No. 714,094.

Patented Nov. 18, 1902.

D. D. BOOK.

GOVERNOR FOR ELASTIC FLUID TURBINES.

(Application filed Mar. 18, 1899. Renewed Jan. 21, 1901.)

(No Model.)

3 Sheets—Sheet 1.

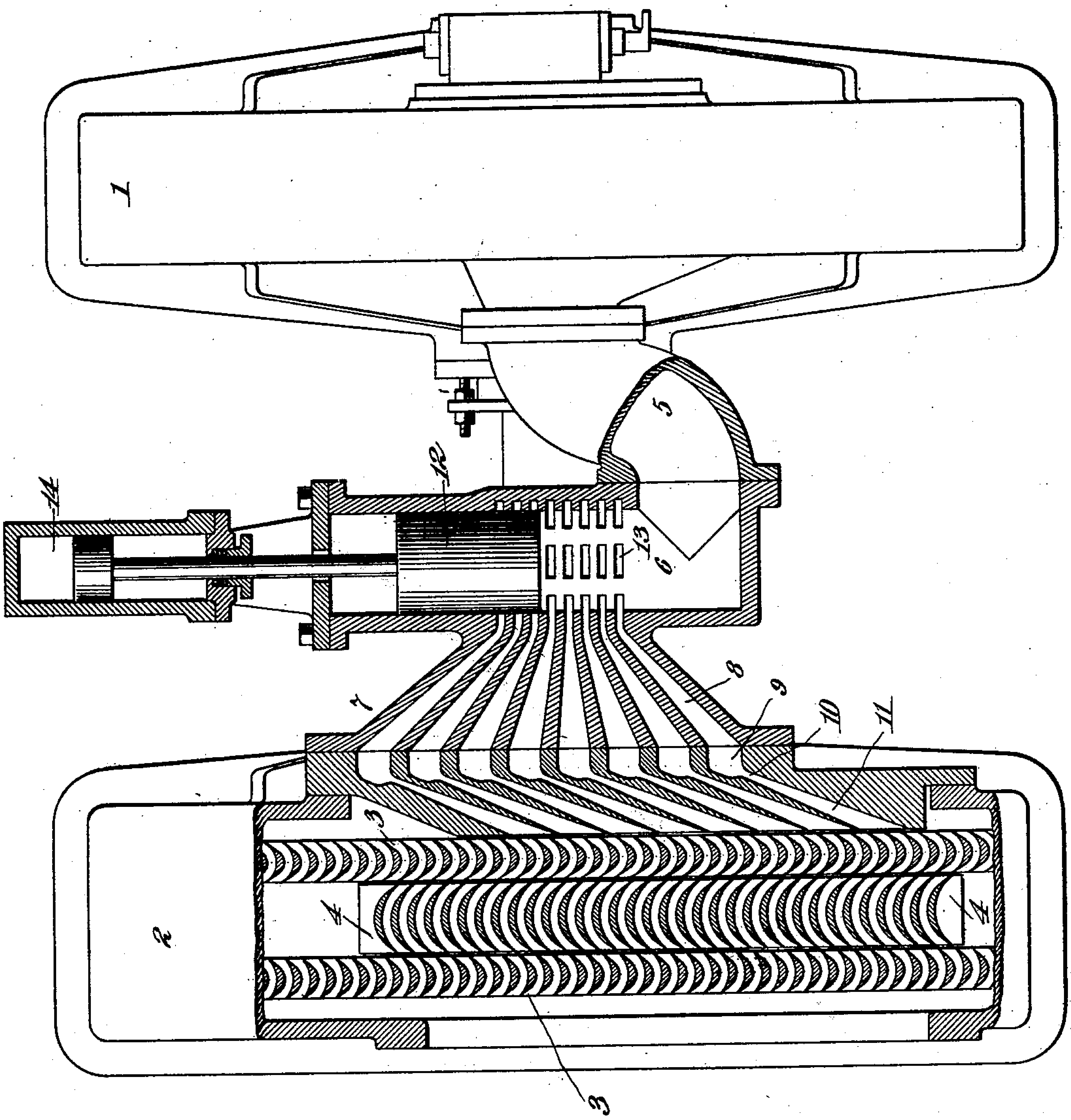

Fig. 1

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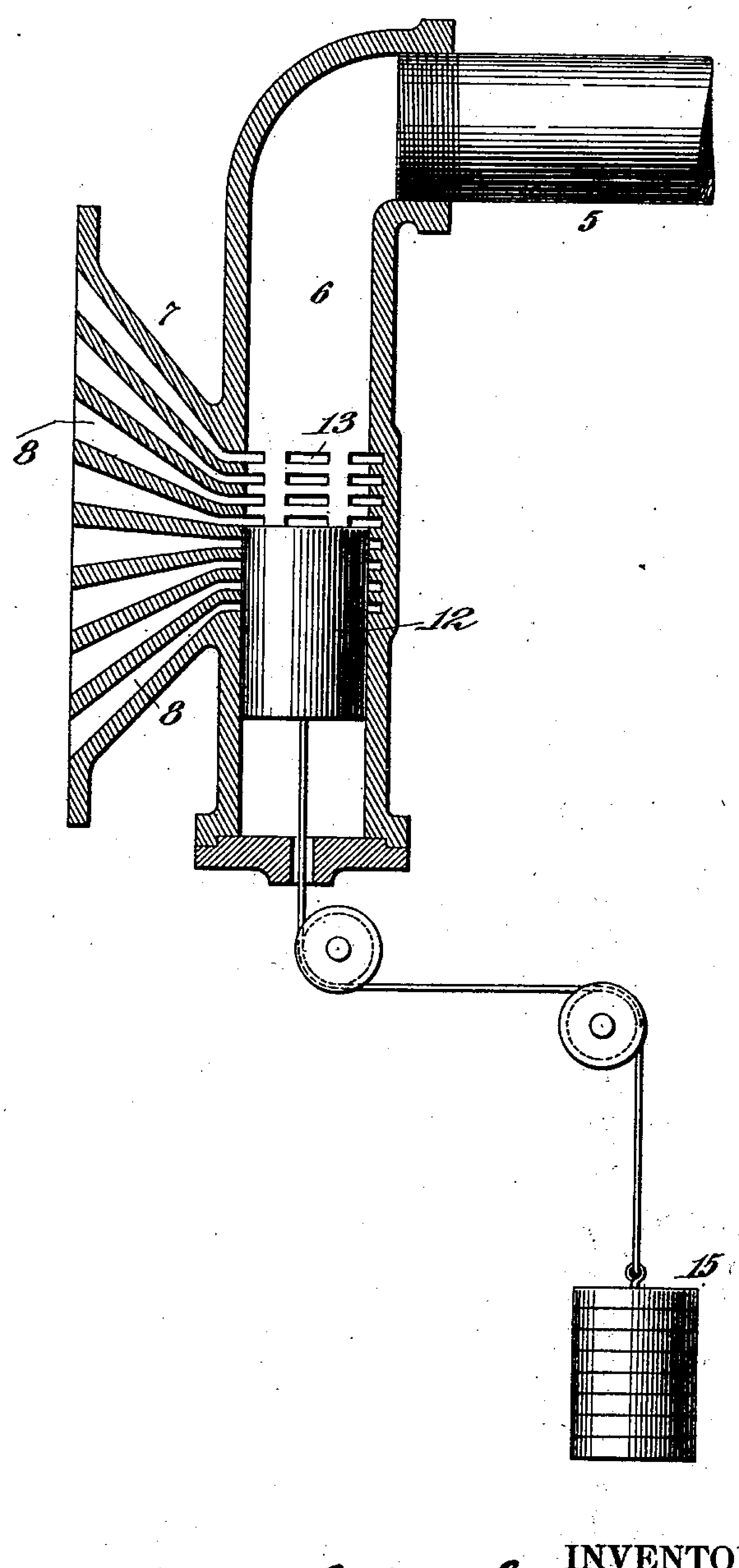
(No Model.) 3 Sheets—Sheet 2.

