G. WESTINGHOUSE.
MARINE TURBINE.
APPLICATION FILED SEPT. 17, 1912. RENEWED OCT. 24, 1913.

1,142,069. Patented June 8, 1915.

5 SHEETS—SHEET 1.

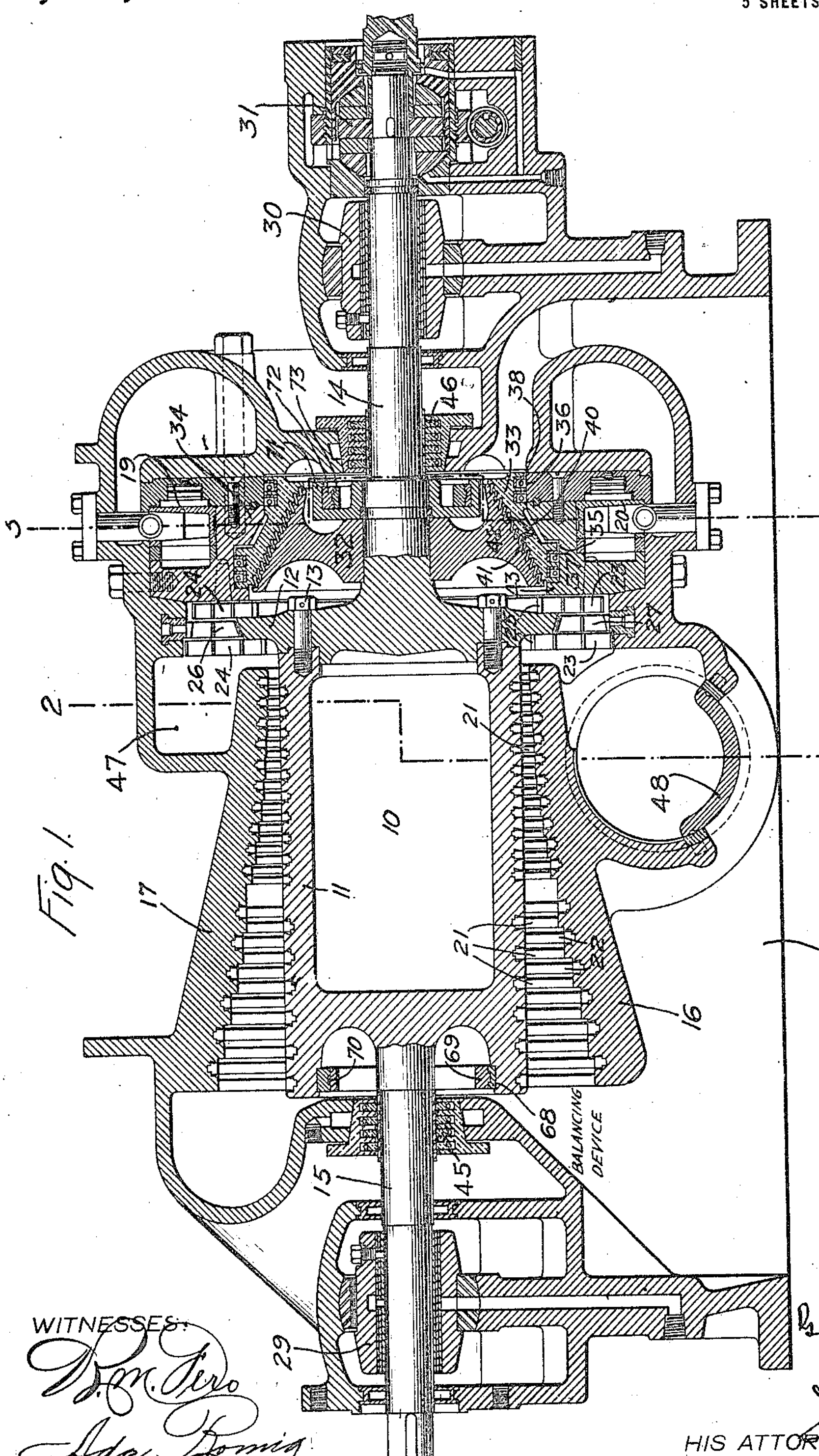

Fig. 1.

