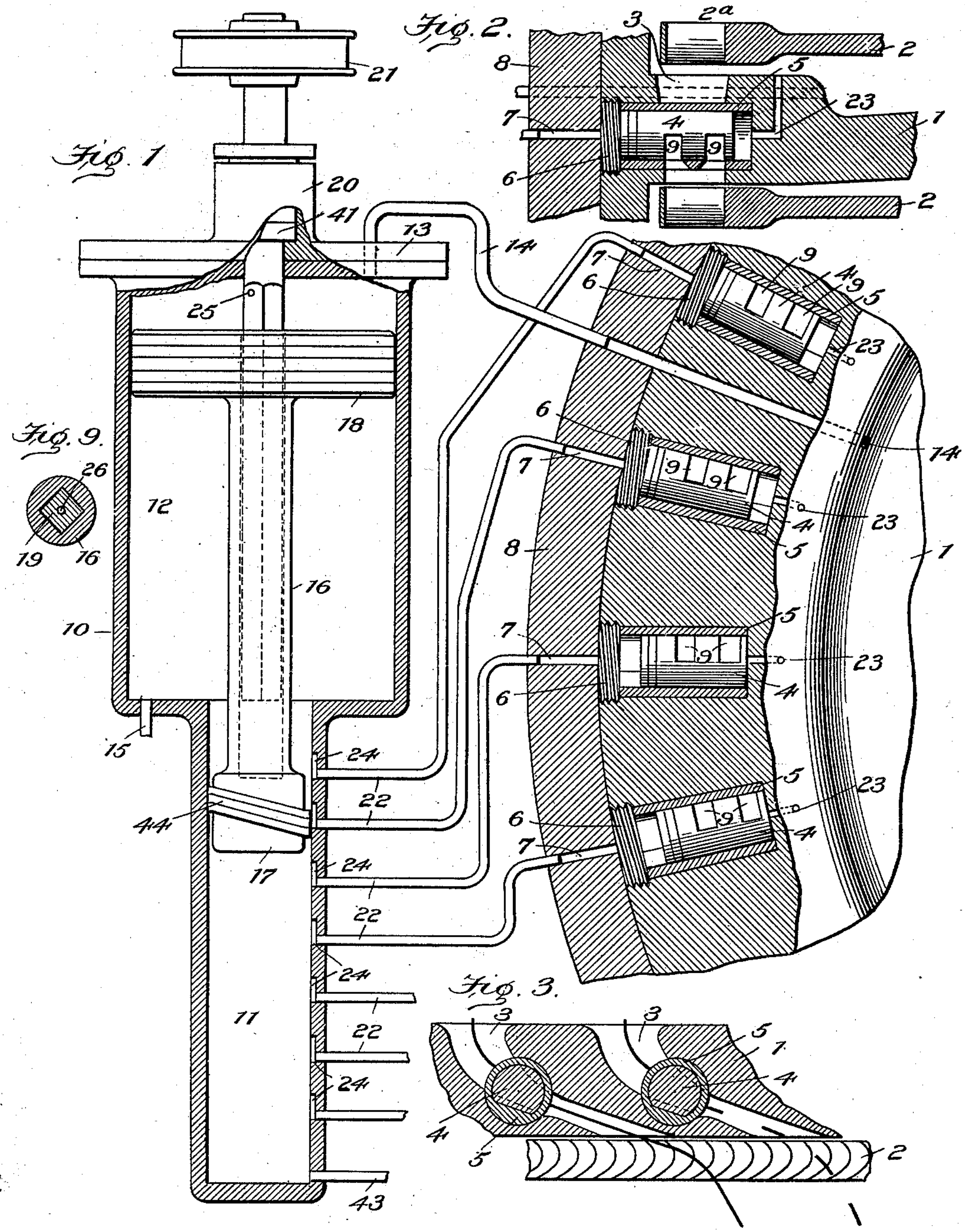
No. 752,610. PATENTED FEB. 16, 1904.

J. WILKINSON.

ELASTIC FLUID TURBINE.

APPLICATION FILED SEPT. 22, 1903.

NO MODEL. 2 SHEETS—SHEET 1.



