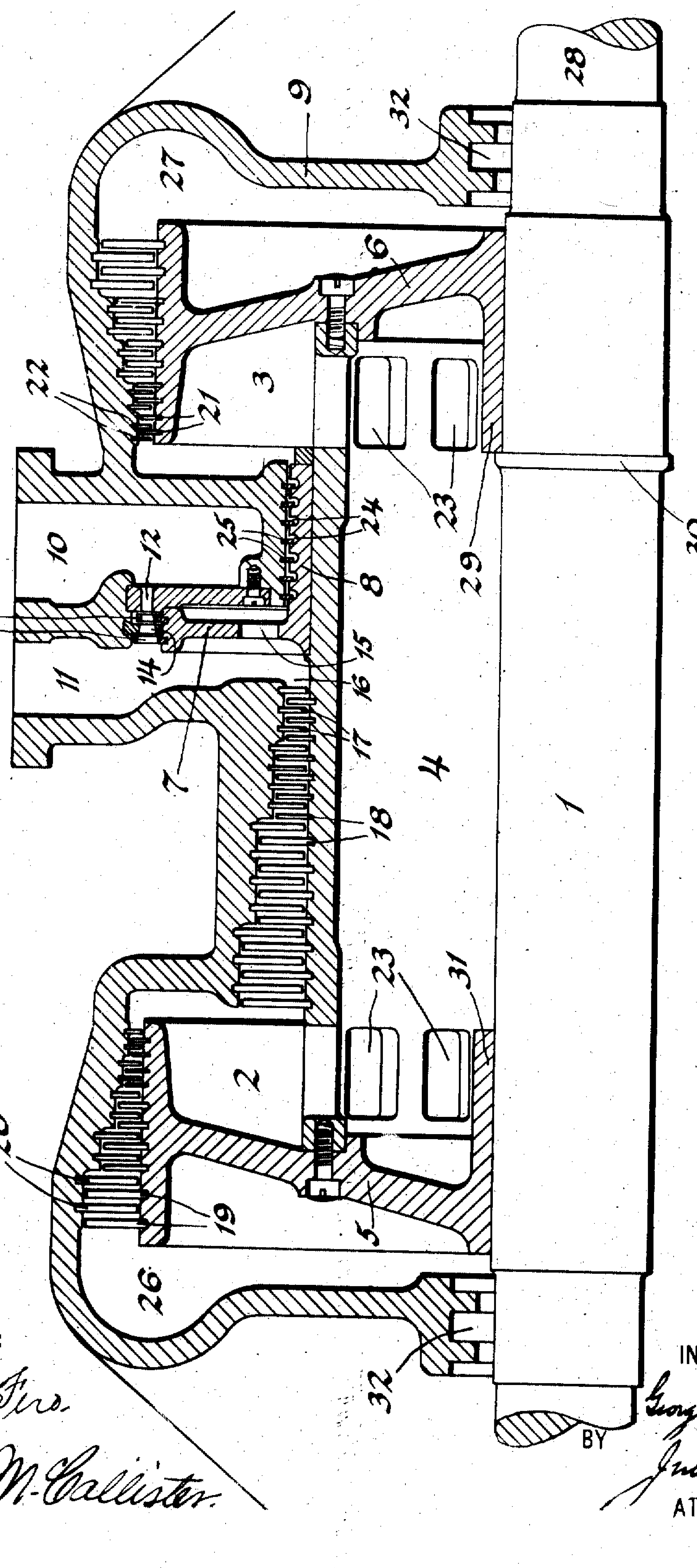
G. WESTINGHOUSE.
ELASTIC FLUID TURBINE.
APPLICATION FILED DEC. 26, 1905.

995,508. Patented June 20, 1911.



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ELASTIC-FLUID TURBINE.

995,508. Specification of Letters Patent. Patented June 20, 1911.

Application filed December 26, 1905. Serial No. 293,162.

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 Improvement in Elastic-Fluid Turbines, of which the following is a specification.

This invention relates to elastic fluid turbines and, as an object, has the production of an organized apparatus of this class which, I believe, is superior to anything heretofore produced.

A further object has been to produce a compound or multi-stage machine, each stage of which develops its proportion of the useful work in the most efficient manner.

