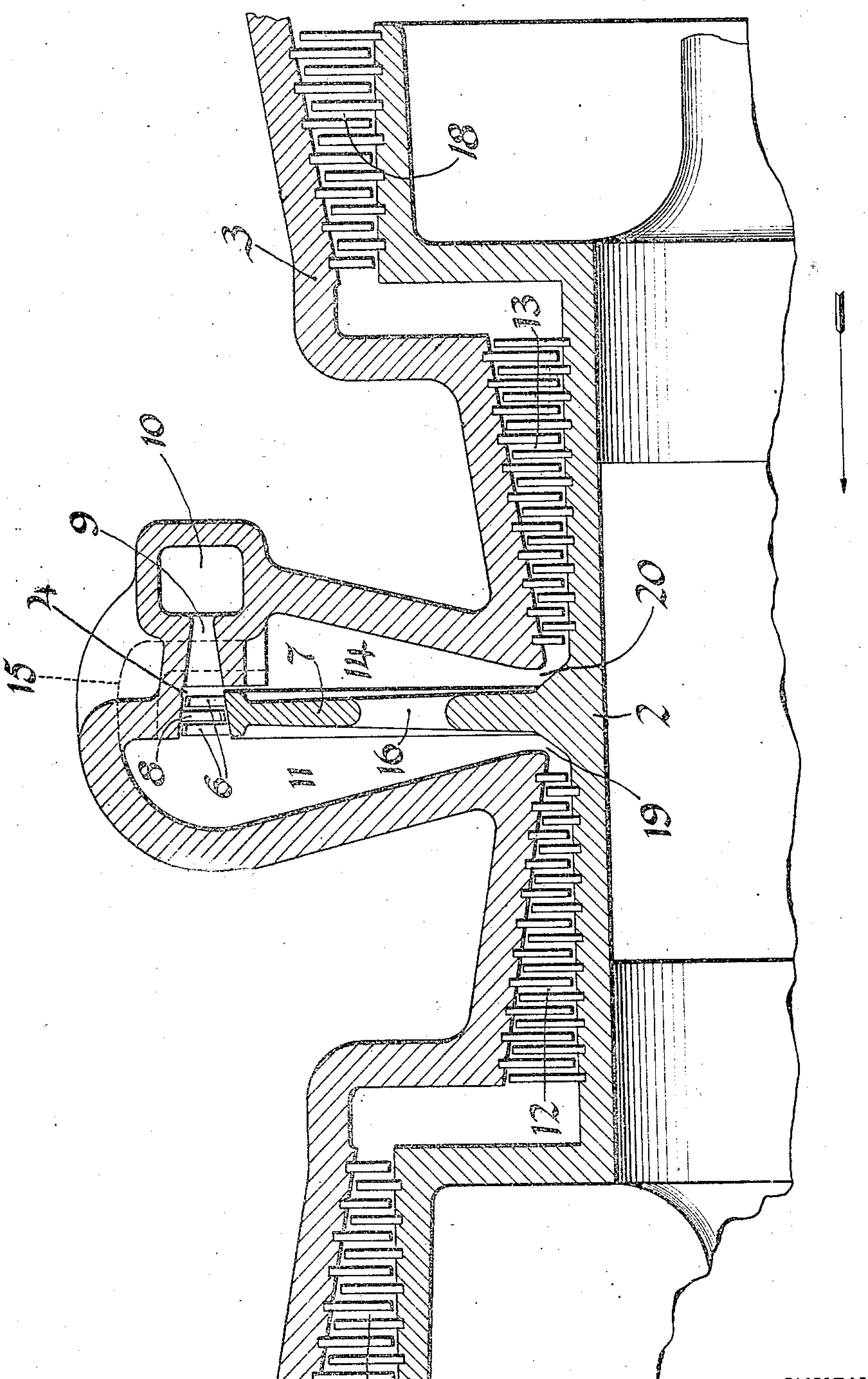
W. J. A. LONDON.

ELASTIC FLUID TURBINE.

APPLICATION FILED AUG. 8, 1907.

943,359. Patented Dec. 14, 1909.



WITNESSES:

INVENTOR.

William James Albert London,

BY Jno. S. Green

ATTORNEY IN FACT.

UNITED STATES PATENT OFFICE.

WILLIAM J. A. LONDON, OF EDGEWOOD PARK, PENNSYLVANIA, ASSIGNOR TO THE WESTINGHOUSE MACHINE COMPANY, A CORPORATION OF PENNSYLVANIA.

ELASTIC-FLUID TURBINE.

943,359. Specification of Letters Patent. **Patented Dec. 14, 1909.**

Application filed August 8, 1907. Serial No. 387,662.

To all whom it may concern:

Be it known that I, WILLIAM J. A. LONDON, a subject of the King of Great Britain, and a resident of Edgewood Park, in the county of Allegheny and State of Pennsylvania, have made a new and useful Invention in Elastic-Fluid Turbines, of which the following is a specification.

