No. 859,286.

PATENTED JULY 9, 1907.

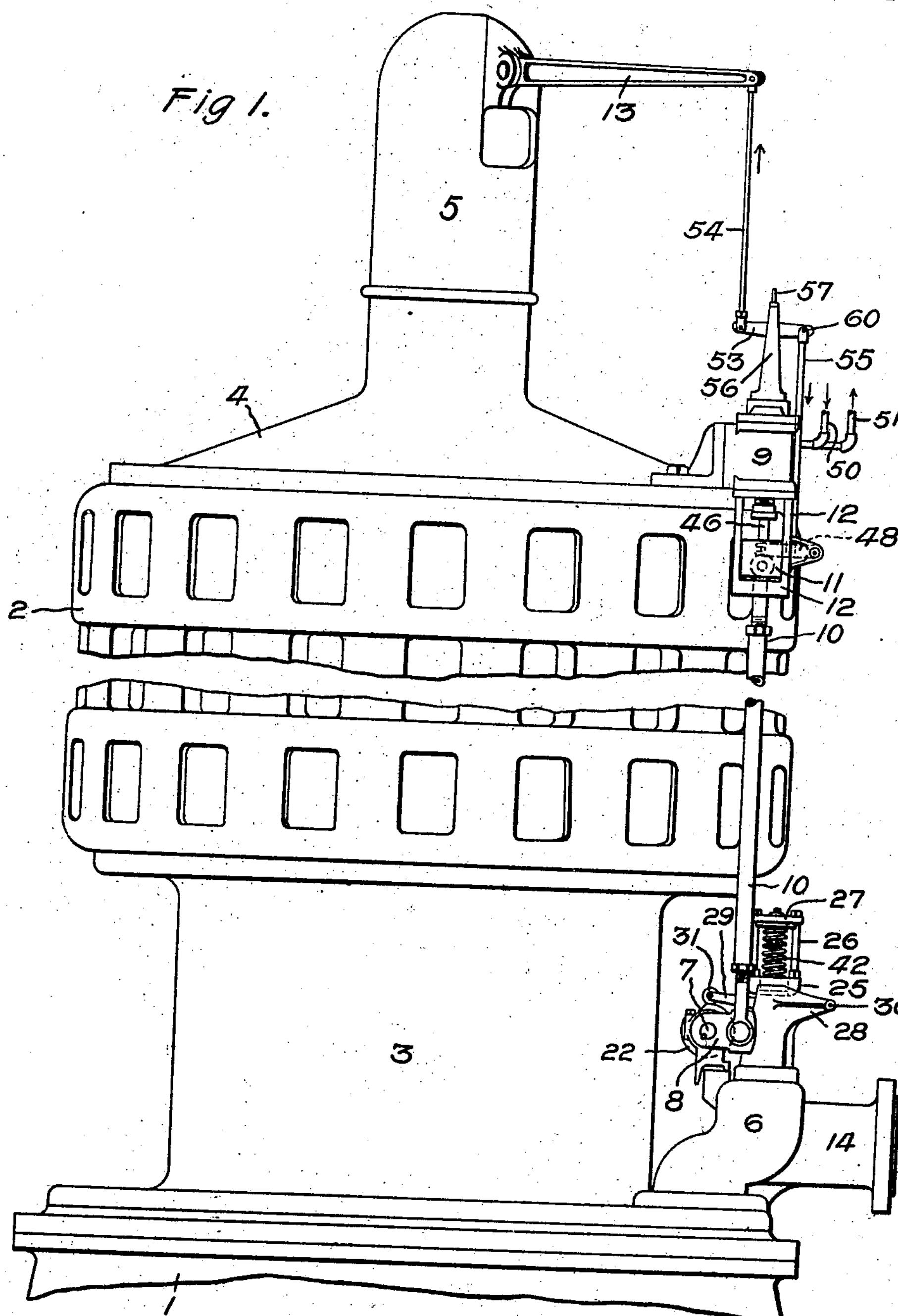
W. L. R. EMMET.

GOVERNING MECHANISM FOR TURBINES.

APPLICATION FILED DEC. 28, 1905.

4 SHEETS—SHEET 1.

Fig 1.



