No. 826,000.

PATENTED JULY 17, 1906.

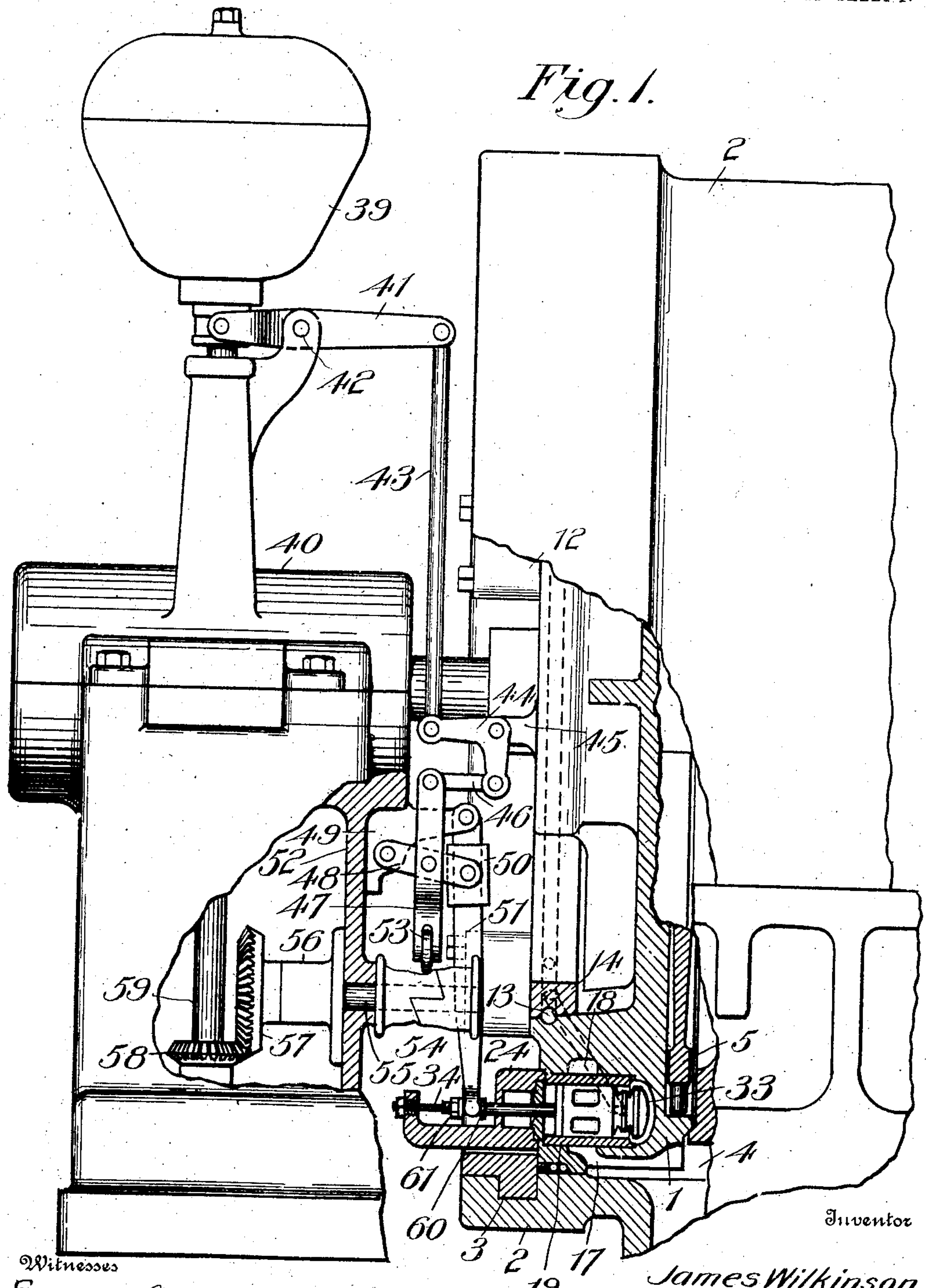
J. WILKINSON.

CONTROLLER MECHANISM FOR TURBINES.

APPLICATION FILED NOV. 23, 1905.

4 SHEETS—SHEET 1.

Fig. 1.



