No. 891,342. PATENTED JUNE 23, 1908.

O. JUNGGREN.

GOVERNING MECHANISM FOR TURBINES.

APPLICATION FILED JAN. 2, 1906.

3 SHEETS—SHEET 1.

Fig. 9.

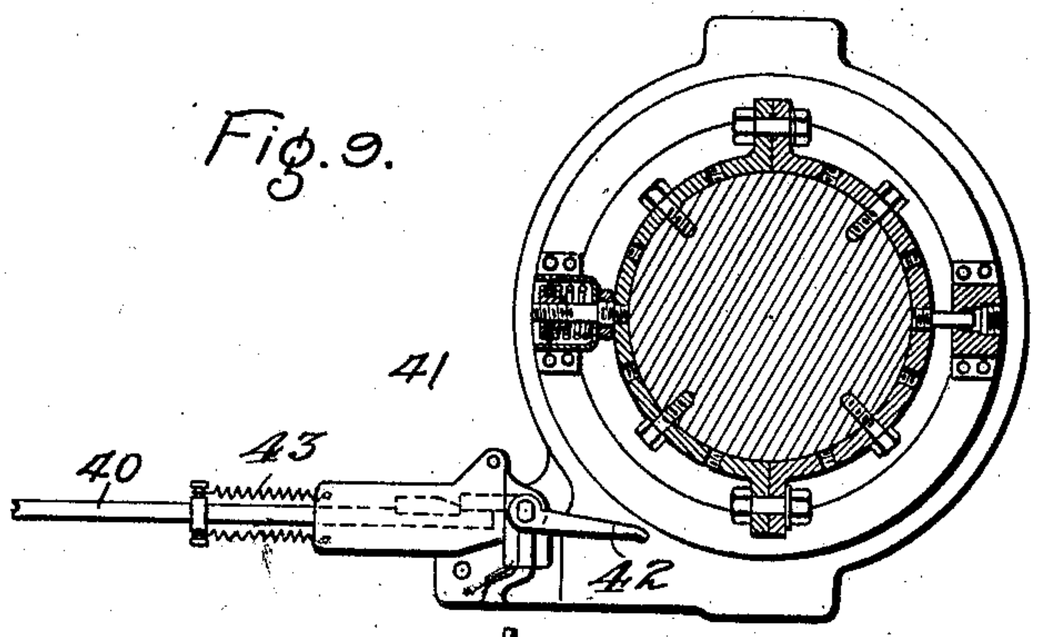

Fig. 2.

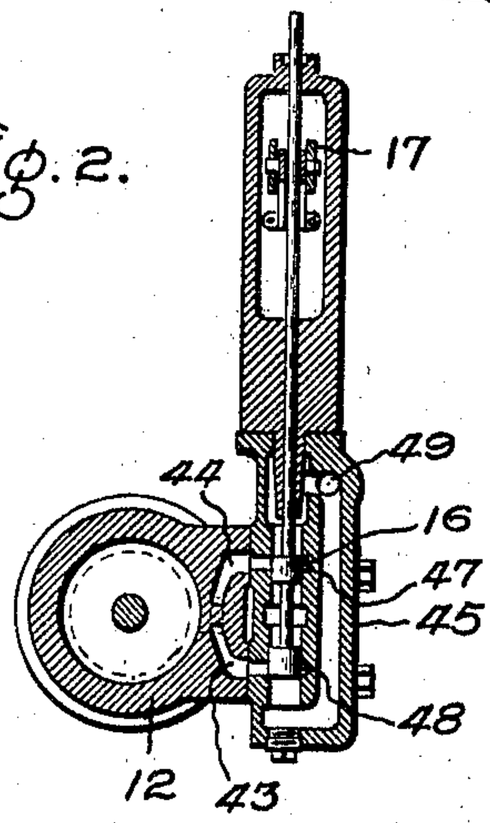

Fig. 1.

Witnesses:
Marcus L. Byng.
Alex. F. Macdonald

Inventor:
Oscar Junggren,
by Albert G. Davis
Atty.

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3 SHEETS—SHEET 2.

Fig. 3.