Witnesses
Edwin L. Bradford
R. D. Johnston

Inventor
James Wilkinson
By Robt. D. Johnston Jr.
Attorney

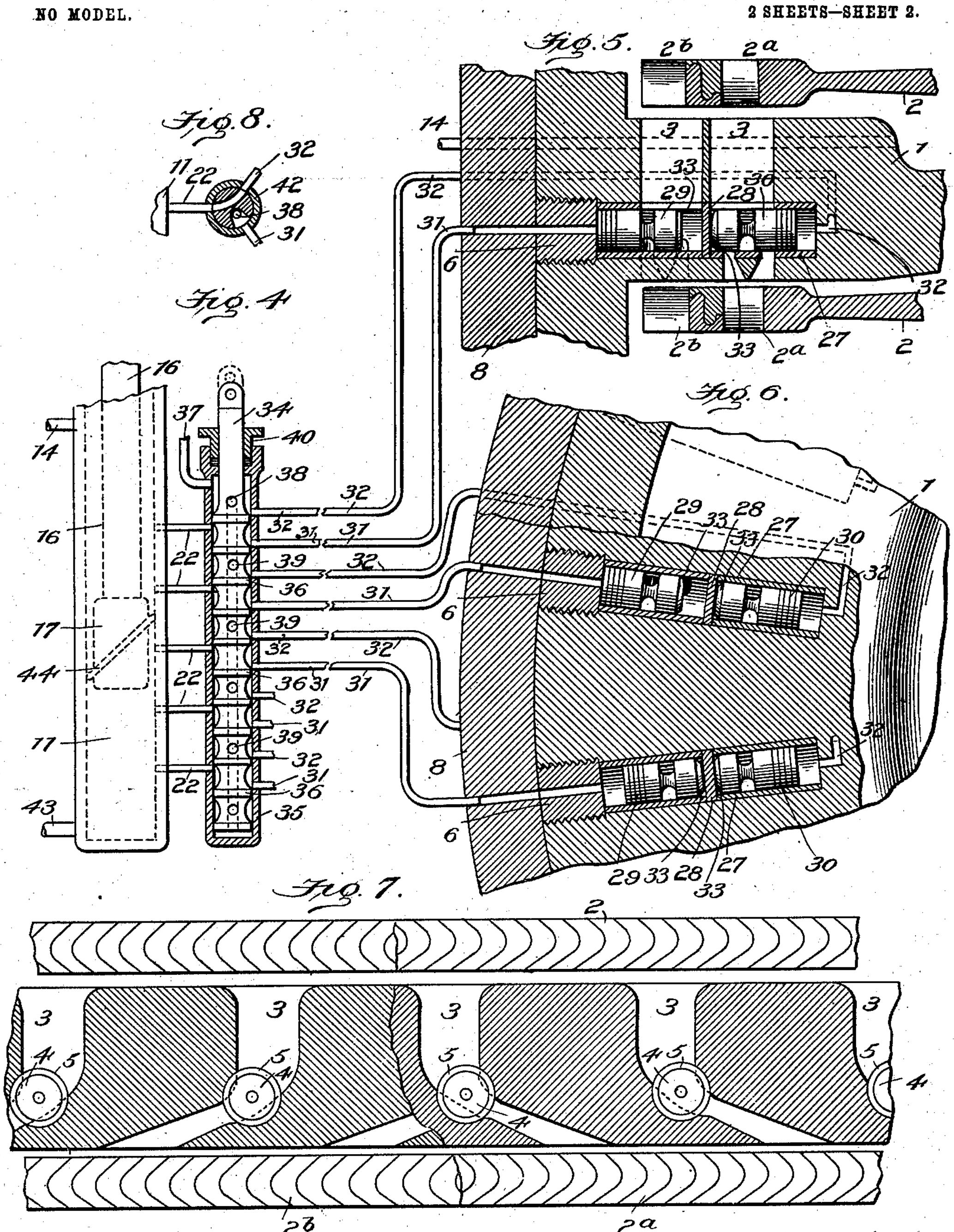
No. 752,610. PATENTED FEB. 16, 1904.

J. WILKINSON.

ELASTIC FLUID TURBINE.

APPLICATION FILED SEPT. 22, 1903.

NO MODEL. 2 SHEETS—SHEET 2.



Witnesses

Edwin L. Bradford

R. D. Johnston

Inventor

James Wilkinson

By Robt. D. Johnston Jr.

Attorney

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 752,610. Patented February 16, 1904.

UNITED STATES PATENT OFFICE.

JAMES WILKINSON, OF BIRMINGHAM, ALABAMA.

ELASTIC-FLUID TURBINE.

SPECIFICATION forming part of Letters Patent No. 752,610, dated February 16, 1904.

Application filed September 22, 1903. Serial No. 174,162. (No model.)

To all whom it may concern:

Be it known that I, JAMES WILKINSON, a citizen of the United States, residing at No. 1212 North Seventeenth street, Birmingham, in the county of Jefferson and State of Alabama, have invented certain new and useful Improvements in Elastic-Fluid Turbines, of which the following is a specification.

My invention relates to improvements in automatic stage-pressure-controlled mechanism for a compound turbine which operates a series of stage-valves in a manner to control the passage of the elastic-fluid supply from stage to stage sensitive to variations in the load.