Witnesses

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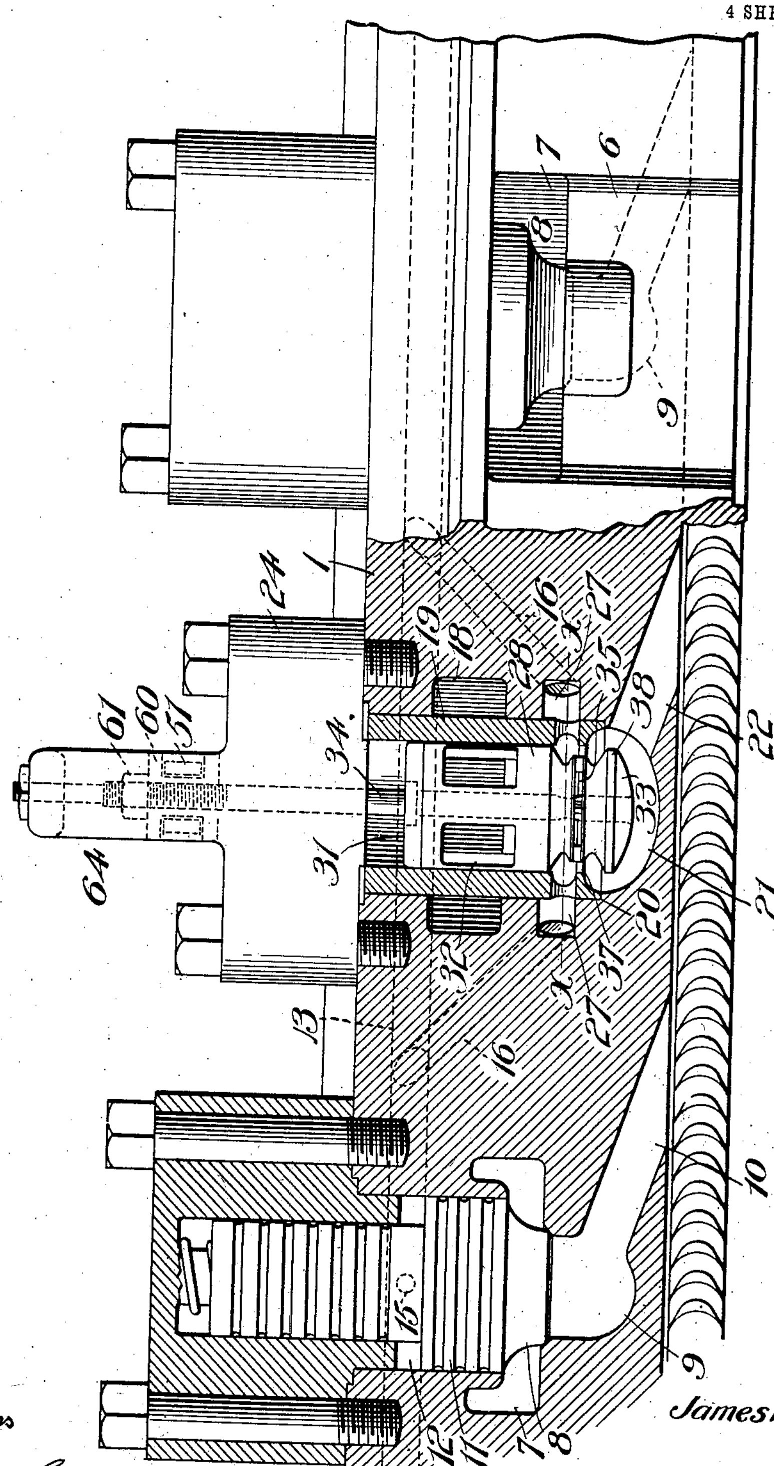
Fig. 2.



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4 SHEETS—SHEET 3.

Fig. 3.

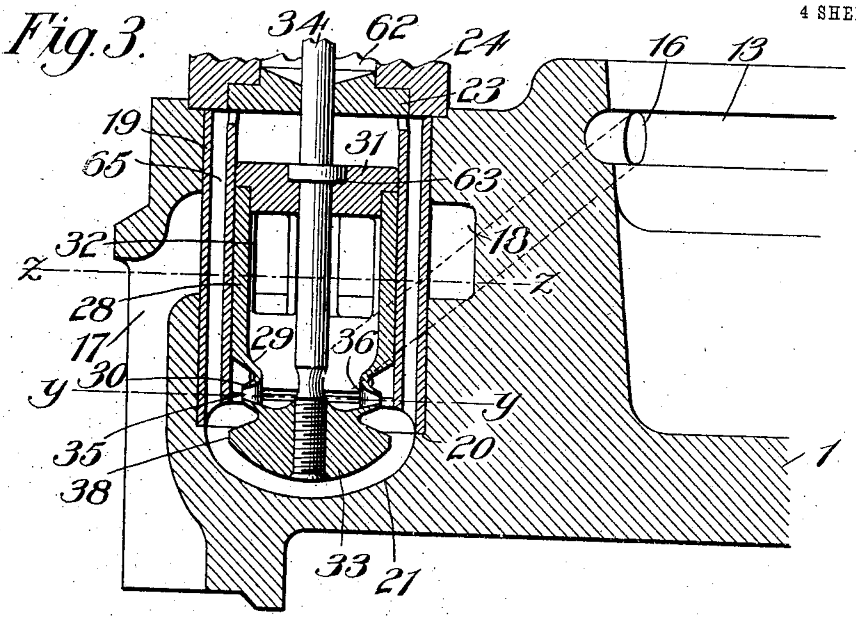


Fig. 4.

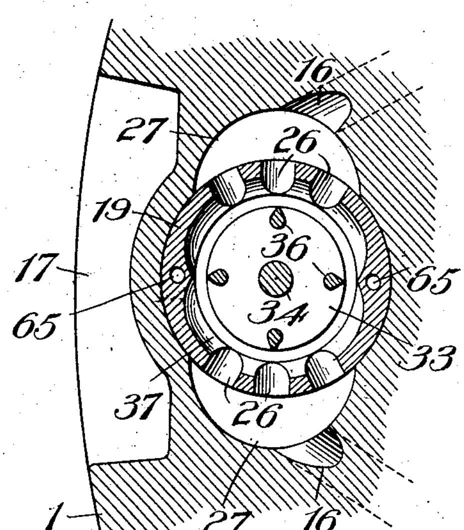
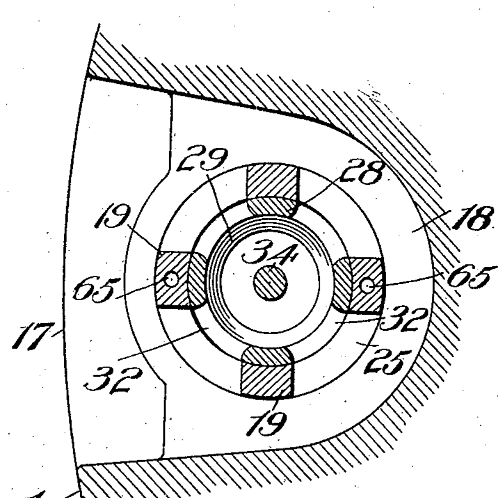


Fig. 5.



