No. 753,774. PATENTED MAR. 1, 1904.

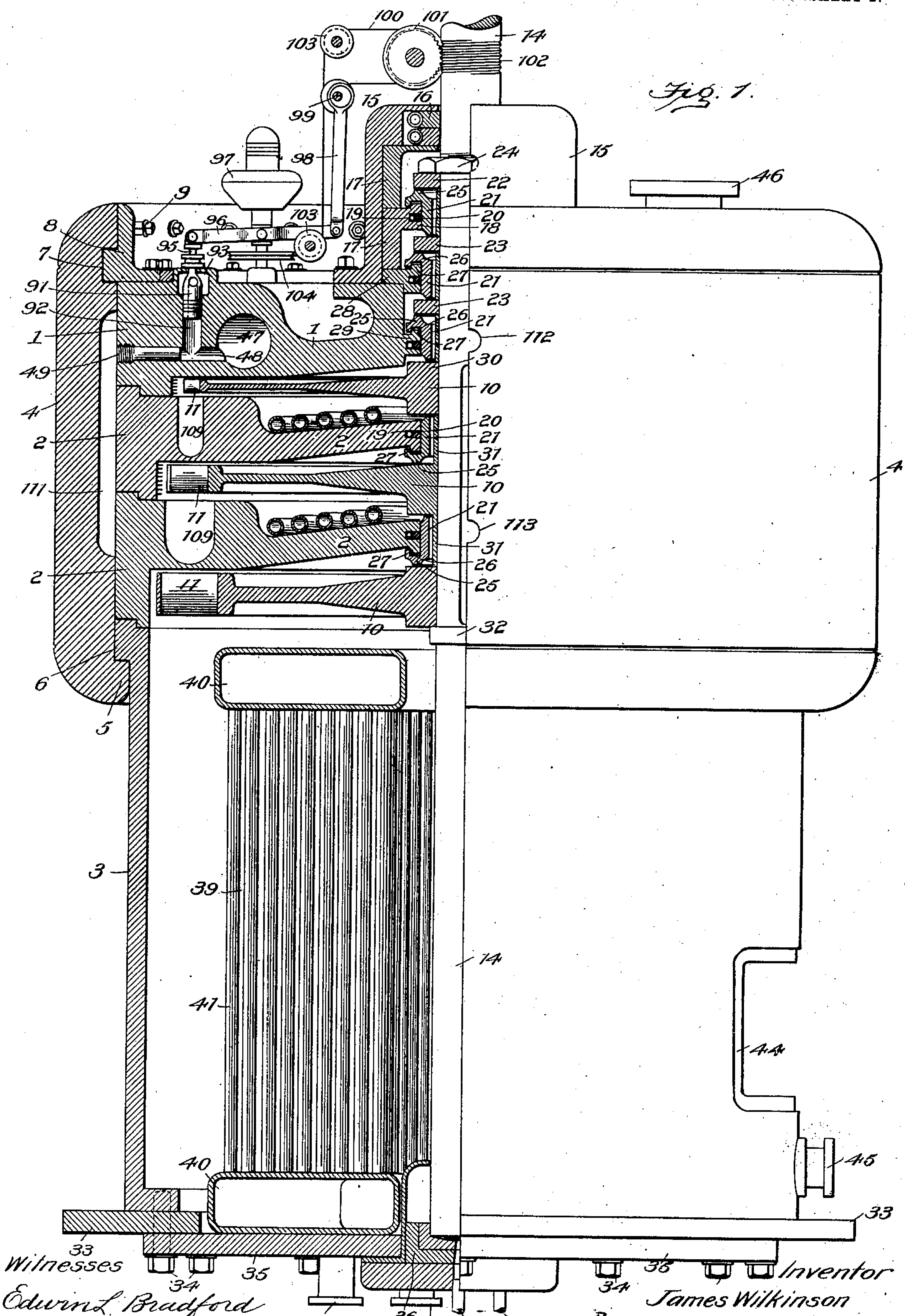
J. WILKINSON.

GOVERNING MEANS FOR ELASTIC FLUID TURBINES.

APPLICATION FILED JAN. 12, 1904.

NO MODEL. 3 SHEETS—SHEET 1.

Fig. 1.



