No. 798,496. PATENTED AUG. 29, 1905.

B. S. CHURCH.

SPEED REGULATOR FOR TURBINES.

APPLICATION FILED NOV. 30, 1904.

2 SHEETS—SHEET 1.

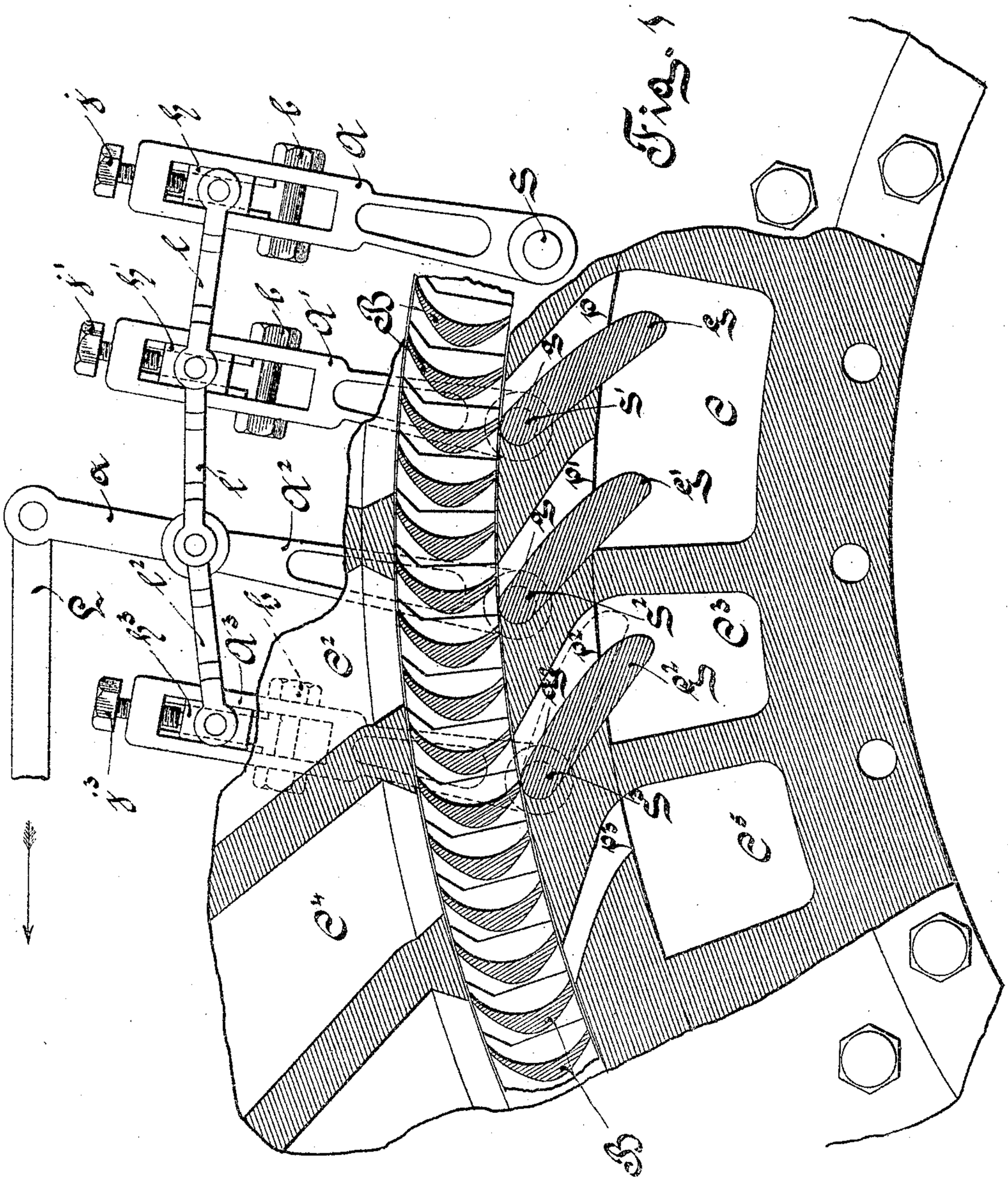

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