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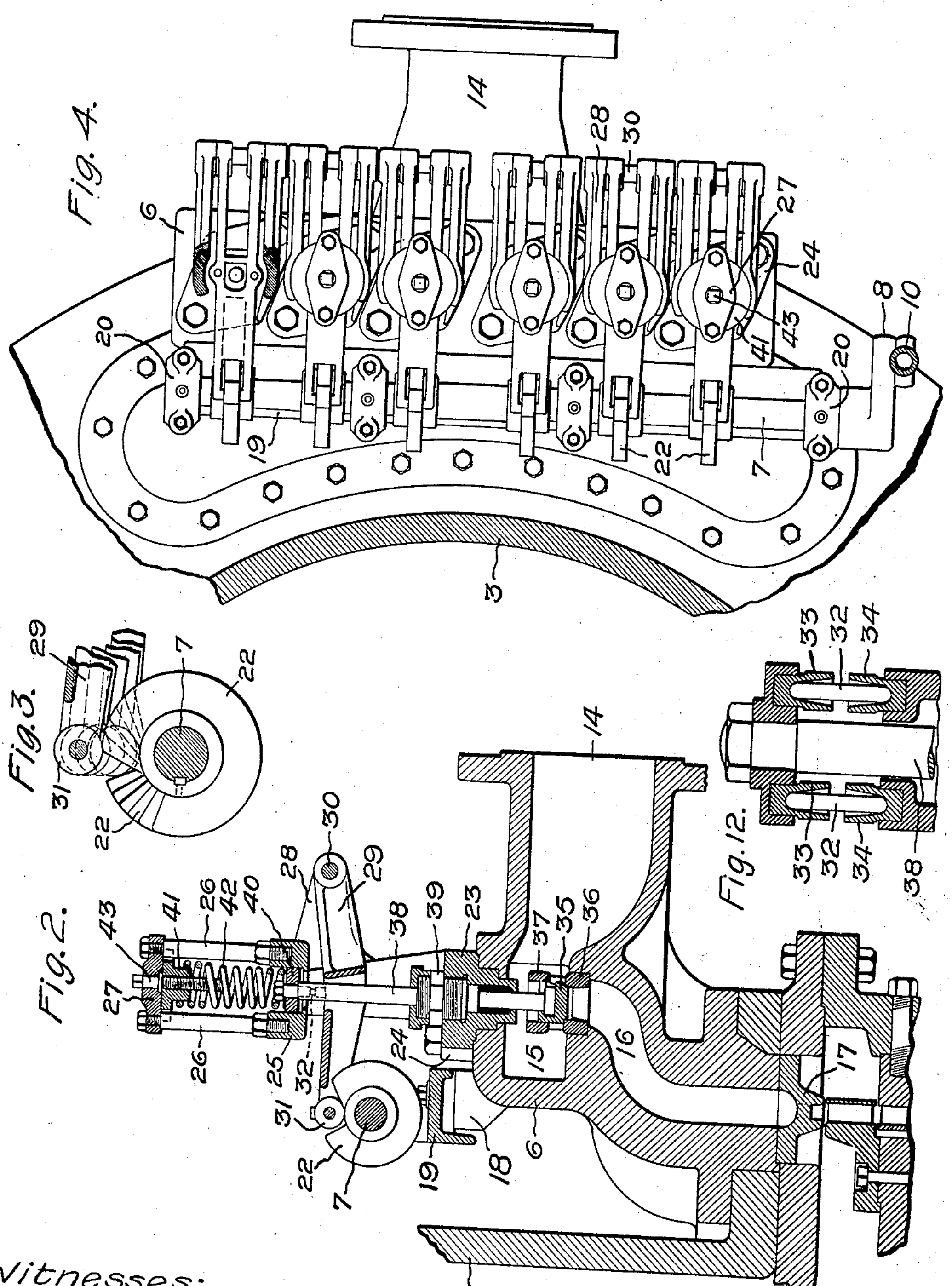

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Fig. 5.

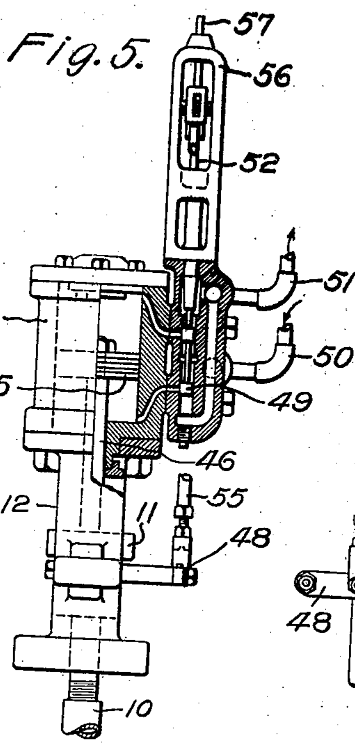


Fig. 6.

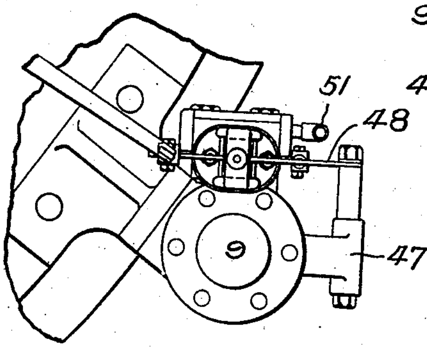


Fig. 7.

