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GOVERNING MECHANISM FOR ELASTIC FLUID TURBINES.

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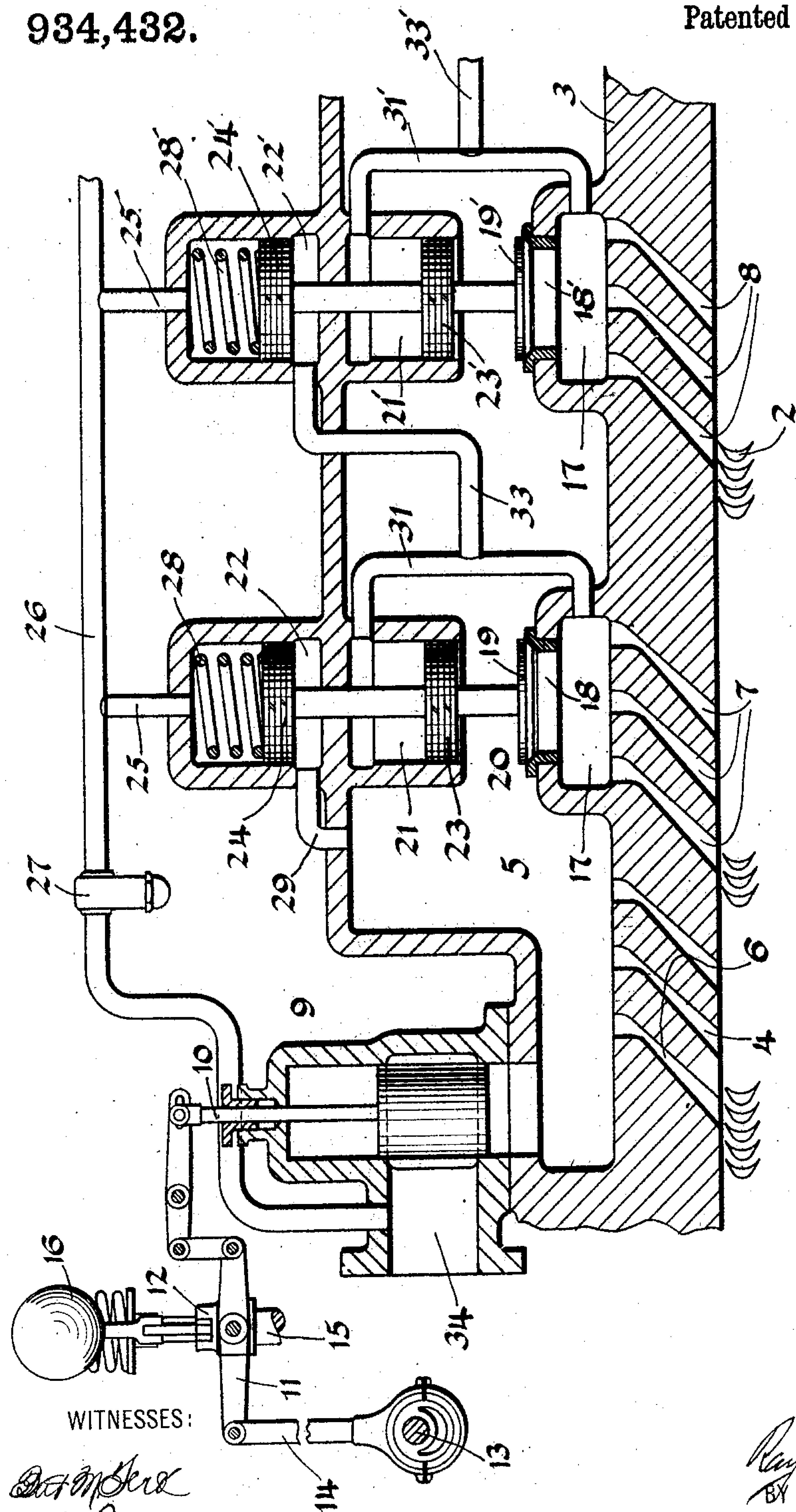

WITNESSES:

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GOVERNING MECHANISM FOR ELASTIC-FLUID TURBINES.

934,432. Specification of Letters Patent. **Patented Sept. 21, 1909.**

Application filed March 19, 1906. Serial No. 306,844.

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 Governing Mechanism for Elastic-Fluid Turbines, of which the following is a specification.

This invention relates to elastic fluid turbines and has for an object the production of improved governing mechanisms for turbines.