This invention relates to elastic fluid turbines and more particularly to marine and other turbines in which the rotor elements are subjected to longitudinal thrusts other than those due to pressure of the motive fluid in traversing the working passages of the turbine.

An object of this invention is the production of simple means for counter-balancing any longitudinal thrust on the turbine rotor.

My invention broadly consists in providing a turbine with a shiftable rotor, and so constructing the motive fluid passages of the turbine that an external or unbalanced fluid pressure thrust on the rotor will vary the distribution of motive fluid to the working passages and cause the pressure of the motive fluid within the working passages of the turbine to preponderate in one direction and counter-balance the external or unbalanced fluid pressure thrust.

In the drawings accompanying this application and forming a part thereof, I have shown a partial section of a turbine embodying my invention, but I do not wish it to be understood that I limit myself to the construction shown or to the type of turbine illustrated.

The turbine illustrated comprises a rotor element 2, which is journaled in suitable bearings, (not shown) and a casing 3 which surrounds the rotor and which is provided with motive fluid admission and exhaust ports, (not shown). The turbine is of the type known as "semi-double flow," and is divided into three stages,—a primary stage 4, through which the fluid flows in one axial direction, a divided intermediate stage, which receives motive fluid from the primary stage and through which the fluid flows in opposite axial directions, and a divided final or low pressure stage, which receives motive fluid from separate sections of the intermediate stage and through which the fluid flows in opposite axial directions to the turbine exhaust.

The primary stage comprises two rows of moving blades 6 mounted on a wheel 7, which is secured to and forms a part of the rotor, an intermediate row of stationary directing vanes 8 mounted on the turbine casing and coöperating with the moving blades and one or more nozzles 9, which are located in the turbine casing and which deliver motive fluid to the first row of blades 6. The nozzles 9 receive motive fluid from a chamber 10, formed in the turbine casing and communicating with the admission port of the turbine, which, as is customary, is controlled by a valve automatically actuated by a speed responsive device, (not shown). The nozzles 9 expand the motive fluid a predetermined amount and the blades 6 abstract without further expansion the velocity energy rendered available by the nozzle expansion.

The motive fluid discharged from the final row of blades of the primary stage is received by a chamber 11, which is located between the turbine casing and wheel 7 and which communicates directly with a section 12 of the intermediate stage. The chamber 11 also communicates with a section 13 of the intermediate stage by means of a chamber 14, formed between the other side of the wheel 7 and the turbine casing, and fluid passages 15, which are located in the casing adjacent to the nozzles 9. The chambers 11 and 14 also communicate with each other by means of openings 16, which extend through the wheel 7.

Each section of the intermediate stage comprises a plurality of alternate rows of moving blades and stationary vanes mounted respectively on the rotor and casing of the turbine and adapted to fractionally expand the motive fluid and abstract the available velocity energy by impact and reaction. The final stage is divided into sections 17 and 18, which communicate respectively with the sections 12 and 13 of the intermediate stage and which, like the intermediate stage, are provided with alternate annular rows of moving blades and stationary vanes.

The primary stage imposes no longitudinal thrust on the turbine rotor, since the motive fluid is expanded by the nozzles a certain predetermined amount and the energy abstracted by impulse or impact without further expansion. The longitudinal thrust on the rotor of the motive fluid in one section of the intermediate stage is balanced by the equal and opposite thrust of the motive fluid in the other section and the longitudinal thrust on the rotor of one section of the low pressure stage is counterbalanced by the equal and opposite thrust of the other section of the stage. Consequently, the turbine is balanced for all loads and steam pressures.

In order that I may balance external thrusts on the rotor, such, for instance, as the thrust occasioned on the rotor of a marine turbine by the propeller, or the thrust of the impeller of a centrifugal pump or compressor directly connected to the operating turbine, I automatically control the distribution of motive fluid to the bilaterally symmetrical portions of the turbine, so that the fluid pressure will preponderate in one direction and induce a thrust on the turbine which is equal and opposite to the thrust imposed by the external disturbing force. I accomplish this by proportioning the cross-sectional areas of the admission passages to the separate sections of the intermediate stage, and by providing the turbine with a shiftable rotor which will, by shifting in response to an unbalanced thrust, vary the effective areas of one or the other of the admission passages.

The admission passage 19 to the section 12 of the intermediate stage is, under normal conditions, equal to the free area of the fluid passage through the first row of stationary vanes of the section and communicates directly with the chamber 11. The admission passage 20 to the section 13 is equal in cross-sectional area to the free area of the fluid passage through the first row of stationary vanes of the section 13 and communicates directly with the chamber 14. These passages are formed between the casing and the wheel 7 of the rotor and are so located that any longitudinal movement of the rotor increases or decreases the areas of one or the other of the passages. With such an arrangement a thrust on the rotor that will shift it in a direction indicated by the arrow in Fig. 1 will decrease the area of the passage 19 and consequently decrease the amount of steam delivered to the section 12 of the intermediate stage and section 17 of the final stage. The amount of fluid delivered to the section 13 of the intermediate stage of the section 18 of the final stage will be unchanged and consequently the pressure within the fluid passages of the turbine will preponderate in a direction opposite to that indicated by the arrow and opposite to the external or disturbing thrust encountered by the rotor. The turbine rotor will adjust itself until the area of the passage 19 is such that the preponderating steam pressure will just balance the disturbing force. The rotor is capable of shifting in either direction and will consequently move under any unbalanced thrust until the rotor is restored to longitudinal equilibrium.