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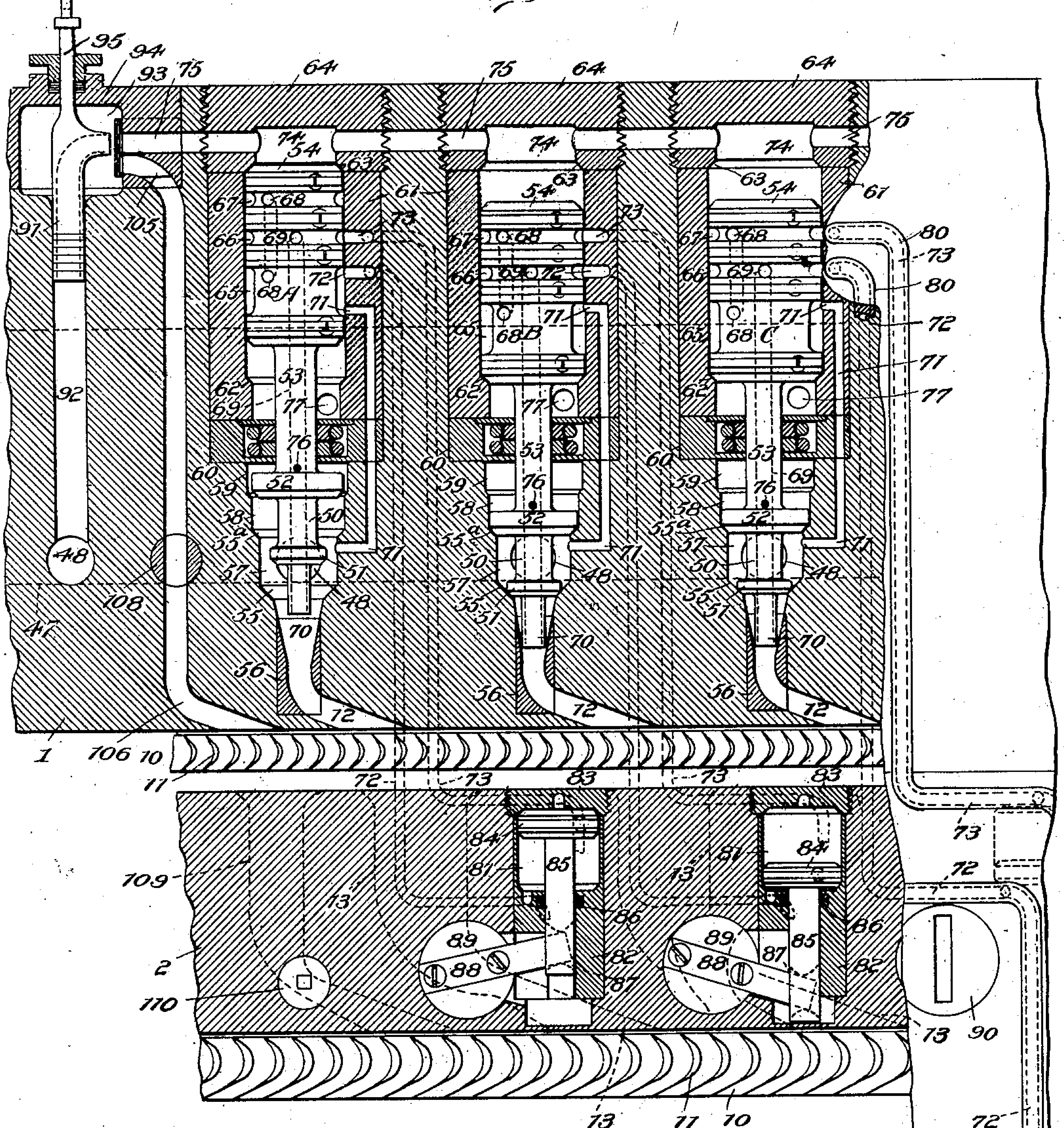
NO MODEL. 3 SHEETS—SHEET 2.

Fig. 2.



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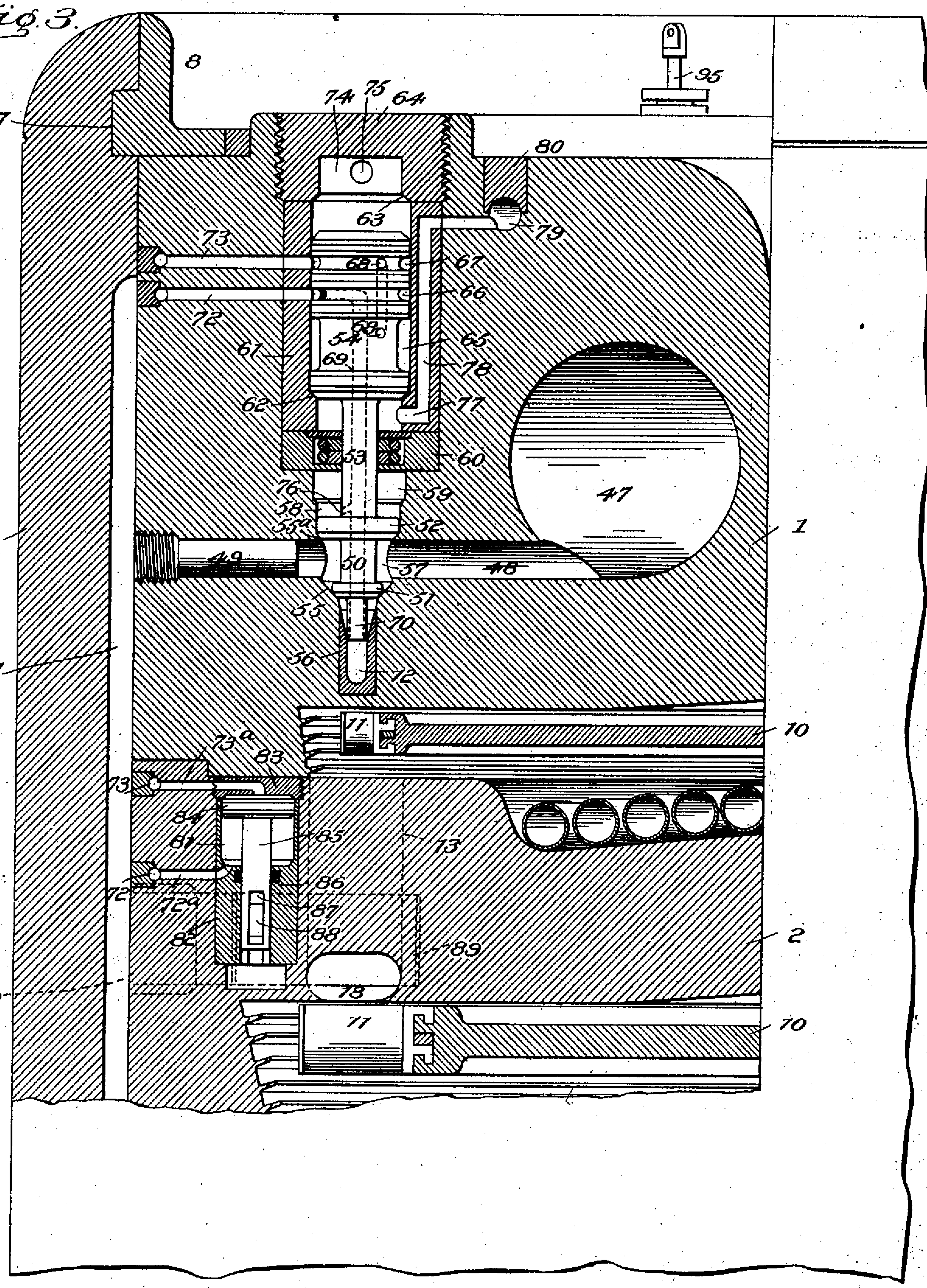
NO MODEL. 3 SHEETS—SHEET 3.