In turbines provided with a plurality of motive fluid nozzles to which the motive fluid is supplied in automatically regulable amounts, in accordance with the load demand as made manifest by the variations of the speed of the turbine, it is necessary, for an efficient operation of the turbine, to proportion the number of nozzles, effective in admitting motive fluid to the turbine, in accordance with the amount of motive fluid supplied, or in accordance with the load demand.

This invention, broadly, consists in providing a turbine with a governor-controlled main supply valve and with means for automatically proportioning the number of effective nozzles in accordance with the amount of motive fluid supplied.

The embodiment of my invention as herein illustrated comprises a turbine provided with a main supply valve which is adapted to supply motive fluid to the working passages in puffs, the duration of the puff, or the amount of fluid supplied, being proportional to the load demand or to the variations in speed of the turbine. A plurality of fluid nozzles are provided between the main supply valve and the working elements of the turbine, which are divided into groups of a suitable number each, and certain of the groups are provided with controlling valves which are adapted to control the supply of motive fluid to the nozzles of the respective groups.

The operating mechanisms of the controlling valves respond to variations of fluid pressure admitted by the main supply valve and are so arranged that the operation of one valve is dependent upon the operation of the preceding valve. By such an arrangement a minimum number of nozzles are opened, which will at once afford a passage to the fluid supplied by the main supply valve and insure an efficient operation of the turbine. The nozzle-controlling valves are operated successively and, independent of the number of controlling valves utilized, the first controlling valve may be arranged to open when the main supply valve is supplying approximately full pressure to the fluid passages and the succeeding valves be arranged to open when the preceding group of nozzles are receiving practically full pressure.

The single sheet drawings accompanying this application and forming a part thereof illustrate in partial longitudinal section a turbine-controlling mechanism embodying my invention.

Annular rows of blades 2 are mounted on a rotor (not shown), which is inclosed within a stationary casing 3. Motive fluid supply nozzles 4, communicating with a fluid supply passage 5, the walls of which are formed contiguous with the casing 3, supply motive fluid to the annular rows of blades 2. The nozzles 4 are arranged in groups 6, 7 and 8 of a suitable number each, the group 6 communicating directly with the fluid passage 5, and the groups 7 and 8 communicating with valve chambers which are located within the fluid passage 5, and are provided with suitable controlling valves. A main supply valve 9 communicates with the fluid passage 5 and is adapted to supply motive fluid to the nozzles periodically or in puffs, the duration of each puff, or the amount of fluid supplied by the valve, being dependent upon the load demand or the variations in speed of the turbine. The valve 9 may be of any type, but as illustrated is an ordinary double piston valve, the stem 10 of which is connected by suitable links and levers to a governor-controlled lever 11, which is fulcrumed on a reciprocating collar rotatably mounted on a reciprocating sleeve 12 of the governor and is periodically oscillated by an eccentric 13 through a suitable rod 14. The sleeve 12 is mounted on a governor standard 15 and is connected with governor balls 16 in such a way that it will occupy different positions along the governor standard corresponding to the governor balls. By this arrangment the valve 9 is periodically opened by the eccentric 13 through the operation of the lever 11 and the amount of the opening is dependent upon the position of the reciprocating sleeve 12. The sleeve 12 occupies different positions, relative to the governor standard, for different speeds of the turbine, and the throw of the valve stem while reciprocating varies with the speed of the turbine and opens the valve different amounts, corresponding to the load demand.

While I have illustrated my invention in connection with a pulsating valve, I do not wish to limit myself to any specific construction and therefore, for the sake of clearness, I will first describe my invention in connection with an ordinary governor-controlled valve.

The nozzles 4 of the group 6 communicate with the chamber 5 and receive motive fluid directly from the main supply valve 9. The groups 7 and 8 are provided with automatically regulable valves which are designed to open when the pressure in the chamber 5 exceeds a certain predetermined amount, or when the valve 9 supplies more motive fluid than the nozzles of the group 6 can deliver to the annular rows of blades 2. The admission portions of the nozzles of the group 7 are inclosed within a chamber 17, which communicates with the fluid passage 5 through a port 18. A valve disk 19 is adapted to control the amount of fluid admitted to the chamber 17 and is provided with a valve stem 20, which extends through a cylinder 21 and into a cylinder 22 of the valve-controlling mechanism. A piston 23, mounted on the valve stem 20, operates in the cylinder 21 and a piston, mounted on the valve stem 20, operates with the cylinder 22.