My invention relates more particularly to improvements on a pending application wherein is disclosed a turbine whose interior is divided into stages within each of which a rotary wheel having a peripheral row of vanes or buckets revolves. A series of nozzle-passages conduct the fluid-supply across the several stages from the inlet to the exhaust head, and a row of rotary valves is disposed within the several nozzle-passages between the stages. An automatic compound cylinder having high and low pressure ends respectively communicating with the boiler or initial pressure and the stage-pressure and having a compound piston movable within said cylinder sensitive to stage-pressure variations acts to control the stage-pressure by opening or closing stage-valves. In this construction each stage-valve is independently controlled and operated by a separate compound cylinder and piston, and in order to prevent the simultaneous action of all the valves of a stage row upon a variation of the pressure in that stage it is necessary to vary the relative proportions of the cylinders and pistons in the same row. In this manner the stage-valves will successively open or close when the stage-pressure rises or falls, and one or more of the stage-valves will be pulsated sensitive to a pulsatory supply delivered by the governing mechanism and will act, in connection with the valves maintained open, to continue the combined constant and pulsatory flow of the fluid-supply throughout the stages.

It is the object of my invention to improve and perfect this automatic method of controlling the stage-valves sensitive to variations in the stage-pressure; and with this object in view I provide an enlarged compound cylinder from whose high-pressure end a series of pipes or passages lead to each of the several valves of the same stage. This cylinder communicates at its high and low pressure ends with the boiler and stage pressures, respectively, and is provided with an opening to the exhaust or condenser pressure, according to the pressure in the stage which it controls. A compound piston in this cylinder moves sensitive to variations in the stage-pressure and exposes a number of valve-controlling fluid-passages to the boiler-pressure to close their stage-valves, while the valves controlled by the passages open to the exhaust or condenser pressure existing between the piston-heads will be maintained open by the stage-pressure which is admitted against their other ends. I rotate this piston so that its high-pressure head, which is formed with a circumferential packing-ring in the shape of conical helix, will intermittently admit pressure to one or more of said valve-controlling passages, with a view to pulsating the stage valve or valves controlled thereby.

My invention further comprises improvements in the construction of the stage-valve and in the adaptation of this method of control to a turbine having two or more concentric rows of supply-passages leading to the several stages, with a view to provide a reversed or fractional speed drive for the turbine, which latter construction is more applicable for marine use.

These and other improvements included in my present invention are described in the following specification, reference being had to the accompanying drawings, in which—

Figure 1 discloses a vertical sectional view of the compound stage-cylinder with the controlling-piston in elevation and a series of passages leading to a partial view of a stage-diaphragm, broken away to show the row of valves therein. Fig. 2 is a vertical section through the turbine parts of Fig. 1, showing the bucket-wheels of the stages above and below a diaphragm. Fig. 3 is a transverse sectional view showing nozzle-passages and valves therein in connection with a single row of buckets. Fig. 4 illustrates an adaptation of this method of control to a turbine having two concentric rows of nozzle-passages, which are shown in vertical section in Fig. 5 and in a broken-away plan view in Fig. 6. Fig. 7 is a sectional view through Fig. 5, taken in a manner to illustrate the reversed disposition of the nozzle-passages in the diaphragm. Fig. 8 is a modification of the valve mechanism for placing the inner or outer row of stage-valves under the active control of the stage-governor.

The same reference-numerals refer to the same parts throughout.

The diaphragm-partition 1 divides the interior of a compound turbine into a series of compartments representing stages, within each of which a rotary wheel 2 revolves, with its row of buckets in line with a series of circumferential nozzle-passages 3, arranged around the diaphragm and disposed so that the succeeding buckets and passages throughout the stages form continuous working passages for the fluid wherein the velocity is fractionally abstracted. A series of circular radially-disposed valve-openings are bored around the outer shouldered edge of the diaphragm and so disposed that a series of piston-valves 4 inserted therein will be seated within the throats or contracted portions of the nozzles 3. These valves 4 are cylindrical and have a flattened side which engages a flattened surface in a cylindrical shell 5, within which the valve moves longitudinally to prevent its rotation. This shell is secured in place in the diaphragm-opening by a screw-plug 6, having a central opening therethrough which admits against the outer end of valve 4 pressure conducted through an opening 7 in the strengthening-shell 8, which surrounds the turbine, pressure being supplied to these passages 7 in the manner hereinafter described. These shells have an unobstructed opening toward the supply end of the nozzle 3 and a grated opening toward the discharge end, forming two or more supply-ports for the succeeding stage, and the valves 4 have ports 9 so disposed that its short longitudinal movement within the shell will shift its ports into alinement with the ports in the shell and admit the fluid to the succeeding stage or will close said ports. The object in flattening a side of the valve is to prevent its rotation and maintain its ports in alinement with those in the shell.