Fig. 3.



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UNITED STATES PATENT OFFICE.

JAMES WILKINSON, OF BIRMINGHAM, ALABAMA, ASSIGNOR TO THE WILKINSON STEAM TURBINE COMPANY, A CORPORATION OF ALABAMA.

GOVERNING MEANS FOR ELASTIC-FLUID TURBINES.

SPECIFICATION forming part of Letters Patent No. 753,774, dated March 1, 1904.

Application filed January 12, 1904. Serial No. 188,763. (No model.)

To all whom it may concern:

Be it known that I, JAMES WILKINSON, a citizen of the United States, residing at Birmingham, in the county of Jefferson and State of Alabama, have invented new and useful Improvements in Governing Means for Elastic-Fluid Turbines, of which the following is a specification.

My invention relates to improvements in elastic-fluid-governing means for turbines and rotary motors, which is particularly adapted for use with multiple-stage turbines, wherein the flow of fluid is controlled by valves in the nozzles connecting the several stages.

It is the object of my invention to reduce the waste of the valve-controlling fluid and increase the economical operation of the motor by using an impact pressure-governor, which forms the subject-matter of a separate application, to control the supply-valves and adapting the supply-valves to control the admission of a relay-actuating pressure to passages leading to rows of valves across the stages and to cause the exhaust-pressure from the passages to do useful work by discharging it into the supply-nozzles. In this manner all the fluid-pressure utilized for the purposes of controlling valves is subsequently converted into velocity and delivered against a rotor or bucket wheel, whereas it has been the general practice heretofore to exhaust it into the atmosphere or condenser or into a lower stage, when one or more of the fractions of its velocity abstraction is lost.

My invention further comprises the construction and arrangement of parts hereinafter described, and more particularly pointed out in the claims, reference being had to the accompanying drawings, in which—

Figure 1 is a side view, partially in section, of a three-stage turbine, showing the controller-nozzle and the governor means therefor in elevation. Fig. 2 is a vertical sectional view broken away and taken on a curved plane through the first two stages of a turbine and illustrating the governor-nozzle and a series of turbine supply and stage valves, and also showing a portion of the inner casing with the outer shell removed. Fig. 3 is an enlarged transverse sectional view showing in side elevation a supply and a stage valve and their respective operating means.

Similar reference-numerals refer to the same parts throughout.