Motive fluid is supplied to the cylinder 22 above the piston 24 through a pipe 25, which communicates with a pipe 26. The pipe 26 communicates with the main supply pipe at 34 and discharges the fluid passing through it into a fluid passage of the turbine of lower pressure than the initial stage. The pipe 26 is provided with a valve 27 which is adapted to restrict the flow of fluid and reduce the fluid pressure delivered by the pipe. A spring 28 is mounted between the piston 24 and the end of the cylinder 22 and operates in conjunction with the fluid pressure admitted through the pipe 25. A pipe 29 connects the portion of the cylinder 22 below the piston 24 with the fluid passage 5. The bottom of the piston 23, which operates in the cylinder 21, is exposed to the fluid pressure of the passage 5 and the portion of the cylinder 21 above the piston 23 communicates with the chamber 17 through a passage 31. Under such conditions the fluid pressure on the bottom of the piston 23 is balanced by the fluid pressure on the valve disk 19, the fluid pressure of the chamber 17 on the bottom of disk 19 is balanced by the fluid pressure above the piston 23, and the fluid pressure in the lower portion of the chamber 22, which tends to raise the valve disk 19 and uncover the port is opposed by the pressure of the spring 28 and the reduced fluid pressure in the top portion of the cylinder 22.

The admission portions of the nozzles of the group 8 are inclosed within a chamber 17′, which is provided with a valve-controlled port 18′. The port 18′ is controlled by a valve 19′, which is provided with a valve-operating mechanism similar to the mechanism of the controlling valve of the nozzles of the group 7. The top portion of a cylinder 22′ of the valve-controlling mechanism is provided with a pipe 25′, which connects with the pipe 26 and supplies fluid pressure to the cylinder above a piston 24′. A passage 33 connects the lower portion of the cylinder 22′ below the piston 24′ with the passage 31 of the controlling mechanism of the group 7 and a passage 31′ connects the upper portion of a cylinder 21′ with the chamber 17′. A piston 23′ of the controlling mechanism of the group 8, and which operates in the cylinder 21′, is subjected on the lower side to the fluid pressure in the pipe 5.

The operation of the nozzle-controlling devices is as follows: When the turbine slows down a predetermined amount the valve 9 opens sufficiently to admit more fluid to the fluid passage 5 than the nozzles of the group 6 can deliver to the working passages of the turbine, pressure at once begins to pile up in the passage 5 and at a predetermined speed of the turbine the flow of motive fluid through the passage 5 is so restricted that the pressure is sufficient to open the valve controlling the admission port of the group 7 and admit fluid to the turbine through the nozzles of the groups 6 and 7. The valve 27 in the pipe 26 maintains a pressure in the top portion of the cylinder 22 which is a predetermined amount less than the pressure of steam at 34, and which, in conjunction with the spring 28, is effective, during the normal operation of the turbine, in closing the port 18 in opposition to the fluid pressure in the lower portion of the cylinder 22. The pressure in the lower portion of the cylinder 22 is sufficient, at a predetermined reduction of speed of the turbine and the consequent opening of the valve 9, to overbalance the adjusted fluid pressure and the spring pressure and raise the disk 19 and thereby admit motive fluid to the nozzles of the group 7. The disk 19 will continue to raise as the speed of the turbine decreases until at a predetermined reduction of speed the disk is raised a maximum amount. The port 18 is of such size that after it is opened a certain amount more motive fluid is supplied to the nozzles of the group 7 than they can readily deliver to the blades 2 and consequently pressure begins to pile up in the chamber 17. At a predetermined position of the valve disk 19 the pressure in the chamber 17 is sufficient to raise the disk 19′ by acting through the passages 31 and 33 against the piston 24′ and in opposition to the adjusted fluid pressure in the top portion of the cylinder 22′ and the pressure of the spring 28′. The disk 19′ will continue to rise and admit more fluid to the nozzles of the group 8 while the pressure in the chamber 17 increases and will have reached its highest position when the pressure in the chamber 17 is equal to the pressure in the passage 5. The pressure in the chamber 17′, due to the restricting effect of the nozzles of the group 8, will open the next succeeding valve and so on until all the valves are open. Under such condition the nozzle opening of the turbine is proportioned in accordance with the port opening of the valve 9 or in accordance with the load demand and one group of nozzles starts admitting steam only after the preceding group is operating efficiently and supplying a maximum amount of motive fluid to the working passages of the turbine.

