C. G. CURTIS.

ELASTIC FLUID TURBINE.

APPLICATION FILED MAY 18, 1907.

917,419.

Patented Apr. 6, 1909.

2 SHEETS—SHEET 1.

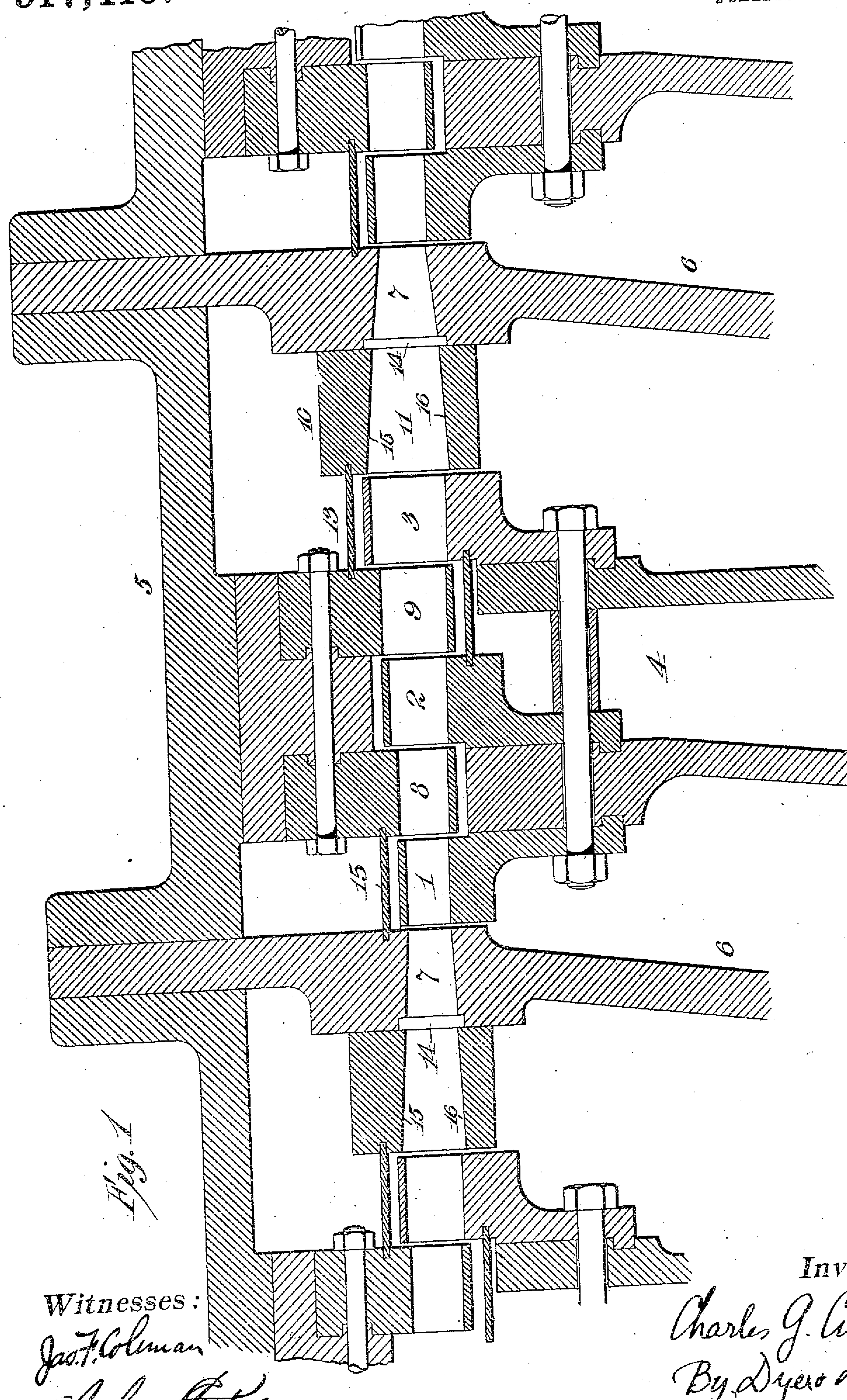

Fig. 1

Witnesses:

