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ELASTIC FLUID TURBINE.

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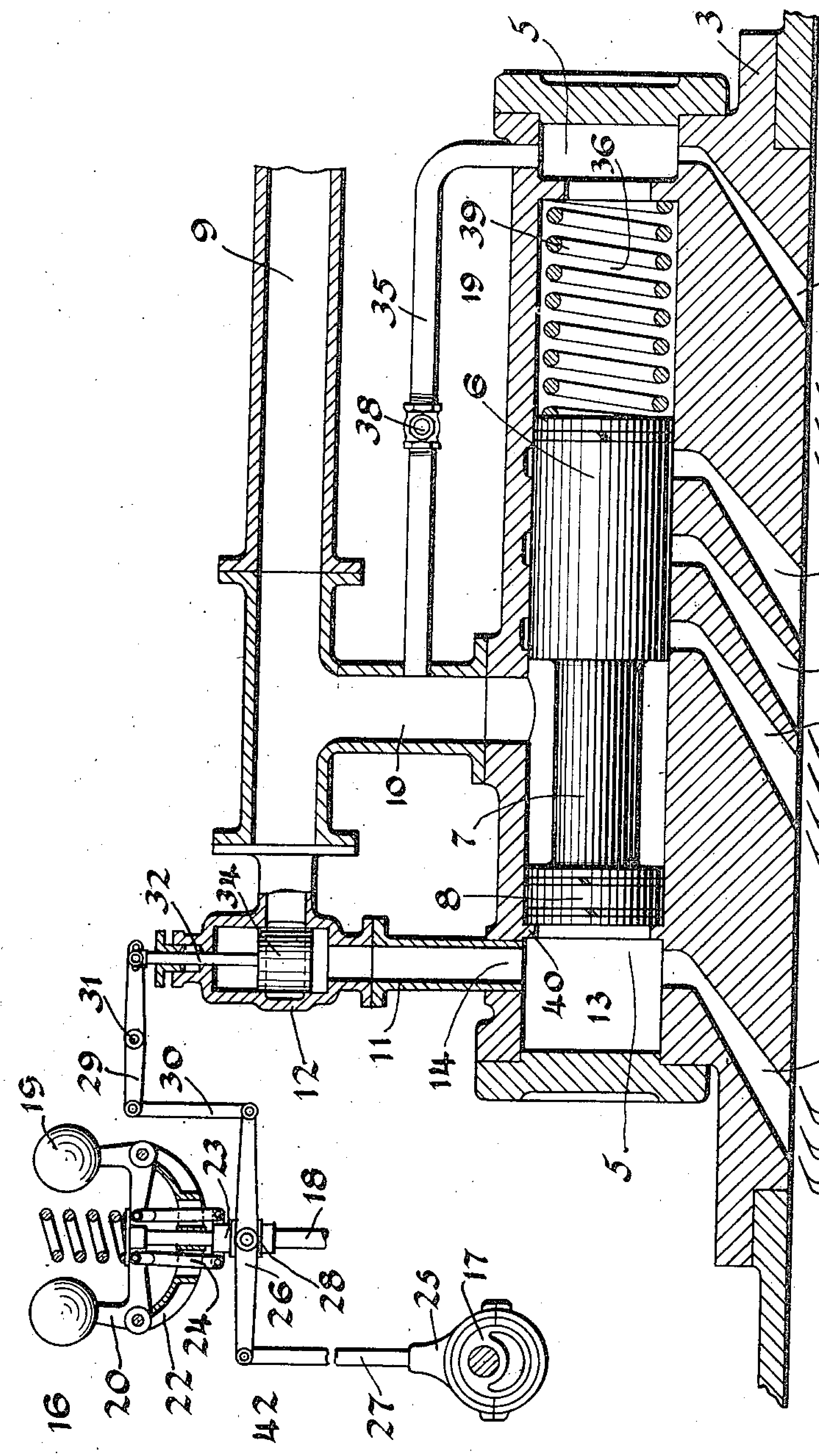
952,792. Patented Mar. 22, 1910



WITNESSES:

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ELASTIC-FLUID TURBINE.