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Ada Romig

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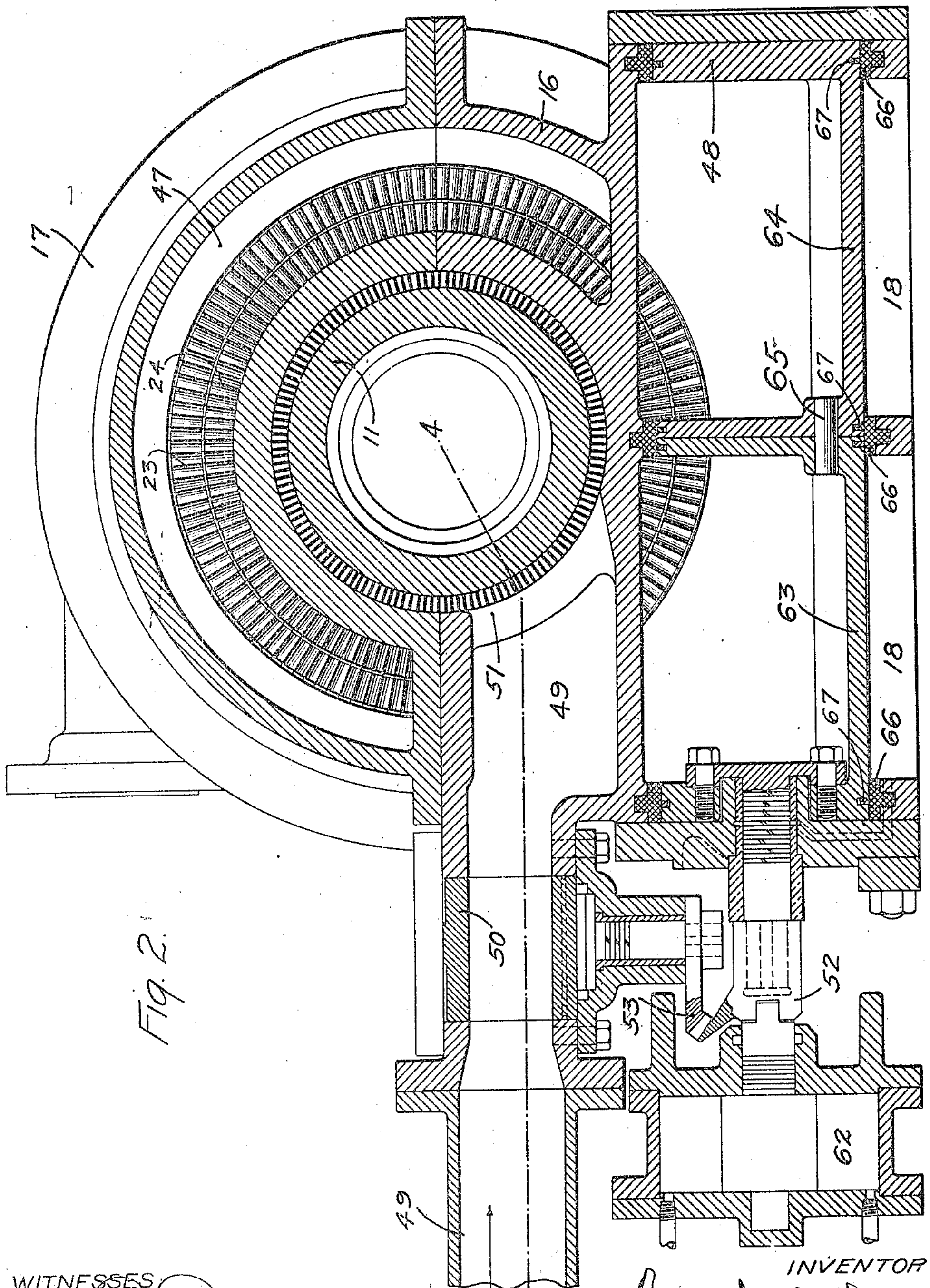

Fig. 2.