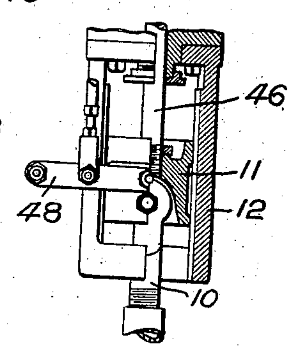
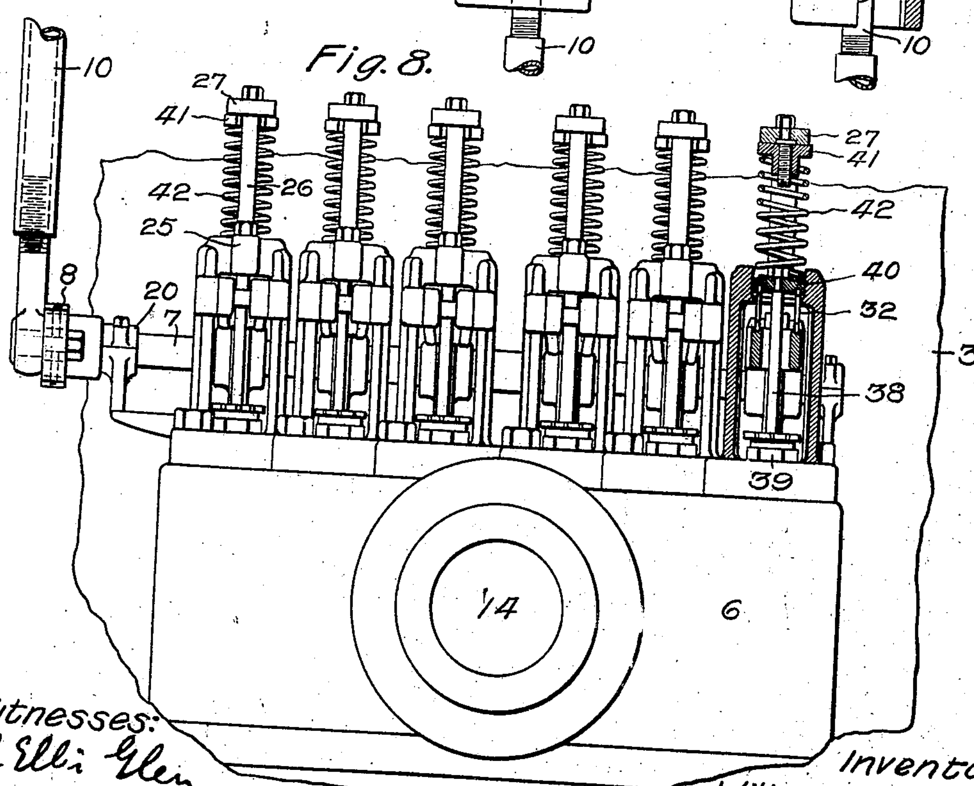


Fig. 8.



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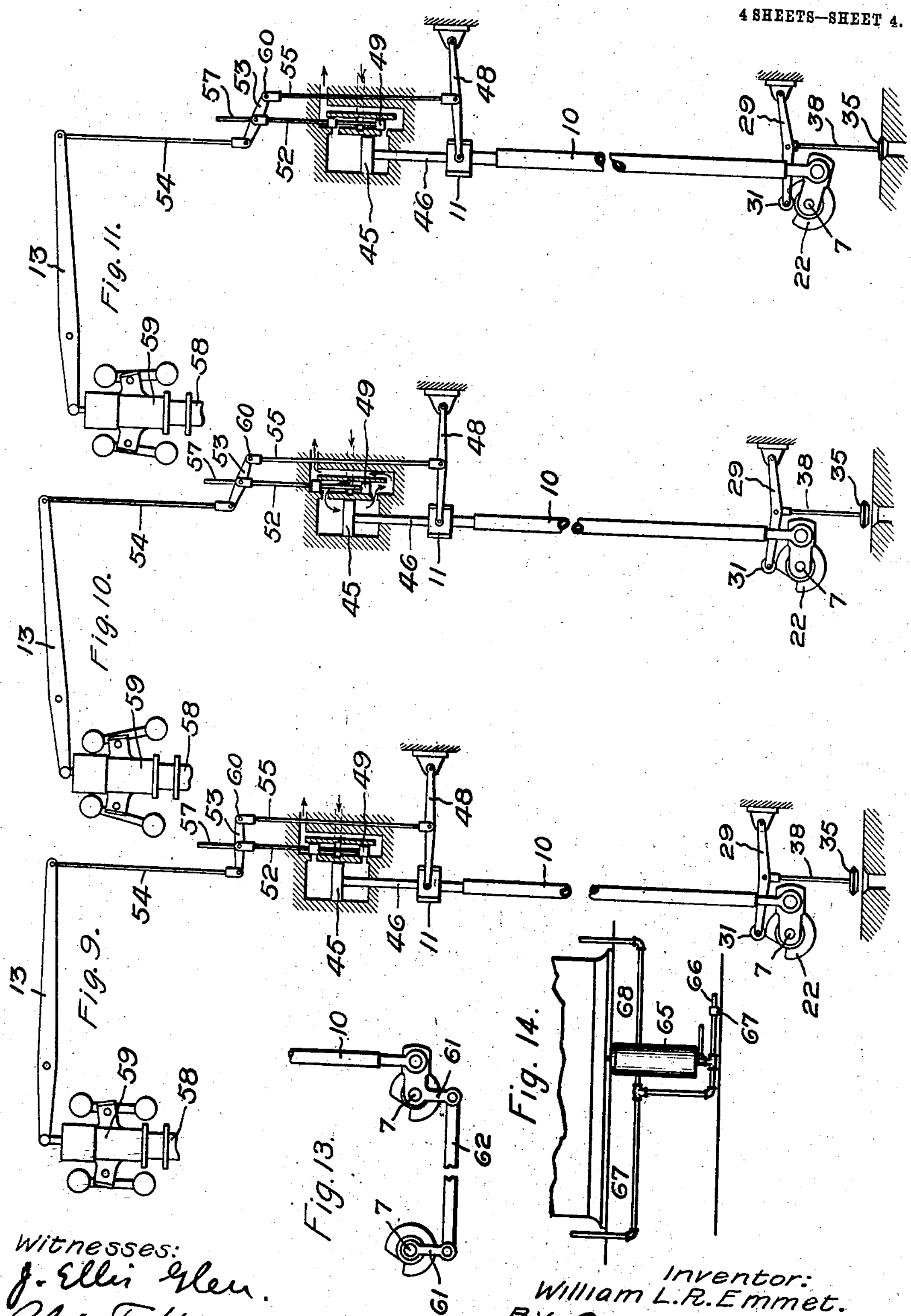

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UNITED STATES PATENT OFFICE.

