

G. WESTINGHOUSE.
ELASTIC FLUID TURBINE.
APPLICATION FILED FEB. 10, 1908.

935,569.

Patented Sept. 28, 1909.

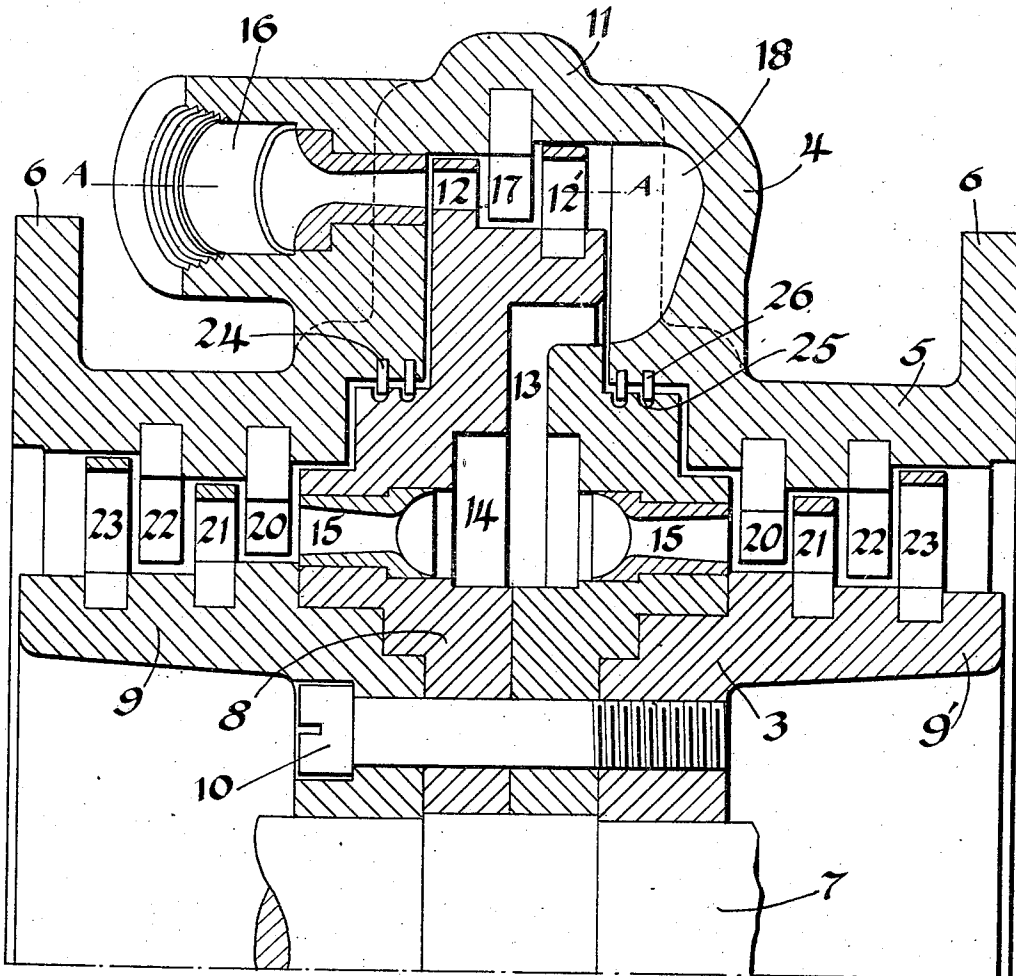


Fig. 1.

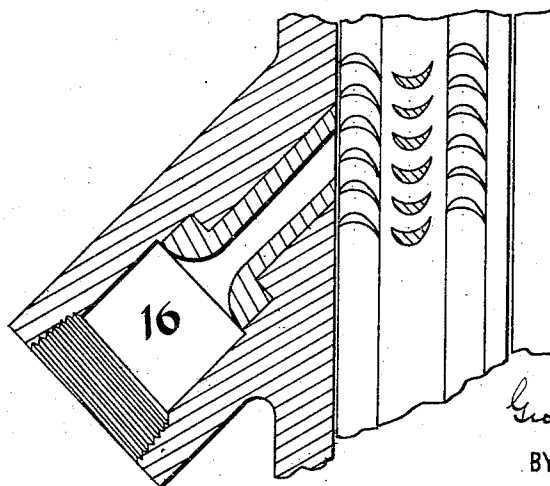


Fig. 2.

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ELASTIC-FLUID TURBINE.

935,569.