952,792. Specification of Letters Patent. Patented Mar. 22, 1910.

Application filed March 19, 1906, Serial No. 306,845. Renewed September 14, 1908. Serial No. 452,933.

To all whom it may concern:

Be it known that I, RAYMOND N. EHRHART, a citizen of the United States, and a resident of Pittsburg, in the county of Allegheny and State of Pennsylvania, have made a new and useful Invention in Elastic-Fluid Turbines, of which the following is a specification.

This invention relates to elastic fluid turbines and has as an object the production of governing means for such turbines.

In turbines provided with fluid discharge nozzles and in which governing is accomplished by varying the motive fluid supply in accordance with the load demand and at the same time in proportioning the effective area of the motive fluid supply passages or the number of operating nozzles in accordance with the amount of motive fluid supplied, it is necessary to employ a powerful governing device or to utilize a mechanically or otherwise actuated relay device under the control of a less powerful and more sensitive governing device. It is, of course, essential that the relay device be effective in operation, reliable and quick to respond to the movements of the governing device, and, for this reason, it has been customary to utilize hydraulically, electrically or fluid actuated relay motors to perform, in conjunction with a speed-responsive device, the governing function of the turbine. For various reasons it has been found desirable to operate the relay motors by fluid pressure and in such cases a waste of motive fluid is occasioned principally because the actuating motors are not thermodynamically efficient and moreover such apparatus are complicated and expensive to build.

The object of this invention is the production of a turbine in which simple means are utilized for varying the motive fluid supply and the effective area of the nozzle supply passages in accordance with the load demand.

A further object is the production of a fluid-actuated and governor-controlled relay device which will be simple and efficient and which will overcome the fluid loss ordinarily encountered.

A further object of this invention is to simplify the construction and decrease the cost of manufacture of turbine-governing mechanism.

These and other objects I attain in a turbine embodying the features herein described and illustrated in the single sheet drawing accompanying this application and forming a part thereof, in which a partial sectional elevation of a turbine is shown illustrating more or less diagrammatically a system of nozzle control.

The turbine is provided with a suitable number of annular rows of blades 2 mounted on a rotor or spindle (not shown), which is inclosed within a stationary casing 3. The casing is provided with a number of motive fluid supply nozzles 4, which are arranged to supply motive fluid to the moving rows of blades 2 in such a way that the pressure and velocity energy of the motive fluid will be effectively transformed into available energy.

The nozzles 4 communicate with a chamber 5, the walls of which are contiguous with the casing 3 and in which a fluid-actuated piston 6 is located. The piston 6 is provided with an extension 7 on which a second piston 8 is rigidly mounted and is adapted to reciprocate with the piston 6 within the chamber 5. A motive fluid supply pipe 9 communicates with the chamber 5 through a branch pipe 10 and is adapted to supply motive fluid through the nozzles 4 to the working passages of the turbine. The piston 6 is arranged to control the effective nozzle opening of the turbine or to open and close the nozzles 4 in accordance with the load demand. The extension 7 and piston 8 are so arranged that for certain positions of the piston 6 the branch pipe 10 will supply sufficient motive fluid to the nozzles to insure an efficient operation.

A branch pipe 11, provided with a governor-controlled valve 12, connects with the pipe 9 and communicates with the forward portion 13 of the chamber 5 through a port 14. A working nozzle 15 communicates with the chamber 5 and, like the nozzles 4, supplies motive fluid to the blades 2. A speed-responsive governor 16 of any suitable construction is situated adjacent to the valve 12 and is arranged to periodically open the valve at the normal or some predetermined speed of the turbine such amounts as to insure efficient action of the nozzle 15. The discharging capacity of the nozzle 15 is such that after a predetermined speed of the turbine is reached and a predetermined port opening of the valve 12 is obtained, the flow of fluid through the forward portion of the chamber 5 is restricted and, consequently, pressure is exerted on the forward end of the piston 8 which is proportional to the amount of restriction or to the amount of port opening of the valve 12.