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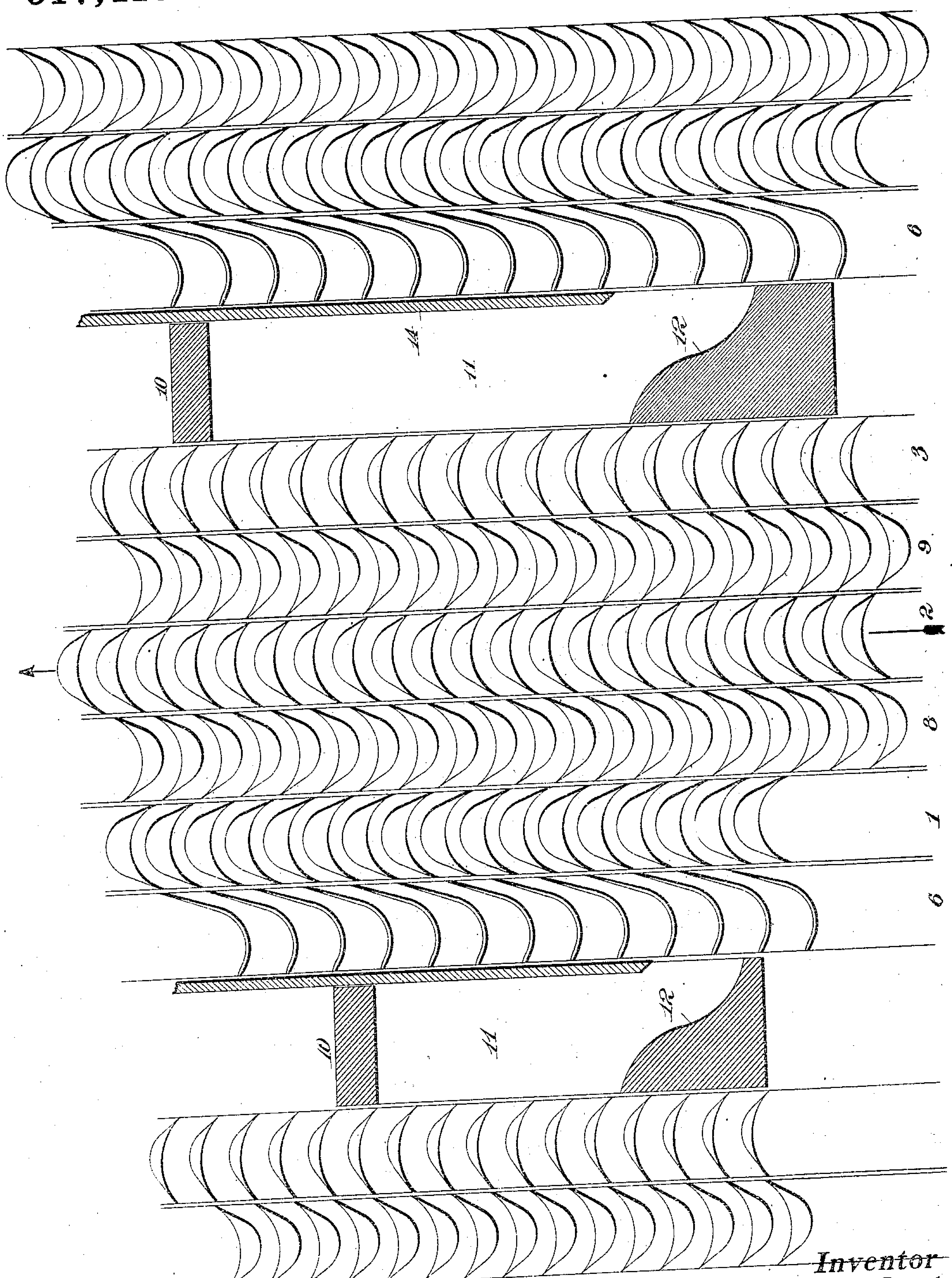

Fig. 2

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UNITED STATES PATENT OFFICE.

CHARLES G. CURTIS, OF NEW YORK, N. Y., ASSIGNOR, BY MESNE ASSIGNMENTS, TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

ELASTIC-FLUID TURBINE.

No. 917,419. Specification of Letters Patent. Patented April 6, 1909.

Application filed May 18, 1907. Serial No. 374,435.

To all whom it may concern:

Be it known that I, CHARLES G. CURTIS, a citizen of the United States, and a resident of the borough of Manhattan, city, county, and State of New York, have invented an Improvement in Elastic-Fluid Turbines, of which the following is a specification.

The object I have in view is to improve the efficiency of elastic fluid turbines and particularly to make them more efficient when running with reduced loads and under less than full speed.

The invention is particularly adapted for steam turbines for marine use, and more especially in connection with vessels of war, yachts and vessels on special service and adapted to be run for a large proportion of the time they are under way at a reduced or cruising speed.