Fig. 3

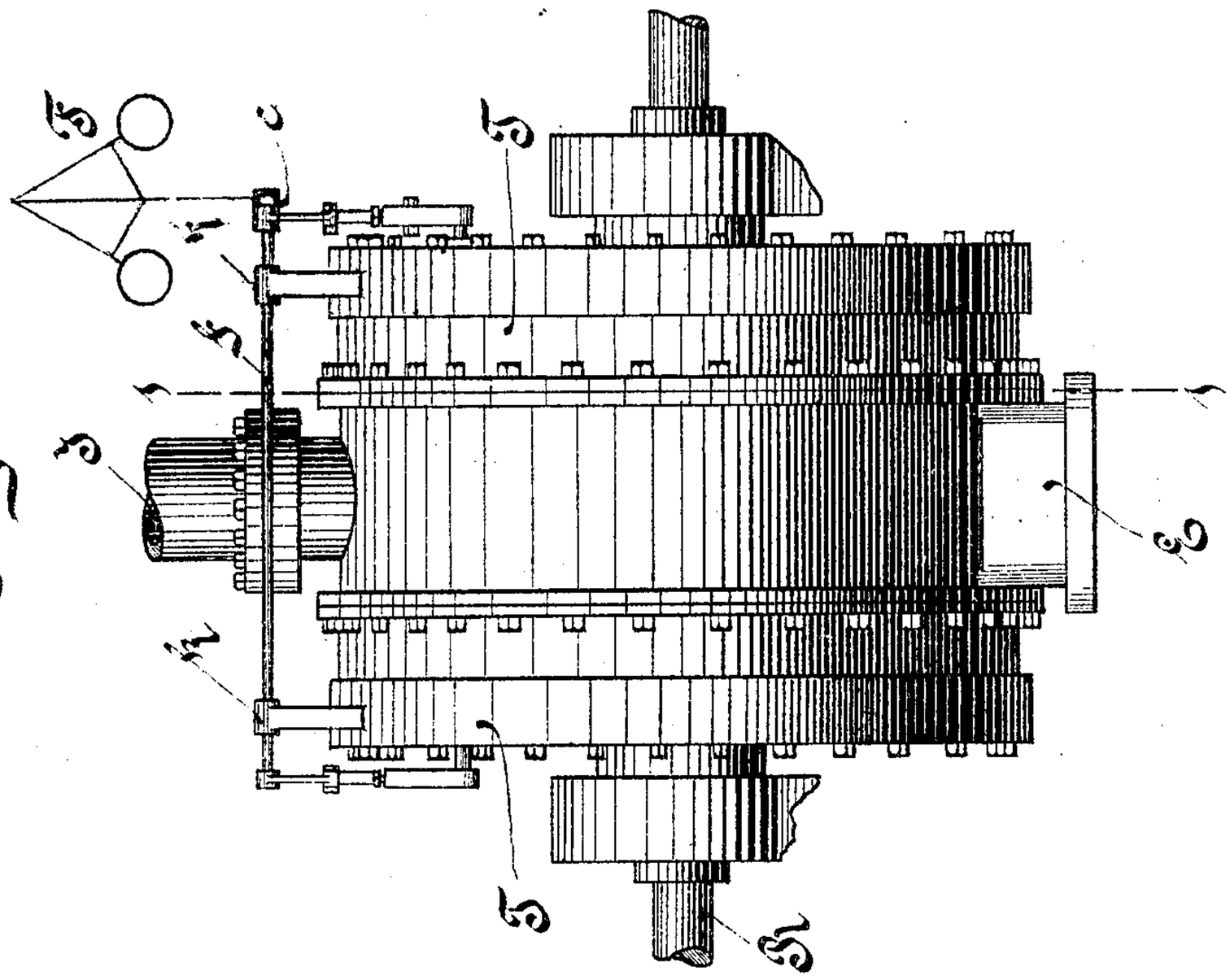
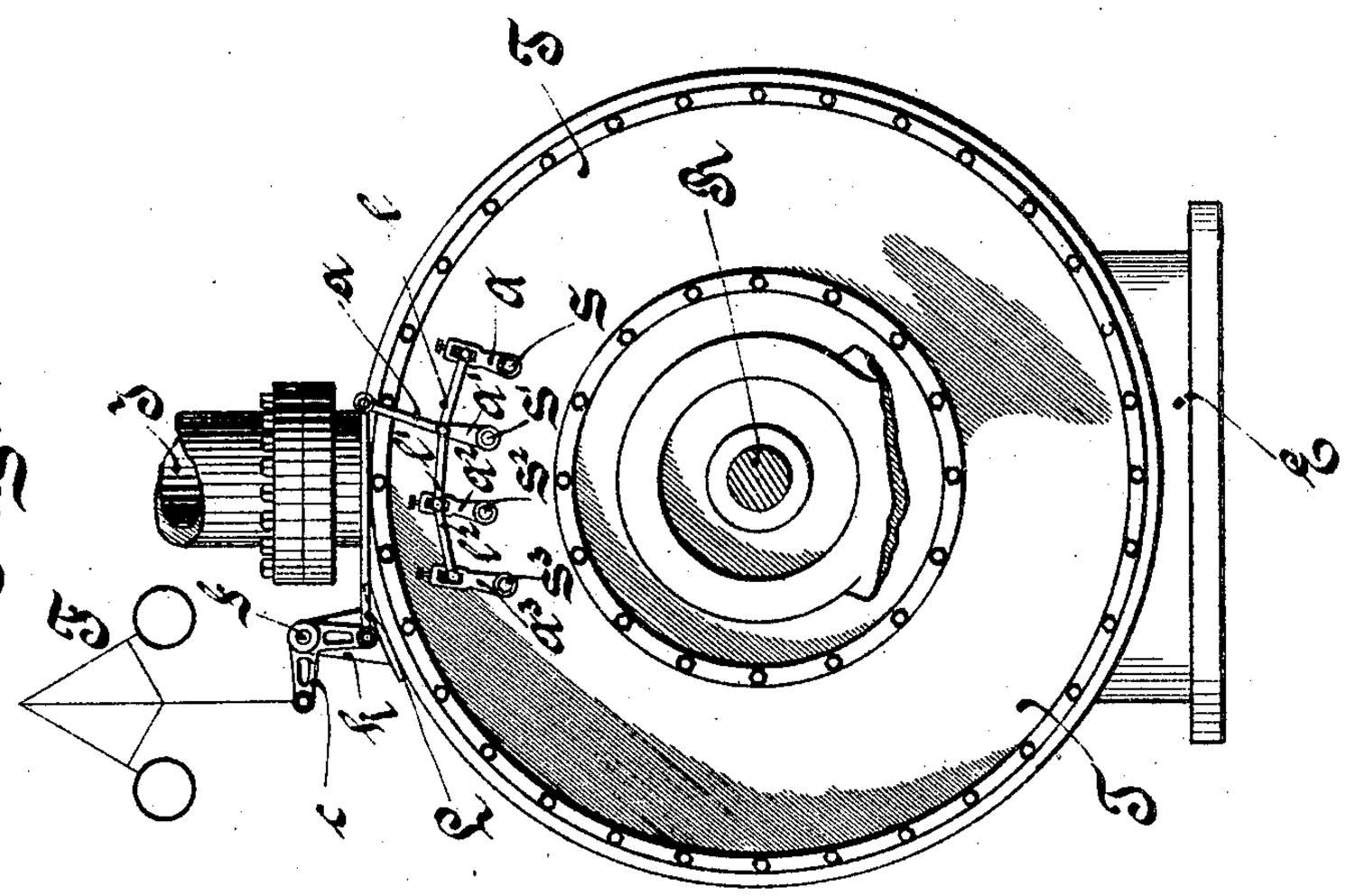