The shifting of the rotor and consequently the throttling of the motive fluid delivered to one half of the intermediate and final stages of the turbine will cut down the effective supply of fluid flowing through the turbine and will consequently tend to reduce the power delivered by the turbine. This tendency will, however, be overcome by the speed responsive device, which will operate the delivery valve to admit more motive fluid to the turbine. When the turbine is relieved of the external thrust, the preponderating fluid pressure within the bi-laterally symmetrical portions of the turbine will move the rotor to the normal or central position and the flow of motive fluid delivered to each side of the bi-laterally symmetrical portion will be equalized. The turbine will automatically control the distribution of fluid so that the preponderating pressure will just counterbalance any longitudinal thrust and consequently the ordinary thrust bearings will be unnecessary.

It will be apparent to those skilled in the art that a turbine constructed in accordance with my invention may be designed to counter-balance any end thrust whatever, either external or resulting from fluid pressure within the working passages of the turbine, and, moreover, it will be apparent that a single flow turbine may be designed and constructed which will automatically balance the longitudinal thrust on the turbine and which will be included within the scope of my invention.

What I claim is:

1. In combination with an elastic fluid turbine, a plurality of working stages and a longitudinally shiftable rotor element for the turbine adapted to control the delivery of motive fluid to said stages.

2. In combination in an elastic fluid turbine, a plurality of working stages and a rotor element for the turbine adapted to variably proportion the delivery of motive fluid to said stages.

3. In combination with the bilaterally symmetrical sections of a double flow turbine, a rotor element shiftable longitudinally of the turbine and adapted to proportion the delivery of motive fluid to said sections.

4. In an elastic fluid turbine, in combination with the rotor, a working stage and a thrust relieving device for said stage and means, dependent on the rotor, for varying the axial thrust of said stage and causing the thrust of said relieving device to preponderate.

5. In an elastic fluid turbine, in combination with a rotor capable of shifting longitudinally in its bearings, a working stage, a thrust relieving device for said stage and means, dependent on said rotor, for throt-

tling the supply of motive fluid to said stage and causing the axial thrust of said relieving device to preponderate.

6. In an elastic fluid turbine, in combination with a rotor capable of shifting longitudinally through its bearings, a working stage, an agent for counter-balancing the axial thrust of said stage and means, dependent on the rotor, for throttling the supply of motive fluid to said stage and causing the axial thrust of said agent to preponderate.

7. In combination with the two sections of a double flow turbine, a motor element adapted to vary the amount of motive fluid delivered to one section of the turbine independently of the amount delivered to the other section.

8. In an elastic fluid turbine, a rotor capable of shifting longitudinally through its bearings, a divided stage through which the fluid flows in opposite directions and means, including said rotor, for varying the amount of fluid delivered to one section of said stage independently of the amount delivered to the other stage.

9. In an elastic fluid turbine, a working stage, a thrust relieving device and means, dependent on the thrust imposed on the rotor of the turbine for varying the amount of motive fluid delivered to said stage.

10. In an elastic fluid turbine, a working stage, means for balancing the inherent axial thrust of said stage by fluid pressure and means dependent on the axial thrust encountered for decreasing the amount of motive fluid delivered to said stage and thereby causing the balancing means to exert a preponderating thrust on the rotor of said turbine.

11. In an elastic fluid turbine, in combination with the rotor, a working stage and an agent for counter-balancing the axial thrust occasioned by the motive fluid traversing the working passages of said stage and means dependent on the axial thrust encountered for causing the thrust of said stage to vary independently of the thrust of said agent.

12. In an elastic fluid turbine, in combination with the rotor, a working stage and a thrust relieving device for said stage, and means dependent on the axial thrust encountered for decreasing the axial thrust of said stage and causing the thrust of said relieving device to preponderate.

13. In an elastic fluid turbine, a divided stage through which the fluid flows in opposite directions, and means dependent on the axial thrust encountered for varying the amount of fluid delivered to one portion of said stage independently of the amount delivered to the other portion of said stage.

14. In an elastic fluid turbine, a plurality of working stages and means within the turbine and controlled by the rotors of the turbine for varying the amount of motive fluid delivered to one or another of said stages.

In testimony whereof, I have hereunto subscribed my name this 6th day of August, 1907.

WILLIAM J. A. LONDON.

Witnesses:

CHARLES W. McGHEE,

R. P. McINTYRE.