The turbine according to my preferred construction comprises a supply-head 1, diaphragm-partitions 2, and a shell forming an exhaust-chamber 3, which interlock, and are surrounded by a strengthening-shell 4, provided with a shoulder 5, engaging a corresponding shoulder 6 around the shell 3. I provide an annular internal channel 7 within the shell and insert therein a locking-strip 8, suitably bolted to the shell by tap-screws 9 and provided with a flange which engages the supply-head 1. The two supply and exhaust ends and the intermediate sections are held firmly in position against internal pressure between the shoulder 5 and the locking-strip 8. The compartments into which the interior of the turbine is divided by the diaphragms 2 form stages, within each of which rotates a wheel 10, provided with a peripheral row of buckets 11, disposed opposite to the supply-nozzles 12 and the stage-nozzles 13, leading through the supply-head 1 and the succeeding diaphragms, so as to deliver the motor fluid at an angle against the rotating buckets. In this manner the succeeding nozzles and rows of rotating buckets form working passages within which the motor fluid is fractionally converted into velocity, which is transmitted by wheels 10 to the turbine-shaft 14, to which they are rigidly keyed. This shaft extends through a stuffing-box 15, secured to the head 1 and recessed to receive the packing-ring 16, which rests upon the top of a recessed filler-block 17, inserted within the stuffing-box 15, and mounted upon a similar block, whose inwardly-disposed shoulder 18 is internally channeled at 19 to receive a packing-ring 20, which engages the side of an annular automatic pressure-reducing ring 21, such as is described in my Patent No. 739,965. This ring moves between two rotating seats 22 and 23, rigidly secured to the said shaft, the former being held against a vertical movement by the nut 24, engaging suitable threads on the shaft. This pressure-reducing ring leaves a clearance around the shaft for the graduated flow of pressure between it and its two seats, which flow is controlled by the automatic movements of the rings, sensitive to the differential in the pressures above and below it. This action being fully described in my Letters Patent aforesaid will not be further referred to herein, except to point out an improvement whereby it is my intention to dash-pot the movements of this ring. With this object in view I provide an annular shoulder 27 on the top of shoulder 18, and I also form the flanged portion 25 of the ring, which is disposed within the low-pressure chamber, on its under side with an annular channel 26, into which said shoulder 27 enters and fits sufficiently close to act as a piston with a dash-pot effect to prevent undue oscillation or sudden movements of the ring 21. It will be seen that I provide a series of three of these automatic pressure-reducing rings 21, the intermediate one of which moves between two rotating seats 23 and is mounted in an annular block 28, held between the block 17 and the head-section 1. The lower pressure-reducing ring is mounted in a channeled shoulder 29, formed integral with the supply-head of the turbine, and moves between the lower seat 23 and the shouldered hub 30 on the wheel 10 in the first compartment. In this manner the several rings act automatically to gradually reduce the pressure existing in their respective low-pressure chambers, so that in conjunction with packing 16 they practically overcome a leakage of pressure about the shaft from the first stage. I dispose one of these automatic rings 21 between the central opening in each diaphragm 2 and the shaft, the channel 19 and packing-ring 20 being here disposed within said diaphragm. It will be noted that the hub of the wheel on the second compartment is not shouldered, as at 30, so that the ring 21 moves between this top surface and the hub of the wheel above it as seats. Here the shoulder 27 is formed integral with the under surface of the diaphragm, and the hub 10 is provided on either side with tubular extensions 31, forming sleeves surrounding the shaft opposite the two lower diaphragms. Similar sleeves surround the shaft between the several wheels and also between the seats 23 and serve as distance-sleeves between these parts, by which they are held firmly in place between a shoulder 32 on shaft 14 below wheel 10 and the nut 24. These sleeves also have the effect of reducing the area of the clearance between the rings and the shaft and also to protect the shaft from the action of steam or other motor fluid. The lower wheel 10 is disposed immediately above the exhaust or condenser chamber 3, which is preferably of the same diameter as the wheel-compartments and forms a continuation of the inner casing of the turbine. This permits the shell 4 to be slipped down after the locking-strip 8 has been removed until it rests on a flanged foundation-plate 33, rigidly secured in place by cap-screws 34 between the end plate 35 and the inwardly-flanged end of the wall of chamber 3. The shaft 14 extends centrally through the exhaust-chamber and is mounted in an end bearing 36, which is preferably adapted to support the shaft on oil circulating under high pressure through pipes 37 and 38 through said bearing. I preferably place within the chamber 3 a circular condenser or feed-water heater 39, having water-legs 40 40, connected by tubes 41. Water is admitted by pipe 42 to one of said water-legs, and after circulating through tubes 41 and the other head is withdrawn through pipe 43. The usual exhaust-port 44 is also provided, as well as an outlet-opening 45 for the water of condensation in the exhaust-chamber.

Motor fluid is admitted by an inlet-port 46 to an annular supply-passage 47, formed within the enlarged periphery of the head 1, and disposed nearer to the shaft center than the row of supply-nozzles 12, to which it delivers motor fluid through branch passages 48, bored substantially radially from the periphery of the head into passage 47 and intersecting the nozzle-passages. I close these passages beyond the nozzles by inserting plugs 49, preferably having elongated bodies and screw-threaded heads, which engage countersunk threads at the outer ends of passages 48. These passages may be formed in any desired manner; but I prefer this manner because of economy in construction. As shown in Fig. 2, I provide each of the nozzles 12 with a differential reciprocating supply-valve 50, which comprises heads 51 and 52, mounted integral upon the stem 53 of a piston 54. Around the upper periphery of the supply-head 1 I bore a series of chambers threaded at their upper ends and internally shouldered to form a seat for the sectional cylinder for the piston 54 and seats 55 and 55ª for heads 51 and 52, respectively, of each valve 50. The lower portion of this chamber forms the induction end of the nozzle 12, and to increase the economy of construction I provide a block 56, which is inserted in this lower portion and provided with a passage forming the intermediate curved portion of the nozzle, whose delivery end leads from this block at an acute angle to the plane of rotation of the bucket-wheel 10. The branch passage 48 admits motor fluid to the lower portion of the chamber 57, within which the head 51 of the valve is disposed. This pressure has access to the head 52, which moves pressure-tight in an open cylinder 58 between the reduced lower portion of chamber 57 and the enlarged upper portion 59. The lower face of heads 51 and 52 and seats 55 and 56 therefor are beveled. The stem 53, carrying valve 50, passes through a suitable stuffing-box 60, seated on the first shoulder in the chamber.