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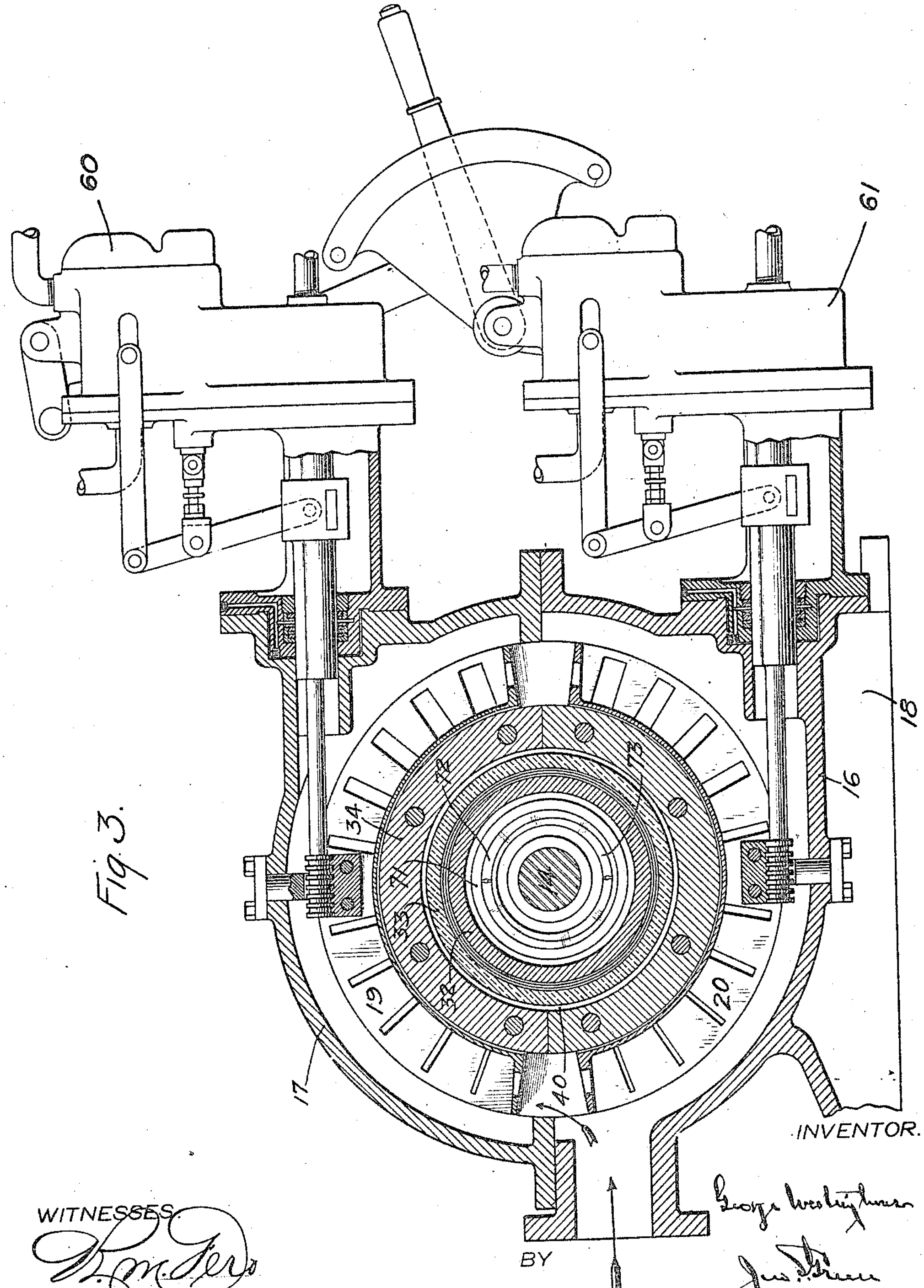

Fig. 3.

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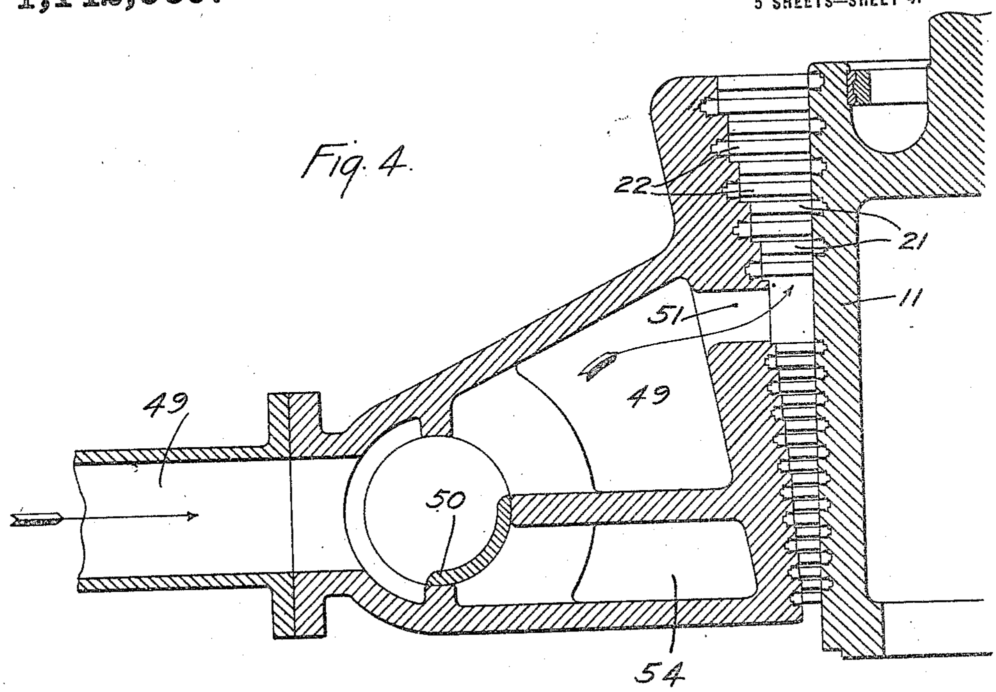
5 SHEETS—SHEET 4.