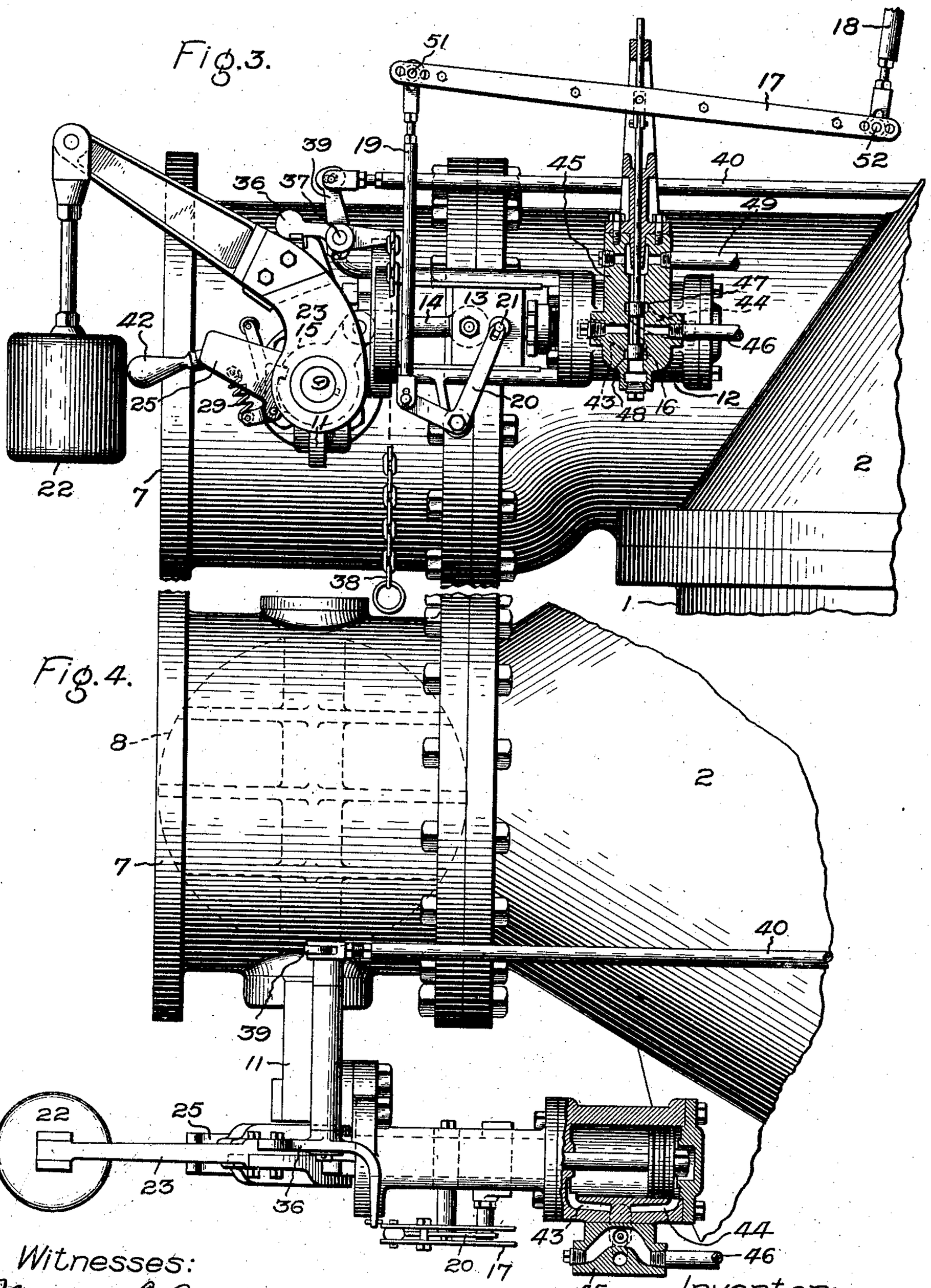

Fig. 4.

Witnesses:
Marcus L. Byng.
Alex. F. Macdonald.

Inventor:
Oscar Junggren,
by Albert G. Davis
Atty.

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3 SHEETS—SHEET 3.

Fig. 5.