A tubular shell 61, inserted in the upper end of the chamber in the head, abuts against the stuffing-box 60 and forms a cylinder for the piston 54, which is beveled on each end, the lower of which engages a bevel-shoulder 62, forming a seat therefor, and the upper of which engages a bevel-seat 63, formed in the screw-plug 64, which closes the upper end of an opening in the head and constitutes the upper head of the cylinder for piston 54. Packing of any desired character may be inserted in the recess formed in the block 60 to prevent leakage of pressure between the piston-cylinder and the valve-chamber. The piston 54 is circumferentially cut away to form a large annular chamber 65 and two small annular chambers 66 and 67. The portions of the piston between these chambers fit pressure-tight within cylinder 61, so that there is no communication of pressure between these chambers except by a passage 68, connecting chambers 65 and 67. A passage 69 leads from the chamber 66 down through the center of the stem 53 and valve 50 and through a nozzle extension 70, disposed within the induction end of the nozzle 12. A passage 71 leads from the lower portion of chamber 57 up through the head and shell 61 into the cylinder, and passages 72 and 73 also lead from this cylinder through the periphery of the head and diaphragm and communicate with the two ends of one or more cylinders for actuating a stage valve or valves, as will be hereinafter described. Chambers 74, formed in the plugs 64 and constituting the upper ends of the cylinders 61, are connected by a continuous passage 75, leading from a suitable source of governed pressure, which is thus admitted to the upper ends of the series of cylinders 61 to actuate the pistons 54 therein and control the action of the supply-valves 50. The several pistons of a row may thus be severally controlled by the governed fluid-pressure, and to provide for the successive operation of the valves I make each succeeding piston of the series of relatively increasing cross-sectional area, as shown more clearly in Fig. 2, so that the governed pressure offers a successively-increasing pressure resistance against the substantially constant pressure of the motor fluid against the valves 50, which are all of uniform proportions. An equalizing-passage 76 leads from passage 69 through stem 53 above head 52. A port 77, disposed within the cylinder 61 below its lower valve-seat 62, communicates by a branch passage 78 with an annular passage 79 common to all the cylinders and leading to an exhaust or condenser pressure. This passage 78 leads upwardly through shell 61 and then at right angles through the head to the passage 79, which is formed in the head by a channeled groove and filler-block 80. In the same manner passages 72 and 73 lead through shell 61 and the head to similarly-formed channels in the latter's periphery, which channels continue through one or more of the diaphragms in the line of the fluid's flow and enter the upper and lower ends, respectively, of cylinders 81. These cylinders are formed by recessed blocks 82, inserted in chambers bored around the diaphragm and closed by screw-plugs 83. Beveled pistons 84 reciprocate in these cylinders and have stems 85 leading through suitably-packed openings 86 through blocks 82 and provided each with a transverse opening 87, flaring at both ends and adapted to receive the end of a crank 88, bolted or otherwise secured to a rotary stage-valve 89, disposed within the diaphragm and at the contracted portion of nozzle 13. The block 82 and the diaphragm are cut away to give the necessary play for crank 88. Suitable seats are provided for these valves 89, preferably being formed by openings bored radially into the diaphragm's periphery and closed by screw-plugs 90. The opening 87 is flared to provide for converting the reciprocating movements of stem 85 to semirotary motion without any binding or undue friction between parts.

My improved governing mechanism for the valve-controlling fluid-pressure forms the subject-matter of a pending application, and, briefly described, comprises a nozzle 91, whose stem or body portion is disposed within a passage 92, leading downwardly through the head and communicating with a branch passage 48, leading from the supply-passage 47. The stem of the nozzle is packed to move pressure-tight in passage 92 and has its jet end disposed within a chamber 93, formed by a recessed block 94, inserted in a suitable cut-away portion in the head. An operating-stem 95 for the nozzle extends through a packing-gland in block 94 and is pivotally connected to a lever-arm 96, connected near its center to a slip-collar on a speed-governor 97, by which the nozzle is raised or lowered and connected at its end to an arm 98, which is oscillated by an eccentric 99. An endless belt 100, driven by a pulley 101 through a worm-gear 102 on shaft 14, passes over idlers 103 to a pulley 104, driving governor 97 and back up to drive the eccentric 99, which gives an oscillatory movement to the nozzle. Passage 75, communicating with the upper ends of the series of cylinders 61, leads through block 94 and enters chamber 93 immediately above the port for a passage 105 through the supply-head, which is curved at its delivery end 106, where it acts like nozzles 12 to deliver the controller-stream against the wheel 10 after it has performed its valve-controlling function. The nozzle 91 through its constant communication with the motor-fluid supply through passage 92 delivers a continuous jet of fluid, more or less of which, according to the nozzle's governor-controlled position, enters the open end of controller-passage 75, which is closed at its other end, and acts with injector effect to vary the potential of the pressure therein. As the nozzle is lifted the pressure in passage 75 rises until it becomes successively superior to the constant pressure against valves 50, and the latter are moved to a closed position. On the contrary, as the nozzle is lowered an ejector effect is produced by the jet in passage 105, while the injector effect in passage 75 decreases, so that pressure in the latter is lowered, and the valves are successively opened by the pressure of the motor fluid. The constantly-flowing stream is thus diverted to control the valves while it does useful work in the turbine. A valve 108 in passage 105 may interrupt this flow, when the fluid-pressure will bank up in chamber 93 and passage 75 and close all valves to shut off all the fluid-supply. The oscillation of the nozzle 91, effected by eccentric 99, causes it to intermittently raise and lower the controller-pressure to pulsate the valve or valves at or nearest the critical point of regulation.

