, as already stated, and to provide means of adjustment, so as to secure at all times the minimum separation, I provide ring-segments or lips, which are attached to the nozzle, and preferably, also, to the other stationary elements, and which overlap the cylindrical surfaces of the rotating elements throughout so much of the circumference as is necessary to cover the buckets in the line of the flow of the elastic fluid. These lips are set in such close proximity to the moving cylindrical surfaces that the virtual clearances are thereby reduced to a minimum. The lips may be made adjustable with respect to the revolving cylindrical surfaces, with which they coöperate, so as to secure the necessary preliminary accuracy of fit and so as to take up any subsequent wear and also to provide for the readjustment of the lips when the position of the axis of rotation of the moving elements is changed from any cause—as, for instance, by the wear or relining of the bearings. I have also found it desirable to make these lips of brass or some metal softer than the steel of which the rotating cylindrical surfaces are constructed, so that if desired the lips may be adjusted into actual contact with the cylindrical surfaces and will quickly wear clear of contact without cutting the cylindrical surfaces.

In the drawings, Figure 1 is a vertical section through the nozzle and the moving and stationary buckets of a turbine of the type referred to equipped with my present improvement in one of its forms and showing the employment of three sets of rotating buckets and two sets of intermediate stationary buckets. Fig. 2 is a section, on a larger scale, showing the construction for reducing the clearances between the end of the nozzle and the first set of revolving buckets; and Fig. 3 is an elevation of the delivering end of the nozzle with the lips attached thereto.

1 represents the shell of an elastic-fluid turbine.

2 is an expansion-nozzle of any suitable type for converting the pressure of the elastic fluid into velocity and for directing the fluid against the first set of revolving buckets. The nozzle illustrated is the sectional nozzle described in my application, Serial No. 666,379, filed January 12, 1898.

3 3 3 are the revolving buckets, all carried on disks or centers on the shaft, and 4 4 are the intermediate stationary buckets, carried on blocks, as shown, formed integral with or attached to the cylindrical portion of the shell. 5 represents the exhaust-opening.

6 6 are the ring-segments or lips for transferring the clearances from the side faces to the cylindrical surfaces of the rotating elements. They are strips having any suitable form in cross-section and having a length sufficient to cover the buckets in the line of flow of the elastic fluid. They also have the proper curvature to fit the cylindrical surfaces of the moving elements, between which cylindrical surfaces the revolving buckets are located. The lips are preferably made of brass or some other metal softer than steel. The lips may be secured in place by means of bolts or screws 7, which pass through slots 8 in the lips, so that such lips can be adjusted toward and away from the cylindrical surfaces. Means may also be provided for adjusting the lips during the running of the turbine. This is particularly desirable with regard to the lips, which are located at the clearances between the nozzle and the first set of revolving buckets. For this purpose cams 9, bearing against the lips and carried by shafts 10, projecting through the flange of the nozzle to the outer side of the turbine, may be used. To adjust the lips while the turbine is in operation, the screws 7 will be slightly loosened and the cams 9 turned so as to force the lips against or close to the revolving cylindrical surfaces, when the screws 7 will be again tightened to hold the lips in place. In constructing the turbine the revolving cylindrical surfaces over which the lips lap will be turned as true as possible after the wheels are finished. After the shaft has been properly mounted in the shell the lips will be adjusted close to or into light contact with the adjacent rotating cylindrical surfaces and will then be secured tightly in position by the screws or bolts 7. When the turbine is started, if the lips are then touching the wheels will at once wear themselves clear, so that the clearance will then be a minimum and the leakage will be as small as possible.

What I claim is—

1. In an elastic-fluid turbine, the combination with a rotating wheel having a rim pierced laterally by vane-passages, and a stationary element adjoining one side of such rim and delivering the elastic fluid to or receiving it from the revolving vane-passages parallel with the axis of such wheel, of a cylindrical surface on the outer or inner side of said rim and adjoining such stationary element, and a concentric lip attached adjustably to such stationary element overlapping such cylindrical surface and having a small clearance therefrom, substantially as set forth.

2. In an elastic-fluid turbine, the combination with a rotating wheel having a rim pierced laterally by vane-passages, and a stationary element adjoining one side of such rim and delivering the elastic fluid to or receiving it from the revolving vane-passages parallel with the axis of such wheel, of cylindrical surfaces both on the outer and inner sides of said rim and adjoining such stationary element, and concentric projections from such stationary element overlapping such cylindrical surfaces and having a small clearance therefrom, substantially as set forth.

3. In an elastic-fluid turbine, the combination with a rotating wheel having a rim pierced laterally by vane-passages, and a stationary element adjoining one side of such rim and delivering the elastic fluid to or receiving it from the revolving vane-passages parallel with the axis of such wheel, of cylindrical surfaces both on the outer and inner sides of said rim and adjoining such stationary element, and concentric lips attached adjustably to such stationary element overlapping such cylindrical surfaces and having a small clearance therefrom, substantially as set forth.

4. In an elastic-fluid turbine, the combination with a rotating wheel having a rim pierced laterally by vane-passages, and a stationary element adjoining one side of such rim and delivering the elastic fluid to or receiving it from the revolving vane-passages parallel with the axis of such wheel, of a cylindrical surface on the outer or inner side of said rim and adjoining such stationary element, and a concentric lip attached adjustably to such stationary element and overlapping said cylindrical surface, such lip being of softer metal than such rim so that such lip when adjusted to touch such surface will wear out of contact therewith, substantially as set forth.

5. In an elastic-fluid turbine, the combination with the shell, a rotating wheel therein having a rim pierced laterally by vane-passages, and a delivery-nozzle entering the shell in line with such vane-passages, of ring-segments projecting from said nozzle over said wheel-rim, whereby the clearances between the nozzle and rotating vanes in the line of the flow of the elastic fluid will be transferred from the radial to the cylindrical surfaces, substantially as set forth.

6. In an elastic-fluid turbine, the combination with two sets of axial-flow rotating vanes

and a set of stationary vanes carried by a block between such rotating vanes, of ring-segments projecting from such stationary vane-block over such rotating vanes, whereby the clearances between the rotating and stationary vanes in the line of flow of the elastic fluid will be transferred from the radial to the cylindrical surfaces, substantially as set forth.

7. In an axial-flow elastic-fluid turbine, the combination with the shell and two or more sets of rotating vanes therein, of a nozzle entering the shell in line with one set of rotating vanes, stationary vanes carried by blocks between the sets of rotating vanes and in line with said nozzle, and ring-segments projecting from such nozzle and stationary vane-blocks over said rotating vanes, whereby the clearances in the line of flow of the elastic fluid will be transferred from the radial to the cylindrical surfaces, substantially as set forth.

This specification signed and witnessed this 15th day of May, 1900.

CHARLES G. CURTIS.

Witnesses:

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JNO. R. TAYLOR.