The operating mechanism of the valve 12 comprises an eccentric 17, which is driven by the shaft of the turbine, in conjunction with the governor 16 and a system of operating links and levers. The governor may be of any suitable type but, as illustrated, consists of a revolving standard 18, driven by the turbine, fly-balls 19, mounted on arms 20, which are pivotally mounted on brackets 22, rigidly mounted on the standard, and a reciprocating collar 23, loosely mounted on the standard and adapted to be actuated by the fly-balls through the agency of the arms 20 and links 24.

The eccentric 17 is provided with an eccentric strap 25 which actuates a lever 26 through a rod 27. The lever 26 is fulcrumed on a collar 28, which is rotatably mounted on the sleeve 23 and is connected to a lever 29 by a link 30. The lever 29 is fulcrumed at 31 and is connected to a valve stem 32, which is connected to the valve disk 34 of the valve 12.

The valve disk 34 is reciprocated synchronously with the revolutions of the turbine shaft by the eccentric and connecting links and levers and the amount of the periodic port opening of the valve 12 is proportioned by the governor 16.

The governor sleeve 23 and the eccentric connections are so arranged that, at the normal speed of the turbine, the valve 12 will periodically open predetermined amounts and supply puffs of motive fluid to the nozzle 15 in amounts that the nozzle can readily deliver to the working passages of the turbine. As the turbine increases in speed, the fly-balls 19 move outwardly and raise the sleeve 23 and the fulcrum of the lever 28, thereby varying the throw of the valve disk 34 relative to the valve ports. The port opening of the valve and the duration of the puff of motive fluid admitted to the nozzle 15 is directly proportional to the speed of the turbine. As the load on the turbine increases and the speed decreases, the port opening of the valve 12 is increased until at some predetermined speed the valve does not close but admits motive fluid to the nozzle 15 in a continuous stream which is periodically pulsated by the reciprocations of the valve disk 34.

A small pipe 35 connects the branch pipe 10 with the rear portion 36 of the chamber 5 and a nozzle 37 connects the rear portion of the chamber with the working passages of the turbine. The pipe 35 is provided with a valve 38, which is adapted to regulate the flow of motive fluid to the rear portion 36 of the chamber, and the effective area of the nozzle 37 is such, relative to the area of the pipe 35, that a fluid pressure may be maintained in the rear portion 36 of the chamber 5, which is a predetermined amount less than the pressure in the branch pipe. By varying the flow of steam through the pipe 35, through the operation of the valve 38, the pressure in the rear portion 36 of the chamber 5 may be varied to suit the existing conditions. A spring 39 is mounted in the rear portion 36 behind the piston 6 and is adapted to act between it and the end wall of the chamber 5 in conjunction with the fluid pressure to close the nozzles 4.

The piston 8 will be held by the spring pressure and the fluid pressure in the portion 36 against a suitably located lug 40 until, at some predetermined load, the turbine slows down sufficiently to cause the valve 12 during its pulsations to admit more steam to the forward portion 13 of the chamber 5 than the nozzle 15 can readily convey to the blades 2 and the pressure in the forward portion 13 exceeds the pressure in the rear portion 36. The unbalanced fluid pressure of the forward portion of the chamber against the forward face of the piston 8 causes the piston 6 to reciprocate and periodically uncover one or more of the nozzles 4. As soon as one of the nozzles 4 is uncovered by the piston 6 and an additional amount of motive fluid is admitted to the turbine, the turbine at once tends to speed up and to reduce the periodic port opening of the valve 12, which tends to reduce the pressure in the forward part of the chamber 5 and to reduce the amount of the reciprocation of the piston 6 and, therefore, the number of nozzles opened.