Fig. 4.



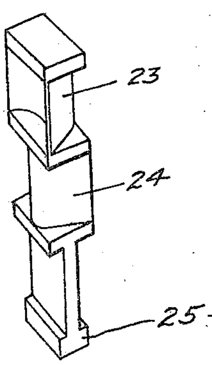


Fig. 5.

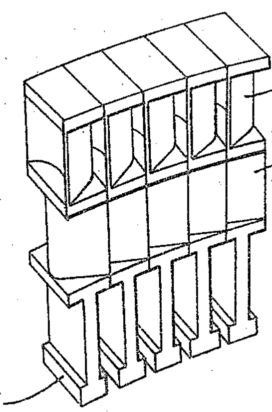


Fig. 6.

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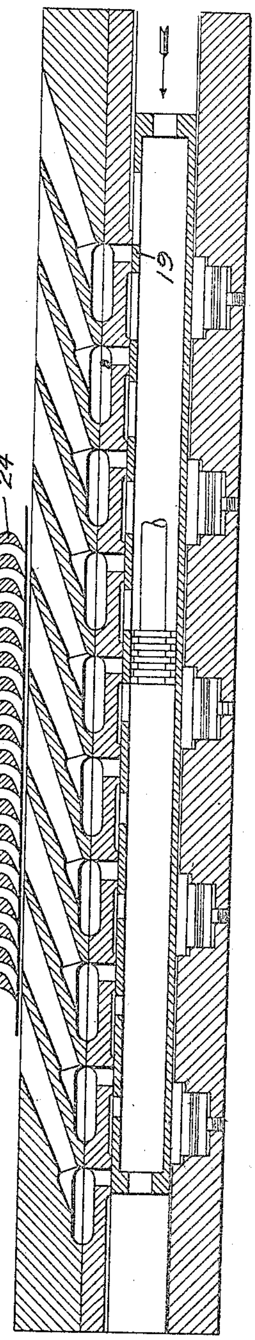


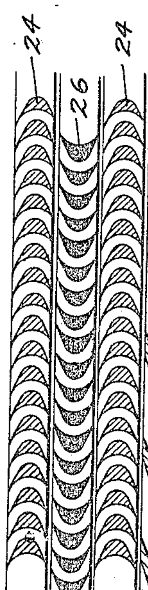
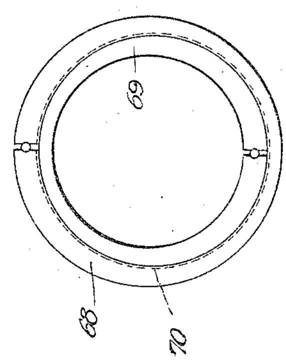


Fig. 7.

Fig. 7a



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UNITED STATES PATENT OFFICE.

GEORGE WESTINGHOUSE, OF PITTSBURGH, PENNSYLVANIA, ASSIGNOR TO THE WESTINGHOUSE MACHINE COMPANY, OF EAST PITTSBURGH, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA.

MARINE TURBINE.

1,142,069. Specification of Letters Patent. Patented June 8, 1915.

Application filed September 17, 1912, Serial No. 720,867. Renewed October 24, 1913. Serial No. 797,113.

To all whom it may concern:

Be it known that I, GEORGE WESTINGHOUSE, a citizen of the United States, and a resident of Pittsburgh, in the county of Allegheny and State of Pennsylvania, have made a new and useful Invention in Marine Turbines, of which the following is a specification.

This invention relates to marine steam turbines.

An object of this invention has been to produce a relatively cheap, simple steam turbine for marine use which is extremely compact for the power developed and which can be easily and quickly reversed.

These, as well as other objects which will readily appear to those skilled in this particular art, I attain in the turbine illustrated in the drawings accompanying this application and forming a part thereof and throughout which like elements are denoted by like characters.

In the drawings: Figure 1 is a longitudinal section of a turbine embodying this invention; Fig. 2 is a cross-sectional view of said turbine taken on line 2—2 of Fig. 1, looking in direction of arrow; Fig. 3 is a cross-sectional view taken on line 3—3 of Fig. 1, looking in direction of arrow; Fig. 4 is a sectional view taken on line 4—4 of Fig. 2; Figs. 5 and 6 are detail views in perspective of the impulse blading for the high pressure section and the astern section; and Fig. 7 is a developed section of the nozzles; the nozzle-controlling valve, and the blades for either the ahead section or the astern section. Fig. 7ª is a detail view of the balancing device.

