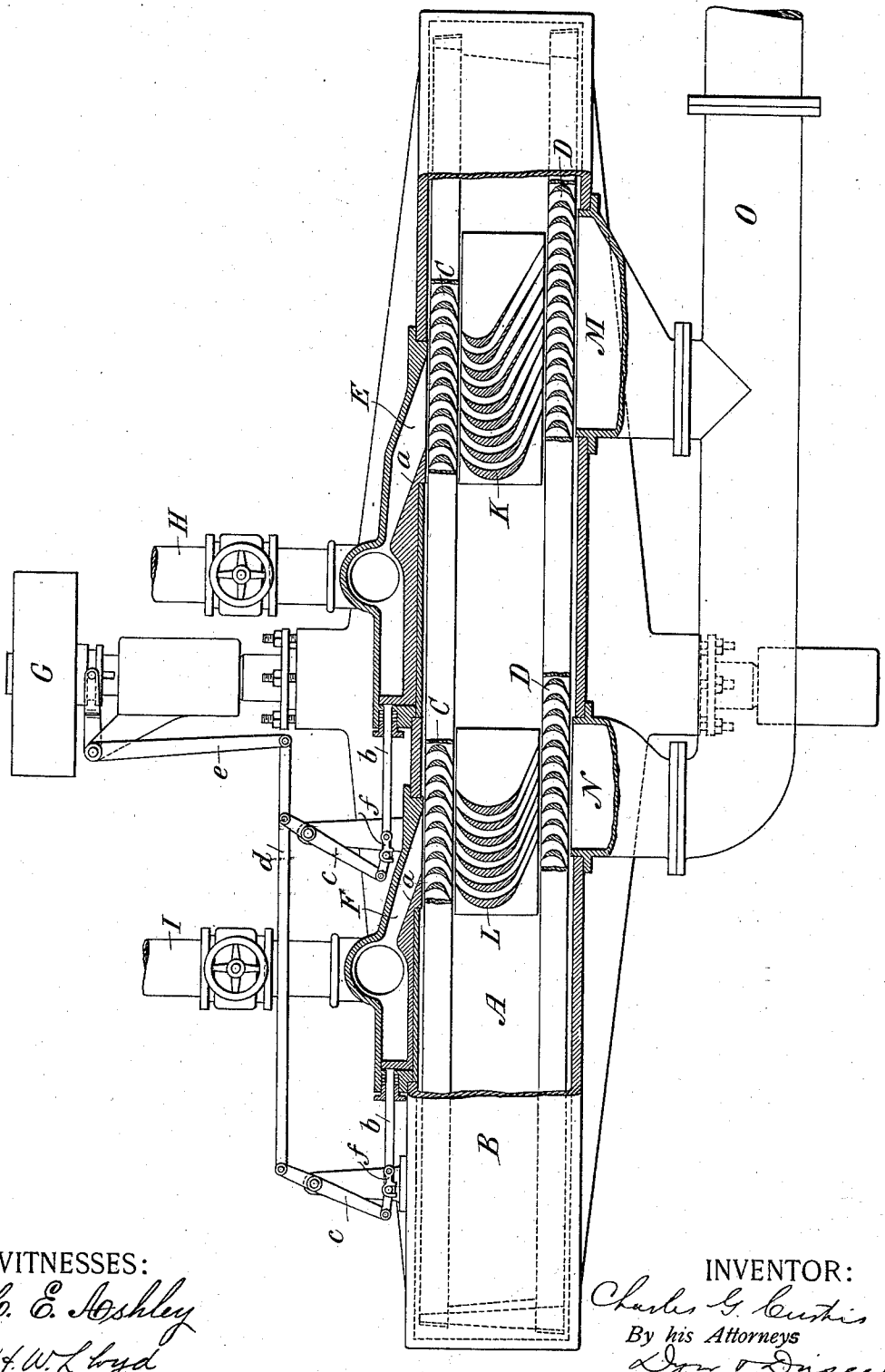
(No Model.)

# C. G. CURTIS.

## ELASTIC FLUID TURBINE.

No. 590,210. Patented Sept. 21, 1897.

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# UNITED STATES PATENT OFFICE.

CHARLES G. CURTIS, OF NEW YORK, N. Y., ASSIGNOR TO THE CURTIS COMPANY, OF SAME PLACE.

## ELASTIC-FLUID TURBINE.

SPECIFICATION forming part of Letters Patent No. 590,210, dated September 21, 1897.

Application filed January 19, 1897. Serial No. 619,742. (No model.)

*To all whom it may concern:*

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

In an application for patent already filed by me (Serial No. 601,601, filed August 4, 1896) I have described an elastic-fluid turbine constructed on the principles laid down in my Patents Nos. 566,967, 566,968, and 566,969, which is adapted to be used either as a condensing or non-condensing engine by utilizing the elastic fluid at different ratios of expansion, and as one illustration of that invention I have described in said prior application providing an elastic-fluid turbine of this character with two delivery-nozzles producing different ratios of expansion of the elastic fluid, one adapted for condensing and the other for non-condensing work, and with separate and properly-proportioned stationary intermediate passages between the movable vanes of the turbine wheel. This form of the broad invention covered by said prior application not being specifically claimed therein, it is my purpose to claim the same in the present application, together with some further improvements which I have devised.