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4 SHEETS—SHEET 4.

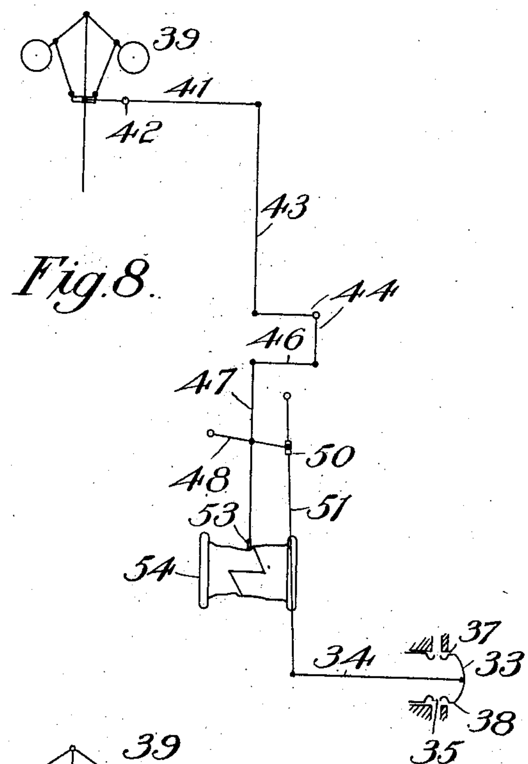

Fig. 8.

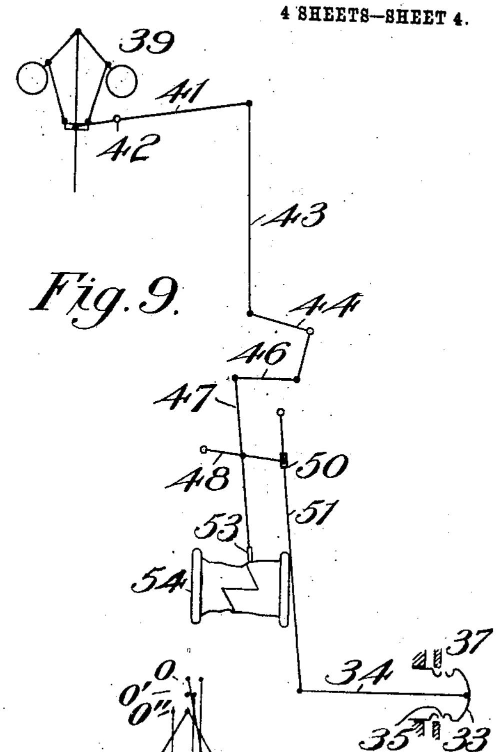

Fig. 9.

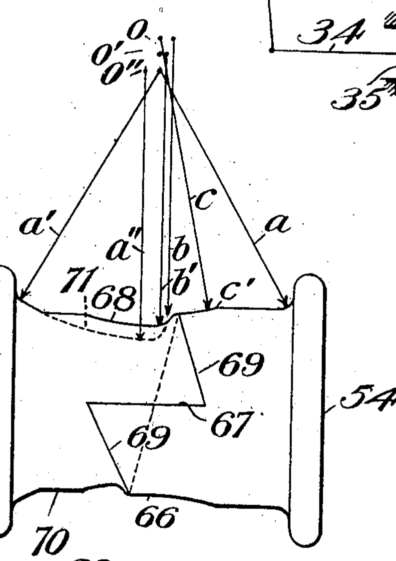

Fig. 6.

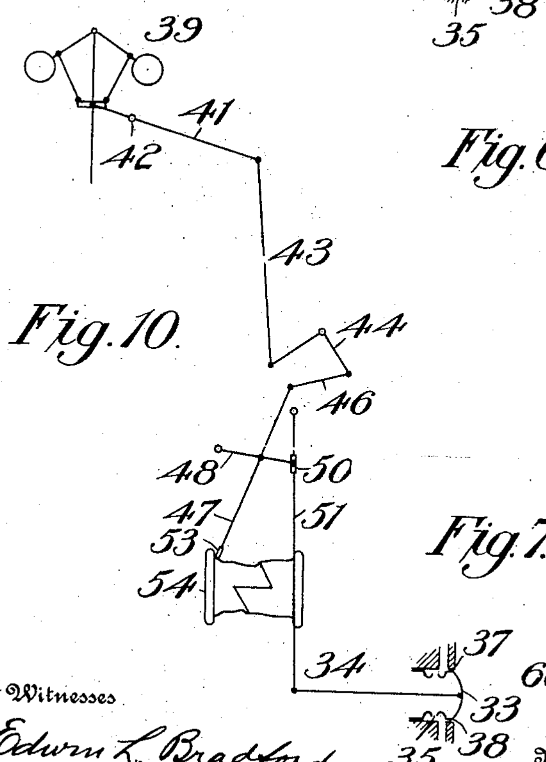

Fig. 10.