The valve-controlling mechanism comprises a compound cylindrical shell 10, having a high-pressure chamber 11 and a low-pressure chamber 12. Pressure from the boiler, initial stage, or other source of high pressure is admitted to the cylinder 11 by a pipe 43, entering its lower end, and stage-pressure is admitted to the head 13 of the cylinder 12 through a pipe 14, which leads through the shell 8, diaphragm 1, and opens into the stage-compartment above said diaphragm. Through a pipe 15 the cylinder 12 is open to the pressure of the atmosphere when the stage-pressure is superior thereto or to a condenser when the pressure of the stage is below that of the atmosphere. A compound differential piston 16, having high and low pressure heads 17 and 18 disposed within the chambers 12 and 13, respectively, is provided with suitable packing to make them pressure-tight within said chambers. The stem of the piston 16 is provided with a squared central opening therethrough, within which a squared shaft 19 telescopes. This shaft 19 has a cylindrical end portion, which extends through the head 13 of the chamber 12 and through a suitable bearing and stuffing-box 20. The shaft is collared at 41 to prevent its longitudinal movement and is provided at its outer end with a pulley 21, driven from the turbine or any desired source of power. The rotation of this shaft 19 causes the piston 16 to rotate therewith, while permitting it to move longitudinally in the cylinder 10. A series of stage-valve-controlling passages 22 lead from the passages 7 of the shell 8 and enter the cylinder 11 at points equidistant from each other and in alinement. There may be as many of these passages as there are valves in the stage row, or each passage may be arranged so that it will simultaneously control the action of two or more valves, with a view to reducing the number of pipes entering cylinder 11. If now the boiler-pressure be admitted through pipe 43 to the cylinder 11, it is obvious that it will enter and pass through so many of the said pipes 22 as are exposed below the piston-head 17 and will act against the outer ends of the valves 4 and move them to a closed position. Stage-pressure is admitted against the inner ends of said valves through pipes 23, leading down through the diaphragm and entering the inner end of the valve-shells 5, and therefore when the boiler-pressure is cut off from the passages leading to the outer ends of the valves and they are exposed to the atmosphere or condenser pressure through chamber 12 and pipe 15 the stage-pressure will automatically move them to an open position, as shown in Fig. 2. By the term "stage-pressure" I mean the pressure which exists in a wheel-compartment, (excepting the one exposed to the exhaust or condenser pressure,) which pressure I design to maintain constant by utilizing its variations to control the delivery of fluid-pressure therefrom, so that the outflow of pressure to the succeeding compartment will be checked when the stage-pressure falls below normal to build it up or the outflow will be increased to reduce the pressure in the stage. This outflow of the pressure depends upon the number of stage-valves 4 which are open, and this in turn depends upon the position of the piston 16, whose head 17 controls the number of valve-actuating passages 22. To enable the stage-pressure to automatically maintain itself and control the action of its stage-valves, I conduct it from the stage by pipe 14 to the upper end of the chamber 12, where it acts against the head 18 and tends to move the piston 16 against the high pressure acting against its head 17. I proportion the heads 17 and 18 so that when the stage-pressure stands at the point where it is desired to be maintained it will counterbalance the boiler-pressure, and it will be noted that variations in the boiler-pressure will be sympathetically responded to throughout the stages. The pressure of the several stages will vary relatively. Hence the proportion between the areas of heads 17 and 18 must vary between the several compound pistons 16, one of which controls each separate stage. Thus if it be desired to maintain a stage-pressure at fifty pounds and the boiler-pressure stands at one hundred pounds the area of the piston 18 will be double that of piston 17. It follows, therefore, that upon a decrease of the stage-pressure the piston 16 will be moved by the high pressure acting against head 17 toward the low-pressure end, since the boiler-pressure remains substantially constant. This will have the effect of closing an additional number of stage-valves to reduce the number which will be discharging fluid-pressure from that stage, and therefore cause the stage-pressure to increase until its effect against piston 16 balances the boiler-pressure or rising superior thereto causes the piston to move downwardly and expose supply-passages 22 to the exhaust-pressure to permit the valves controlled thereby to move to their open position. In this manner the stage-pressure as it varies causes the piston to assume different operating positions, at which points it will remain without longitudinal movement so long as the stage-pressure remains normal, and therefore balances the boiler-pressure. The uniform or normal stage-pressure which it is desired to maintain will be that at which the turbine operates at greatest efficiency under a normal load, and it will be the tendency of the automatic pressure-controlled action of the compound piston to maintain this stage-pressure constant under varying turbine loads. As the piston 16 moves within its cylinder it will successively open the passages 22 to the boiler or exhaust pressure; but it is evident that if the high-pressure-piston head be straight and squared off at its ends its movements between the passages will have no regulating effect on the valves controlling the supply and that there will also be a tendency to wiredraw the pressure admitted to a passage which is only partly closed by the lower end of the piston-head. This would affect the accuracy and efficiency of the regulation and would also cause an uncertain intermediate action of the valve controlled by the passage whose opening into chamber 11 is throttled, causing it to wiredraw the nozzle-opening, with a resulting loss of economy in operation. To obviate this difficulty, I provide the high-pressure head 17 with a circumferential pressure-tight packing-ring 44 in the form of a conical helix, and I arrange the several passages so that they open into the chamber 11 at points whose distance apart from each other is slightly in excess of the pitch of the helix. Hence as the piston revolves this ring will control but one passage at a time, though this passage may control several stage-valves when coupled up, and will intermittently open it to high and low pressure to oscillate the valve or valves controlled thereby. I form the vertically-disposed recesses 24 in the inner wall of the chamber 11, and from the lower ends of each of them the passages 22 lead outwardly to the valves of a stage row. These recesses are less in vertical length than the width of the ring 44, and the object of elongating them is to increase the extent of the openings to passages 22 until they are almost as wide as the ring, so that as the ring moves with the rotating head 17 it will without appreciable interval open this recess to one pressure after cutting it off from the other, but without, however, at any time permitting the escape of the high pressure through said recesses past the piston to the atmospheric pressure above it. The operation of this piston 16 is therefore, first, to automatically adjust itself, sensitive to the stage-pressure, to a point where by exposing a number of the passages 22 to the low pressure the stage-valves controlled thereby will deliver constant streams of pressure to the bucket-wheel proportioned to the load, and, second, by the rotation of the helical packing-ring to admit impulses of fluid-pressure accurately proportioned to variations in load intermediate the points at which a constant stream will be cut on or off. The heavy continuous line in Fig. 3 indicates a constant stream of pressure delivered by a stage-valve whose controlling-passage is above the piston-head 17, and therefore exposed to the atmospheric or condenser pressure, so that the stage-pressure maintains the valve open. The broken line in the adjoining nozzle represents the pulsatory supply of fluid delivered by the valve whose controlling-passage is alternately open to the boiler and exhaust pressure by the rotation of the helical packing-ring 44 on the head 17. The absence of any wiredrawing action in connection with the operation of the ring 44 will cause the stage-valves to move always to a definite open or closed position, so that there will be no wiredrawing of the nozzle delivering the pulsatory stream, and the pulsations will be of constant volume and velocity, but of varying duration, according to the load. It is my intention to deliver to the turbine a governor-controlled supply of fluid in constant streams roughly proportioned to the load and pulsatory blasts in proportion to slight or intermediate variations in the load, and it is the object of my stage-valve-controlling mechanism to automatically continue this combined constant and pulsatory supply throughout the several stages. The small opening 25 in the head of the shaft 19 admits pressure by a passage 26, leading down through the shaft to the chamber below said shaft to provide a dash-pot effect to the piston's movements.