Fig. 2



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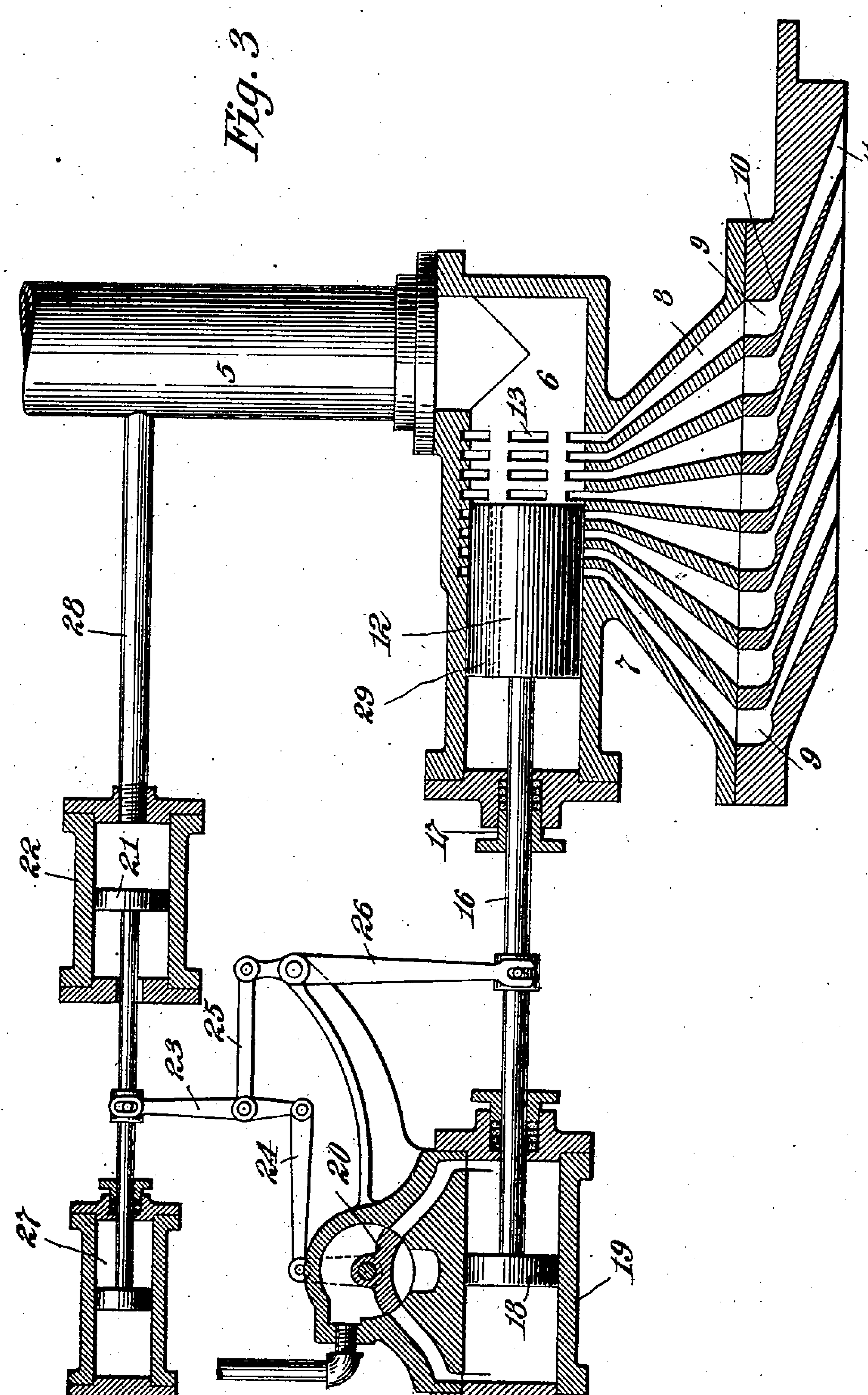

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UNITED STATES PATENT OFFICE.

DWIGHT DANA BOOK, OF BROOKLYN, NEW YORK, ASSIGNOR, BY MESNE ASSIGNMENTS, TO CURTIS STEAM TURBINE COMPANY, A CORPORATION OF WEST VIRGINIA.

GOVERNOR FOR ELASTIC-FLUID TURBINES.

SPECIFICATION forming part of Letters Patent No. 714,094, dated November 18, 1902.

Application filed March 18, 1899. Renewed January 21, 1901. Serial No. 44,156. (No model.)

To all whom it may concern:

Be it known that I, DWIGHT DANA BOOK, a citizen of the United States, residing in the borough of Brooklyn, in the city of New York, county of Kings, and State of New York, have invented a certain new and useful Improvement in Governors for Elastic-Fluid Turbines, of which the following is a specification.

My invention relates to an improvement in governors for elastic-fluid turbines.

In governing multiple-stage elastic-fluid turbines, such as are described in United States Patent No. 566,969, dated September 1, 1896, or in general turbines having parts of their working passages inclosed in two or more shells connected by passages or chambers, the problem is presented of affording a proper outlet for a varying quantity of fluid from such passage or chamber to the portion of the working passage of the next shell. If the outlet is of fixed effective area, the variation in quantity flowing will be necessarily accompanied by a variation of pressure in the passage or chamber and at the outlet, and if such variation of pressure is not desired the effective area of the outlet must be at all times proportionate to the quantity of fluid flowing.