I attain these objects by the mechanism illustrated in the accompanying drawings, in which—

Figure 1 is a sectional view of a portion of a turbine embodying my invention, and Fig. 2 is a development thereof.

In both of the views like parts are designated by the same reference characters.

The drawings illustrate one stage of a multi-stage turbine of the axial flow type; the number of stages used is immaterial, but one whole stage and portions of two other stages are illustrated.

In the drawings the moving buckets 1, 2, 3, are carried upon the periphery of the wheel 4. The wheel turns within a shell or casing 5. This shell is separated by diaphragms 6—6 into stages, there being one or more rows of moving buckets in each stage. The nozzles 7 are formed in the diaphragm 6 and direct the elastic fluid into the first row of moving buckets 1. Intermediate nozzles 8 and 9 are fixed to the shell 5, and are arranged between the moving buckets 1 and 2, and 2 and 3 respectively. The nozzles 7, 8 and 9 serve the twofold purpose of directing the elastic fluid against the moving buckets and also of converting a portion of the pressure of the fluid into velocity.

I prefer in practice to arrange each row of moving buckets so as to absorb an equal amount of energy, although this may be varied, if desired. The elastic fluid, which may be steam or other gas or fluid under pressure, after traversing the rows of moving buckets and nozzles, will issue out of the last row of moving buckets 3, and will be discharged into the next nozzle 7. The usual practice is to provide a considerable interval of space between the last row of moving buckets 3 and the next diaphragm, so that the steam or other elastic fluid employed may have an opportunity to expand to the pressure existing in that stage before it escapes through the next nozzle, and from there into the next wheel.

By my invention I provide an opening 11 which is arranged so that it forms a passageway between the discharge from the buckets 3 and the entrance to the nozzle 7. This opening has a top wall 15 and a bottom wall 16. In the embodiment illustrated the walls are formed by an opening made in a block 10. This block 10 is preferably attached to the diaphragm 6. The circumferential length of the opening is equal to the length of the nozzle 7, against which it abuts, as is shown in Fig. 2. The radial depth of the opening 11 is preferably at its proximate end slightly greater than the radial depth of the bucket 3. The excess of depth over the depth of the bucket is provided for the purpose of preventing an obstruction to the free discharge of the fluid from the buckets 3. The radial depth of the ultimate end of the opening 11 is that of the depth of the nozzles 7, against which it abuts. The fixed nozzles may increase in circumferential length toward the exhaust in order to provide for the increased volume of fluid.

In order to prevent obstruction to the free passage of the fluid through the opening 11, the latter is made to increase in circumferential length in the direction of the exhaust, or transverse to the travel of the fluid. This increase in circumferential length of the passage may be made by inclining one of the walls 12. This incline is best made upon the curve shown in Fig. 2, which I find to be substantially the path that steam will take in discharging from buckets of the shape illustrated.

In order to prevent an objectionable expansion which would be caused by the cross-sectional area of the opening 11 increasing by the increase of peripheral length, I prefer to have the cross-sectional area of the ultimate and proximate ends of the opening 11 equal. This may be made by contracting the top and bottom walls of the opening 11 at a ratio equal to the contraction of the side walls.

In order to prevent the escape of fluid from the joint between the moving buckets 3 and block 10, I provide a guard plate 13 interposed between the block 10 and the base of the fixed nozzle 9. A second guard plate 15 may be used to prevent escape of fluid from the nozzles 7 around the top of the row of buckets 7.

By the construction described it will be seen that the elastic fluid, in traversing the turbine and passing successively through the nozzles and moving buckets, will expand and increase or fan outward circumferentially in the direction of the exhaust. After issuing from the last row of moving buckets 3 it will enter the opening 11 and pass through the nozzles 7 without losing its velocity or forming eddies, or otherwise undergoing losses. On the contrary, the elastic fluid will freely issue from the row of moving buckets 3 into the next nozzles 7 without appreciable loss.

In connection with the opening 11, I provide a valve 14. This valve is shown mounted in ways in the diaphragm 6, although it may be carried in any other manner. It is adapted to be slid to expose or open up a certain peripheral extent of buckets 7. The valve is so arranged that as it is opened, the open portion will be in the direction of the discharge of the moving buckets. This is apparent from the illustration in Fig. 2, in which the moving buckets travel in the direction of the arrow, and their discharge is in the opposite direction. As the valve 14 is opened, the nozzles 7, adjacent to the wall 12, will be the first ones exposed. I prefer to provide one of these sliding valves 14 for each diaphragm. In the first diaphragm or head of the shell, the ordinary separate valves, which are now used in elastic fluid turbines, may be used for cutting in or cutting out one or more separate nozzles at a time. These nozzles when cut out are cut out in the direction opposite to the rotation of the wheel.