WILLIAM L. R. EMMET, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

GOVERNING MECHANISM FOR TURBINES.

No. 859,286. **Specification of Letters Patent.** **Patented July 9, 1907.**

Application filed December 28, 1905. Serial No. 293,604.

To all whom it may concern:

Be it known that I, WILLIAM L. R. EMMET, a citizen of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Governing Mechanism for Turbines, of which the following is a specification.

The present invention has for its object to provide a governing mechanism for turbines which is simple in construction, requires a minimum amount of space, is powerful and quick in operation, and is not subject to overtravel.

For a consideration of what I believe to be novel and my invention, attention is called to the description and claims appended thereto and to the annexed drawings.

In the accompanying drawings which illustrate one embodiment of my invention, Figure 1 is a view in side elevation of part of a vertical shaft turbine and the generator driven thereby; Fig. 2 is a cross-section through one of the nozzle valves and means for actuating it; Fig. 3 is a detail view showing the position of the cams with respect to the nozzle-operating levers; Fig. 4 is a plan view of the valve chest and valve-actuating means; Fig. 5 is a detail view, partially in section, of the hydraulic or other fluid pressure motor for actuating the cam shaft; Fig. 6 is a plan view of the motor showing the position of its controlling valve and the actuating means therefor; Fig. 7 is a view in quarter section of the cross-head of the motor; Fig. 8 is a view in front elevation of the valve chest and valve-actuating means; Fig. 9 is a diagrammatic view showing the position of the parts when the speed of the turbine shaft is normal for a given load; Fig. 10 shows the position of the parts when the speed of the turbine is abnormal; and a nozzle valve is in the act of closing; Fig. 11 shows the position of the parts when one of the nozzle valves has just closed; Fig. 12 (Sheet 2) is a detail view of the struts for transmitting motion from one of the levers to a valve; Fig. 13 is a detail view showing an arrangement whereby two or more cam shafts may be operated to control separate sets of valves, and Fig. 14 is a detail view showing an accumulator for supplying fluid for actuating the valves in event of failure of the main source.

Referring to Fig. 1, 1 represents the casing of the turbine, and located above it and supporting the generator 2 is a stool 3. The upper end of the generator is closed in by a head 4 which is provided with a dome 5 that surrounds the shaft governor and supports the lever for transmitting motion from the speed-responsive device to the controlling valve or regulator of a hydraulic or other motor. Situated at a convenient point on the turbine casing is a valve chest 6; in the present illustration only one of these chests is shown, but the number can be duplicated *ad libitum*. Each of the nozzle valves is directly connected to or actuated by a lever and the levers are operated successively by means of cams, as will appear more fully hereinafter. The cams are carried by a rock-shaft 7 that is supported in suitable bearings on the steam chest and on the end of the shaft is a crank 8. This crank is connected to the movable element of the motor 9 by means of the adjustable connecting rod 10. A hydraulic motor is illustrated as one embodiment of the invention, and the outer end of the piston rod is provided with a cross-head 11 that is connected to the upper end of the connecting rod 10. This cross-head is arranged to slide up and down in a frame 12 carried by the lower end of the motor 9, the latter being attached by a bracket to the head 4 of the generator. The lever 13 is connected to the shaft governor at one end while the outer end is moved up and down as the speed of the turbine changes. This in turn moves the controlling valve or regulator of the hydraulic or other motor 9, a suitable follow-up device being provided to prevent over-travel of the motor, as will hereinafter appear.

It is important that the valve mechanism shall occupy a minimum amount of space, and also that every part shall be so constructed that it is a duplicate of every other similar part; and also that it shall be readily accessible. It is also important to so arrange the passages within the valve chest leading from the valve seats to the bowls of the nozzles, that they shall be of minimum length, and be free from sharp bends or turns. This is important for two reasons; first, it prevents undue resistance to the passage of steam or other elastic fluid, and also it simplifies the making of the castings.

Referring more particularly to Figs. 2 to 4 inclusive, 6 represents the valve casing which is provided with an inlet 14 and a longitudinally extending chamber 15 which supplies fluid to the individual passages 16, each of which is connected to one or more sections of a sectionalized nozzle 17 for converting the pressure of the motive fluid into velocity. It is preferable to have the nozzle orifices closely associated in order that the jet issuing therefrom may be in the form of a solid column, but my invention is not limited in all respects to this construction since under certain conditions the nozzles or nozzle sections can be separated by a space more or less great. The fluid issuing from the nozzles strikes the buckets located adjacent thereto which fractionally abstract the energy therefrom. Formed on the upper side of the valve chest are two or more lugs 18 which support the transversely extending plate 19, the latter being provided with two or more bearings 20 for the rock-shaft 7. On the rock-shaft are mounted as many cam projections 22 as there are valves to be operated. These cam projections are so constructed that a relatively small movement of the cam about its axis causes the nozzle valve to be fully opened or fully closed. As shown, the working face of the cam is substantially tangential to its hub. The cam and shaft may be integral or separate as desired. Mounted on top of the valve chest and seated in suitable cylindrical openings therein are as many frames 23 as there are valves. Obviously the number of valves and frames can readily be increased or decreased to suit the requirements of the particular machine. Each of the frames is provided with two flanges 24 extending at right angles to the axis of the valve spindles for securing it to the valve chest. On referring to Fig. 4, it will be seen that these flanges are set on a diagonal so that the flange on one frame overlaps a flange on the other frame. By means of this arrangement I am able to place a maximum number of valves and frames in a minimum space. The upper end of each of the frames is provided with a head 25 which forms a support for the upright rods 26 that carry the head 27. Extending to the right of each leg of the valve frame is a bracket 28 and between the brackets and pivotally supported thereby is a valve-actuating lever 29. This lever is forked at its right-hand end and is provided with a pivot 30. The left-hand end of the lever is provided with an anti-friction roller 31 that engages with and is actuated by the cam 22. These levers comprise two side members which are connected at the left-hand end by a horizontal web or rib, and on the right-hand side of the valve rod by a vertically extending rib. By reason of this construction a very strong lever is provided of minimum size and weight. Between the horizontal web and the vertical rib is an opening through which the valve rod passes.