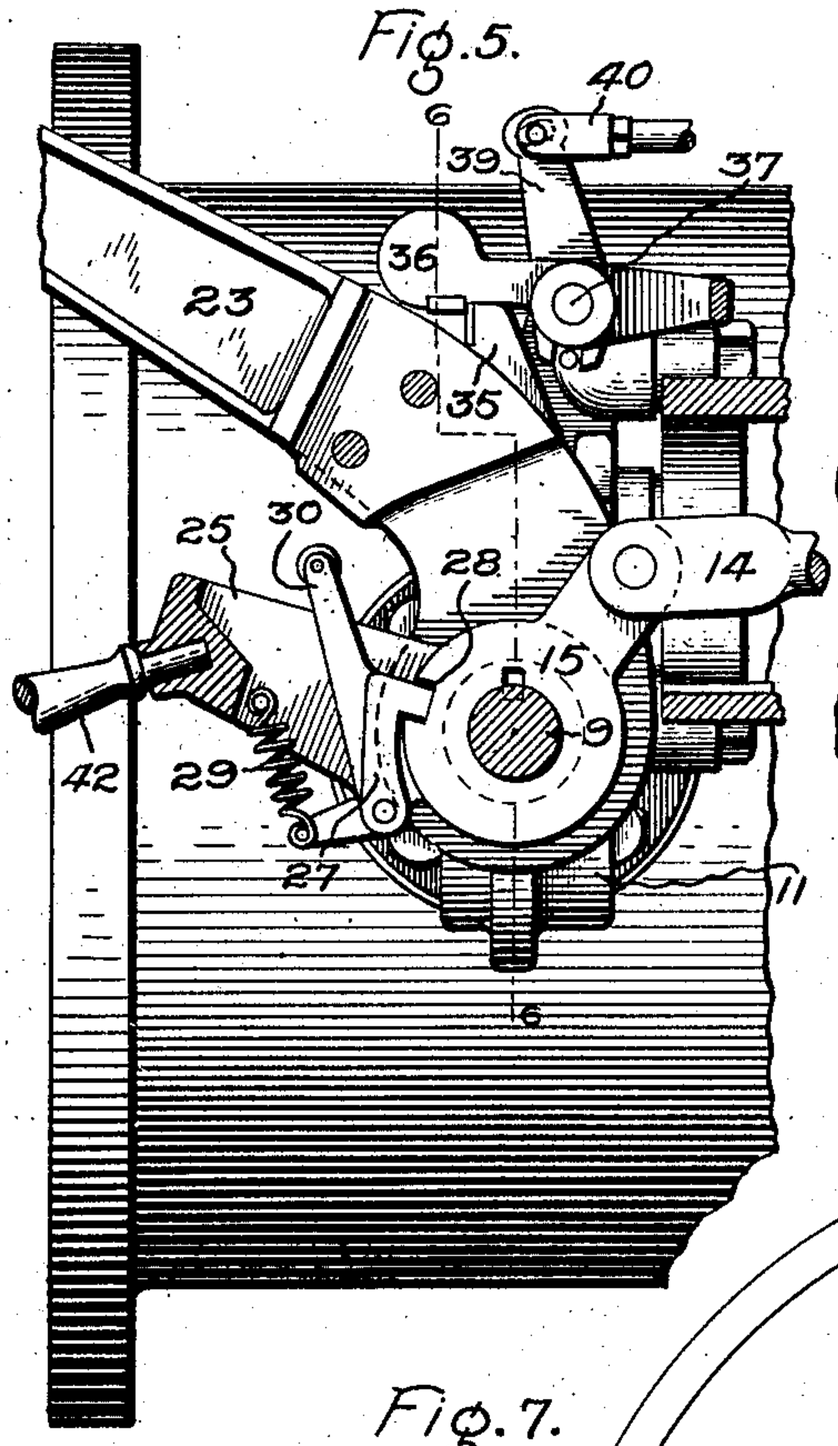

Fig. 6.