Specification of Letters Patent. Patented Sept. 28, 1909.

Original application filed June 24, 1903, Serial No. 162,910. Divided and this application filed February 10, 1908. Serial No. 415,090.

To all whom it may concern:

Be it known that I, GEORGE WESTINGHOUSE, a citizen of the United States, and a resident of Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Elastic-Fluid Turbine, of which the following is a specification, this application being a division of an application filed by me on June 24, 1903, Serial No. 162,910.

This invention relates to elastic fluid turbines and an object has been to produce a compact and relatively cheap turbine of comparatively low speed having relatively short blades in the low-pressure section. This and other objects, which will readily appear to one skilled in this art, I attain in the turbine illustrated in the accompanying drawings which form part of this application.

The turbine illustrated comprises a single parallel-flow primary stage and a divided secondary or low-pressure stage through the divisions of which the exhaust fluid from the primary stage flows in opposite directions.

A further object is the production of specific details of construction and arrangement of parts whereby a simple, efficient and compact turbine of relatively great capacity and low speed is obtained.

In the drawings, Figure 1 is a partial longitudinal section of a turbine embodying my invention; and, Fig. 2 is a transverse section along the line A—A of Fig. 1.

The motive fluid is admitted to the turbine by one or more expansion nozzles and is first caused to flow in an axial direction through the initial stage of the turbine.

The motive fluid is expanded by the divergent nozzles from the initial pressure to some predetermined lower pressure and the energy rendered available by the expansion is fractionally abstracted in the initial stage.

The fluid discharged from the initial or primary stage is conducted by a series of passages formed in the stationary casing and the rotor element to a pressure or rest chamber which is located in the rotor. The fluid leaving the chamber is divided and discharged in opposite directions by reaction nozzles into bi-laterally symmetrical sections of the low-pressure stage. The reaction

nozzles are arranged to expand the motive fluid from the pressure encountered in the rest chamber down to exhaust pressure and the velocity energy due to the expansion is fractionally abstracted by means of a plurality of rows of moving blades carried by the rotor. The reaction nozzles are so arranged that the reactive force of the expanding motive fluid passing through them is effective as a driving agent of the turbine. Such an arrangement under ordinary conditions would induce a longitudinal or endwise thrust of the rotor element, which is objectionable unless counterbalanced. I have, therefore constructed the rotor element with two rows of oppositely-disposed nozzles for the purpose of counterbalancing. The volume of the motive fluid increases as the fluid traverses the turbine and, consequently, the area of the working passages must be increased proportionally. To obtain working passages of adequate section, the working blades and vanes must ordinarily be made objectionably long or the turbine must be increased in diameter. A second, but none the less important, object, that of providing adequate fluid passages without unnecessarily increasing the length of the blades or the diameter of the turbine, is, therefore, attained by dividing the low pressure stage into sections.

Referring more particularly to the drawings: The turbine comprises a rotor element 3, provided with a plurality of rows of rotating blades, and a stationary casing 4, which incloses the rotor element and is provided with motive fluid supply nozzles and stationary vanes, which cooperate with the moving blades of the rotor.

The casing 4 consists of a substantially cylindrical portion 5 and end portions, (not shown) which are adapted to be secured on each end of the cylindrical portion by means of annular flanges 6. The rotor element 3 is rigidly mounted on a shaft 7 and consists of a middle portion 8 and end portions 9 and 9' of smaller diameter, which are secured on opposite sides of the middle portion by bolts or screws 10. The middle portion 8 of the rotor is inclosed within an enlarged portion 11 of the cylindrical portion 5 of the casing and is provided with annular rows 12 and 12' of peripherally mounted radial blades, a

centrally - disposed and radially - extending passage 13, a centrally - located annular chamber 14 and two rows of oppositely-disposed nozzles 15. The passage 13 communicates with the chamber 14 and the chamber 14 in turn communicates with the nozzles 15.