The turbine may be so arranged that the nozzle 15, in conjunction with the nozzle 37, is sufficient to insure an efficient operation of the turbine for light loads, or a suitable number of normally-opened nozzles may be provided to act in conjunction with the nozzle 15. The nozzle 37 is made so small, however, that the amount of steam discharged, while not wasted, is not appreciable as a working agent of the turbine.

Although I have illustrated my invention as embodying a pulsating control valve, I wish it to be understood that I do not limit myself to such a construction, as the valve 12 may be of any kind and may be operated by the governor balls 19 through the agency of a relay device or directly by a system of levers and links. With a valve designed to be operated by the governor without reciprocating, the eccentric 17 is not utilized and lever 26 is pivoted at 42 on a stationary pin. The governor 19 is then arranged to open the valve at the normal speed of the turbine such an amount that an efficient operation of the nozzle 15 is insured. As the turbine decreases in speed below the normal, the centrifugal balls move inwardly and open the valve 12, the amount of port opening being directly proportional to the speed of the turbine. At some predetermined load the turbine slows down an appreciable amount and causes the valve 12 to admit more steam to the forward portion of the chamber 5 than the nozzle 15 can readily convey to the blades 2 and fluid pressure in the forward portion 13 piles up until it exceeds the combined fluid and spring pressure at the rear of the piston 6 and causes the pistons 8 and 6 to uncover one or more of the nozzles 4. As the speed of the turbine increases, the valve 12 throttles the supply of motive fluid to the nozzle 15 and the pressure in the forward portion 13 decreases until, at some predetermined speed, the combined fluid pressure and spring pressure at the rear of the piston 6 is sufficient to close one or more of the nozzles 4. With this construction the effective nozzle opening will vary in direct proportion with the speed of the turbine. It is obvious, therefore, that with this method of governing a small and simple governor of almost any construction may be utilized with turbines of any size or type, since the governing of the turbine is controlled by the amount of steam admitted to one fluid nozzle.

Various means may be utilized for adjusting the pressures in the forward portion 13 and the rear portion of the chamber 5 and for varying the effective port opening of the valve 12 in proportion to the load demand, and various other arrangements and constructions may be utilized by those skilled in the art and still fall within the spirit and scope of my invention.

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

1. In an elastic fluid turbine, a main supply valve, an auxiliary supply valve, means whereby said main supply valve is held closed by a regulable fluid pressure and means, dependent upon the amount of fluid supplied by said auxiliary valve for overpowering said closing pressure and opening said valve.

2. In an elastic fluid turbine, a main supply valve, an auxiliary supply valve, means whereby said main supply valve is closed by a spring in conjunction with a regulable fluid pressure and means, dependent on the amount of fluid supplied by said auxiliary valve for overpowering said spring and fluid pressure to open said main valve.

3. In an elastic fluid turbine, a plurality of supply nozzles, an auxiliary nozzle, an agent dependent on the amount of fluid supplied to said auxiliary nozzle for opening said supply nozzles in accordance with the load demand and means comprising a constant fluid pressure, operating in opposition to said agent, to close said supply nozzles.

4. In an elastic fluid turbine, a plurality of fluid supply nozzles, a chamber communicating with said nozzles, a motive fluid supply pipe communicating with said chamber and adapted to supply motive fluid to said nozzles, a piston reciprocally mounted within said chamber and adapted to close said nozzles, an auxiliary fluid nozzle communicating with said chamber and separated from said supply pipe, an auxiliary supply pipe communicating with said auxiliary nozzle and means dependent on the amount of fluid supplied to said auxiliary nozzle for actuating said piston to open said nozzles in accordance with the load demand.

5. In an elastic fluid turbine, a plurality of fluid supply nozzles, a chamber communicating with said nozzles, a motive fluid supply passage communicating with said chamber, a piston mounted within said chamber, an auxiliary nozzle communicating with said chamber adjacent to the forward end of said piston, an auxiliary nozzle communicating with said chamber at the rear end of said piston, a valved fluid passage communicating with said forward end of said chamber and a fluid passage communicating with said rear end of said chamber, means for maintaining an approximately constant pressure in the rear end of said chamber behind said piston and means, dependent on the amount of fluid supplied to said forward end of said chamber for reciprocating said piston to open and close said nozzles in accordance with the load demand.