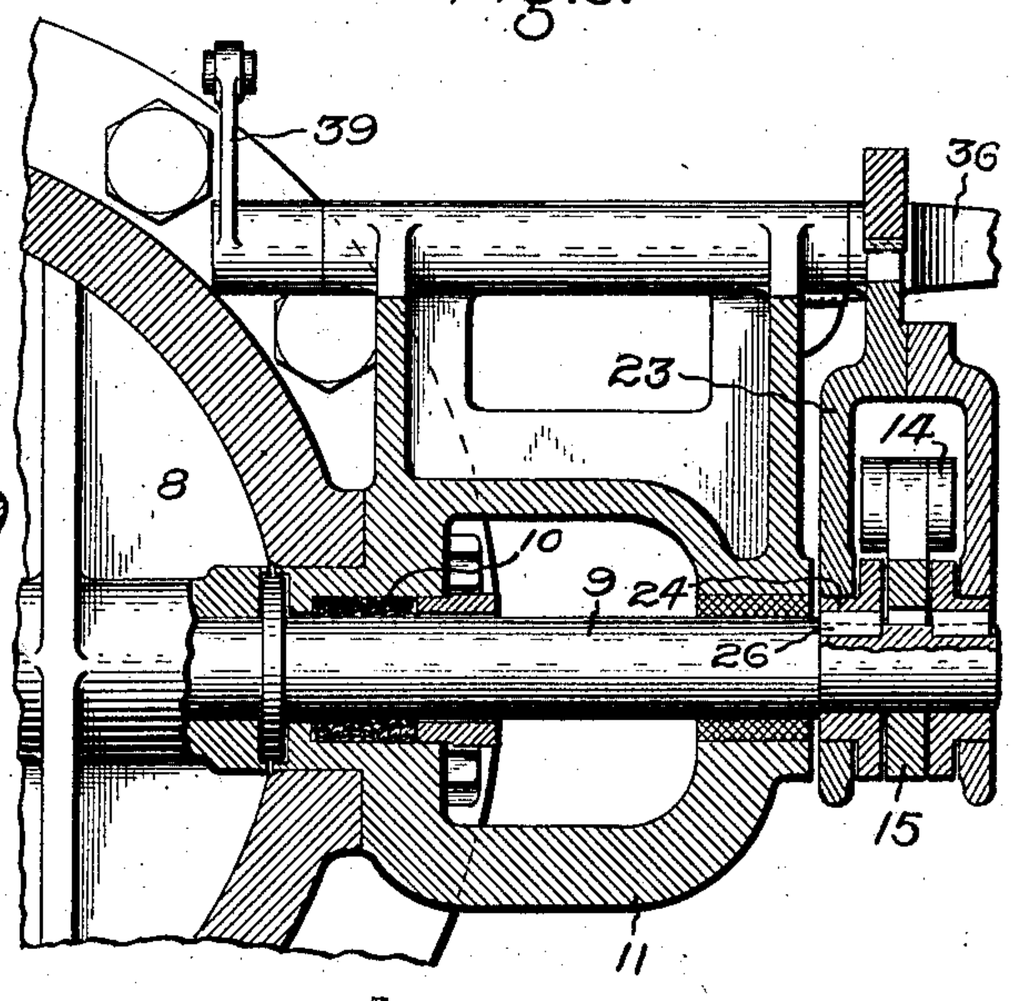

Fig. 7.