In the accompanying drawing, forming a part hereof, the figure represents a top view and partial horizontal section of a turbine embodying my invention.

A is the turbine wheel, inclosed in a suitable case B and carrying on its periphery at its two edges the two complete circular ranges of movable vanes C D. The passages formed by the vanes C D preferably expand in the direction of the flow of the elastic fluid to overcome frictional retardation, the vanes D being deeper radially than the vanes C, as illustrated by the dotted lines to the right and left of the figure.

E and F are two delivery-nozzles, preferably expansion-nozzles. These nozzles are differently proportioned so as to produce different ratios of expansion, the nozzle E having the proper expansion to adapt it to condensing work, while the nozzle F has the proper expansion to adapt it to non-condensing work. The nozzles are provided with sliding tongues *a* for varying the volume of the elastic fluid without changing its velocity. These tongues *a* are connected by stems *b* with pivoted levers *c*, which are connected through rods *d e* with a speed-governor G. The stems *b* and levers *c* are connected together by gab-hooks *f*, so as to permit the disconnection of the sliding tongue of either nozzle from the governor, if desired.

The particular form of adjustable expansion-nozzle which is illustrated is that described and claimed in my application, Serial No. 601,605, filed August 4, 1896.

Connected with the nozzles E and F are pipes H and I, leading to the steam-boiler or other source of elastic fluid under pressure and provided with suitable valves. Located in line with the two nozzles E F, so as to deliver the elastic fluid from one set of movable vanes to the other, are two intermediate stationary passages K L, having peculiarities which will be presently described.

Opening out of the shell B opposite the two points of delivery of the elastic fluid from the second set of movable vanes D are the exhaust-ports M N, connected with the exhaust-pipe O. The exhaust-pipe O extends to a condenser or other means for producing less than atmospheric pressure and to an atmospheric exhaust, one or the other form of exhaust being used, according to the conditions of operation.

The intermediate stationary passages K L are preferably divided by vanes into a number of passages in order to avoid eddy-currents and to make such passages automatically adjustable to convey a fluid-jet of greater or less volume, according to the adjustment of the nozzles. The stationary passage K in line with the nozzle E for condensing work is wider than the stationary passage L for non-condensing work to accommodate the larger volume of the steam-jet. It is also necessary that the stationary passage K for condensing work should have a greater ratio of expansion between its delivering and discharging ends than the stationary passage L, because a greater increase of volume is re-

quired to overcome frictional retardation. This I accomplish by widening circumferentially the delivery end of the passage K. The delivery end of the passage L is not widened out circumferentially at all, as illustrated in the drawing, but it may be wider than the receiving end of the passage L.

As illustrated in the drawing, the vanes C and D are so proportioned that the receiving and discharging ends of the stationary passage L can have the same width, and the radial expansion produced by the flaring inner and outer walls, as illustrated in dotted lines to the left of the figure, will be sufficient to produce the required increase in volume of the fluid-jet to overcome frictional retardation when the turbine is operating as a non-condensing engine. In order to get the greater increase of volume required for the operation of the machine as a condensing-engine, the stationary passage K has not only varying top and bottom walls, but the discharging end is made wider circumferentially than the receiving end and delivers the fluid-jet to a larger number of the vanes of the second set. In this way the same vanes C D can be utilized for both condensing and non-condensing work with the same relative efficiency.

The invention involved in constructing the intermediate stationary passage by expanding it circumferentially I do not claim herein, except in its combination with the double-nozzle arrangement for producing a condensing or non-condensing turbine, because I propose to claim that invention in a separate application for a patent.

What I claim is—

1. An elastic-fluid turbine having in combination with the same wheel, two nozzles and two working passages through movable vanes, one nozzle and working passage being adapted to utilize the elastic fluid at a different ratio of expansion from the other nozzle and working passage, whereby the turbine may be used either as a condensing or non-condensing engine, substantially as set forth.

2. In an elastic-fluid turbine, the combination with a compound wheel (*i. e.*, one having movable vanes upon which the fluid acts two or more times in succession), of two nozzles and two working passages including movable vanes, one nozzle and working passage adapted to utilize the elastic fluid at a different ratio of expansion from the other nozzle and working passage, substantially as set forth.

3. In an elastic-fluid turbine, the combination with a compound wheel having two sets of movable vanes, of two nozzles and two stationary intermediate passages, adapted to utilize the elastic fluid at different ratios of expansion, the difference in expansion of the intermediate passages being secured by expansion circumferentially, substantially as set forth.

4. In an elastic-fluid turbine, the combination with a wheel having movable vanes, of two nozzles and working passages, adapted to utilize the elastic fluid at different ratios of expansion, and means for varying the volume of fluid-jet in each working passage, without substantial change in its velocity, substantially as set forth.

5. In an elastic-fluid turbine, the combination with a wheel having two sets of movable vanes, of two adjustable expansion-nozzles and two adjustable intermediate stationary passages, one nozzle and intermediate passage adapted to utilize the fluid at a different ratio of expansion from the other nozzle and intermediate passage, substantially as set forth.

This specification signed and witnessed this 8th day of January, 1897.

CHARLES G. CURTIS.

Witnesses:
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JNO. R. TAYLOR.