It will be noted that there will be no loss or waste of the valve-actuating fluid-pressure in controlling the row of supply-valves 50, and it is the further object of my invention to prevent any such loss occurring while my governing mechanism is required to control the stage-valves of a compound turbine operating by stage expansion. With this object in view I adapt the piston 54 to act as a valve to direct the motor fluid as a relay-power to actuate the motors controlling the stage-valves. Piston 54 by reason of its beveled ends will assume no intermediate operating positions, so that when stationary it will be at one or the other end of its stroke. Referring to Fig. 2 and considering the load to be increasing, nozzle 91 will raise the potential of the controller-pressure until piston 54^A will be moved down to close its valve 50. Before this movement occurs it will be noted that the motor-fluid pressure is admitted below stage-piston 84 to hold it open through passage 71, chamber 65, and passage 72. At the same time the pressure above piston 84 is reduced by the ejector action of the fluid in nozzle 12 in connection with extension 10 of passage 69, with which the upper end of cylinder 81 communicates through passage 73 and chamber 66. As piston 54 moves downwardly the high pressure in chamber 65 is cut off from passage 72 and enters passage 73 through passage 68 and chamber 67, which is opposite said passage 73 when the piston is lowered. At the same time passage 72 is placed in communication with chamber 66, so that as the high pressure admitted above piston 84 moves it downwardly the fluid-pressure in the cylinder and in passage 72 will escape through passage 69 to nozzle 12 and do useful work. The discharge of this pressure into passage 69 causes the pressure in chamber 59, through equalizing-passage 76, to assist in seating the valve. After the valve is closed the stage-pressure will exist in passage 69, chamber 59 above valve-head 52 in passage 72, and below piston 84 in cylinder 81; but this pressure being lower than the supply-pressure existing in passage 73 and above piston 84 this piston will be firmly held to its seat with stage-valve closed. As the valve 50 rises the ejector action in passage 69 reduces pressure in chamber 59 and by creating a partial vacuum in said passage and chamber 66 causes a quick discharge of the pressure from passage 73 through said chamber and passage, which assists the pressure above piston 84 in moving it upwardly and compensates the increased power required to open the stage-valves 89 and overcome the friction of rest, due to the unbalanced condition of the valve when closed. As the valve-head 52 moves out of cylinder 58 into chamber 52 it becomes balanced except to the constant end pressure against stem 53, since the supply-pressure has access to all sides of valve 50 equally. The exhaust-ports 77 admit an atmospheric pressure below the piston 54, which is proportioned to counterbalance the constant end thrust of the supply-pressure against stem 53 when exposed to a predetermined critical governed pressure. In this manner when valve 50 is open it is balanced, and its downward movement will commence when the governed pressure overcomes the said end-thrust pressure. When the valve is closed, it will be opened when the supply-pressure acting against the larger of the valve-heads overcomes the governed pressure against piston 54. The valves will be designed to maintain the unbalancing end-thrust pressure the same in both its open and closed positions. It will thus be seen that each of the reciprocating pistons for the supply-valves acts as a valve to direct a relay-power to the controlling-motors for a row of valves across the several stages, for passages 72 and 73 may lead across all the stages and connect with a cylinder 81 in each stage by the radially-disposed branch passages 72^a and 73^a, Fig. 3. Following the line of the fluid's flow, I provide a row of nozzles 109 for the controller-stream of fluid across the stages controlled by independently-actuated rotary valves 110. If desired, valves 108 and 110 may be simultaneously controlled manually or in any desired manner.

I provide an annular steam or superheating jacket 111 about the turbine, formed by a recess in the inner face of the shell 4, through which steam may be circulated by passages 112 and 113, Fig. 1.

I use the reciprocating valves for the initial stage, because I find it difficult to properly lubricate slide or rotary valves on account of the superheated condition of the motor fluid at this and its high pressure. In the succeeding stages, where the pressure will have been reduced, lubricant may be readily supplied to any desired character of valve.

I claim—

1. In a turbine operating by stage expansion, a plurality of supply-nozzles, independent valves therefor, and a plurality of stage-valves, one or more of which are opened and closed under the control of each of said supply-valves.

2. In a motor adapted to fractionally expand the motor fluid, a plurality of supply-nozzles, valves therefor, and means to successively operate said valves, in combination with a plurality of valves between two compartments where the fluid is fractionally expanded, passages leading to each of said latter valves to deliver an actuating fluid to open or close them successively under the control of said supply-valves.

3. In a governing means for multiple-stage turbines, supply and stage valves, passages, connecting each supply-valve with one or more stage-valves, which are alternately opened to a high and low pressure by the movement of said supply-valve, and a governing means to control the independent operation of said supply-valves.

4. In a governing means for multiple-stage turbines, a supply-valve, means to actuate said valve, a stage-valve, passages leading to said stage-valve, and a valve-actuating fluid which is admitted to said passages to open and close said stage-valve under the control of said actuating means for the supply-valve and which is exhausted from said passages into the first stage.

5. In a governing means for multiple-stage turbines, supply-valves, fluid-actuated stage-valves, and means to utilize the same power means to open and close part of said stage-valves, when a supply-valve opens or closes.

6. In a motor, a nozzle-passage, a valve therefor, and an actuating-piston for said valve which is recessed to form, in connection with its cylinder, peripheral chambers.

7. In a motor, nozzle-passages, valves therefor, cylinders and pistons for actuating said valves, each of said pistons having annular channels, and valve-actuating fluid-conduits with which said channels communicate.

8. In a motor, fluid-supply passages, valves therefor, an actuating-piston for each valve recessed to form chambers in which different pressures are maintained, and passages to deliver said pressures to other valve-actuating means.

9. In a motor, a fluid-supply nozzle, a valve therefor, a fluid-actuated piston connected to said valve and provided with a plurality of annular channels which form pressure-tight chambers with the piston's cylinder, means to maintain different pressures in said chambers, and fluid-conducting passages, leading to another valve, which are alternately opened to said chamber-pressures.