From the foregoing it will be seen that each of the valve frames comprises a base portion connecting the two uprights and a head connecting the uprights at the upper end and two laterally extending brackets which support the levers. This furnishes a very rigid construction and one that is not liable to be distorted due to any cause. The head and base portion being formed integrally, the alining of the various parts is a simple matter. The base portion of each frame is provided with shoulders arranged in step-like formation which serve to center the frames and also to prevent the escape of motive fluid from the chest.

Each nozzle valve 35 has an open and a closed operating position and also an infinite number of intermediate throttling positions. It is provided with a seat 36 that is separate from the valve chest. Each seat is also provided with a guide 37 formed integrally therewith, suitable openings being provided for the admission of steam or other fluid. The valve stem 38 is provided with an enlarged head to receive the valve 35, the latter being provided with a slot with overhanging walls to permit of its being slipped over the head by a motion transverse to the axis of the rod. The rod extends through a suitable packing located in the base portion of the valve frame, which packing is adjusted by means of a gland nut 39. The gland nut is provided with an upwardly extending screw-threaded portion to receive an adjusting nut, and inside of this upwardly extending portion is a second suitable packing. Owing to the inclined surface of each cam connecting the parts of minimum and maximum diameters there will be a throttling action on the part of the nozzle valves as the anti-friction roller 31 rides up or down the inclined surface or occupies a position thereon intermediate the ends. As shown, the relation of the parts is such that one, two or more valves may be in throttling positions for a given position of the cam shaft. From this it will be seen that the valve rod has an upper and a lower packing which effectively prevents the escape of steam at this point. The upper end of the valve rod is provided with a cross-head 40. The latter may be of cylindrical or other suitable shape. This cross-head is guided in its vertical movement by suitable guides formed on or carried by the head 25 of the valve frame. Situated between the cross-head and the adjustable nut or abutment 41 is a compression spring 42 which at all times tends to close the nozzle valve and hold it on its seat. This spring should be located outside of the steam space so that its temper will not be affected by the hot steam in the chest. It is also advantageous to locate it outside of the chest because space is not so valuable at this point and it is more easily inspected and adjusted. The nut 41 is provided with forks which partially surround the uprights 26 and is thereby prevented from turning when the adjusting bolt 43 is rotated in one direction or the other. In order to transmit motion from the lever to the cross-head 40 two struts or compression members 32 are provided which are provided with cup-like seats 33 and 34, Fig. 12. The struts are located on opposite sides of the valve rod and it is important to make the seats 33 and 34 relatively deep so as to prevent the struts from jumping out of place when the valves operate.

In Fig. 3 the arrangement of the several cams 22 on the rock-shaft 21 is shown. It will be seen that when viewed from one end the active surfaces of the cams are so disposed that one is slightly behind the other. By reason of this arrangement one nozzle valve will open after the other and close in like order.

Referring to Fig. 5, 9 represents the hydraulic motor and 45 the piston thereof. The piston is connected by the piston-rod 46 with the cross-head 11, the latter being mounted in suitable guides in the depending frame 12. The upper end of the connecting rod 10 extending to the rock-shaft 7 is also pivotally connected to the cross-head. Mounted on the side of the hydraulic motor or at any other suitable point, is a projection 47 which carries the pivot for the lever 48, the latter being connected at its free end to the cross-head 11 and forming part of the follow-up device to prevent overtravel of the parts as will hereinafter appear. The hydraulic motor is controlled by a balanced piston valve 49, and fluid under pressure is admitted to the space between the pistons on the valve stem by the pipe 50; fluid is exhausted from the cylinder by the pipe 51. The fluid for the motor may be taken from any suitable source, such as that which supplies lubricant to the bearings. The valve is arranged to control two ports extending to opposite ends of the cylinder. The valve should overlap the ports by only a very small amount so that the minimum movement of the shaft governor will cause the opening or closing of the ports. The valve is actuated by a rod 52, best shown in Figs. 9 to 11. This rod is connected to the floating lever 53, and the inner end of the latter is connected by an adjustable connecting rod 54 with the free end of the governor operated lever 13 (Figs. 1, 9, 10 and 11). The right-hand end of the floating lever 53 is attached by an adjustable connecting rod 55 to the lever 48 of the follow-up device. The rod 52 for actuating the piston valve 49 is extended beyond the floating lever and through the casing 56 as at 57 to form a guide for the floating lever and attached parts. The arrangement of the levers 48 and 53 and connecting rod 55 is such that the piston-valve 49 or other regulator for controlling the motor will be moved to the closed position after the motor piston and also the cam shaft have been moved a certain distance. In other words, this forms a device which anticipates to a certain extent the movements of the shaft governor and by so doing prevents surging of the machine above and below normal speed, which would take place if such a device were omitted. This forms an important feature of the invention.