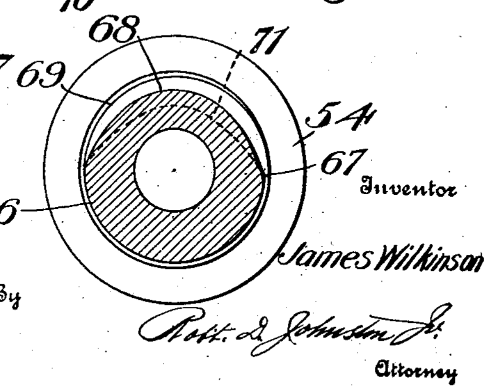

Fig. 7.

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JAMES WILKINSON, OF PROVIDENCE, RHODE ISLAND, ASSIGNOR TO WILKINSON TURBINE COMPANY, A CORPORATION OF ALABAMA.

CONTROLLER MECHANISM FOR TURBINES.

No. 826,000. Specification of Letters Patent. Patented July 17, 1906.

Application filed November 23, 1905. Serial No. 288,779.

To all whom it may concern:

Be it known that I, JAMES WILKINSON, a citizen of the United States, residing at Providence, in the county of Providence and State of Rhode Island, have invented new and useful Improvements in Controller Mechanism for Turbines, of which the following is a specification.

My invention relates to improvements in fluid-pressure-controller mechanism for elastic-fluid turbines.

In Letters Patents heretofore issued to me I have shown a jet-controller device diverting a freely-flowing stream of motor fluid to control the operation of fluid-actuated supply-valves for the turbine. The jet-stream after performing its controlling function was discharged into the turbine without being under the control of the jet device or governor. For this reason a stream of small volume was used—such, for instance, as would operate the turbine under its friction load. In my present invention I propose to adapt the governor to control the jet-stream like a part of the main supply. This is most simply done by adapting the jet-controller device to act as a valve in regulating or cutting off the flow of the jet-stream into the turbine. Inasmuch as the jet action of the stream will be relied upon to control the main turbine-supply valve or valves, this jet-stream should not be valved in a manner to interfere with its control of the supply-valves. I therefore cause the device to valve it off only after the other turbine-supply has been cut off by the action of the jet on the turbine-supply valve or valves.

I have illustrated my invention applied to an impact-turbine, in which case the main supply of motor fluid, as well as the jet-stream, will be discharged into the turbine through nozzle-passages. It is desirable from a point of design and regulation (but not essential) that the jet-stream should be substantially of equal volume with the supply-nozzle streams, and it will be evident that where provision is made whereby the speed-responsive device can control the jet-stream efficiently as a part of the supply it may be of large power.

In handling jets of large power the increased area of the jet-orifice and of the port coöperating therewith tends to increase the travel of the controller device requisite to give the desired injector and ejector effects. This is not desirable, and I propose to avoid it by enlarging or spreading the jet-orifice in a direction at right angles to that of its controlling movements. The coöperating port or passage is similarly extended. This feature of my invention is of marked importance in practice and, as developed, leads to the use of an annular jet as the preferred construction, for by its use the jet device is balanced and compact, and a jet of large power can be controlled in a small chamber with a minimum movement. Thus a jet-orifice one-eighth of an inch wide extending around a controller device between two and three inches in diameter can give a jet of approximately five-hundred-horse power, the full controlling injector and ejector effect of which may be obtained by a governed movement of about an eighth of an inch. It is necessary to give the device a further travel to cause it to valve off the jet-stream from the turbine; but this will not be required under the usual operating conditions and may be effected by increasing the travel of the device another eighth of an inch. According to the character of the governor-controlled means for operating the jet or controller device it may be adapted to intermittently cut off the supply-nozzles for varying time intervals until they are held closed, when the device will commence to valve off the jet-stream from the nozzle-passage, through which it enters the turbine, or the controller device may be so actuated as to cut off the nozzle under its control when it cuts off the other supply-nozzles, as by giving it a full quarter-inch stroke in the preceding illustration, thereby intermittently cutting off or pulsating the whole supply for the turbine under intermediate load conditions. The rapidity with which the controller device acts to cut off the supply-nozzles is a factor in determining the most desirable manner of controlling the jet-stream.

Where as in my Letters Patent No. 753,773 the valves controlling the supply-nozzles are adapted to operate successively as the jet device varies the controller-pressure, the oscillatory movement of the device may be dispensed with, if desired, and as it is shifted under the control of the governor it will first open the nozzle under its control and then gradually vary the pressure of the controller fluid to cause the other nozzles to open successively or, reversely, will successively close the supply-nozzles and then the nozzle under its control. When the device is oscillated under these conditions, it will effect a successive intermittent cut-off of the several supply-valves. The construction of the controller mechanism also determines the manner in which the jet-stream is cut off. This may be by a wire-drawing action of the jet-valve or by intermittently pulsating the stream in the manner described in my pending application, Serial No. 136,229.

My present invention further comprises improvements in the governor-controlled actuating mechanism for the jet device comprising a rotating actuator and an element positioned by a governor and operated by said actuator to move the jet device to produce the desired operation of the nozzle-valves. I have illustrated this in the preferred form for oscillating the device only during its active control of the supply-nozzles.