In adapting this automatic stage-pressure-controlling mechanism for use in connection with turbines having two or more concentric rows of supply-passages forming continuous working passages throughout the stages I elongate the circular opening in the rim of the diaphragm to receive a compound valve-shell 27, divided into compartments by an intermediate partition 28. Within these compartments are spool-valves 29 and 30, whose outer ends are exposed to pressure higher than that of the stages through pipes 31 and 32, which lead through the diaphragm and enter the opposite ends of the shell 27. The stage-pressure will act against the beveled heads 33 of these valves to move them outwardly or away from the partition 28 when either pipe 31 or 32 is exposed to the exhaust or condenser pressure. By beveling heads 33 a more positive action of the valves is secured, and the possibility of intermediate wiredrawing positions is avoided. I provide the wheel 2 with two superimposed rows of buckets 2^a and 2^b, the inner row of buckets 2^a being integral with or secured to the rim of the wheel in any desired manner. The head-blocks of these latter buckets are recessed to receive the base-blocks of the outer row of buckets 2^b, which are secured thereto, either permanently or detachably, but preferably in the manner described in the pending application, Serial No. 173,339, filed September 15, 1903. It is evident if the boiler-pressure be constantly admitted to passages leading to the inner row of stage-valves that that row will be held constantly closed and all flow of fluid-pressure will be shut off from the working passages which they control, while the other row of stage-valves may be subjected to the control of the stage-valve-governing mechanism to regulate the flow of the fluid through the working passages controlled thereby independently of the inner row. As shown in Figs. 6 and 7, the inner row of valves are held closed. To close either row of valves and throw the other into communication with the governed pressure, I employ a compound piston-valve 34, movable in a casing 35, into which the passages 22 from the chamber 11 lead. The passages 31 32 lead from the opposite side of this casing and are double in number to the passages 22. The piston 34 is in the form of a compound spool-valve with a series of equidistant packing-rings 36, between which the valve-chambers are formed and which are pressure-tight to prevent the leakage of pressure from one valve-chamber to another. The length of these valve-chambers and the throw of the valve is such that each pipe 22 will be always in communication with one and only one of each pair of passages 31 32. High pressure from the boiler or auxiliary source is admitted through pipe 37 to the shell 35 and is directed by an opening 38, passing longitudinally through the stem 34 to each alternate valve-chamber by by-passages 39. The stem 34 is suitably packed at 40 to prevent the escape of this pressure. If now the stem 34 be in the position shown in the drawings, this auxiliary pressure will be admitted to each of the passages 32, which lead to the valves controlling the inner working passages, and this pressure being superior to that of the stages will move the valves to their closed position and hold them thus until the stem 34 has been shifted. It will be seen that the passages controlling the action of the stage-valves 29 will be each in direct communication with one of the several passages 22 through the valve-chambers and subject to the compound piston 16 will be exposed to the boiler or exhaust pressure represented by the pipes 43 and 15. Hence the governor control of these valves 29 will be the same as in Fig. 1 and will not be at all affected by the fact that there is another row of stage-valves. If, however, the stem 34 be moved to the position shown in dotted lines, the valves 29 through passages 31 will be open to the auxiliary pressure and held constantly closed, while the valves 30 through passages 32 will be actuated subject to the governor's control. The passage 38 leads entirely through the stem 34 to admit pressure below it and partly balance the piston. This stem 34 may be operated by hand or in any other suitable manner, or the several stems 34 for the various stages may be simultaneously operated by pistons moving in cylinders controlled by a common valve.