The turbine consists of a rotor element 10 made up of a drum 11 to which an impulse wheel 12 is bolted by means of bolts 13. Shaft end 14 is formed integrally with the impulse wheel while shaft end 15 is formed integrally with the drum. The rotor element is surrounded by a housing divided on its horizontal axis into two parts 16 and 17. The base 16 is provided with a turbine exhaust 18 adapted to be connected to a suitable condenser. The cover 17 carries the distributing valve 19 for the nozzles of the ahead section, while the base 16 carries the distributing valve 20 for the nozzles of the astern section.

The drum is provided with a number of rows of blades 21 which may be either of the Parsons or Rateau type, while that part of the casing surrounding the drum carries rows of blades 22 which alternate with the rows of blades 21 and which may be of either the Parsons or Rateau type. The running wheel 12 carries two rows of compound impulse blades, blades 23 being utilized for running astern while blades 24 are for the ahead section, and the exhaust steam from the last row of blades 24 passes through the section made up of the blades 21 on the drum and 22 on the casing.

The impulse blades 23 and 24 are shown in detail in Figs. 5 and 6. The blades may be secured to the impulse wheel in any desired manner but as shown are fitted into slots cut in the side of the running wheel with bases 25 which lie up against the under side of the overhang of the wheel.

Intermediate guide vanes formed with a portion 26 for the ahead section and 27 for the astern section lie between the two rows of impulse blades and extend the necessary distance around the casing to redirect the steam issuing from the different nozzle sections.

The shaft ends 14 and 15 are journaled in suitable bearings 29 and 30 and a thrust block 31 is carried by shaft end 14 in order to counterbalance the axial thrust of the rotor element not cared for by balance piston 32.

One end of the rotor element carries a coned balance piston 32 serrated to form one-half of a labyrinth packing system. A reversely serrated cupped member 33 lies within a differentially bored portion 34 of the casing and forms the other half of the labyrinth packing system. The bored portion 34 has two diameters 35 and 36. The faces of these two diameters are concentric and packing rings 37 and 38 prevent leakage of steam between the casing and member 33. A chamber 40 is formed within member 33 between the two series of piston rings, and this chamber is connected to an intermediate portion 41 of the labyrinth packing system by means of a duct 42. This duct is so placed that the steam leaking therethrough from the labyrinth packing system into chamber 40 will tend to yieldingly hold the cupped member 33 in contact with stop 43 formed in the casing. If for any reason the several sections of the labyrinth packing should seize one upon the other, it will be seen that the cupped member will be fairly free to turn in the casing and yet under normal conditions will be steam-tight in the casing on account of the packing rings 37 and 38. Packing glands 45 and 46 for the ends of the casing are provided and the shaft ends extend through these.

The steam issuing from the last row of blades on the impulse wheel for both the ahead and the astern sections passes into chamber 47. When the ahead section is operating this steam passes on through the blading on the drum and casing. When the astern section is in operation, however, the steam from this chamber 47 passes to the exhaust 18 through a valve 48, which valve, when the ahead section is in operation, is closed. The turbine casing is provided with a supplementary inlet 49 for exhaust steam from the auxiliaries aboard the ship on which the turbine is used. This exhaust steam passes in through valve 50 to a point 51, which, when the ahead section is in operation, will have substantially atmospheric pressure. This steam from that point on to the exhaust will augment the steam coming through the high and intermediate sections. Valve 50 is so coupled up with valve 48 by means of segmental gears 52 and 53 that valve 50 closes as valve 48 opens and opens as valve 48 closes. When valve 50 is in closed position the steam from the auxiliaries passes through chamber 54 to the main exhaust 18 and thence to the condenser.

The construction of the distributing valves, one of which is illustrated in Fig. 7, is so similar to that of the valve illustrated in my application Serial No. 684,738, filed by me on the nineteenth day of March, A. D., nineteen hundred and twelve, that a detailed description of the same is deemed unnecessary.

The distributing valves 19 and 20 for the ahead and astern sections respectively are so connected up to motor devices 60 and 61 under the control of the man on the bridge of the vessel on which the turbine is used that the turbine may be driven at the desired speed ahead or astern from the bridge. It is desirable to also have these motors capable of control in the engine room and they will be so connected up to rotary motor 62, which may be of any desired type and which operates valves 48 and 50, that when the astern distributing valve 20 is open, valve 48 will be open and valve 50 closed, and when the ahead distributing valve 19 is open, valve 50 will be open and valve 48 closed. Various types of motors may be utilized for operating valves 19 and 20, but the type preferred by me is one forming the subject-matter of an application about to be filed by another.

Valve 48 is of sufficient size to bypass the exhaust steam from the astern section direct to the condenser through main exhaust 18 around the drum 11 and as this valve is of necessity long, it is preferably made in sections as shown in Fig. 2 secured together so that the longitudinal axis of one section may incline slightly to the axis of the other section. The valve as shown in Fig. 2 is made of two sections 63 and 64 secured together by means of pins 65. The seats 66 for this valve are preferably babbitted and the valve is provided with snap rings 67 which bear on the babbitt seats and prevent steam leakage.