Referring to the drawings, which show an illustrative embodiment of my invention, Figure 1 shows the high-pressure end of a horizontal axial-flow impact-turbine with the adjacent shaft-bearing, the head and bearing being broken away to illustrate the controller device and its actuating mechanism in side elevation. Fig. 2 is an enlarged detail view of a portion of the supply-head, shown partly in section to illustrate the controller device, and a supply-valve in elevation. Fig. 3 is a vertical section along the line x x, Fig. 2. Fig. 4 is a cross-sectional view along the line y y, Fig. 3. Fig. 5 is a similar view along the line z z, Fig. 3. Fig. 6 is a detail view of the rotating actuator or controller-cam. Fig. 7 is a cross-sectional view through the middle of the actuator. Figs. 8, 9, and 10 are diagrammatic views, respectively, illustrating the positions of the operating devices of the jet-nozzle when the latter is adjusted to operate with full injector action, full ejector action, and to valve off the jet-supply from the turbine.

Similar reference characters refer to similar parts throughout the drawings.

My invention is applicable to any type of turbine, but for purposes of illustration is shown in connection with a horizontal impact-turbine having a supply-head 1, held in place in a shell 2 by a locking-ring 3. The shell surrounds the inner sectional casing of the turbine and forms a motor-fluid-supply chamber 4, which is connected in any suitable manner with a source of fluid-pressure and with the several nozzle-passages disposed around head 2 and adapted to discharge against a bucket-wheel 5 in the turbine. As shown in Fig. 2, grooves 6 in the head lead from chamber 4 and admit the motor fluid to valve-chambers 7. Valves 8 control the admission of the fluid to the bowls 9 of the main supply-nozzles 10. Any desired number of nozzles 10 may be used, and they may be of any desired capacity or design. The valves 8 are shown as reciprocating puppet-valves operated by spring-loaded pistons 11, which operate in cylinders 12, exposed below to the supply-pressure and above to a controller-fluid pressure in a conduit 13. The construction of the valves and motors, however, forms no part of my present invention, it being only necessary that the valve-motors respond to changes in the controller-fluid pressure to open or close the valves. The valve-and-motor construction forms the subject-matter of a pending application, Serial No. 287,363. The conduit 13, which is shown as formed between a grooved ring 14 and the head, is connected by passages 15 with the valve-cylinders and by one or more passages 16 with the fluid-pressure-controller mechanism, which will now be described.

The motor fluid in chamber 4 flows through a passage 17 into a chamber 18, preferably formed in the head. A shell 19, open at both ends, is inserted through an opening in the head and passes through chamber and rests upon a shoulder 20, surrounding the supply-bowl 21 for a nozzle 22, leading through the head and discharging against wheel 5. A plate 23, held by a bonnet 24, closes the upper end of the shell and the chamber in which it is disposed. The shell is provided with one or more ports 25 opposite chamber 18 and with one or more ports 26, disposed nearer its inner end and opposite a recess, groove, or chamber 27 in the supply-head, from which the passage or passages 16 lead to the controller-conduit. As a preferred construction I use two chambers 27, formed as crescent-shaped grooves in cross-section, which extend each nearly half around the shell 19 and into each of which a plurality of ports 26 open. Passages 16 lead in opposite directions, one from each chamber 27, to conduit 13. The chamber 27 may be formed as an annular groove surrounding the shell, if desired, and may be connected in multiple or series with the several valve-motors.

The controller device is disposed within the shell 19 and comprises a cylindrical body portion 28, which at one end tapers inwardly at 29, Fig. 3, and then flares outwardly at 30. The body portion being cored out or hollow is left open at the top and closed by a separate plate 31, suitably connected thereto. Ports 32 in the controller device register with ports 25 in the shell and admit the motor fluid into the controller device. An end piece 33, which tapers inwardly and then flares outwardly in the same manner as the end of the portion 28, is connected to said body or to a stem 34, passing therethrough, and disposed so as to leave a narrow circular jet-orifice 35 of the desired cross-sectional area between it and portion 30 of the device 28, through which the fluid-pressure entering the latter through ports 25 and 32 escapes in the form of an annular jet. To maintain the edges of the jet properly spaced, I provide wedge-shaped lugs 36, preferably formed integral with the body portion of the controller device. These spacing-lugs have their points toward the outer edge of the jet, so that it flows in a substantially annular stream. Though I prefer to use an annular stream, oppositely-flowing jets in the shape of segments will give the desired effect and also balance the controller device. The thickness of the shell 19 is reduced opposite ports 26, so as to leave a narrow edge 37, from which the end of the shell tapers to the shoulder 20 of the head. This thin division edge between the ported portion of the shell and the nozzle-bowl 21 requires only a short movement of the controller device to shift the jet from a point where it acts with full injector effect, Fig. 8, to raise the pressure in chambers 27 to a point where it is deflected directly into the nozzle and acts with an ejector effect, Fig. 9, to lower the pressure in chambers 27. The tapered formation of the jet portion of the controller device is provided to permit a ready escape for the jet-stream between it and the edge 37 of the shell into the nozzle 22.

The end piece 33 is provided with an annular valve-face 38, adapted to engage the edge 37 of the shell 19 as a seat and cut off the jet-stream, which would otherwise flow through the shell, from the nozzle 22 when the controller device is moved to its extreme outer position, Fig. 10. The valve is so disposed relatively to the jet-orifice 35 that it does not commence its valving action of the jet-stream until the orifice has reached a position opposite the ports 26, where it exerts its full injector effect. As this will produce the highest controller-pressure requisite to insure the closing of all the supply-valves 8, it follows that the controller device first causes all the nozzles 10 to be cut out of service, after which it commences to throttle the supply to the jet-nozzle 22 for light loads and finally acts to cut the latter out of service and cut off all fluid-supply from the turbine.