Fig. 2 illustrates the position of the valves when the turbine is operating under part load. The initial valves are all cut off except the one or ones which control but one or two nozzles at the initial end of the turbine. The valves 14—14 for the stages shown in the drawings are partly closed so that but two or three of the nozzles 7 in each diaphragm are open. The elastic fluid in traversing the turbine will be confined to a path adjacent to the edges 12 of the openings 11. While it may fan out to some extent in each stage, yet when it reaches the opening 11 at the end of each stage it will be confined to the opening disclosed by the valve 14. At part loads, therefore, the turbine will operate without undue loss of efficiency because the elastic fluid will have a free passage through the entire length of the turbine and will be concentrated at each diaphragm in such a manner that the nozzles at the diaphragm will be utilized to their complete capacity.

The invention may be applied to other forms of elastic fluid turbines and is not necessarily restricted to the axial flow type. Instead of using intermediate fixed nozzles 8 and 9, intermediate buckets may be employed which serve solely for the purpose of diverting the fluid discharged from the moving buckets. In this case the entire expansion will be made by the nozzles 7 on the principle disclosed in my Patent No. 566,968.

In accordance with the provisions of the patent statutes, I have described the principle 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 merely illustrative and that the invention can be carried out in other ways.

Having now particularly described the nature of my invention, and in what manner the same is to be performed, what I claim and desire to secure by Letters Patent, is:

1. An elastic fluid turbine having a shell divided by diaphragms into separate stages, moving and stationary buckets in each stage, and nozzles in the diaphragms, there being a space between the discharge from a moving bucket in a stage to the next diaphragm and an element having a passage in the space, the said passage connecting the discharge from the bucket to the next nozzle, it being substantially of the same shape as the fluid jet.

2. A turbine divided into stages by diaphragms, there being an element with a passage between the row of moving buckets which last discharges fluid in each stage and the next diaphragm, the passage increasing circumferentially and decreasing radially, in the direction of the exhaust.

3. A turbine divided into stages by diaphragms, there being confining walls to carry the fluid from the last bucket to the next nozzle, the said walls being so shaped as to conduct the fluid without substantial loss of velocity.

4. A turbine divided into stages by diaphragms, there being top and bottom confining walls to carry the fluid from the last bucket to the next nozzle, the said walls being so shaped as to conduct the fluid without substantial loss of velocity.

5. A turbine having stages, with a block in a stage, adjacent to the diaphragm of the next stage, the said block having a passage, receiving fluid from the discharge of the wheel within the stage, one edge being substantially parallel to the axis of the wheel, and the other inclined.

6. A stage turbine, having a space in a stage between the discharge from the buckets of the wheel and the nozzles admitting to the next stage, there being an element with

an opening in the space, with a valve adjacent to the nozzles for controlling admission of fluid to them.

7. A stage turbine, having a space in a stage between the discharge from the buckets of the wheel and the nozzles which admit to the next stage, there being an element with an opening in the space, with a valve at the ultimate end of the opening.

8. A stage turbine, having a space in a stage between the discharge from the buckets of the wheel and the nozzles which admit to the next stage, there being an element having a passage within the space, the said passage increasing circumferentially in the direction of the exhaust, the circumferential enlargement being made by an inclined edge of the passage and means for varying the cross sectional area of the passage, the said means operating to expose the nozzles in the direction opposite to the direction of rotation of the wheel, so that the fluid at low loads will flow along the inclined edge of the opening.

9. A stage turbine, a space in a stage between the discharge from the buckets of the wheel and the nozzles which admit to the next stage, there being an element having a passage within the space with a slide valve at the ultimate end thereof, the passage increasing circumferentially in the direction of the exhaust, the circumferential enlargement being made by an inclined edge of the passage, the valve moving to expose the nozzles in the direction opposite to the direction of the rotation of the wheel, so that the fluid at low loads will flow along the inclined edge of the opening.

10. A stage turbine, having a space in a stage between the discharge from the buckets of the wheel and the nozzles which admit to the next stage, there being a passage within the space, with a slide valve at the ultimate end thereof, the passage increasing circumferentially and decreasing radially in the direction of the exhaust, the circumferential enlargement being made by an inclined edge of the passage, the valve moving to expose the nozzles in the direction opposite to the direction of rotation of the wheel, so that the fluid at low loads will flow along the inclined edge of the opening.

This specification signed and witnessed this 27th day of April, 1907.

CHARLES G. CURTIS.

Witnesses:
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