The casing 4 is provided with one or more expansion nozzles 16 which communicate with a source of motive fluid supply and extend at suitable angles through the walls of the enlarged portion 11. The nozzles 16 are constructed to partially expand the motive fluid and thereby convert a portion of its thermal and pressure energy into kinetic energy in the form of fluid velocity, which is delivered to the first row 12 of rotating blades. The blades of the row 12 are so constructed that they abstract a portion of the kinetic energy from the fluid stream and deliver the stream to intermediate guide vanes 17, which are mounted on the casing and which redirect the flow of fluid and deliver it to the rotating blades 12'. The blades 12' are preferably arranged to abstract the remaining kinetic energy of the motive fluid. The fluid discharged from the blades of the row 12' passes through a passage 18, formed between the rotor and the casing, and thence through the passage 13 of the rotor to the chamber 14. The chamber 14 is essentially a pressure or rest chamber inasmuch as the motive fluid entering it has practically no inherent velocity and must be further expanded before doing further work in the turbine. The motive fluid leaving the chamber 14 is delivered by the nozzles 15 to bi-laterally symmetrical working passages, which are located on each side of the chamber 14. Since the passages communicating with the nozzles 15 are similar, with the exception of their location, one only will be described in connection with the description of the travel of the motive fluid through the turbine.

The nozzles 15 are constructed so as to expand the motive fluid from the pressure of the chamber 14 down to exhaust pressure and thereby convert the remaining pressure and thermal energy of the fluid into kinetic energy in the form of fluid velocity. The nozzles 15 are rearwardly disposed relative to the direction of rotation of the rotor element and are so arranged that the reactive force of the expanding motive fluid passing through them will impart energy to the turbine. An annular row of radially-disposed directing vanes 20, mounted on the casing, receives the fluid delivered by the nozzles 15 and directing its flow delivers it to an annular row of rotating blades 21 mounted on the rotor. The blades 21 are so constructed that they abstract a portion of the available energy of the fluid stream and deliver the fluid to an adjacent row of stationary vanes 22, mounted on the casing, which redirect

the flow of fluid and deliver it to an annular row of rotating blades 23 mounted on the rotor. The blades 23, preferably, are so constructed that they abstract the remaining energy of the fluid and discharge the fluid into the exhaust passages of the turbine. The exhaust passages are located at either end of the turbine and are arranged to connect with a common condenser or the atmosphere, as desired.

Fluid packing glands 24, which consist of grooves 25 cut in the rotor and strips 26 mounted in the casing, which interleave with the grooves, are located on both sides of the chamber 14, and by presenting a tortuous passage to the motive fluid prevent it from leaking through the clearance space between the rotor and casing.

The capacity of the turbine may be increased by increasing the number of nozzles 16 and the number of nozzles 15; and various other changes may be made in the specific arrangement of parts and still fall within the spirit and scope of my invention.

What I claim is:

1. In a turbine, a stage through which the fluid flows in one axial direction and two stages through which the fluid simultaneously flows in different axial directions.

2. In an elastic fluid turbine, an impulse stage and a double flow re-action stage of smaller diameter than said impulse stage.

3. In an elastic fluid turbine, an impulse stage and a full peripheral admission double flow impulse and re-action stage of smaller diameter than the impulse stage.

4. In combination with an impulse stage of an elastic fluid turbine, through which the fluid flows in one axial direction only, a low-pressure re-action stage divided into two sections and through which the working fluid flows in opposite directions and a fluid passage within the turbine rotor, placing the inlets to said sections in communication one with the other.

5. In combination with a single-flow impulse stage of an elastic fluid turbine, a low-pressure re-action stage divided into two sections located on opposite sides of the center of the turbine and through which the working fluid flows in opposite directions and a fluid passage within the turbine rotor, placing the inlets to said sections in communication one with the other.

6. An elastic fluid turbine employing a single-flow primary stage and a divided low-pressure stage through which the working fluid flows in opposite axial directions.

7. An elastic fluid turbine employing a single-flow primary stage and a divided lower stage through which the working fluid flows in opposite directions.

8. In an elastic fluid turbine, an initial or primary stage through which the working fluid flows in one axial direction only and a

divided low-pressure stage through which the working fluid flows in opposite axial directions.

9. In combination with an initial or primary stage of an elastic fluid turbine through which the working fluid flows in one axial direction only, a divided low-pressure stage or section receiving the fluid leaving said other stage and through the divisions of which the fluid passes in opposite axial directions.

10. In a multi-stage elastic fluid turbine, two low-pressure stages arranged in parallel and through which the fluid from a single stage of higher pressure flows in opposite directions, a stage of higher pressure and means for passing the fluid from said stage of higher pressure to the inlets to said two stages.

11. In a multi-stage elastic fluid turbine, a stage through which the fluid flows in one axial direction only, two stages adapted to exhaust into a common condenser and means for passing the fluid from said stage to the inlets to said two stages.

12. In a multi-stage elastic fluid turbine, a stage employing stationary nozzles, two stages arranged in parallel and employing oppositely discharging nozzles and means for passing the fluid from said first stage to said two stages.