Though the controller device may be operated by hand, I prefer to effect this mechanically under the control of a speed-responsive device, which may be a governor 39, driven in any suitable manner from the turbine-shaft and mounted on the shaft-bearing 40. The governor acts to rock a lever 41, fulcrumed at 42 and connected at a rod 43, which is swivelly connected to a bell-crank lever 44, journaled on a stud 45, carried by the turbine-head 1. A link 46 connects the lever 44 with the upper end of a bar 47, pivotally connected at an intermediate point to a pivoted lever 48, the opposite ends of which are respectively pivoted to a fixed stud 49 and to a sleeve 50, which slides on a lever 51, also pivotally connected to the stud 49. The latter stud is shown mounted on the supporting-frame 52 for the bearing 40. The lower end of the governor-shifted bar 47 is bifurcated and has a roller 53 journaled therein. This roller is adapted to engage a rotating actuator 54 in the form of a cam-cylinder mounted on a shaft 55, journaled in a bearing 56 in the bearing-frame 52 and carrying a gear 57, meshing with a gear 58 on a shaft 59, which may be a continuation of the shaft which drives the governor. The gear connections between the turbine-shaft and shaft 55 will serve as speed-reducing means to give the actuator any desired speed or rotation. Any other suitable means may be used to give the actuator a slow rotation. The lever 51 has its free end bifurcated and rounded so as to straddle a shifting block 60, threaded onto the stem 34 and provided with collars between which the rounded ends of the lever are disposed. A jam-nut 61 is provided for the block. The stem 34 passes through a packing-gland 62 in the bonnet 24 and through top plates 23 and 31 for the shell and controller device, respectively, a collar 63 on the stem engaging the top of plate 31 to hold the controller device against movement on the stem. The bonnet 24 carries an extension 64, which serves as an outer end bearing for the stem 34.

Since the levers 48 and 51 are connected by a sliding sleeve and are eccentrically pivoted, it follows that any movement given lever 48 will act to shift the position of lever 51, stem 34, and the controller device. The desired controlling movements are given the lever 48 by the actuator 54, acting through the governor-shifted bar 47. To hold this bar against the actuator, I may use a spring, or, as shown, I may cause pressure of the motor fluid, acting against the stem 34 of the controller device, to move lever 51 outwardly and through lever 48 press bar 47 against the actuator. I provide one or more passages 65, which lead from a point below the valve-seat 37 to the upper end of shell 19, thereby balancing the controller device except as to the stem 34. I show two of these pressure-balancing passages 65 formed in the shell and arranged on opposite sides between the chambers 27. The details of construction of the actuator may best be described in connection with the operation of the controller mechanism, and for this purpose reference will be made to Sheet 4 of the drawings, wherein the actuator is shown in detail in Fig. 6. The several arrows leading to different points in the periphery of the actuator correspond with the positions of the bar 47, as shown in the diagrammatic views. Before steam is admitted to the turbine the arrow a indicates the position of the bar. The governor is set by moving it by hand to the position shown in Fig. 9, when the bar 47 assumes the position of the arrow c, and steam is then admitted. As the turbine speeds up the governor swings the bar across toward the position of arrow a'. As the bar is shifted to the left from the position of arrow a it is lifted to its highest position, (indicated by the point c'.) This lifting movement of the bar acts to gradually move the valve-face 38 away from its seat 37, so that pressure is permitted to flow through the controller device and nozzle 22 into the turbine. When the bar has reached the position of the arrow c, it will have moved the controller-jet to the position shown in Fig. 9, where it acts with full ejector effect and all of the nozzle-valves are open. This full supply of motor fluid will speed the governor up and cause the bar to swing toward the position of the arrow a''. If the load be now placed on the turbine, the resulting speed will swing the bar over the curved surface of the spiral-shouldered portion 66 of the actuator. This shoulder has a straight edge 67 struck on an arc from the point o. When the bar is on the shouldered portion, it is lifted to the position of the arrow b, which is the position of the parts in Fig. 9 when all the valves are open. When the bar rides off the shoulder, it drops onto the curved surface 68 of the actuator and assumes the position of the arrow b', which shifts the bar to the position o' corresponding to Fig. 8, when the nozzles, excepting 22, are closed. As the edge 69 of the shoulder is in the form of a spiral, it follows that the period during which the bar is in the position of arrows b or b' depends upon the point of engagement of the roller 53 with the shoulder 66. As the bar is swung back and forth over this shouldered portion of the actuator it controls the nozzles 10 to intermittently cut them off for graudally increasing portions of the cycles of rotation of the actuator until and when the bar rides on the surface 70 the nozzles are held closed. Should the load become excessive, thereby lowering the speed too far, or should the speed be too high, due to racing or other cause, the bar 47 will be shifted to the position a or a', where, it will be noted, it adjusts the controller device to the position o'' and cuts off all supply from the turbine, as in the overspeed position. (Shown in Fig. 10.)