As the multi-expansion "Parsons" type of turbine has proven to be exceptionally efficient; as various forms of impulse types have proven to be efficient as high pressure turbines and as the balance pistons necessary in the "single flow" "Parsons" type of machine are a source of more or less serious trouble, a further object of this invention has been to produce an organized apparatus of the class known as "two-bearing machines" in the initial or high pressure stage or section of which the "impulse system" is utilized, while in the intermediate or low pressure section or stage the "Parsons" principle is made use of, and the low pressure section so arranged that the low pressure balance pistons now common to the single flow "Parsons" type are rendered unnecessary.

While various means have been suggested for doing away with the balance pistons necessary in the "Parsons" turbine, none, so far as I am aware, have met with success. The means most widely tried, I believe, has been to build the machine so that the working fluid is taken in at the center or at opposite ends and flows in two directions through bi-laterally symmetrical halves. This necessitates a long machine with relatively great distance between the bearings, and, either necessitates a higher speed than is practical for a given sized machine, or such short blades and vanes in the primary and intermediate stages or sections, that the radial-clearance-leakage therein becomes of serious moment.

The balance pistons now common in the "Parsons single flow" machines, which balance the axial thrust due to fluid pressures inherent in this type of turbine (in which the fluid is expanded in the passages both between the blades forming the annular rotor rows as well as the vanes forming the annular stator rows and in which the power is derived both by impulse and reaction), are made steam tight by the "labyrinth system" of packing and the fine clearances necessary in this type of packing have rendered it practically impossible to utilize balance pistons when the low pressure blade drums are of large diameter.

A further object has been to so divide the low pressure "Parsons" element of my organized machine that the fluid flows through it in opposite directions, much the same as in the double-flow machine above referred to, whereby the axial thrusts of the low pressure stage or section are balanced. The objections which are present in a machine which is entirely "double flow", however, do not hold with the low pressure section alone, as utilized by me, for the working fluid in this stage is of such relatively large volume and the blades are of such length that the leakage due to radial clearance is negligible, which is not the case in the high and intermediate stages of "double flow" machines.

A further object has been to so construct the apparatus that all exterior ports or conduits, not only for the balance pressures but for conducting working fluid from the outlet of the intermediate stage or section to the balance division of the low pressure stage, are done away with.

A still further object has been to produce an organized machine having a divided low pressure section as described, in which the blades of the intermediate sections may be long enough to render the radial clearance leakages of comparatively small value.

These and other objects I attain in a turbine constructed as described in the specifications, illustrated in the single sheet drawing and pointed out in the appended claims.

The single view is a longitudinal section of the upper half of an organized turbine embodying this invention.

The turbine rotor, which is carried on the shaft 1, comprises two drums 2 and 3 with an intermediate quill or drum 4 bolted or otherwise secured to webs 5 and 6 of said drums. The quill or drum carries an impulse wheel 7 which is preferably formed integrally with a ring 8 forming a balance piston for the intermediate stage or section of the turbine. A casing 9 divided on the horizontal plane through its axis, as is now common, surrounds the rotor and has its inner surface so formed that fluid passages of the proper area are provided. A normal inlet 10 and an overload inlet 11 lead to the interior of the casing or stator, and each is provided with a suitable controlling valve (not shown). Nozzles 12 communicating with inlet 10 convert a portion of the thermal energy of the working fluid passing therethrough, into kinetic energy in the form of velocity, and the impulse wheel 7 is provided with a plurality of annular rows of impulse blades 13 between which intermediate guide vanes 14 are located; these impulse blades being arranged to fractionally abstract the energy due to said velocity. The nozzles 12 may be either divergent or not, depending upon the pressure drop desired.

The running wheel 7 is provided with openings 15 therethrough to insure like pressures on its opposite side at all times. The working fluid issuing from the last row of impulse blades 13 enters the annular opening 16 at the beginning of the intermediate stage or section; which section comprises annular rows of stationary vanes 17 secured to the stator and annular rows of blades 18 carried by the rotor. These vanes and blades 17 and 18 respectively are formed and spaced apart so that the fluid passing through the intermediate stage or section will be fractionally expanded, and so that said expansion will occur both in the passages between the blades and the passages between the vanes, whereby the useful work will be performed both by impulse and by reaction.

Drums 2 and 3 carry the blades for the divided low pressure stage or section; drum 2 carries annular rows of blades 19 similar to blades 18 which alternate with annular rows of stationary vanes 20 similar to vanes 17, while drum 3 carries similar annular rows of blades 21 which alternate with similar rows of vanes 22.