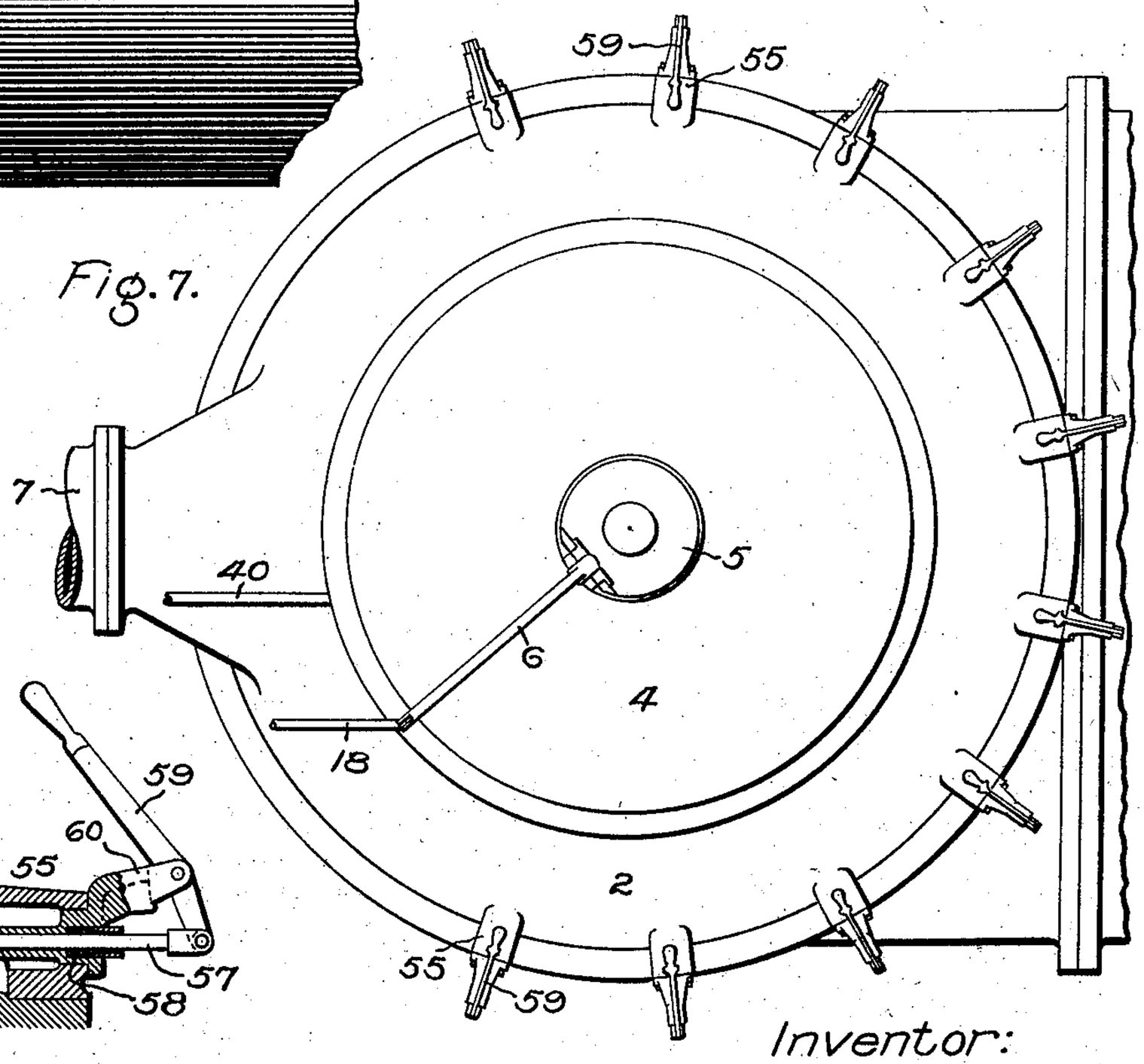

Fig. 8.

Witnesses:
Marcus L. Byng.
Alex. F. Macdonald

Inventor:
Oscar Junggren,
by Allen A. Dow
Atty.

UNITED STATES PATENT OFFICE.

OSCAR JUNGGREN, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

GOVERNING MECHANISM FOR TURBINES.

No. 891,342. Specification of Letters Patent. Patented June 23, 1908.

Application filed January 2, 1906. Serial No. 294,163.

To all whom it may concern:

Be it known that I, OSCAR JUNGGREN, 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 of improved construction.

The invention is particularly directed to governing mechanism for low-pressure turbines receiving exhaust steam or other elastic fluid from one or more high-pressure reciprocating engines, either directly or indirectly, as from a header or accumulator, but it is also applicable for governing high-pressure turbines.

In carrying out the invention, a single valve is provided which has two functions, *i. e.*, that of automatically regulating the admission of steam or other fluid to the turbine as the load changes, and that of shutting down the turbine when the speed becomes excessive, or manually when it is desired for any reason. It is manifestly of great advantage to use a single valve for both purposes on account of simplicity and relatively small cost.

In order that the valve may perform the two functions specified, two motors are provided, one for automatically moving it to and fro to throttle or otherwise control the admission of fluid to the turbine, the other for completely closing the valve under emergency or other conditions. In the preferred form of the invention a hydraulic motor is employed to actuate the valve for regulating purposes, and a weight for suddenly closing it. Between the hydraulic motor and the valve is a lock which is released when the weight falls, the arrangement being such that the releasing takes place irrespective of the position of the valve and moving part of the motor. The hydraulic motor is controlled by a speed-responsive device through the intervention of a pilot valve which admits fluid to or cuts it off from the motor cylinder. A follow-up device is provided for preventing over-travel of the motor. The weight or second motor is controlled by an emergency governor, or it may be released manually.