13. In an elastic fluid turbine, a stage employing expansion nozzles and impulse blades and through which the working fluid flows in one axial direction only, a divided section of lower pressure employing oppositely discharging expansion nozzles and impulse blades and a passage for conducting the working fluid leaving the blades of said stage to the nozzles in the divisions of said section.

14. In combination with a stage of an elastic fluid turbine provided with nozzles discharging the working fluid in one direction only, a low-pressure section provided with oppositely discharging nozzles and a passage for conducting the working fluid from said stage to the divisions of said low-pressure section.

15. In combination with a stage of an elastic fluid turbine through which the fluid flows in one axial direction only, a divided low-pressure section through the divisions of which the fluid flows in opposite axial directions and a passage for equally distributing the fluid leaving said stage to the divisions of said section.

16. In combination with a stage of an elastic fluid turbine through which the fluid flows in one axial direction only, a divided low-pressure section and a passage for conducting the fluid from said stage to the divisions of said low-pressure section.

17. In a turbine, an axial single-flow stage, a stage of lower pressure and working fluid

utilizing means for dynamically balancing the longitudinal or endwise thrust of said stage of lower pressure; the working fluid flowing through said means in a direction opposite to the flow of working fluid through said stage of lower pressure.

18. In a turbine, an axial single-flow stage, a second stage of lower pressure, and a blade-carrying element within the turbine casing through which the fluid flows in a direction opposite to that which flows through said second stage for balancing the axial or endwise thrust of said second stage.

19. In a turbine, a stage through which the working fluid flows toward one end of the turbine only, a second stage of lower pressure and a blade-carrying element, between the blades of which the fluid flows in a direction opposite to that which flows through said second stage for balancing the axial thrust of said second stage.

20. In combination with a stage of an elastic fluid turbine through which the fluid flows in one axial direction only, a low-pressure stage divided into two symmetrical sections located on opposite sides of the center of the turbine and through which the working fluid flows in opposite axial directions and a fluid passage within the turbine rotor, placing the inlets to said sections in communication one with the other.

21. In combination with a stage of an elastic fluid turbine through which the fluid flows in one axial direction only, a low-pressure stage divided into two sections, located on opposite sides of the center of the turbine, and through which the working fluid flows in opposite directions, and a fluid passage within the turbine rotor, placing the inlets to said sections in communication one with the other.

22. In combination with a single-flow stage of an elastic fluid turbine, a low-pressure stage divided into two sections, located on opposite sides of the center of the turbine and through which the working fluid flows in opposite directions, and a fluid passage within the turbine rotor, placing the inlets to said sections in communication one with the other.

23. In combination with a stage of an elastic fluid turbine through which the fluid flows in one axial direction only, a low-pressure stage divided into two symmetrical sections through which the fluid flows in opposite axial directions and a fluid passage within the rotor, placing the inlets to said sections in communication one with the other.

24. In a multi-stage elastic fluid turbine, a single-flow primary stage, two stages of lower pressure arranged in parallel and a chamber within the rotor for collecting the fluid issuing from said primary stage and distributing it to the inlets to said two stages of lower pressure.

25. An elastic fluid turbine having a plurality of expansion stages in each of which nozzles are utilized for converting thermal energy into kinetic energy in the form of fluid velocity and in which the energy due to said velocity is fractionally abstracted; one of said expansion stages being formed so that the working fluid passes therethrough in one general direction only and the low-pressure stage being formed of two symmetrical sections through which the working fluid flows in opposite axial directions, whereby proper expansion is obtained with smaller working areas in each division than would be possible if the low-pressure stage were not divided and was of the same diameter as each of said divisions.

26. In combination with a stage of an elastic fluid turbine through which the fluid flows in one axial direction only and in which velocity, due to the conversion of thermal

energy into kinetic energy in the form of velocity, is fractionally abstracted, a divided low-pressure section through the divisions of which the fluid flows in opposite axial directions and in each division of which velocity energy, due to the conversion of thermal energy into kinetic energy, is fractionally abstracted and means for distributing the fluid leaving said stage to said section.

27. In a turbine, a single flow stage and two full peripheral admission stages through which fluid from the first stage flows simultaneously in different axial directions.

In testimony whereof, I have hereunto subscribed my name this fifth day of February, 1908.

GEO. WESTINGHOUSE.

Witnesses:

GEO. J. TAYLOR,
JNO. S. GREEN.