By utilizing boiler pressure in conjunction with the spring pressure to close the controlling valves, the valves will operate effectively no matter what the boiler or full pressure may be, and moreover the last valve to open will supply steam to its respective group of nozzles in accordance with the variations of speed of the turbine and the function of governing the turbine, while always dependent on the valve 9, will be accomplished by the last opened controlling valve. As the load on the turbine diminishes and the speed increases, the valves will close successively, the last opened valve closing first and so on until at a predetermined speed of the turbine the valve 19 starts to close and to restrict the flow of fluid through the port 18 and thereby decreases the pressure in the chamber 17. At a predetermined speed of the turbine the pressure in the valve chamber 17 is decreased to such an extent that the pressure exerted by the spring 28 and the reduced fluid pressure in the top portion of the cylinder 22′ predominates and closes the valve 19′. As the turbine continues to increase in speed, the pressure in the valve chamber 5 decreases until the reduced pressure in the top portion of the cylinder 22′ in conjunction with the pressure of the spring 28 predominates and closes the valve 19. Motive fluid is then supplied to the turbine through the nozzles of the group 6 only, and the governing of the turbine is dependent upon the amount of fluid supplied by the valve 9. By controlling the operation of one controlling valve through the preceding valve, in the order of operation, the governing function of the turbine is accomplished with but a slight variation of speed and the first controlling valve may be arranged to open at approximately full pressure, the succeeding valves being caused to open by a variation in pressure in the passage 5 of only a few pounds.

In the mechanism as illustrated, the valve 9, as has been described, is adapted, through the operation of the eccentric 13, to supply motive fluid to the fluid passage 5 in puffs. During the normal operation of the turbine the valve-operating mechanism and the valve 9 is arranged to reciprocate and to periodically supply such amounts of fluid as the nozzles of the group 6 can readily deliver to the blades 2. As the speed of the turbine increases and the governor balls 16 move closer together, the sleeve 12, upon which the lever 11 is fulcrumed, will be lowered and the period of the port opening, or the relative positions of the valve disk, with reference to the ports of the valve 9, will be varied in accordance with the variation of speed and motive fluid will periodically be admitted to the turbine in regulable amounts. At a still further slowing down of the turbine, the disk 32 of the valve 9 will continue to reciprocate but will never entirely close the valve and motive fluid will be admitted to the turbine in a continuous, though pulsating stream. The controlling valves of the nozzle groups 7, 8, etc., will respond to the variations in the passage 5 and while pulsating will admit steam to their respective nozzles. At a certain speed of the turbine the valve 19 will respond to the periodic variations of pressure in the passage 5 and will periodically admit steam to the nozzles of the group 7. At a predetermined pressure in the passage 5 the valve 19 will cease to close the port 18 during its pulsations and fluid will then be admitted to the nozzles 7 in a continuous stream and the valve 19′ will respond to the variations of pressure in the chamber 17 and start to periodically admit fluid to the nozzles of the group 8 and so on until a sufficient number of nozzles are open to operate the turbine under the existing conditions. As the load decreases and the turbine starts to speed up the last opened controlling valve will close and the preceding valve will start to periodically close. As the load continues to decrease the controlling valve will successively cease to supply motive fluid to the turbine until all are closed and only the nozzles of the group 6 are supplying fluid in regulable amounts to the turbine.

Various other arrangements may be utilized for carrying out my invention and I do not wish to limit myself to the specific construction shown or to any specific type of valves, as it may be utilized in connection with hand-operated valves or any governor-controlled valve, and various other changes may be made and still fall within the spirit and scope of this invention.

What I claim as new and useful is:

1. In an elastic fluid turbine, a governor-

controlled main supply valve, a plurality of nozzles communicating therewith and adapted to deliver motive fluid to the turbine, a plurality of interdependent valves controlling the delivery of motive fluid through said nozzles and means sensitive to variations of fluid pressure delivered by said main valve for proportioning the number of effective nozzles in accordance with the load demand.

2. In an elastic fluid turbine, a governor-controlled main supply valve, a plurality of nozzles communicating therewith and adapted to supply motive fluid to the turbine, a plurality of interdependent valves controlling the delivery of fluid through said nozzles and means sensitive to variations of fluid pressure supplied by said main supply valve, for successively operating said nozzle valves.

3. In an elastic fluid turbine, a supply valve, a plurality of nozzles communicating therewith, a plurality of controlling valves adapted to control the amount of fluid supplied to certain of said nozzles, means sensitive to the variations of fluid pressure admitted by said main supply valve whereby said controlling valves are held closed by a regulable fluid pressure in conjunction with a spring pressure, and means dependent upon the amount of fluid supplied by said main supply valve for overpowering said regulable fluid and spring pressure and opening said valves.