The operation just described provides for an intermittent cut-off of the nozzles 10 during intermediate load conditions and for throttling the action of the valve 38 in opening and closing the nozzle 22. If it is desired, the whole supply to the turbine may be intermittently cut off by reducing the diameter of the surface 67 to the point indicated by the dotted line 71, Fig. 6. This leaves the shouldered portion 66 of the same size and causes the bar 47 as it rides off the shoulder to drop to the position of the arrow a''. It will be noted that this corresponds to the position o'', which is that of the controller device in Fig. 10 or when all nozzles are closed. A cam of this construction will cause the device to move from the position in Fig. 9 to the position in Fig. 10 during each rotation of the controller device, so long as the governor holds the bar opposite the shoulder 66. Though I prefer to utilize this intermittent cut-off of the supply, it will be evident that a gradually-tapering actuator may be employed, which would cause the controller device to move gradually under load changes from the position in Fig. 9 to that in Fig. 10, and vice versa, and in this connection the several nozzle-valves could be adapted to operate successively or respond in any desired manner to the gradually rising and falling pressure in the conduit 13.

I have thus described in detail an illustrative embodiment of my invention and in its preferred form for my uses; but as it is obviously capable of modification for other types of impact and reaction turbines that which is hereinafter claimed as new is not to be construed as limited to such details.

What I claim as new, and desire to secure by Letters Patent, is—

1. In a turbine having a plurality of supply-passages of substantially uniform capacity, valves therefor, and means to utilize the freely-flowing fluid-supply for one nozzle to control the operation of the valves for the other nozzles.

2. In a turbine having a plurality of nozzle-passages through which streams of substantially equal volume enter the turbine, valves to cut off said streams, and means utilizing one of said streams to cut off the other streams before its controlling-valve takes effect upon it.

3. In a turbine having a plurality of supply-nozzles of substantially equal capacity, a controller-chamber through which motor fluid flows to one of said nozzles, means to divert the stream of motor fluid as it flows through said chamber, means, movable responsive to the diversion of said stream, which cut off said other nozzles, and means to cut off said stream from the turbine.

4. A controller mechanism for a turbine comprising a controller-fluid chamber, a port leading therefrom into the turbine, a device which discharges a jet of fluid into said chamber and acts as a valve to close said port, and a turbine-supply valve controlled by the action of said jet.

5. In a controller mechanism for a fluid-motor, a controller-chamber from which fluid-pressure enters the motor, a device in said chamber movable responsive to speed conditions and adapted to divert the stream of fluid entering said chamber and to valve

it off from said motor, and one or more supply-valves whose operation is controlled by said device.

6. In a turbine, a nozzle therefor, a supply-chamber from which said nozzle leads, a device which discharges fluid-pressure into said chamber in the form of a jet and which is adapted to act as a valve to control the supply of fluid to said nozzle, and one or more fluid-operated supply-valves controlled by said jet and adapted to regulate the admission of motor fluid through other nozzles.

7. In a controller mechanism for a fluid-motor, a stream of fluid utilized to drive the motor, valve means to cut off said stream, one or more supply-valves for the motor, means to divert said stream to control said supply valve or valves, and speed-responsive means which control the diversion and cutting off of said stream.

8. In combination with a fluid-motor having one or more fluid-pressure-controlled supply-valves, a controller mechanism for said valves utilizing a substantially annular jet to regulate the pressure of the valve-controlling fluid.

9. In a motor, one or more fluid-pressure-controlled valves, a controller device for discharging a jet of fluid in annular form, and means coöperating with said jet for controlling the operation of said valve or valves.

10. In a valve-controlling mechanism, means under the control of a speed-responsive device to produce a substantially annular movable jet of fluid-pressure, one or more ports or passages, the pressure in which is controlled by the relative position of said jet, and valve means controlled by the pressure in said port or ports.

11. In a valve-controlling mechanism, a jet device through which a substantially annular jet of fluid flows, a substantially annular controller-chamber with respect to which said jet is adapted to act with injector or ejector effect, valves having motors connected with said chamber, and means to vary the pressure in said chamber by moving said jet to control the operation of said valves.

12. In a controller mechanism for a fluid-motor having a plurality of supply-streams of fluid, an adjustable jet-controller device through which one of said streams flows and is discharged laterally in a thin flaring jet or jets, a speed-responsive device for operating said jet device, one or more passages having a flaring inlet end or ends in which said jet or jets act with injector and ejector effect, and controller means for the other streams which operate responsive to the fluid-pressure in said passage or passages.

13. In a fluid-pressure-controller mechanism for motor-supply valves, a hollow shell having a port for the admission of fluid-pressure and a side orifice for its lateral discharge, a chamber into which said side orifice discharges, a passage for receiving the impact effect of said lateral discharge, one or more supply-valves which operate responsive to the pressure in said passage, and an exhaust-port for said chamber adapted to be closed by said device.

14. In a fluid-pressure-controller mechanism for motor-supply valves, means movable with one of said valves which utilizes the freely-flowing fluid-supply to said valve to create a variable controller-pressure for said other valves, said means being adapted to effect, by said controller-pressure and devices responsive thereto, the closure of the other valves before the valve movable with it closes.

15. In an elastic-fluid turbine, a nozzle-passage, a shell seated above said nozzle and provided with one or more ports leading to a controller-fluid passage, and ports for the admission and discharge of fluid into said nozzle, in combination with a device through which the fluid-pressure, admitted to said shell, flows and is discharged as a jet with injector or ejector effect in the port or ports leading to said controller-fluid passage, said device moving responsive to speed changes and being adapted to cut off said jet fluid from said nozzle, and devices controlled by the pressure in said controller-fluid passage for varying the volume of fluid admitted to the turbine.

16. In an elastic-fluid turbine, a nozzle-passage, a chamber supplied at one end with motor-fluid pressure and communicating with said nozzle, a controller device in said chamber through which the pressure flows to said nozzle, said device having lateral intermediate discharge-openings for the fluid, a valve at its end which cuts off the fluid flowing through said discharge-openings from said nozzle, and a controller-fluid passage whose pressure is varied by the impact action of the flowing stream and which acts to open and close other nozzle-valves.