6. In combination with an elastic fluid turbine, a plurality of fluid nozzles, a chamber communicating with said nozzles, a compound piston mounted within said chamber and adapted to close said nozzles, a motive fluid supply pipe communicating with said chamber, an auxiliary supply pipe provided with a governor-controlled supply valve communicating with said chamber at one end of said piston, an auxiliary nozzle communicating with said chamber and receiving motive fluid from said auxiliary supply pipe, a secondary auxiliary supply pipe communicating with said chamber at the other end of said piston and adapted to supply steam to a secondary auxiliary nozzle.

7. In an elastic fluid turbine, a plurality of fluid supply nozzles adapted to supply motive fluid to said turbine, an auxiliary nozzle communicating with the working passages of said turbine, agents, sensitive to the variations of fluid pressure admitted to said auxiliary nozzle, whereby said supply nozzles are closed by a regulable fluid pressure until the pressure admitted to said auxiliary

nozzle is sufficient to overpower said regulable pressure and open said nozzles.

8. In an elastic fluid turbine, a plurality of nozzles adapted to supply motive fluid to said turbine, a secondary nozzle communicating with the working passages of said turbine, and fluid pressure and spring restrained means, dependent upon the fluid supplied to said secondary nozzle, for closing said supply nozzles.

9. In an elastic fluid turbine, a plurality of fluid supply nozzles adapted to supply motive fluid to said turbine, a secondary nozzle communicating with the working passages of said turbine, agents for supplying a regulable amount of fluid to said secondary nozzle, and fluid pressure and spring restrained means, dependent upon the amount of fluid supplied to said secondary nozzle, for closing said supply nozzles.

10. In an elastic fluid turbine, a fluid supply nozzle adapted to supply motive fluid to said turbine, an auxiliary nozzle communicating with the working passages of said turbine, a secondary nozzle communicating with the working passages of said turbine and adapted to receive a regulable fluid supply, and agents, sensitive to the variations of fluid pressure admitted to said auxiliary nozzle and dependent upon the fluid pressure supplied to said secondary nozzle, for closing said supply nozzles.

11. In an elastic fluid turbine, a main supply valve, a governor controlled auxiliary valve, means comprising constant fluid pressure and a spring for closing said main valve and means, dependent upon the amount of fluid supplied by said auxiliary valve, for overpowering said closing means to open said main valve.

12. In an elastic fluid turbine, a plurality of fluid nozzles adapted to supply motive fluid to said turbine, an auxiliary nozzle communicating with the working passages of the turbine, a fluid pressure and spring restrained agent for closing said supply nozzles and means, dependent upon the amount of fluid supplied to said auxiliary nozzle for actuating said agent to open said nozzles.

13. In an elastic fluid turbine, a plurality of supply nozzles, an auxiliary nozzle, an agent dependent upon the amount of fluid supplied to said auxiliary nozzle for opening said supply nozzles and means, comprising a constant fluid pressure in conjunction with a spring for operating in opposition to said agent, to close said supply nozzles.

14. In an elastic fluid turbine, a plurality of supply nozzles, an auxiliary nozzle and an agent subjected to a constant fluid pressure and sensitive to the variations of fluid pressure delivered to said auxiliary nozzle for controlling the operation of said supply nozzles.

15. In an elastic fluid turbine, a plurality of supply nozzles, an auxiliary nozzle and an agent subjected to a constant fluid pressure and a cumulative force and sensitive to variations of the fluid pressure delivered to said auxiliary nozzle for controlling the operation of said supply nozzles.