If the method of governing is that described in United States Patent No. 566,967, dated September 1, 1896, whereby changes of quantity or volume of flow are had without changing the velocity at the point or points where the fluid acts upon the movable elements of the turbine, changes in the effective area of outlet are necessary and, as shown in said patent, are obtained by mechanical means actuated by the shaft-speed governor. The ideal conditions are had when such changes of outlet area accompany the variations of flow, so as to maintain a substantially constant pressure in the passage or chamber. Whether this method of governing is used or any other and whether more or less variation in pressure in the chamber or passage is permissible or not a method of causing such changes of the area of outlet by means set in motion by the fluid itself as its rate of flow changes may be availed of.

In practicing my invention in the particular case of a two-stage turbine governed in accordance with the method set forth in United States Patent No. 566,967 and having sectional nozzles, such as are described in application, Serial No. 666,379, of Chas. G. Curtis, filed January 12, 1898, I introduce as part of the passage or chamber connecting the shells a cylinder or other form of valve provided with one or more valve-ports, connecting with the various sections of the nozzle of the second shell or with the nozzle as a whole. If a cylinder is used, a piston is fitted therein which in different positions closes or discloses more or less of the valve-port area. The effective area of outlet thus depends upon the position of the piston in the cylinder. It may be made to close by its own weight or by any other means all the ports when the flow stops. As the flow begins again the fluid on reaching the chamber or passage the outlet from which is closed by the piston at once rises in pressure, and as soon as this pressure is sufficient to lift the weight of the piston or to overcome whatever force holds it in its then position a movement of the piston will take place, whereby an area of outlet will be disclosed sufficient to carry the flow of fluid at a pressure at which the piston will be in balance. If the mechanism has been arranged to that end, the force tending to move the piston into the position where it closes all outlet areas may be constant at all times, in which case the force required to hold it in balance and disclose any required area of outlet will always be constant, and as the cross-sectional area of the piston is constant the piston will always tend to move one way or the other, except when the fluid is at some particular pressure. Any drop in pressure will tend to reduce the outlet area by a movement of the piston, and a rise in pressure will tend to increase it. As the flow varies a concomitant variation in the outlet area is thus had, so that the pressure of the fluid will remain constant in the passage or chamber. Instead of moving the piston or valve directly it may be moved by a suitable relay-motor or other device, the latter being subjected to and under the control of the pressure, which it is desired to maintain uniform. If an absolutely constant pressure is not desired in the passage or chamber, the piston or valve may be moved by the fluid-pressure upon its cross-sectional area and against the resistance of a spring or other device which is not constant in all positions of the piston or valve.

If the outlets from the passage or chamber are not ample in effective area to carry all the fluid which may reach them from the anterior portions of the turbine, the results aimed at may not be had.

It is understood that the method described may be practiced between any two shells of a multiple-stage turbine—for example, a three, four, or five or more stage turbine—and the desired absolute pressures may be thereby automatically maintained by means set in motion by the fluid itself as its rate of flow from the main supply changes.

Instead of the sectional nozzle shown in the drawings any form of device for admitting the fluid to any stage whereby it may be governed in accordance with the method described in United States Patent No. 566,967 may be used—for instance, an adjustable nozzle; but such method of governing need not be applied to all the stages.

In the accompanying drawings, Figure 1 represents a two-stage turbine, illustrating an embodiment of my improved governor applied to the sectional nozzle of the second shell, the construction illustrated providing for the maintenance in the distributing-chamber of a pressure above that of the atmosphere; Fig. 2, a sectional view showing only the distributing chamber and passages to the sectional nozzle and illustrating a construction that may be employed where the pressure to be maintained is below atmospheric pressure; and Fig. 3, a smilar view showing the distributing-chamber and sectional nozzle and illustrating devices that may be used when it is desired to control the valve indirectly—as by a power-relay, for example.

In all the above views corresponding parts are represented by the same numerals of reference.

1 and 2 represent the shells of a two-stage turbine, such as described in United States Patent No. 566,969, before referred to. In each shell a wheel rotates, carrying one or more movable vanes 3 3, and usually a set of stationary intermediate vanes 4 is mounted between the movable vanes.