For the purpose of obtaining perfect running balance of the rotor element, each end of the rotor is provided with a balancing device. One of such balancing devices consists of an eccentric ring 68 fitted into a groove turned in the end of the rotor. A split ring 69 is provided with a tongue 70 which fits into a groove in the ring 69. By moving these two rings around within the rotor it will be seen that the balance of the same can be changed and proper running balance obtained. After the rings are in proper position, they may be locked to the rotor in any desired manner. The balancing device for the other end of the rotor consists of a housing element 71 within which two rings 72 and 73 are placed which correspond to rings 69 and 70 and which may be adjusted in the same manner.

In accordance with the provisions of the patent statutes I have described the principle of operation of my invention together with the device which I now consider to represent the best embodiment thereof, but I desire to have it understood that the device shown is only illustrative and that the invention can be carried out in other ways.

Having thus described my invention, what I claim is:

1. In a steam turbine, an ahead section divided into a high pressure stage followed by a stage of lower pressure, an astern section through which the steam flows in the same direction as the high pressure stage of the ahead section, and a valved passage for leading the exhaust from the astern section directly to the main turbine exhaust.

2. In a steam turbine, an ahead section employing an impulse wheel followed by a stage of lower pressure, astern blades carried by said impulse wheel, and a valved passage for placing the exhaust of the astern section in direct communication with the turbine exhaust.

3. In a steam turbine, an ahead section, an astern section, a supplemental inlet leading to the ahead section, a valved passage for placing the astern section in direct communication with the main turbine exhaust, and a valve in the supplemental inlet connected to the exhaust valve of the astern section in such manner that as the valve in the astern section exhaust opens, the valve in the supplemental inlet closes, and vice versa.

4. In a steam turbine, a labyrinth packing system comprising a coned member on the turbine rotor and a cupped member in the turbine casing externally, differentially formed, and means whereby steam from said packing tends to hold said cupped member in normal position.

5. In a steam turbine, a running wheel carrying two concentric rows of reversely faced blades, a stage of lower pressure through which the steam from one of said rows of blades is adapted to pass, a main exhaust, and a valve for placing the outlet of said running wheel blades in direct communication with said exhaust.

6. In a steam turbine, an ahead section, an astern section, a main exhaust, and means for bypassing the exhaust from the astern section around a portion of the ahead section.

7. In a turbine, an ahead section, an astern section, a supplemental inlet leading to the ahead section, a fluid delivery valve for the astern section, a valve for controlling the delivery of fluid from the supplemental inlet to the ahead section, and means for connecting said valves so that one is open when the other is closed, and vice versa.

8. In a turbine, an ahead section, an astern section, a supplemental inlet leading to the ahead section, a passage for placing said supplemental inlet in direct communication with the turbine exhaust, a valve for controlling communication between the inlet and the ahead section and between the inlet and the passage, a valve for the astern turbine, and means operatively connecting said valves whereby the supplemental inlet is placed in communication with the turbine exhaust through the passage, during the operation of the astern turbine.

9. In a turbine, an ahead section, a supplemental inlet for delivering fluid to the ahead section, a passage communicating with the exhaust of the turbine, a valve for delivering fluid from the supplemental inlet to the ahead section of the turbine, or through said passage to the turbine exhaust, an astern section communicating with the turbine exhaust, a valve between the astern section and the exhaust, and means operatively connecting both of said valves, whereby the first mentioned valve establishes communication between the inlet and the exhaust when the second mentioned valve is open.

10. In a turbine, an ahead section, a supplemental inlet for delivering fluid to the ahead section, a valve for controlling the delivery of fluid through the supplemental inlet to the turbine, an astern section communicating with the exhaust of the turbine, a valve between the astern section and the exhaust, and means for simultaneously operating both of said valves.

11. A turbine comprising a high pressure section, a low pressure section and an astern section through which the motive fluid flows in the same axial direction as through the high pressure section, a chamber for receiving the fluid discharged from the high pressure section and from the astern section, and provided with a port communicating with the turbine exhaust, and a valve controlling the delivery of fluid through said port to the exhaust.

12. In a turbine, a high pressure section comprising a rotor wheel, impulse blades mounted on the wheel, and a coöperating delivery nozzle, a low pressure section receiving motive fluid from the high pressure section, an astern section comprising blades, mounted on said wheel, and a coöperating fluid delivery nozzle, a chamber common to both the high pressure section and the astern section for receiving the motive fluid discharged therefrom, and having a port communicating with the exhaust of the turbine, and a valve for controlling the delivery of motive fluid through the port.