Referring to the diagrams, Figs. 9 to 11 inclusive, the action of the hydraulic motor and follow-up device will readily be understood. 58 represents the main shaft of the turbine upon which the bucket wheels and moving part of the generator are mounted when the turbine is employed for driving electric generators. Mounted on the shaft is a suitable fly-ball governor 59 which responds to changes in the speed of the turbine. This speed-responsive device actuates the lever 13 that is mounted on the dome 5 of the generator.

Referring to Fig. 9, it will be seen that the piston 45 of the motor is in the central position and the piston valve 49 is covering both of the ports admitting fluid to the cylinder. With the piston in this position it is locked against movement and one or more of the nozzle valves 35 are open. The parts will remain in the position shown until there is a change in load on the turbine which causes the speed to change. In Fig. 10 it is assumed that the speed of the turbine has been increased, the amplitude of movement of the various parts being somewhat exaggerated in order to illustrate the operation of the invention more clearly. The movement of the weights on the shaft governor has caused the outer end of the lever 13 to be raised and the inner end of the floating lever 53 has also been correspondingly raised, the pivot 60 acting as a fulcrum. The rod 55 which supports the pivot 60 is connected at its lower end to the lever 48, the latter being suitably pivoted at its right-hand end. Since at the instant the speed changed, the cross-head 11 was stationary and also the pivot for the lever 48 it follows that any upward movement of the rod 54 must be accompanied by the piston valve 49. This upward movement of the piston valve admits fluid to the upper end of the cylinder and depresses the piston 45. Depressing the piston 45 moves the cam shaft 7 in a clock-wise direction, and one or more of the nozzle valves 35 will close when the anti-friction roller 31 rolls down the inclined portion of the face of the cam. As soon as the piston starts into motion, the cross-head 11 also moves and with it the left hand end of the lever 48 of the follow-up device. This movement of the lever causes the rod 55 to lower the position of the pivot 60, which in turn causes the floating lever 53 to depress the piston valve 49 and close the cylinder against the admission of motive fluid and also lock the piston against movement. This action commonly takes place before the change in steam admission affects the speed of the shaft, or at least before there is any substantial change in speed. In Fig. 11 the nozzle valve is shown as closed and the pilot valve 49 in the act of closing. The operation of the hydraulic motor is the same for each nozzle valve both in opening and closing. When the nozzle valves are to be opened the pilot valve moves in one direction to start the motor, and when they are to be closed it moves in the opposite direction to start the motor in the opposite direction. The levers 48 and 53 and connecting rod 55 form a follow-up or anti-hunting device which is effective for each position of the parts both in opening and closing.

In Fig. 14 is shown an accumulator 65 containing liquid from a supply pump or other source and air or other gas under an initial pressure. The object of this accumulator is two-fold,—it acts as a cushioning device between the supply pump or other source and the motors for actuating the cam-carrying shafts, and also as a means for supplying fluid for a limited time in event of the pump or other source breaking down. Fluid for operating the motors is supplied by the pipe 66 containing a check-valve 67 to prevent return. This pipe feeds the secondary pipes 67 and 68 connecting with the inlets 50 of the motor cylinders, one on each side of the turbine. The tank is directly connected with the supply pipe so that fluid may freely enter and leave it depending upon the relation existing between the source and the initial air pressure. A pipe is connected to the tank for supplying the necessary air pressure. The accumulator should be of sufficient capacity to operate the valves for a limited time after the source of supply fails.

Thus far the invention has been illustrated as applied only to the first-stage nozzle valves of a multistage turbine, but I may use the same mechanism for controlling the admission of steam to the stages of lower pressure, or the passage of steam from one stage to another, in which case the valve mechanism will be a duplicate of that shown except that the valves themselves will be somewhat larger to accommodate the increased volume of motive fluid. I may actuate the stage valves by the same motor which actuates the admission valves, or a separate motor may be provided for the purpose which is under the control of the same speed-responsive device which controls the admission valves or under the control of a different one. Where the admission or stage valves are divided into groups the rock-shafts 7 of the groups may be connected by a suitable mechanism so that one motor may be employed for actuating the sets.

In Fig. 13 is shown an arrangement suitable for operating two cams and the rock-shafts from a single motor. Mounted on the end of each rock-shaft 7 is a lever 61 and the levers are connected by an adjustable connecting rod 62 which extends from one side of the turbine to the other. When stage valves are employed and they are under the control of the shaft governor, the arrangement shown in Fig. 13 may be employed except that the cams, instead of being placed side by side, will be located one above the other and the connecting rod 62 will extend at right angles to that shown.

I have shown my invention as applied to a vertical machine of the Curtis type, but it may be used with machines of other types either occupying a vertical or horizontal position.

In the present embodiment of the invention, motive fluid flows through the turbine in an axial direction, but the invention is applicable to machines in which the flow is in a radial or other direction.

One important feature of the invention resides in the fact that by removing the two bolts passing through the flanges in each valve frame, the latter, together with the nozzle valve actuating lever, closing spring, etc., can be removed as a unit, and this without changing the tension on the spring. In this connection it is to be noted that the diameter of the nozzle valve is less than the diameter of the opening in the valve chest receiving the valve frame. Making the frames, valves, actuating levers, etc., duplicates greatly simplifies the valve mechanism and permits of assembling the parts of each valve on a work bench or other suitable stand and afterwards mounting the assembled parts on the turbine. In this way the tension of the springs can be correspondingly adjusted. By blocking up each of the levers the cams and their supporting rock-shaft can be removed as a unit without taking off the valve parts. The shaft may be removed independently of its supporting plate or both may be removed as a unit.