5 is the exhaust from the first-stage turbine, which leads into a distributing-chamber 6, distributing into the sections of a sectional nozzle 7 for the second-stage turbine 2. This sectional nozzle comprises a series of passages 8, each leading into separate sections of a sectional expansion-nozzle 9, such as described in the application Serial No. 666,379, before referred to, having a contracted throat 10 and diverging walls 11, which extend to the discharging ends of the sections, at which point the separating-walls are made as thin as possible, whereby the several separate jets or streams will merge into a single jet or stream at the points of discharge. The first stage of the turbine 1 may be provided with a sectional nozzle for receiving the elastic fluid from the source of supply or with any other variety of nozzle adapted to govern it, as may be desired, provision being preferably made to regulate the supply of elastic fluid by a centrifugal governor. (Not shown.) In order that regulation may be effected, in the particular instance in which my invention is illustrated the pressure within the distributing-chamber 6 should be preferably maintained approximately constant, notwithstanding any changes in quantity of volume delivered to it from the first stage of the turbine. The distributing-chamber is therefore provided with a valve 12, which closes and discloses a varying number of the ports 13, which connect with the passages 8.

In Fig. 1 it will be observed that the weight of the valve 12 opposes the pressure within the distributing-chamber, and in consequence the pressure of the elastic fluid in the distributing-chamber will be determined thereby and will be kept constant, since if the pressure tends to increase the valve 12 will be elevated to disclose an increased number of the ports 13 to compensate for the increase in the flow of the elastic fluid which caused the rise in pressure. On the other hand, should the flow of the elastic fluid decrease its pressure will also tend to fall, and the valve 12 will descend to close more of the ports 13, whereby the opportunity for escape of the elastic fluid will be reduced and its pressure increased. I illustrate a dash-pot 14, connected to the stem of the valve 12, to prevent extreme sudden movements of the valve under sudden changes in volume or quantity flowing.

Obviously with the device shown in Fig. 1 the pressure of the elastic fluid in the distributing-chamber will be maintained as much above atmospheric pressure as is required to balance the excess weight of the valve 12.

If the valve were inverted, whereby its weight tended to disclose an increased number of the ports 13, the pressure within the distributing-chamber would be maintained below that of the atmosphere. This is practically the construction shown in Fig. 2, except that in addition to the weight of the valve 12 I have shown a separate weight 15 attached thereto. It will be observed that the combined weight of 12 and 15 is opposed by the atmospheric pressure, the difference between the two determining the ultimate pressure of the elastic fluid in the distributing-chamber. As the flow of the elastic fluid, and therefore as the absolute pressure in the distributing-chamber tends to increase, the valve 12 will descend to disclose an increased number of the ports 13, and vice versa.

Instead of operating a valve to disclose a varying number of the sections of the sectional nozzle by the direct pressure of the elastic fluid whose escape is effected through the nozzle the valve may be operated indirectly by a relay-motor under the control of that pressure, and in Fig. 3 I illustrate an embodiment of means to this end. The valve 12 is provided with a stem 16, passing through a stuffing-box 17 at the end of the distributing-chamber and connected to a piston 18 in a fluid-pressure cylinder 19, the latter having a valve 20, which may be moved to permit fluid-pressure to reciprocate the piston 18 in one direction or the other. The valve 20 is operated from a piston 21, mounted in a cylinder 22, the particular connection between the piston 21 and said valve comprising a lever 23 and a connecting-link 24. The lever 23 is fulcrumed on a link 25, connected to a lever 26, the lower end of which is actuated from the valve 12. In order to prevent sudden movements of the parts to avoid overthrow, the piston 21 is preferably connected with a dash-pot 27. The cylinder 22 is connected by a pipe 28, so as to be influenced by the pressure of the elastic fluid. The pressure side of the piston 21 is opposed by a counterbalancing force, which is varied to suit the desired conditions of work. In Fig. 3 the pressure side of the piston is opposed by atmospheric pressure. With the device shown in Fig. 3 it will be observed that when the balance is disturbed between the piston 21 and the valve 12, caused by a variation in the pressure on the pressure side of the piston 21, the latter will be moved either by the elastic-fluid pressure or by the opposing pressure, whichever predominates. This movement of the piston 21 opens the valve 20 in the proper direction to permit the fluid-pressure cylinder 19 to move the piston 18 in the same direction as the piston 21. This carries the valve 12 with it, so as to disclose a varying number of the ports 13, whereby the increase in the quantity of the elastic fluid flowing will be compensated for, so as to result in a maintenance of the desired pressure. The movement of the piston 18, it will be observed, actuates the lever 26, which in turn operates the lever 23 to close the valve 20 when the piston 18 has moved to an extent corresponding to the movement of the piston 21, this form of connection between a controlling-cylinder and a power-cylinder being common in the mechanical arts. In order to balance the pressure on the valve 12, a passage 29 is formed in it. The advantage of the construction shown in Fig. 3 is that the controlling-cylinder 22 may be made relatively small, so that its piston will operate with but little friction, whereby the device will be more sensitive in operation than when a directly-actuated controlling-valve is employed.