The hollow quill or drum 4 at each end is provided with fluid passages 23 in order that half the fluid issuing from the outlet of the intermediate section may pass through the quill to the balance division of the low pressure section, including blades 21 and vanes 22.

Balance piston 8, for the intermediate stage or section, is made steam tight by the "labyrinth system" of packing which, in the example shown, comprises annular grooves 24 formed in ring 8 and annular renewable flanges or strips 25 secured to the stator and which lie within said grooves. The two exhausts 26 and 27 connect with a common condenser so that the pressures on the outer sides of the drums 2 and 3 are the same. The pressure on the inner sides of the drums are the same owing to the fluid passage through the hollow quill. What working fluid leaks through the labyrinth packing for the intermediate balance piston does useful work in the balance division of the low pressure stage or section.

It will be understood that a so-called thrust bearing (not shown) adjacent to end 28 of shaft 1 is utilized for maintaining the proper axial clearances between the co-acting portions of the labyrinth packing.

The hub 29 of drum 3 is rigidly secured to the shaft and prevented from movement therealong by means of a collar 30, while hub 31 is free to move longitudinally thereof to accommodate the expansions which occur in the rotor.

It will be understood that any suitable type of packing glands may be utilized at 32 between the casing and the shaft ends.

It will be understood that various changes may be made in the apparatus without departing from the spirit of this invention and that a specific structure is shown and described merely for the sake of illustrating and describing my invention.

What I claim as new and useful and desire to secure by Letters Patent is:

1. In combination with one or more stages of an elastic fluid turbine having an inherent dynamic axial thrust in one direction only, means tending to statically counteract said thrust and a divided low pressure stage receiving the fluid from said stage or stages and through which the fluid passes in opposite directions whereby the axial thrusts of said divisions are balanced.

2. In an elastic fluid turbine, a single-flow high-pressure impulse section, a single-flow intermediate section in which alternate annular rows of stationary vanes and moving blades are utilized for fractionally expanding the working fluid, and a divided low pressure stage, each division of which receives working fluid from the intermediate stage and through which the fluid flows in opposite directions.

3. In combination with an elastic fluid turbine, one or more stages through which the fluid flows in one axial direction only, means for statically balancing the axial fluid pressure in said stages and a divided and counterbalanced low pressure stage in each division of which the working fluid performs useful work.

4. In an elastic fluid turbine, an initial stage through which the working fluid flows in one axial direction only, and in which velocity energy, due to the conversion of the working fluid's thermal energy into kinetic

energy in the form of velocity is abstracted without further expansion, an intermediate stage receiving the working fluid from said initial stage, through which the fluid flows in one axial direction only, and which comprises alternate annular rows of stationary vanes and moving blades whereby the fluid is fractionally expanded and energy derived both by impulse and by reaction, means for statically balancing the axial thrust inherent in the intermediate stage, a divided low pressure stage, each division of which comprises alternate annular rows of vanes and blades similar to those of the intermediate stage, through which the fluid flows in opposite axial directions and a hollow rotor or spindle placing the inlets to said low pressure stage in communication one with the other.

5. In an elastic fluid turbine, an initial stage through which the working fluid flows in one direction only and in which velocity energy, due to the conversion of the working fluid's thermal energy into kinetic energy in the form of velocity is absorbed, an intermediate stage through which the fluid flows in one direction only and which comprises alternate annular rows of stationary vanes and moving blades, formed and spaced apart so that the fluid passing therethrough is fractionally expanded and energy derived, both by impulse and by reaction, a divided low pressure stage, each division of which comprises alternate annular rows of vanes and blades similar to those of the intermediate stage, and through which the fluid flows in opposite directions and a hollow rotor or spindle placing the inlet ends of the low pressure stage in communication one with the other.

6. In an elastic fluid turbine, an initial stage through which the working fluid flows in one axial direction only, and in which velocity energy, due to the conversion of the working fluid's thermal energy into kinetic energy in the form of velocity is fractionally abstracted, an intermediate stage receiving the working fluid issuing from said initial stage, through which the fluid flows in one axial direction only and which comprises alternate annular rows of stationary vanes and moving blades, whereby the fluid passing therethrough is fractionally expanded, a divided low pressure stage, each division of which comprises alternate annular rows of blades and vanes so formed and spaced apart that the fluid passing therethrough is fractionally abstracted and energy derived both by impulse and by reaction, and through which the fluid flows in opposite axial directions and a passage through the turbine rotor placing the inlet ends of the divisions of the low pressure stage in communication one with the other.