13. In a turbine, a composite high pressure section and reversing section, comprising concentric rows of oppositely faced blades mounted on a single rotor element, separate fluid delivery nozzles for each row of blades, a chamber communicating with the delivery ends of the concentric rows of blades, a low pressure section communicating with the chamber, said chamber being provided with a port communicating with the turbine exhaust, and a valve for controlling the delivery of fluid through the port.

14. In a turbine, a composite ahead and reversing section comprising concentric rows of blades mounted on a single rotor element, a separate fluid delivery nozzle for each row of blades, a chamber communicating with the delivery ends of the blades and provided with a port communicating with the turbine exhaust, a low pressure section communicating with the chamber, a supplemental inlet communicating with the low

pressure section, a valve for controlling the delivery of fluid through the supplemental inlet to the turbine, and means for simultaneously opening one of said valves, and closing the other.

15. In a turbine, a composite high pressure ahead section, and a[illegible]ern section comprising two separate rows of blades to which motive fluid is delivered in substantially the same axial direc[illegible]ion, a chamber formed within the casing of the turbine and communicating with the delivery end of both sets of blades and provided with a port communicating with the turbine exhaust, a low pressure ahead section communicating with the chamber, a supplemental inlet for delivering fluid to the low pressure section, a valve for the port formed in said chamber, a valve for controlling the delivery of fluid to the supplemental inlet, and means for actuating both of said valves to close the supplemental inlet simultaneously with the opening of the chamber port.

16. In an elastic fluid turbine, a labyrinth packing system comprising a member mounted on the rotor and having grooves and ridges formed on a peripheral face thereof, a concentric member movably mounted on the casing of the turbine, and having grooves and ridges formed on a peripheral face thereof and coöperating with the grooves and ridges of the rotor member to form a labyrinth packing, and means whereby fluid traversing the labyrinth packing so formed, tends to yieldingly hold the member mounted on the casing in the normal position relatively to the member mounted on the rotor.

17. In a turbine, a labyrinth packing system comprising a member mounted on the rotor and having grooves formed on the peripheral face thereof, a member mounted on the stator of the turbine concentric with the rotor member and having grooves and ridges formed in its inner peripheral face and coöperating with the grooves and ridges of the rotor member to form a labyrinth packing, and having a duct formed therein and communicating with an intermediate point of the labyrinth packing so formed, and a chamber surrounding the stator member and located between it and the stator.

18. In a turbine, a labyrinth packing system comprising a substantially cone-shape member mounted on the rotor and having a series of grooves and ridges formed in the tapered peripheral face thereof, a substantially cup-shape member mounted within the stator of the turbine and having a series of grooves and ridges formed on the inner face thereof, and coöperating with the grooves and ridges of the rotor member to form a labyrinth packing, and a passage for delivering fluid from an intermediate point of the packing so formed to the exterior face of the cup-shape member, whereby the cup-shape member is yieldingly held by fluid pressure against a stop formed on the stator of the turbine.

19. In a turbine, a labyrinth packing system comprising a member rigidly mounted on the rotor of the turbine, a member coöperating therewith to form a labyrinth packing loosely mounted on the stator of the turbine, and packings between the stator and said last mentioned member.

20. In an elastic fluid turbine, a labyrinth packing system comprising a member rigidly mounted on the rotor of the turbine, a member loosely mounted on the stator of the turbine and coöperating with the first mentioned member to form a labyrinth packing, packings between said last mentioned member and the stator, and means for introducing fluid pressure from an intermediate point in the labyrinth packing to a chamber located between said packings.

21. In a turbine, a member rigidly mounted on the rotor, a member coöperating therewith to form a labyrinth packing and loosely mounted on the stator of the turbine, packings between said last mentioned member and the stator, and means for subjecting said last mentioned member to fluid pressure and for thereby forcing the member axially against a stop formed on the stator.

22. In a turbine, a combination ahead and reversing section, an exhaust chamber common to the ahead and reversing portions of said section, a low pressure ahead section communicating with said chamber and with the exhaust of the turbine, and a valve for placing said chamber in communication with the turbine exhaust.

23. A turbine rotor comprising a blade-carrying wheel having an end supporting shaft integrally formed therewith, a blade-carrying drum having an end supporting shaft integrally formed wherewith, means for rigidly securing the wheel and the drum together so that the end supporting shafts project in opposite axial directions and are axially alined with each other, and a separate balancing device comprising relatively movable eccentric rings mounted on each portion of said rotor, so that each set of rings encircles one of the end supporting shafts.

24. A turbine comprising a casing, a rotor mounted within the casing, a balance piston mounted on the rotor, and an annular member surrounding the balance piston and loosely mounted on the casing, so that it is capable of rotating with the piston.