Having now described my invention, what I claim as new, and desire to secure by Letters Patent, is as follows:

1. In an elastic-fluid turbine, the combination with two connected stages, one of said stages being adapted to utilize varying quantities of fluid with a substantially constant expansion in the working passage thereof, of valve mechanism automatically controlled by the intermediate pressure and maintaining the intermediate pressure substantially constant by varying the effective outlet for the fluid to the second of said stages, whereby an approximately constant expansion of the elastic fluid will be had in the stage adapted thereto, under change of load, substantially as set forth.

2. In an elastic-fluid turbine, the combination with two connected stages, each of said stages being adapted to utilize varying quantities of fluid with a substantially constant expansion in the working passage thereof, of valve mechanism automatically controlled by the intermediate pressure and maintaining the intermediate pressure substantially constant by varying the effective outlet for the fluid to the second of said stages, whereby an approximately constant expansion of the elastic fluid will be had in both stages, under change of load, substantially as set forth.

3. In an elastic-fluid turbine, the combination with two connected stages, one of said stages being adapted to utilize varying quantities of fluid without substantial concomitant changes of its velocity in the working-bucket passages, of valve mechanism automatically controlled by the intermediate pressure and maintaining the intermediate pressure substantially constant by varying the effective outlet for the fluid to the second of said stages, whereby an approximately constant velocity of the fluid will be had in the working-bucket passages of the stage adapted thereto under change of load, substantially as set forth.

4. In an elastic-fluid turbine, the combination with two connected stages, each of said stages being adapted to utilize varying quantities of fluid without substantial concomitant changes of its velocity in the working-bucket passages, of valve mechanism automatically controlled by the intermediate pressure and maintaining the intermediate pressure substantially constant by varying the effective outlet for the fluid to the second of said stages, whereby an approximately constant velocity of the fluid will be had in the working-bucket passages of both stages, under change of load, substantially as set forth.

5. In a multiple-stage elastic-fluid turbine, the combination with two connected stages, of means responsive to variations in the pressure of the elastic fluid discharged from the first of said stages and controlling the flow of the elastic fluid into the second in proportion to the varying volume or quantity discharged from the first so as to maintain a substantially constant terminal pressure for the first of said stages, whereby an approximately constant expansion of the elastic fluid will be maintained in either of said stages

under change of load, substantially as set forth.

6. In a multiple-stage elastic-fluid turbine, the combination with two connected stages, of means responsive to variations in the pressure of the elastic fluid discharged from the first of said stages and controlling the flow of the elastic fluid into the second in proportion to the varying volume or quantity discharged from the first so as to maintain a substantially constant terminal pressure for the first of said stages, whereby an approximately constant expansion of the elastic fluid will be maintained in both said stages under change of load, substantially as set forth.

7. In a multiple-stage elastic-fluid turbine, the combination with two connected stages, of an expansion-nozzle for the second stage, and means controlled by the pressure of the elastic fluid discharged from the first stage for varying the cross-sectional area of said nozzle without substantial change in the proportions between the cross-sectional areas of its receiving and discharging ends, substantially as set forth.

8. In a multiple-stage elastic-fluid turbine, the combination with two connected stages, of a sectional expansion-nozzle for the second stage, and a valve mechanism automatically controlled by the pressure of the elastic fluid discharged from the first stage and opening and closing by its movement the ports leading to the sections of said nozzle, substantially as set forth.

9. In an elastic-fluid turbine, the combination with an expansion-nozzle adapted to have its cross-sectional area changed without substantial change in the proportions between the cross-sectional areas of its receiving and discharging ends, of means controlled by the pressure of the elastic fluid in the chamber or conduit leading to said nozzle for effecting changes in the cross-sectional area of the nozzle, substantially as set forth.

10. In an elastic-fluid turbine, the combination with a sectional expansion-nozzle, of a valve controlled by the pressure of the elastic fluid in the chamber or conduit leading to said nozzle for opening and closing the sections of said nozzle, substantially as set forth.

This specification signed and witnessed this 9th day of March, 1899.

DWIGHT DANA BOOK.

Witnesses:
JNO. R. TAYLOR,
ARCHIBALD G. REESE.