4. In an elastic fluid turbine, a main supply valve, a series of auxiliary valves communicating therewith, a plurality of nozzles communicating with said auxiliary valves, agents sensitive to the variations of fluid supplied by said supply valve whereby said auxiliary valves are yieldingly held closed, means dependent upon the amount of fluid pressure supplied by said main valve for overcoming said agents and opening the first auxiliary valve of said series, and means dependent upon the amount of fluid pressure supplied by each auxiliary valve for opening the next succeeding valve of said series.

5. In an elastic fluid turbine, a main supply valve, a series of auxiliary valves receiving motive fluid therefrom, means dependent upon the amount of fluid supplied by said supply valve for opening the first valve of said series, and means dependent upon the motive fluid supplied by each valve for opening the succeeding valve of said series.

6. In an elastic fluid turbine, a main supply valve, a plurality of nozzles communicating therewith, a series of auxiliary valves receiving motive fluid from said supply valve, a plurality of auxiliary nozzles communicating with each of said auxiliary valves, means dependent upon the amount of fluid supplied by said supply valve for opening the first valve of said series, and means dependent upon the amount of fluid supplied by each of said auxiliary valves for opening the succeeding valve of said series.

7. In an elastic fluid turbine, a main supply valve, an auxiliary valve communicating therewith and adapted to receive motive fluid therefrom, means sensitive to the variations of fluid pressure supplied by said supply valve whereby said auxiliary valve is closed by a combination of fluid and spring pressure, and means dependent upon the fluid supplied by said supply valve for opening the said auxiliary valve in accordance with the load demand.

8. In an elastic fluid turbine, a main supply valve, a plurality of nozzles communicating therewith, a plurality of controlling valves adapted to control the amount of fluid supplied to certain of said nozzles, mechanisms whereby the fluid passing said supply valve is caused to pulsate, and means sensitive to the variations of fluid pressure supplied by said supply valve for closing said controlling valves.

9. In an elastic fluid turbine, a main supply valve, a plurality of nozzles communicating therewith, a plurality of controlling valves adapted to control the amount of fluid supplied to said nozzles, mechanisms whereby the fluid passing said main supply valve is caused to pulsate, means sensitive to the variations of pressure admitted by said main supply valve whereby said controlling valves are held closed by regulable fluid and spring pressure, and means dependent upon the amount of fluid supplied by said main supply valve for overpowering said regulable fluid and spring pressure and opening said valves.

10. In an elastic fluid turbine, a main supply valve, a series of auxiliary valves communicating therewith, a plurality of nozzles communicating with said auxiliary valves, means whereby the fluid passing said main supply valve is caused to pulsate, agents sensitive to the variations of fluid pressure supplied by said supply valve whereby said auxiliary valves are yieldingly held closed, means dependent upon the amount of fluid supplied by said main supply valve for overcoming said agents and opening the first auxiliary valve of said series, and means dependent upon the amount of fluid pressure supplied by each auxiliary valve for opening the succeeding valve of said series.

11. In an elastic fluid turbine, a main supply valve, a series of auxiliary valves receiving motive fluid therefrom, mechanisms whereby the fluid passing said supply valve is caused to pulsate, means dependent upon the amount of fluid supplied by said supply valve for opening the first valve of said series, and means dependent upon the motive fluid supplied by each auxiliary valve for opening the succeeding valve of said series.

12. In an elastic fluid turbine, a main supply valve, a plurality of nozzles communicating therewith, a series of auxiliary valves receiving motive fluid from said supply valve, a plurality of auxiliary nozzles communicating with each of said auxiliary valves, mechanisms whereby the fluid passing said main supply valve is caused to pulsate, means dependent upon the amount of fluid supplied by said supply valve for opening the first auxiliary valve of said series, and means dependent upon the amount of fluid supplied by each of said auxiliary valves for opening the succeeding valve of said series.

13. In an elastic fluid turbine, a main supply valve, an auxiliary supply valve communicating therewith and adapted to receive motive fluid therefrom, means whereby the fluid passing said supply valve is caused to pulsate, means sensitive to the variations of the fluid pressure supplied by the said main valve whereby said auxiliary valve is closed by a combination of fluid and spring pressure, and means dependent upon the fluid pressure supplied by said main valve for opening said auxiliary valve in accordance with the load demand.

14. In an elastic fluid turbine, a main supply valve, an auxiliary valve between said main supply valve and the working passages of said turbine, a fluid pressure and spring-restrained agent for closing said auxiliary valve and means dependent upon the amount of fluid delivered by said main valve for overcoming said agent to open said auxiliary valve.