By disposing the levers between the guides for the valves and the valves themselves, I am enabled to reduce the vertical height of the parts to a minimum consistent with the character of the apparatus and the work to be performed. The cross-heads or guides, being located outside of the steam space, are free from troubles due to excessive heating and may be readily lubricated. By locating the parts outside of the steam space their action can be observed and any defect immediately corrected. The positions of the levers serve to indicate the valves that are open, the valves that are closed and the one that is doing the regulating by opening and closing a comparatively frequent intervals.

In accordance with the provisions of the patent statutes, I have described the principle of operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof; but I desire to have it understood that the apparatus shown is only illustrative and that the invention can be carried out by other means.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. In a governing mechanism for elastic-fluid turbines, the combination of a plurality of valves controlling the admission of motive fluid to the turbine, levers for actuating the valves, cams for moving the levers in a manner to successively actuate the valves to increase or decrease the amount of fluid passing through the turbine, springs located outside the motive fluid space for moving the valves in a direction opposite to that of the levers, a motor responding to speed changes for moving the cams, and a follow-up device which prevents the motor from over-traveling.

2. In a governing mechanism for elastic-fluid turbines, the combination of a plurality of valves controlling the admission of motive fluid to the turbine, packings for the valve stems, guides for the stems located outside of the valve casing, levers for actuating the valves in predetermined order, and a motor responding to speed changes of the turbine for actuating the levers.

3. In a governing mechanism for elastic-fluid turbines, the combination of a plurality of valves controlling the admission of motive fluid to the turbine, guides for the valve stems located outside of the valve casing, levers for actuating the valves in predetermined order to increase or decrease the supply of motive fluid to the turbine, a motor responding to speed changes of the turbine for actuating the levers, and a follow-up device for preventing the motor from over-traveling.

4. In a governing mechanism for elastic-fluid turbines, the combination of a plurality of valves controlling the admission of motive fluid to the turbine, guides for the valve stems, levers for actuating the valves which are located between them and the guides, and a motor for actuating the levers which is responsive to speed changes of the turbine.

5. In a governing mechanism for elastic-fluid turbines, the combination of a plurality of valves controlling the admission of motive fluid to the turbine, cross-heads for guiding the valve stems, springs which urge the cross-heads and valves in one direction, levers for actuating the valves in opposition to the springs, cams for actuating the levers, and a motor which rocks the cams as the speed of the turbine changes.

6. In a governing mechanism for elastic-fluid turbines, the combination of a plurality of valves controlling the admission of motive fluid to the turbine, cross-heads for guiding the valve stems, springs which urge the cross-heads and valves in one direction, levers for actuating the valves in opposition to the springs, cams for actuating the levers, a motor which moves the cams to and fro as the speed of the turbine changes, a regulator for the motor, and a follow-up device which prevents overtravel of the motor.

7. In a governing mechanism for turbines, the combination of a valve chest, a valve frame detachably mounted thereon comprising a base portion, a head, a connecting piece between the base and head, and a bracket, a valve stem which extends through the frame, and a lever for actuating the valve stem which is pivotally supported by the bracket.

8. In a governing mechanism for turbines, the combination of a valve chest containing a plurality of valves, frames through which the stems of the valves extend, cross-heads engaging the frames for guiding the valve stems, levers for actuating the valves which are located between the cross-heads and the valves, cams for actuating the levers, and a motor for moving the cams to and fro.

9. In a governing mechanism for turbines, the combination of a valve chest containing a plurality of valves, frames through which the stems of the valves extend, cross-heads engaging the frames for guiding the valve stems, springs acting on the cross-heads to move the valves in one direction, levers for actuating the valves, cams for moving the levers successively, a motor for moving the cams to and fro as the speed of the turbine changes, and a regulator for the motor responsive to speed changes.

10. In a governing mechanism for turbines, the combination of a valve chest containing a plurality of valves, duplicate frames for the valve-actuating mechanism which are closely associated, a valve-actuating lever pivoted to each frame, cams on a shaft extending at right angles to the levers, the said cams having a to-and-fro movement, and a motor responsive to speed changes for imparting movement to the cams, the amount and direction of said movement bearing a definite relation to the changes in load.

11. In a governing mechanism for turbines, the combination of a valve chest containing a plurality of valves, duplicate frames for the valve-actuating mechanism which are closely associated, a valve-actuating lever pivoted to each frame, cams on a shaft extending at right angles to the levers, the said cams having to-and-fro movements, a support for the cams that is secured to the valve chest, and a motor responsive to speed changes for imparting movement to the cams, the amount and direction of said

movement bearing a definite relation to the changes in load.

12. In a governing mechanism for turbines, the combination of a valve chest containing a plurality of valves, means including levers for directly opening and closing the valves, cams which have a to-and-fro motion for actuating the valves through the levers and causing some of them to be normally opened and others normally closed, a motor for moving the cams, a regulator for the motor which responds to movements of a speed governor, and a follow-up device which anticipates the changes in speed of the turbine and prevents the motor from overtraveling.