10. In a rotary motor, nozzle-passages, fluid-actuated valves therefor, and means to exhaust by an ejector action the valve-actuating fluid, after it has performed its work, into a motor-fluid-supply nozzle.

11. In a governing means for a multiple-stage turbine, supply and stage valves, passages conducting an actuating fluid to said stage-valves, and means to exhaust said passages into a supply-nozzle.

12. In a governing means for a multiple-stage turbine, stage-valves, means for actuating said valves by fluid-pressure, and means to exhaust the valve-actuating fluid-pressure into a stage by an ejector action of the motor fluid.

13. In a governing means for a multiple-stage turbine, stage-valves, fluid-conduits leading to said valves, and means to exhaust the valve-actuating fluid, after it has performed its work, against a rotating bucket element by the ejector action of a stream of motor fluid.

14. In a governing means for a multiple-stage turbine, stage-valves, two fluid-conduits leading to each valve, and means to admit a high pressure to one conduit as the other is exhausted into the motor-fluid supply to a stage.

15. In a turbine operating by stage expansion, supply and stage nozzles, fluid-controlled valves therefor, and means to discharge the valve-controlling fluid, after it has performed its work, against a bucket element in the initial stage.

16. In a turbine operating by stage expansion, fluid-actuated stage-valves, fluid-conduits leading to said valves, and ejector means to exhaust the valve-controlling fluid, after it has performed its work, into an induction-nozzle for a preceding stage.

17. In a turbine, a nozzle-passage leading at an angle through a supply-head and having a detachable intermediate portion.

18. In a turbine, a nozzle-passage leading at an incline through a stationary portion, and a block seated in a recess in said portion and formed with a curved passage-way constituting a portion of said nozzle.

19. In a turbine, a nozzle, a valve therefor, an actuating-stem for said valve, and a passage leading through said valve and stem for the purposes specified.

20. In a turbine, an induction-passage, a valve therefor having a nozzle-opening exposed to the pressure in said induction-passage and a passage leading from said nozzle-opening and through said valve and opening into a multiported valve-chamber.

21. In a turbine, a nozzle, a valve having an actuating-stem disposed within a valve-chamber, passages leading from said chamber

and a passage through said stem and valve, and means to move said stem to place said valve-passage into communication with one or the other of said first-mentioned passages.

22. In a turbine, supply and stage nozzles, valves therefor, two passages leading from a supply - valve to a stage - valve - operating means, and means to operate said supply-valve, and means under the control of said last-mentioned means to admit high pressure to one of said passages and exhaust the other into a supply-nozzle for the first stage.

23. In a turbine operating by stage expansion, reciprocating supply-valves for the first stage, and rotary valves, controlling the flow of fluid between stages, whose operation is controlled by said supply-valves.

24. In a turbine wherein the velocity of the motor fluid is fractionally abstracted, the combination of supply, nozzle - passages and reciprocating valves therefor, with nozzle-passages leading between compartments wherein the velocity of the motor fluid is fractionally abstracted, semirotary valves therefor, and means controlled by said supply-valves to operate said semirotary valves.

25. In a motor comprising compartments wherein the velocity of the motor fluid is fractionally abstracted, the combination of a reciprocating supply-valve, a rotary valve between compartments, and fluid - pressure means to control the operation of said valves in rows across the stages.

26. In a turbine, nozzles, valves therefor, and actuating means for a valve, a passage for fluid-pressure to actuate another valve, and conduits, one opening into a nozzle and the other communicating with the motor - fluid pressure, which are alternately placed in communication with said passage by the movement of said actuating means.

27. In a turbine, nozzles, valves therefor, and actuating means for a valve, passages for fluid-pressure to actuate another valve, and conduits, one opening into a nozzle and the other communicating with the motor - fluid pressure, which are alternately placed in communication with said passages by the movement of said actuating means.

28. In a turbine, a nozzle-passage leading through a stationary element and having a curved intermediate portion, and a piece inserted in said element and forming the curved intermediate portion of said nozzle.

29. In a turbine, a rotary turbine-valve, a crank to move said valve, and an actuating-piston whose stem has an opening to receive said crank.

30. In a turbine, a rotary turbine-valve, a crank to move said valve, and an actuating-piston whose stem has a flaring opening to receive said crank.

31. In a governing mechanism for multiple-stage turbines, a supply-valve, an operating-stem therefor, and a plurality of annular channels around said stem, and a passage-way connecting two of said channels.

32. In a governing mechanism for multiple-stage turbines a supply-valve, an operating part for said valve movable therewith and provided with a plurality of separate channels, means to maintain the motor-fluid pressure in two of said channels and the pressure below the valve in the other, and means for operating a stage-valve which is exposed to the pressures in said channels.

33. In a fluid-pressure-governing mechanism for turbines, an oscillating controller-nozzle governing the admission of motor fluid to the turbine.

34. In a motor, the combination of rotating buckets, one or more nozzles delivering motor fluid thereto, means for controlling the flow of fluid through said passage or passages, and a governor-controlled oscillating nozzle for controlling the action of said means.

35. In a motor, a fluid-pressure-controlled valve, and fluid-impact controller means therefor comprising an oscillating nozzle, and means to oscillate and shift said nozzle.

36. In a motor, a fluid-pressure-controlled valve, and fluid-impact controller means therefor comprising an oscillating nozzle, an eccentric means to oscillate said nozzle, and a governor means to shift its position.