Fig. 2



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UNITED STATES PATENT OFFICE.

BENJAMIN S. CHURCH, OF NEW YORK, N. Y.

SPEED-REGULATOR FOR TURBINES.

No. 798,496. Specification of Letters Patent. Patented Aug. 29, 1905.

Application filed November 30, 1904. Serial No. 234,962.

To all whom it may concern:

Be it known that I, BENJAMIN S. CHURCH, of the borough of Manhattan, city, county, and State of New York, have invented certain new and useful Improvements in Speed-Regulators for Expansible-Fluid Turbines, of which the following is a full, complete, and exact description, reference being had to the accompanying diagrams, which are hereby made part thereof.

The object of my invention is to produce, first, a speed-regulator for expansible-fluid turbines by means of which the speed of rotation may be varied under all conditions of load without material diminution of efficiency, and, second, a speed-regulator adapted to maintain an approximately constant speed under variable load and depending upon principles which are better suited to the requirements of the expansible-fluid turbine than those upon which the ordinary throttling-governor operates.

I have shown my invention in connection with one of my turbines, for which I have filed an application for patent, the serial number of which application is 227,294, and the date of filing October 5, 1904; but it will be clear upon examination that my invention can be applied with such modifications as would readily suggest themselves to any of the well-known forms of turbines, and I desire to cover the application of my speed-regulator to any and all such turbines and to any and all turbines using expansible fluids where the expansible quality of the fluid is rendered available for the development of power.

Figure 1 is an enlarged view of a portion of one of my turbines, showing the operating parts of the speed-regulator in position, the portion of the view showing the interior of the turbine being taken along the line 1 1 of Fig. 3. Figs. 2 and 3 are exterior views of one of my turbines, showing a method of connecting the speed-regulator with the devices intended to actuate it when used as a governor for constant speed with variable load, for which use I will now proceed to describe it; but I would be understood as claiming equally its use as a speed-regulator for variable speed and load, such use being more readily explained after a description of its use as a governor for constant speed.

In Fig. 1 it will be understood that the high-pressure expansible fluid entering the turbine through the inlet I (shown in Figs. 2 and 3) fills the chamber C, from which it passes out through the ports p and p' against the moving bucket-blades, (marked B.) Inasmuch as my turbine is double on each side, as is described more fully in my patent application above referred to, it is necessary to consider for the purposes of explanation only the portion of expansible fluid passing through the port p', since the said ports p and p' are of equal size and are each the beginning of a series of ports and chambers in all respects similar, in consequence of which each of the said ports p and p' passes one-half of the expansible fluid entering the chamber C, and each of the said portions of expansible fluid operates in a precisely similar manner upon the moving bucket-blades B. The portion of expansible fluid passing out through p' after making its impact upon the bucket-blades B enters the chamber C^2, from which it passes into the chamber C^3 through the casing of the turbine in a manner described fully in my patent application above referred to. From C^3 it passes out through the port p^2 against the blades B and into the chamber C^4, from which it passes into the chamber C^5 and through the port p^3 against the blades B, and so on until finally exhausted. The ports p', p^2, and p^3 increase in size by an amount which cannot well be shown in a small figure and which increase is calculated to correspond with the increasing volume of the expanding fluid in such manner that the velocity of the successive jets of expanding fluid is approximately uniform in the full-load or open position of the speed-regulator, as will be subsequently explained. Each of the ports p p' p^2 is rectangular in cross-section and is provided with a gate G G' G^2, fitting closely and capable of being moved across the said ports into the position shown by the dotted lines in connection with the gate G^2 by a partial rotation of the shafts S' S^2 S^3, to which the said gates are suitably connected. The shaft S is also provided with a gate, which is not shown. Each of the said shafts has at its outward extremity an arm A A' A^2 A^3, each arm being provided with a cross-head h h' h^3 except the arm A^2, which has an extension a, to which is connected, by means of the link L, the conical pendulum or other mechanism intended to actuate the speed-regulator when used as a governor for constant speed. The cross-heads h, h', and h^3 are connected together and to the arm A^2 by means of the links l l' l^2, and each cross-head is provided with