25. A turbine comprising a casing, a rotor mounted within the casing, and a substantially conical balance piston rigidly mounted on the rotor and having its larger

end exposed to fluid pressure within a working passage of the turbine, and its smaller end exposed to exhaust pressure.

26. A turbine comprising a stator, a rotor mounted within the stator, a balance piston rigidly mounted on the rotor and having a tapered peripheral face, means for subjecting opposite ends of said piston to different fluid pressures, and a packing around the peripheral face of the member.

27. A turbine comprising a stator, a rotor within the stator, a balance piston having a tapered peripheral face rigidly mounted on the rotor so that the opposite ends thereof are of different areas, a member loosely mounted within the stator element and surrounding said piston, and forming with the peripheral face thereof a labyrinth packing, and an annular packing surrounding said member and located between it and the stator.

28. A turbine comprising a stator, a rotor mounted within the stator, a balance piston rigidly mounted on the stator and having a tapered peripheral face so that opposite ends of the piston are of different areas, a member surrounding the peripheral face of said piston and movably mounted on the stator element, and forming with the peripheral face of the piston a fluid packing, and means whereby leakage fluid through the packing tends to move the member and to adjust the clearance between the piston and the member.

29. A turbine comprising a stator, a rotor mounted within the stator, a balance piston having a tapered peripheral face mounted on the rotor so that the larger end face thereof is exposed to the fluid pressure of a working passage of the turbine, a movable member mounted on the stator and forming with the peripheral face thereof a fluid packing, and having a passage formed therein and communicating with an intermediate point of the packing, and with a fluid chamber surrounding the member whereby leakage fluid through the packing tends to shift the member axially of the piston to adjust the clearance between the member and the piston.

30. A turbine comprising a stator, a rotor mounted within the stator, a balance piston having a tapered peripheral face mounted on the rotor so that the larger end face thereof is exposed to the fluid pressure of a working passage of the turbine, a movable member mounted on the stator and forming with the peripheral face thereof a fluid packing, and having a passage formed therein and communicating with an intermediate point of the packing, and with a fluid chamber surrounding the member whereby leakage fluid through the packing tends to shift the member axially of the piston to adjust the clearance between the member and the piston, and annular packings between the member and the stator, and located on each side of the chamber.

31. In combination with a turbine rotor, a balancing device surrounding the axis of rotation of the rotor and comprising two eccentrically loaded rings fitted one within the other.

32. In combination with a turbine rotor, a balancing device surrounding the axis of rotation of the rotor and comprising eccentrically loaded rings located eccentrically with relation to each other and movably mounted on the rotor.

33. In a turbine, a high pressure section, a low pressure section adapted to receive fluid from the high pressure section and to discharge the fluid to the turbine exhaust, a chamber located between and communicating with both of said sections, and having a port communicating with the turbine exhaust, a reversing section discharging into said chamber and a valve for controlling the delivery of fluid through said port to the turbine exhaust.

34. In a turbine, an ahead section comprising a high pressure stage to which motive fluid is initially delivered, and a low pressure stage receiving motive fluid from the high pressure stage, an astern section through which motive fluid flows in substantially the same direction as in the ahead section and which communicates with the exhaust of the turbine, an exhaust valve between the astern section and the exhaust for controlling the delivery of fluid therefrom to the exhaust, a valve for controlling the delivery of motive fluid to the ahead section, a valve for controlling the delivery of motive fluid to the astern section, and means for operating said valves so arranged as to cause a simultaneous opening of the exhaust valve and the controlling valve of the astern section, and a simultaneous closing of the exhaust valve and the controlling valve of the ahead section.

35. In a turbine, an ahead section comprising a high pressure stage and a low pressure stage, an astern section through which motive fluid flows in substantially the same direction as through the ahead section, an exhaust valve for by-passing fluid discharged from the astern section around the low pressure stage to the turbine exhaust, separate valves for controlling the delivery of motive fluid to the separate sections, means for actuating all of said valves whereby the exhaust valve is closed during the delivery of motive fluid to the ahead section and is open during the delivery of motive fluid to the astern section.

36. In a steam turbine, an ahead section having a high and low pressure stage, an

astern section, an exhaust valve for by-passing fluid discharged from the astern section around the low pressure stage to the turbine exhaust, a separate valve for controlling the delivery of motive fluid to each section, means for actuating all of said valves whereby each delivery valve is simultaneously closed when the other is opened and the exhaust valve is simultaneously closed with the opening of the delivery valve of the ahead section and simultaneously opened with the closing of the ahead section delivery valve.

In testimony whereof, I have hereunto subscribed my name this 13th day of September, 1912.

GEO. WESTINGHOUSE.

Witnesses:
B. B. Hines,
B. M. Fero.