37. In a fluid-pressure motor, a plurality of supply-valves, and a plurality of fluid-pressure-operated stage - valves, one or more of which open or close in correspondence with each of said supply-valves.

38. In a governing mechanism for multiple-stage turbines, a plurality of supply-valves, a plurality of fluid - actuated valves for each stage, and means to connect said stage-valves in independent rows across the stages, each of said rows being controlled by one of said supply-valves.

39. In a governing mechanism for turbines, fluid-actuated supply and stage valves, means to group each supply-valve with one or more stage-valves, and a governing means to actuate said groups of valves independently.

40. In a governing mechanism for turbines, fluid - pressure - controlled supply and stage valves, means to group each supply-valve with one or more stage - valves, and a governing means to intermittently actuate one or more of said groups while holding the others open or closed.

41. In a governing mechanism for multiple-stage turbines, supply and stage valves, a governor-controlled power means for successively operating said supply-valves, and means, under the control of said supply-valves, to successively operate said stage-valves.

42. In a governing mechanism for multiple-stage turbines, a plurality of independent supply - valves, and a plurality of independent fluid-actuated stage-valves, whose operation is controlled by said supply-valves.

43. In a governing mechanism for multiple-stage turbines, a plurality of independently and successively controlled supply-valves, a governor-controlled power means for operating said supply-valves, stage-valves and means to transmit the operating power from said supply-valves to successively operate said stage-valves.

44. In a turbine, means for fractionally converting the motor-fluid pressure into velocity, wheel-compartments, supply-valves, fluid-pressure-actuated valves to vary the volume of fluid discharged from a wheel-compartment, and a governing means controlling said supply and compartment valves in independently-operated groups.

45. In a governing mechanism for multiple-stage turbines, a plurality of fluid-pressure-operated supply and stage valves, and a governor means to control said valves in independent rows across the stages and to successively operate said independent rows.

46. In a governing mechanism for multiple-stage turbines, a plurality of fluid-actuated supply and stage valves, independent fluid-conducting passages leading to said stage-valves which are successively operated by an actuating fluid, admitted to said passages under the control of said supply-valves.

47. In a governing mechanism for turbines, fluid-pressure motors, fluid-conduits leading from one to another of said motors, motor-fluid supply and stage valves, piston-valves in said motors for the supply-valves which control the admission of pressure to conduits leading to a motor or motors for stage-valves, and a governing means to serially operate said piston-valves.

48. In a turbine, fluid-pressure-controlled supply and stage valves, and passages to conduct actuating fluid between supply and stage valves which lead through the turbine-casing.

49. In a turbine, fluid-actuated supply and stage valves, and passages to conduct the actuating fluid between supply and stage valves which are disposed inside of the outer casing.

50. In a turbine, supply and stage valves, and fluid-pressure motors for actuating said valves disposed within the turbine.

51. In a multiple-stage turbine, a plurality of wheel-compartments, a plurality of supply-passages and a plurality of passages between compartments, valves for said passages, fluid-pressure means to operate said valves in independent groups comprising supply and stage valves, and a controller means to pulsate the valves of at least one of said groups while the valves of the other groups are held open or closed.

52. In a multiple-stage turbine, a plurality of supply and stage nozzles, valves therefor, rotating buckets, and a fluid-pressure-governing means for said valves controlling their operation in independent groups or rows across the stages and intermittently operating a row to pulsate part of the fluid-supply throughout the stages.

53. In a turbine operating by stage expansion, two or more working passages comprising supply and stage nozzles, valves therefor, and rotating rows of buckets, in combination with a fluid-pressure governing means which intermittently opens the valves of one of said working passages to pulsate the flow of fluid therethrough, while the valves of the other working passage or passages are held closed according to the load on the turbine.

54. In a fluid-motor, a working passage in which the velocity of the motor fluid is fractionally abstracted, and a rotary fluid-actuated valve in said passage.

55. In a turbine, a diaphragm-partition therein, a fluid-passage therethrough, a valve for said passage, and actuating means for said valve carried by said diaphragm.

56. In a turbine, a diaphragm-partition therein, a fluid-passage through said partition and a valve therefor, and actuating means for said valve seated in said partition.

57. In an elastic-fluid turbine operating by stage expansion, a stage-valve that is unbalanced when closed, and means to open said valve by a relay power.

58. In an elastic-fluid turbine operating by stage expansion, a diaphragm-partition therein dividing the interior into stage-compartments, a series of valve-seats therein formed by openings around its periphery, and stage-valves therein.

59. In an elastic-fluid turbine operating by stage expansion, a diaphragm-partition therein dividing the interior into stage-compartments, a series of rotary stage-valves seated in peripheral openings around said diaphragm and controlling the admission of fluid-pressure to the succeeding stages.

60. In an elastic-fluid turbine operating by stage expansion, a diaphragm-partition therein, passages forming nozzles therein, and valves controlling the admission of fluid to said passages seated in the nozzle-passages in said partition.

61. In an elastic-fluid turbine operating by stage expansion, a diaphragm-partition therein, a series of rotary valves seated in the peripheral openings in the turbine-head and around the diaphragm, and pressure-controlled means for operating said valves.

62. In an elastic-fluid turbine operating by stage expansion, means to deliver a part constant and part pulsatory supply of elastic fluid to the first stage, and means to pulsate part of the supply to the succeeding stage or stages.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

JAMES WILKINSON.

Witnesses:
R. D. JOHNSTON,
H. M. HARTON.