13. In a governing mechanism for turbines, the combination of a valve chest containing a plurality of valves, cross-heads for guiding the outer ends of the valve stems, springs located outside of the chest for moving the valves in one direction, levers also located outside of the chest for moving the valves in the opposite direction, a fluid-actuated motor acting through the springs and levers to open and close the valves, and a regulator for the motor sensitive to speed variations of the turbine.

14. In a governing mechanism for turbines, the combination of a valve chest containing a plurality of valves, cross-heads for guiding the outer ends of the valve stems, springs located outside of the chest for moving the valves in one direction, levers also located outside of the chest for moving the valves in the opposite direction, cams for operating the levers successively to increase or decrease the supply of motive fluid to the turbine, a fluid-actuated motor for rocking the cams as the demand for motive fluid changes, a regulator for the motor responsive to speed changes, and a follow-up device to prevent overtravel of the motor.

15. In a governing mechanism for turbines, the combination of a plurality of valves located within a valve chest which vary the admission of motive fluid to the turbine, cross-heads for guiding the stems of the valves, levers for actuating the valves, a fluid-actuated motor for moving the levers, and a regulator responsive to speed variations of the turbine for regulating the motor.

16. In a governing mechanism for turbines, the combination of a plurality of valves located within a valve chest which vary the admission of motive fluid to the turbine, cross-heads secured to and guiding the valve stems, levers for actuating the valves, means intermediate the cross-heads and the levers for transmitting motion from one to the other, and cams which have a rocking motion for moving the valves and are themselves responsive to speed variation.

17. In a governing mechanism for turbines, the combination of valves located within a valve chest which vary the admission of motive fluid to the turbine, bifurcated levers for actuating the valves, stems for the valves which extend freely through the levers, means for transmitting motion from the levers to the valves, a rocking cam for actuating each of the levers, and a means responsive to speed changes for moving the cams.

18. In a governing mechanism for turbines, the combination of valves located within a valve chest which vary the admission of motive fluid to the turbine, a frame for the actuating mechanism of each valve, a lever pivoted to the frame for moving the valve, a spring tending to oppose the action of the lever on the valve, an adjustable abutment for the spring supported by the frame, and speed-responsive means for operating the levers.

19. In a governing mechanism for turbines, the combination of valves located within a valve chest which vary the admission of motive fluid to the turbine, levers for actuating the valves, a cam having a to-and-fro movement for operating each of the levers, a motor for moving the cams as the load conditions on the turbine change, and a follow-up device for preventing overtravel of the motor which includes a floating lever, and a member connecting the lever with the motor.

20. In a governing mechanism for turbines, the combination of valves located within a valve chest which vary the admission of motive fluid to the turbine, levers for directly actuating the valves, a single motor for actuating the valves successively through the levers to increase or decrease the supply of motive fluid delivered to the turbine, a regulator for the motor which is connected to a speed governor, a floating lever included in the connection between the governor and the regulator, and a connection between the floating lever and the motor which moves the regulator to its initial position after one or more valves have been opened or closed.

21. In a governing mechanism for turbines, the combination of valves arranged in sets for governing the passage of motive fluid through a turbine, levers for actuating each set of valves, cams for moving the levers, a motor which is common to the cams, and a regulator for the motor which is responsive to speed variations.

22. In a governing mechanism for turbines, the combination of valves arranged in sets for governing the passage of motive fluid through a turbine, levers for actuating each set of valves, cams for moving the levers, a connection between the cams for transmitting motion from one to the other, a motor common to the cams for moving them, a regulator for the motor, and a means for preventing overtravel of the motor.

23. In a governing mechanism, the combination of a regulating valve, a fluid-actuated motor for opening and closing it, a load-responsive device governing the motor, a source of fluid supply for the motor, and an accumulator in circuit between said source and the motor.

24. In a governing mechanism, the combination of a plurality of valves, a fluid-actuated means for successively operating the valves, a source of fluid supply, an accumulator containing a body of compressed gas and included in circuit between the source of supply and the actuating means, a means for maintaining the accumulator under suitable pressure, and a speed-responsive device controlling the movements of the valve-actuating means.

25. In a governing mechanism for turbines, the combination of a valve chest having an inlet and containing a chamber and a plurality of independent passages leading from the chamber, nozzles supplied by the passages, valves for controlling the flow of fluid from the chamber to the passages, the stems of which extend through the chest, levers for actuating the valves pivotally supported at one side of the valve stems, a cam for actuating each of the levers mounted on the other side of the stems, a fluid actuated motor responsive to load changes for turning the cams, and a means for preventing the motor from over-traveling.

26. In a governing mechanism for turbines, the combination of a valve chest, a plurality of valves therein, independent frames supporting the valve actuating mechanism, a pivoted lever for each valve supported by the frames, a cam for actuating each lever, a shaft common to the cams, the pivots for the levers being located on one side of the valve stems and the cams on the other, and a support detachably secured to the chest and carrying the cam shaft so that the shaft and cams can be assembled in place or removed without disturbing the valves, levers and frames, and vice versa.

27. In a governing mechanism, the combination of a chest, a valve therein having a stem projecting through a wall of the chest, a lever for actuating the valve, a cam for moving the valve in one direction, a spring for moving it in the other, and compression members located on opposite sides of the stem for transmitting motion between the lever and spring.

In witness whereof, I have hereunto set my hand this 27th day of December, 1905.

WILLIAM L. R. EMMET.

Witnesses:
BENJAMIN B. HULL,
HELEN ORFORD.