7. In an elastic fluid turbine, an initial stage through which the working fluid flows in one axial direction only and in which velocity energy, due to the conversion of the thermal energy of the working fluid into kinetic energy in the form of velocity is fractionally abstracted without further expansion, an intermediate stage receiving the working fluid through said initial stage, through which the fluid flows in one axial direction only and which comprises alternate annular rows of stationary vanes and moving blades so formed and spaced apart that the fluid passing through such stage is fractionally expanded and energy derived both by impulse and by reaction, means for statically balancing the axial thrust inherent in the intermediate stage, a divided low pressure stage, each divison of which comprises alternate annular rows of blades and vanes similar to those of the intermediate stage, and through which the fluid flows in opposite axial directions and a hollow rotor forming the passage whereby the inlet ends of the divisions of the low pressure stage are placed in communication one with the other.

8. In an elastic fluid turbine, a rotor having two low pressure drums and a fluid conduit or passage within the rotor for placing the inlet ends of said drums in communication one with the other.

9. In an elastic fluid turbine, a turbine rotor having low pressure drums at its opposite ends and a fluid passage within the rotor whereby the inlet ends of said drums are placed in communication one with the other.

10. In combination in an elastic fluid turbine, a turbine spindle, a casing therefor having low pressure chambers at opposite ends, bladed pistons mounted on said spindle and located within said chambers and means of communication leading through said spindle from one to the other of said chambers.

11. In an elastic fluid turbine, an initial stage, a normal load admission port communicating therewith, a secondary stage, an overload admission port communicating therewith, means for balancing the axial thrust of said secondary stage and a divided final stage, through the separate sections of which the fluid flows in opposite axial directions whereby said turbine is balanced for all loads and steam pressures.

12. In an elastic fluid turbine, a series of working stages arranged to successively receive motive fluid, a divided stage located in said series, through the separate sections of which the working fluid flows in opposite axial directions, and a passage located within the rotor of said turbine and located between the separate sections of said divided stage.

13. In an elastic fluid turbine, a series of working stages arranged to successively re-

ceive motive fluid, a divided stage located in said series, through which the working fluid flows in opposite axial directions and a passage through the rotor of said turbine for placing the inlet ends of the divisions of said stage into communication one with the other.

14. In an elastic fluid turbine, a series of working stages arranged to successively receive motive fluid and a divided stage, the separate sections of which are located symmetrically with respect to the center of said turbine and through which the motive fluid flows in opposite directons.

15. In an elastic fluid turbine, a series of working stages arranged to successively receive motive fluid, a divided stage located in said series, the separate sections of which are located symmetrically with respect to the center of said turbine and a passage through the rotor of said turbine for placing the inlet ends of said sections in communication one with the other.

16. In an elastic fluid turbine, a rotor having two working drums of equal diameters, one being located at each end of said turbine, and a passage within the turbine rotor for placing said drums in communication one with the other.

17. In a multi-stage elastic fluid turbine, a high-pressure stage, one or more stages of lower pressure, and means for balancing one or more of said stages of lower pressure, said means employing relatively high pressure steam and being located between the high-pressure stage and the stage of lower pressure.

18. In an elastic fluid turbine, two working stages of equal diameters located at opposite ends of the turbine and through which the motive fluid flows in opposite directions toward the ends of the turbine, and a passage located within the turbine rotor connecting the inlets to said stages.

19. An elastic fluid turbine provided with two working stages of equal diameters, one located at each end of the turbine, and through which the motive fluid flows in opposite directions and a passage located within the rotor element of the turbine connecting the inlet ends of the stages.

20. An elastic fluid turbine having two working stages of equal diameters through which the working fluid flows in opposite axial directions and a passage located in the rotor of the turbine between the stages.

21. In an elastic fluid turbine, the combination with the shaft, of a casing, a packing between the shaft and the casing, a drum having a high pressure part and a low pressure part, and a single packing between the casing and the drum located between the high pressure part and the low pressure part.

22. In an elastic fluid turbine, the combination with the shaft, of a casing, a packing between the shaft and the casing, a drum having a high pressure part and a low pressure part, means for causing the fluid to traverse the low pressure part in the opposite direction to the high pressure part, and a single packing between the casing and the drum located between the high pressure part and the low pressure part.

In testimony whereof, I have hereunto subscribed my name this 21st day of December, 1905.

GEO. WESTINGHOUSE.

Witnesses:

H. C. Tener,

Wm. H. Capel.