17. In a turbine, a controller device formed with a hollow body portion, a jet nozzle or nozzles communicating therewith and set in from the side of the device, a valve-face beyond said jet-nozzle, in combination with a passage to supply fluid-pressure to said device, a passage controlled by said valve-face and through which the said fluid flows from the jet-nozzle into the turbine, and fluid-operated means which open and close supply-valves responsive to the movements of the fluid-jet, substantially as described.

18. In a turbine, a jet-controller device through which motor fluid flows into the turbine, a valve movable with said device for cutting off said fluid from the turbine, a stem for operating said device, and means to equalize the pressures acting on said device to substantially balance it, except as to the area of said stem, substantially as described.

19. In an elastic-fluid turbine, a nozzle-passage, a bowl for said nozzle, a detachable casing above said bowl having a valve-port at its lower end and one or more ports at an intermediate point for the admission of motor fluid, a controller device having ports registering with the intermediate ports in said casing whereby motor fluid enters said device, means for discharging the fluid from said device in the form of a jet, a controller-fluid passage coöperating with said jet and leading to valve-controlling means, a valve carried by said device and disposed below said jet, said valve being adapted to engage a seat above said bowl, one or more passages to equalize the pressures at opposite ends of the casing between which said controller device acts, and speed-responsive devices to operate said device.

20. In a controller mechanism for motor-valves, a controller device for the valve-controlling fluid, an operating mechanism for said device comprising a lever pivotally connected to a swinging arm, a governor-actuated arm, a swivel-link connecting said latter arm and one end of said lever, a rotating actuator for engaging the other end of said lever and oscillating it without effect upon said governor-actuated arm, and means for operating said device adjusted by the free end of the arm to which said lever is pivotally connected.

21. A controller mechanism for an elastic-fluid turbine comprising a speed-responsive device, one or more fluid-pressure-controlled supply-valves, a controller device for the valve-controlling fluid-pressure, a pivoted arm for operating said device, a pivoted lever having a sliding connection with said arm, an actuator for intermittently moving said lever and arm, and connections between said speed-responsive device and lever to control the extent of its movement by engagement with said actuator.

22. In a controller mechanism for turbines, a speed-responsive device, a cam, a lever moved by said device over said cam, an arm shifted by said lever, a device for controlling the operation of a supply valve or valves for the turbine, and a sliding member movable with said device to which said arm is swivelly connected, as and for the purposes described.

23. In a controller mechanism for turbines, a speed-responsive device, a device movable responsive thereto which controls the operation of supply-valve means, a rotating cam-actuator, and means to adjust said device comprising a lever, a roller carried thereby and adapted to engage said actuator, means controlled by said speed-responsive device to shift said actuator and arm relatively, and a sliding connection between said lever and controller device, whereby the latter moves responsive to changes in position of said lever.

24. In an elastic-fluid turbine, a plurality of fluid-controlled valves, a controller device utilizing fluid-pressure to effect the operation of said valves, a valve movable with said controller device for cutting off the controller fluid from the turbine, an operating mechanism for said device comprising a speed-responsive device, a rotating actuator provided with a shouldered portion, operating connections for said controller device which are shifted by said speed-responsive device, said connections being adapted to engage said actuator and to be moved thereby to hold all the turbine-supply valves open, to intermittently close the fluid-pressure-controlled valves, and to close said valve for the controller fluid after the other valves have been closed thereby.

25. In a controller mechanism for a turbine, a fluid-controlled supply-valve, a controller device operating on the valve-controlling fluid, a governor, a rotating actuator, and devices shifted by said governor and actuator which move said controller device, as and for the purposes described.

26. In a controller mechanism for valves, the combination of a rotating actuator, an element operated by said actuator and adjustable relatively thereto, a controller-nozzle operatively connected to said element, and a valve controlled by fluid-pressure flowing through said nozzle.

27. In combination, a rotating cam-actuator, a governor-shifted element engaged and moved thereby, a controller-nozzle, and means to transmit the movements imparted to said element by said actuator to said nozzle, substantially as described.

28. The combination, in a valve-controller mechanism, of a cam, an actuator-bar engaged and oscillated by said cam, governor means to shift said bar relatively to said cam, a controller-nozzle, and means to transmit the oscillatory movements of said bar to said nozzle, for the purposes described.

29. The combination, in a valve-controller mechanism for turbines, of a cam, an actuator-bar resting thereon and oscillated thereby, governor means to adjust said bar and cam relatively, one or more nozzles and valves, and fluid-pressure-controller devices for said valves connected to and moved by said bar.

30. The combination, in a valve-controller mechanism for turbines, of a rotatable actuator, an element provided with an antifriction-wheel which rides on an actuator, governor means to move the wheel relatively to said actuator, one or more nozzles and valves, and fluid-pressure-controller devices for said valve operated by said element.

31. The combination, in a valve-controller

mechanism for turbines, of a rotatable cam, an actuator-bar supported by said cam, contact means between said bar and cam, governor means to adjust said cam and bar relatively, one or more nozzles and valves, and fluid-pressure-controller devices for said valves operated by said bar.

In testimony whereof I have hereunto set my hand in presence of two subscribing witnesses.

JAMES WILKINSON.

Witnesses:
JAMES H. NOLAN,
THOMAS H. SHEPARD.