Instead of using the compound piston-valve 34 I may use a four-way valve 42 to alternately open the passages 31 and 32 to the governed pressures in the compound cylinder through passage 22 and to the auxiliary pressure through pipe 37, which branches to each of the valves.

The form of the stage-valve may be varied at will, and by giving it a longer stroke the nozzle-passage need not be divided by ports in the shell.

Though I have referred to the turbine as of the compound type which is subdivided into compartments, my invention is equally applicable where separate turbines, between which the rows of nozzle-passages form conduits, act to fractionally abstract the velocity from the fluid-pressure, and therefore form stages within the meaning of that term.

Though I prefer to use the boiler or initial stage pressure as the constant pressure, I may use gravity or the atmosphere under certain circumstances, and I therefore desire it to be understood that the term "constant pressure" will include all of these.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. In a turbine operating by stage expansion, a controlling-valve automatically movable between a constant pressure and a variable stage-pressure which regulates by its position means to control the volume of fluid-pressure delivered from said stage to a succeeding wheel-compartment.

2. In a turbine operating by stage expansion, a controlling-valve automatically movable between the initial pressure and a succeeding stage-pressure and means controlled thereby to regulate the volume of fluid-pressure delivered from said stage to a succeeding wheel-compartment.

3. In a turbine operating by stage expansion, a stage controlling-valve in the form of a compound differential piston which is exposed to two different pressures, one constant and the other variable, and moved by relative variations between said pressures, and means controlled by said valve for varying the flow of fluid through the turbine.

4. In a turbine operating by stage expansion, a differential controlling-valve for each stage which is automatically adjustable between a constant pressure and a pressure varying with the load and which controls means to regulate the flow of pressure between wheel-compartments.

5. In a turbine operating by stage expansion, a stage controlling-valve exposed to a constant and a variable pressure, and moved by relative variations between said pressures, and a plurality of stage-valves which are opened or closed by the movement of said controlling-valve.

6. In a turbine operating by stage expansion, a controlling piston-valve exposed to a constant and a variable pressure, a row of stage-valves between wheel-compartments, and a relay-power controlled by said piston-valve which actuates said stage-valves.

7. In a turbine operating by stage expansion, a passage for discharging fluid-pressure from a stage, a piston-valve controlling the flow of fluid in said passage exposed to the stage-pressure tending to move it one way, and to a stage-pressure-controlled power tending to move it the other way.

8. In a turbine wherein the pressure of the motor fluid is fractionally converted into velocity, a working passage for said fluid, means disposed at an intermediate point in said passage to open or close it, and pressure-controlled means to intermittently actuate said first-mentioned means.

9. In a turbine operating by stage expansion, a plurality of passages for discharging fluid-pressure from a stage, valves controlling the flow of fluid through said passages, and means sensitive to variations in the pressure of said stage which actuate said valves to control the volume of fluid discharged from said stage.

10. In a turbine operating by stage expansion, a plurality of fluid-conducting passages between stages, a stage controlling-valve exposed to a constant pressure and a stage-pressure and means controlled by said valve to vary the number of said passages delivering fluid between stages.

11. In a turbine operating by stage expansion, a stage-pressure-controlling mechanism comprising a cylinder communicating with the initial pressure and with a stage-pressure, a differential piston therein movable sensitive to variations between said pressures, a plurality of passages for discharging pressure from said stage, and means controlled by said piston for regulating the flow of pressure through said passages.

12. In a turbine, working passages for the motor fluid, means to vary the flow of the fluid through said turbine, and a governing-valve controlling said means and exposed to internal pressure by which it is adjusted to set operating positions sensitive to variations in said pressure.

13. In a turbine operating by stage expansion, a differential governing-valve which is exposed to two different pressures, one of which is a stage-pressure, and which automatically adjusts itself to a different set operating position upon a temporary variation in the difference between said pressures, and means controlled by said valve to regulate the discharge of fluid-pressure from a stage.

14. In a turbine wherein the pressure of the motor fluid is fractionally converted into velocity, nozzle-passages for the fluid, valves in said passages and means to pulsate said valves subject to a governor control.

15. In a turbine operating by stage-expansion, nozzle-passages between stages, a rotating stage-pressure-controlled piston and means controlled thereby which regulates the flow of fluid through a row of said passages, pulsating it in one or more to compensate small variations in the said stage-pressure.