adjusting-screws j j' j^3, by means of which the position of the said cross-heads as respects the shafts S, S′, and S³ can be varied and in similar degree the relative angular movement of the said gates. The bolts marked b are provided in order to bind the cross-heads h, h', and h^3 in their required positions, as will subsequently be explained. The upper edges g, g', and g^2 of the gates G, G′, and G² are in the form of a curve which is so shaped that in all positions of the gate other than the full-open position the passage remaining open is in the form of an expansion-tube, as is shown by the dotted lines in connection with the gate G². It will be apparent that the nearer the gate approaches its closed position the greater will be the angular divergence between the edges g, g', and g^2 of the said gates and the opposite sides of the ports p, p', and p^2, and consequently the degree of expansion will be greater, and that I have accordingly devised a form of expansion-tube wherein the degree of expansion may be varied, and as this takes place during the first expansion of the fluid, before it strikes the blades of the turbine, the result is the same as admitting the expansible fluid at lower pressure to the turbine-wheel, with a consequent reduction of its velocity of rotation. As the expansion is increased the velocity of the expanding jet is similarly accelerated, and in order that this velocity may not become too great to prevent the jet from transferring its kinetic energy to the blades B in an efficient manner I have provided that the expansion shall take place in a plurality of steps, of which I have shown two—to wit, those taking place at the ports p' and p^2. I have not shown more for the sake of simplicity; but it is to be understood that I might have shown a gate in connection with the port p^3 and may use as many such gates as seem desirable, which will depend upon the conditions under which the expansible fluid operates. In many cases a single gate will obviously be sufficient. The reason for using the adjustable cross-heads will now be apparent, which is that the angular movement of the said gates must be in some degree proportional to the size of the ports in which they operate.

In Figs. 2 and 3 I have indicated a fly-ball or conical pendulum F, which is connected by the bell-crank c, the rock-shaft f, turning in the brackets k k, and the link L to the extension a of the arm A², whereby any change in the position of the arm of the conical pendulum will produce a corresponding change in the position of the gates G G′ G². Instead of a conical pendulum I may use any form of centrifugal governor or hydraulic governing device, or I may use any form of suitably-wound solenoid or other electrical governing device where the turbine is used in connection with an electric generator.

In order to prevent any irregularity in the operation of my speed-regulator by reason of unequal and unbalanced pressures on the opposite sides of the gates G, G′, and G², which would tend to interfere with their movement, I may provide a suitable piston working in a cylinder containing fluid at a pressure sufficient to balance such unbalanced pressures, the said piston being connected to any suitable portion of the mechanism—as, for instance, the link L. I may also provide any suitable system of springs or dash-pots to prevent irregular working; but I have not shown any such devices for the sake of simplicity and for the reason that their use would readily suggest itself.

In Fig. 3 I have shown my speed-regulating device as a governor operating on both sides of the turbine, which is so shown because my turbine is in general double-sided, both of which sides are in all respects similar. In Figs. 2 and 3, E is the exhaust for the expansible fluid, T the casing of the turbine, and R the rotating shaft, to which are connected the various devices intended to transmit or consume the power generated by the turbine.

Having described my speed-regulator when used as a governor for constant speed, it will be readily seen that by omitting the conical pendulum or other automatic device for compensating any change in load and substituting a suitable hand-lever and sector or similar device I may use my invention as a speed-regulator for variable speed and load—as, for instance, where the turbine to which it is connected is used for marine propulsion.

Having now fully illustrated and described my invention, what I desire particularly to claim is—

1. An adjustable expansion-tube having a side movable about a point at the discharge end of said expansion-tube.

2. An adjustable expansion-tube having a gate rotatable upon a shaft situated at the discharge end of said expansion-tube.

3. A speed-regulator for expansible-fluid turbines, having an expansion-tube with a movable side, a centrifugal or other governing device, and connecting means for operating the said movable side by said governing device, the said connecting means being adjustable to vary the relative movement of said movable side and said governing device.

4. A speed-regulator for expansible-fluid turbines operating in a plurality of stages, the said speed-regulator comprising a centrifugal or other governing device, a series of variable expansion-tubes, and connecting means for adjusting the said variable expansion-tubes by means of the movement of said governing device, the said connecting means being adjustable to vary the degree of adjustment of said expansion-tubes as respects the movement of said governing device.

5. A speed-regulator for expansible-fluid

turbines operating in a plurality of stages, the said speed-regulator comprising a centrifugal or other governing device, a series of variable expansion-tubes having movable sides, and connecting means for operating the said movable sides by the said governing device, the said connecting means being adjustable to vary the relative movement of the said adjustable sides, both as respects themselves and as respects the said governing device.

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Witnesses:
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