16. In an elastic fluid turbine, a main admission port, an auxiliary admission port, a valve controlling the delivery of motive fluid through said auxiliary port and an agent subjected to a regulable fluid pressure and sensitive to variations of fluid pressure delivered by said valve for controlling the delivery of motive fluid through said main admission port.

17. In an elastic fluid turbine, a main admission port, an auxiliary admission port, a valve controlling the delivery of motive fluid to said auxiliary port, and an agent subjected to a regulable fluid pressure and a spring pressure and sensitive to variations of fluid pressure delivered by said valve for controlling the delivery of motive fluid through said main admission port.

18. In an elastic fluid turbine, a main admission port, an auxiliary admission port, a governor-actuated valve controlling the delivery of motive fluid through said auxiliary port and an agent subjected to a constant pressure and sensitive to variations of fluid pressure delivered by said valve for controlling the delivery of motive fluid through said main admission port.

19. In an elastic fluid turbine, a main admission port, an auxiliary admission port, a valve controlling the delivery of said port and an agent subjected to admission pressure, a regulable constant pressure and a cumulative pressure and sensitive to variations of pressure delivered by said valve for controlling the delivery of motive fluid through said main admission port.

20. In an elastic fluid turbine, a main admission port, an auxiliary admission port, a valve adapted to open predetermined amounts for different turbine speeds and an agent responsive to the pressures delivered by said auxiliary valve for controlling the delivery of motive fluid through said main admission port.

21. In combination in an elastic fluid turbine, a plurality of supply nozzles, an agent controlling the delivery of fluid through said nozzles, an auxiliary nozzle located at one end and a discharge nozzle located at the other end of said agent.

22. In combination in an elastic fluid turbine, a plurality of supply nozzles, an auxiliary nozzle, a discharge nozzle, and an agent, subjected to the fluid pressure delivered to said discharge nozzle and sensitive to variations of pressure delivered to said auxiliary nozzle, for controlling the delivery of motive fluid through said supply nozzles.

23. In an elastic fluid turbine, a plurality of supply nozzles, an auxiliary nozzle, a governor actuated valve controlling the delivery of motive fluid to said auxiliary nozzle, and a piston for controlling the delivery of motive fluid through said nozzle, subjected at one end to fluid pressure delivered by said valve and at the other end to a regulable pressure.

24. In an elastic fluid turbine, a plurality of supply nozzles, an auxiliary nozzle, a piston for controlling the delivery of motive fluid through said supply nozzles, subjected at one end to a regulable pressure and at the other end to the fluid pressure delivered to said auxiliary nozzle.

25. In combination in an elastic fluid turbine, a plurality of supply nozzles, an auxiliary nozzle, a discharge nozzle, a governor actuated valve controlling the delivery of motive fluid to said auxiliary nozzle, means for admitting a constant supply of motive fluid to said discharge nozzle, and an agent subjected to fluid pressure delivered to said discharge nozzle and sensitive to variations of fluid pressure delivered to said auxiliary nozzle for controlling the delivery of motive fluid through said supply nozzles.

26. In an elastic fluid turbine, a plurality of supply nozzles, a discharge nozzle, a governor actuated valve, and an agent subjected to the motive fluid pressure delivered to said discharge nozzle and sensitive to variations of pressure delivered by said valve for controlling the delivery of motive fluid through said supply nozzles.

27. In a turbine, the combination of a main supply pipe, nozzles communicating therewith, an auxiliary supply pipe for the turbine and governor controlled means for by-passing steam around the main supply pipe to control the effective area of the main supply pipe nozzles.

28. In a turbine, the combination, with a source of steam supply, a main supply pipe and a branch pipe, of nozzles in communication with the main supply pipe, a valve for the nozzles, one end of which is adjacent to the branch pipe, and speed controlled means for by-passing steam around the main supply pipe through the branch pipe to actuate the valve to uncover the nozzles.

In testimony whereof, I have hereunto subscribed my name this 16th day of March, 1906.

RAYMOND N. EHRHART.

Witnesses:

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E. W. McCALLISTER.