16. In an elastic-fluid turbine, a nozzle-passage delivering fluid-pressure against a rotating element, and a multiported valve controlling the flow of fluid through said nozzle and seated within a diaphragm-partition of said turbine.

17. In an elastic-fluid turbine, a nozzle-passage, and a multiported slide-valve controlling the flow of fluid through said nozzle and seated in an opening disposed in the nozzle-bearing portion and intersecting said passage.

18. In an elastic-fluid turbine, a plurality of nozzle-passages, circular valve-openings intersecting said passages at their contracted

portions, a grated shell inserted in said opening, and a multiported valve movable over the grated openings in said shell to control the flow of fluid through said passage.

19. In an elastic-fluid turbine, a nozzle-passage, a valve-shell in said passage having an unobstructed opening toward the inlet end of said passage, and a grated opening toward the discharge end of said passage, and a multiported piston-valve longitudinally movable in said shell.

20. In an elastic-fluid turbine operating by stage expansion, a plurality of concentric rows of working passages for the fluid, and independent rows of valves controlling said rows of passages.

21. In an elastic-fluid turbine, two independent working passages disposed in reverse directions, valves controlling the fluid-supply to said passages, a valve-controlling means, and means to connect either of said valves with said controlling means.

22. In a turbine wherein the pressure of the motor fluid is fractionally converted into velocity, working passages for said fluid, means disposed at intermediate points in said passages, to open or close them, and pressure-controlled means to intermittently actuate a part of said first-mentioned means.

23. In an elastic-fluid turbine, a stage-pressure-governing mechanism comprising means to vary the volume of the fluid discharged from a stage, and a rotating controller device for said means having an eccentric controller portion.

24. In an elastic-fluid turbine, a governing mechanism comprising means to vary the volume of fluid discharged from a stage and a pressure-shifted rotating controlling device acting to intermittently actuate part of said means to pulsate part of said discharge.

25. In a governing mechanism, a plurality of pressure-operated valves controlling the flow of motive fluid, a series of pressure-conducting passages leading to said valves, and a rotating governor-piston which successively opens said passages to the admission of pressure.

26. In a governing mechanism, a plurality of pressure-operated valves controlling the flow of motive fluid, a series of pressure-conducting passages leading to said valves, and a rotating pressure-shifted piston, movable over said passages, to control the admission of pressure thereto and having its controlling portion tapering.

27. In an elastic-fluid turbine, a plurality of independent working passages at different radial distances from the center, valves controlling the fluid-supply to said passages, a valve-controlling means, and means to connect either of said valves with said controlling means.

28. In an elastic-fluid turbine, two or more concentric rows of working passages for the fluid, means to control the flow of fluid in said passages, controlling mechanism and means, interposed between said mechanism and said pressure-controlling means, to place the means controlling the flow of fluid through one of said rows of passages under the control of said device and to disconnect the other controlling means therefrom.

29. In an elastic-fluid turbine having two or more rows of concentric working passages in which the velocity of the fluid is fractionally abstracted, valves controlling the flow of fluid through said passages, a controller device, and means to confine the controlling effect of said device to any desired row of working passages.

30. In an elastic-fluid turbine, a nozzle-passage, a multiported valve-seat inserted in said passage, and a multiported piston-valve movable over said ports.

31. In a governing mechanism, a plurality of pressure-operated valves admitting motor fluid to a wheel-compartment, a series of pressure-conducting passages leading to said valves, and a rotating governor-piston alternately opening part of said passages to a high and an exhaust or condenser pressure.

32. In a fluid-motor, in combination, working passages for the motor fluid, valves therefor which are held in one position by the action of internal pressure, a rotating controller device, and pressure controlled thereby to actuate said valves against said internal pressure.

33. In a fluid-motor, in combination, a working passage for the motor fluid, a valve therefor normally held in one position by the action of internal pressure, and a rotating pressure-controlling means to move said valve from its normal position.

34. In a fluid-motor, in combination, a nozzle-passage for the motor fluid, a valve therefor normally held in one position by the action of pressure within the motor, and a rotating valve controlling the delivery of a superior pressure to actuate said valve.

35. In an elastic-fluid turbine operating by stage expansion, a stage-valve and means to deliver intermittent impulses of actuating fluid to said valve to pulsate the fluid-supply admitted by said valve to a succeeding wheel-compartment.

36. In a turbine, a plurality of groups of working passages, designed to exert different driving effects upon said turbine, independently-actuated valves to vary the flow of motor fluid through said passages, and governing means for said valves actively controlling the flow of fluid in one of said groups of passages, while maintaining said other passages inactive.

37. In a turbine, two or more working passages at different radial distances from the shaft center, and valves for said passages disposed substantially in radial alinement.

38. In a turbine, a plurality of nozzle-passages at different radial distances from the shaft center, a substantially radially disposed

valve-seat, and means thereon to control the admission of pressure to said nozzle-passages.