15. In an elastic fluid turbine, a main supply valve, a series of auxiliary valves between said main valve and the working passages of the turbine, fluid pressure and spring-restrained agents sensitive to the variations of fluid pressure supplied by said main valve for closing said auxiliary valves, means dependent upon the amount of fluid supplied by said main valve for opening the first auxiliary valve of said series and means dependent upon the amount of fluid pressure supplied by each auxiliary valve to the working passages of the turbine for opening the next succeeding valve of the series.

16. In an elastic fluid turbine, a main supply valve, a series of auxiliary valves between said main valve and the working passages of the turbine, fluid pressure and spring-restrained agents sensitive to the variations of fluid pressure supplied by said main valve for closing said auxiliary valve, means dependent upon the amount of fluid supplied by said main valve for opening the first auxiliary valve of said series, means dependent upon the amount of fluid supplied to the working passages of the turbine by each auxiliary valve for opening the next succeeding valve of the series and mechanisms whereby the fluid passing said main supply valve is caused to pulsate.

17. In an elastic fluid turbine, a main supply valve, a series of auxiliary valves between said main supply valve and the working passages of the turbine, fluid pressure and spring-restrained agents for closing said auxiliary valves, means dependent upon the operation of said main valve for opening the first valve of said series and means dependent upon the operation of each auxiliary valve for opening the next succeeding valve of said series.

18. In an elastic fluid turbine, a main supply valve, a series of auxiliary valves between said main supply valve and the working passages of the turbine, means dependent upon the operation of said main valve for opening the first valve of said series and means dependent upon the operation of each auxiliary valve for opening the next succeeding valve of said series.

19. In an elastic fluid turbine, a plurality of nozzle-control valves, a governor-controlled valve supplying motive fluid to said nozzle-control valves and interdependent actuating means for each of said nozzle valves and sensitive to variations of fluid pressure admitted by said governor-controlled valve and operating to successively actuate said valves.

20. In an elastic fluid turbine, a plurality of nozzle-control valves, a governor-controlled valve supplying motive fluid thereto and actuating means for each of said nozzle-control valves coupled in series and sensitive to variations of fluid pressure delivered by said governor valve.

21. In an elastic fluid turbine, a main supply valve, a series of auxiliary valves receiving motive fluid therefrom and interdependent actuating means for each of said auxiliary valves and sensitive to variations of fluid pressure admitted by said main supply valve, and operating to successively actuate said auxiliary valves.

22. In an elastic fluid turbine, a main supply valve, a series of auxiliary valves receiving motive fluid therefrom, actuating means for each of said auxiliary valves sensitive to variations of fluid pressure admitted by said main supply valve and coupled in series one with the other and means for causing said main supply valve to pulsate the fluid delivered to said auxiliary valves.

23. In an elastic fluid turbine, a main supply valve, a series of auxiliary valves receiving motive fluid therefrom and operating in parallel and interdependent actuating means for each of said auxiliary valves coupled in series one with the other and operating to successively actuate said valves.

24. In an elastic fluid turbine, a main supply valve, a series of auxiliary valves receiving motive fluid therefrom and operat-

ing in parallel, interdependent actuating means for each of said auxiliary valves coupled in series one with the other and operating to successively actuate said valves and means for causing one of said auxiliary valves to pulsate the fluid passing therethrough.

25. In an elastic fluid turbine, a main supply valve, a series of auxiliary valves receiving motive fluid therefrom, interdependent actuating means for each of said auxiliary valves, sensitive to variations of fluid pressure admitted by said main supply valves, and means for causing one or more of said auxiliary valves to pulsate the fluid passing therethrough.

26. In a turbine, a main supply valve casing in open communication with the turbine blades or vanes, a plurality of auxiliary valve casings receiving motive fluid therefrom and means sensitive to variations of fluid pressure delivered from said main supply valve casing and responsive to fluid pressure delivered by said auxiliary valves for successively operating the said auxiliary valves.

27. In an elastic fluid turbine, a main supply valve, a plurality of auxiliary valves receiving motive fluid therefrom, means, sensitive to variations of fluid pressure delivered by said main supply valve and responsive to fluid pressure delivered by said auxiliary valves, for successively operating said auxiliary valves and means for causing one of said valves to pulsate the fluid passing therethrough.

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

RAYMOND N. EHRHART.

Witnesses:
CHARLES W. MCGHEE,
E. W. MCCALLISTER.