39. In a turbine, a plurality of nozzle-passages at different radial distances from the shaft center, a substantially radially disposed valve-seat and independently-acting valves thereon for said nozzles.

40. In a turbine, a plurality of nozzle-passages at different radial distances from the shaft center, a valve-seat extending substantially radially from the periphery of the nozzle-bearing portion toward the shaft center, and means to control the flow of fluid in one of said passages while maintaining the other closed.

41. In a turbine, concentric rows of nozzle-passages, a valve-seat communicating with a nozzle of each row, valves on said seat controlling the fluid-supply for the passages with which their seat communicates.

42. In an axial-flow turbine having independent rows of working passages, groups of substantially radially disposed fluid-actuated valves for said passages.

43. In a turbine, a plurality of nozzle-passages, a valve-seat intersecting a plurality of said passages and substantially radially disposed, and valves for each nozzle disposed on said seats.

44. In a governing mechanism for turbines, a plurality of turbine-valves, fluid-conducting passages leading to said valves, valve means to close part of said passages and open the rest to a fluid-pressure-controller means, said controller means being adapted to govern the admission of fluid-pressure to said open passages and control the operation of the turbine-valves to which they lead.

45. In a governing mechanism for turbines, concentric rows of working passages, valves therefor, a controller means delivering valve-actuating fluid to a valve-casing, passages leading from said casing to said rows of turbine-valves and means in said casing to direct said valve-actuating fluid to the passages leading to one row of valves by cutting off said fluid from the other row of valves.

46. In a governing mechanism for turbines, concentric rows of working passages, valves therefor, a controller means delivering valve-actuating fluid to a valve-casing, passages leading from said casing to said rows of turbine-valves and means in said casing to direct said valve-actuating fluid to the passages leading to one row of valves and to open the passages leading to said other row of valves to the exhaust-pressure, and means to move said latter row of valves against said exhaust-pressure.

47. In a governing mechanism for turbines having a plurality of concentric rows of working passages, controlling means admitting valve-actuating fluid to a series of passages leading to a valve-casing, a plurality of passages leading to the valves of each of said rows of working passages, and a compound piston-valve in said casing acting to throw said first-mentioned passages into communication with the passages leading to but one of said rows of turbine-valves at a time.

48. In a turbine, a plurality of fluid-actuated valves at different radial distances from the shaft center, a group of passages leading to said valves, a passage communicating with a source of valve-actuating pressure, and means to open said passage to one of said group.

49. In a turbine, a stationary element, two nozzle-passages leading in reverse directions therethrough and having their contracted portions oppositely disposed, and an opening in said element intersecting said contracted portions, and motor-fluid-controlling means therein.

50. In a turbine, nozzles and rotating buckets forming independent working passages wherein the motor fluid acts with different driving effects upon a rotating element of said turbine, and governor-controlled fluid-actuated valves in said passages.

51. In a turbine, a plurality of nozzle-passages at different distances from the shaft center, valves for said passages, fluid-pressure means to control the action of one or more of said valves at the same radial distance from said shaft center, and means to maintain said other valves closed.

52. In a turbine, rows of working passages and valves therefor at different distances from the shaft center, groups of passages conducting fluid-pressure to actuate a series of valves across said rows, means to control said valve-actuating fluid, and means to direct said controlling fluid to the corresponding passage of each group.

53. In a fluid-pressure motor operating by stage expansion, independent working passages designed to exert different driving effects on said motor, and means to maintain one of said passages inactive and to interrupt the flow of motor fluid through the active passage to pulsate it.

54. In a turbine, a plurality of working passages at different distances from the shaft center, valves in said passages, means to pulsate a valve or valves at a given radial distance from said shaft center, and means to maintain the valves at other radial distances closed.

55. In a fluid-pressure motor, independent working passages designed to exert different driving effects on said motor, valves controlling the flow of fluid in said passages, means to maintain a valve in one of said passages closed and to intermittently actuate a valve in the other of said passages.

56. In a reversing-turbine, reversely-disposed nozzles and rotating buckets, and fluid-pressure means to cut off the motor fluid from the nozzles disposed in one direction and to

intermittently open one or more nozzles disposed in the opposite direction to pulsate the motor fluid delivered by them to the turbine.

57. In a reversible turbine, nozzles delivering motor fluid against a rotating element to drive it in opposite directions means to close the nozzle or nozzles disposed in one direction, and means to intermittently open one or more of the nozzles disposed in the opposite direction under the control of a governing means.

58. In a turbine, two independent stage-valves controlling the flow of motor fluid through nozzle-passages at different distances from the shaft center, and a controller means to interrupt the flow of fluid through one of said passages for periods of varying duration, while the other passage is constantly closed.

In testimony whereof I affix my signature in presence of two witnesses.

JAMES WILKINSON.

Witnesses:
H. M. HORTON,
R. D. JOHNSTON, Jr.