In the accompanying drawings, which illustrate one embodiment of the invention, Figure 1 is a partial side elevation of a low-pressure turbine arranged to drive an electric generator; Fig. 2 is a detail sectional view of the pilot-valve for controlling the hydraulic motor, taken on the line 2—2 of Fig. 1; Fig. 3 is a view in side elevation on a somewhat larger scale of the hydraulic motor and weight for actuating the throttle valve; Fig. 4 is a plan view of the same, with the cylinder of the motor in section; Fig. 5 is an enlarged detail view of the means for locking the hydraulic motor to the valve-spindle; Fig. 6 is a sectional view of the same taken on line 6—6 of Fig. 5; Fig. 7 is a plan view of a turbine showing a number of hand valves for varying the number of nozzles in service; Fig. 8 is a detail sectional view of one of the hand-operated valves; and Fig. 9 is a detail view of an emergency governor for releasing the weight when the speed becomes excessive.

1 represents the upper part of a multi-stage elastic-fluid turbine of the Curtis type. The invention however can be applied to other types of turbines, as will be readily understood. Situated above the turbine and resting thereon is a valve chest 2, and rising above the chest is a stool which carries the electric generator 3. The upper end of the generator is inclosed by a cover 4 that supports the dome 5, the latter surrounding the speed-responsive device which acts on the lever 6. Steam or other elastic fluid is admitted to the valve chest of the turbine from a high-pressure engine by the conduit 7, the latter forming the inlet portion of the valve chest. The source of supply may be the exhaust from one or more high-pressure reciprocating engines of the simple or compound type, or it may be that from one or more high-pressure turbines, either of the single or multi-stage type. Under certain conditions the governing mechanism may be employed with turbines arranged to receive high-pressure steam or other motive fluid. Located in the conduit 7 is a butterfly valve 8 (Figs. 4 and 6) which is rigidly secured to an oscillating spindle 9, the latter being mounted in suitable bearings formed in the conduit and provided with packings 10, as shown in Fig. 6, to prevent the escape of steam. Extending outwardly from the supply conduit and

supported thereby, is a bracket 11 that supports the hydraulic motor 12 and attached parts, as will appear more fully hereinafter.

The piston-rod of the motor is attached to a cross-head 13, Fig. 1, the latter moving to and fro in guides located above and below it. To the cross-head is secured a connecting-rod 14, and the latter is connected to an actuator or lever 15, Fig. 5, which is loosely mounted on the valve spindle 9. It will thus be seen that by means of the connecting-rod and actuator rectilinear movements of the piston are transformed into oscillatory movements of the regulating valve. On the front of the hydraulic motor, which is capable of assuming intermediate positions, is a pilot valve 16 that is raised and lowered by the lever 17, the latter being connected at one end to the adjustable rod 18 leading to the governor lever 6 and at the other end by the adjustable rod 19 to the bell-crank lever 20. The lever 20 is pivotally supported upon an extension from the lower guide, and the upper end of the long arm is slotted to engage with a pin 21 on the cross-head 13. The lever 17, rod 19 and bell-crank lever 20 engaging the pin 21 form a follow-up device for restoring the pilot valve 16 to its initial position after the motor piston moves a definite amount, which amount is controlled by the movement of the lever 6. This follow-up device is operative irrespective of the position of the motor piston and cross-head 13.

In order to shut the valve under emergency conditions or when it is desired to manually shut down the machine, a weight 22 having two positions is provided and attached to the free end of the arm 23, the said arm being loosely mounted on the hub of the locking device 24 as shown in Fig. 6. The locking device comprises a clevis 25, the arms of which are secured to the valve spindle by the keys 26, Fig. 6. The part 25 is preferably made with two arms as shown on account of the increased strength and the ample bearing surfaces but a plain lever can be substituted if desired. Pivotally mounted on the clevis is a locking device 27 that normally occupies the position shown in Fig. 5, that is to say, the free end is in the notch 28 in the actuator 15 and the piston of the motor is thereby rigidly connected to the valve spindle by means of the piston rod, cross-head, connecting-rod 14, actuator 15, lock 27 and clevis or fork 25. The latch is normally retained in the position shown by the extension spring 29. The locking device is extended to a point above the fork, as at 30, and mounted on the end thereof is a roller adapted to be engaged when the weight-arm 23 is released. On the weight-arm is a shoulder 35 adapted to engage with and be held by the latch 26, the latter being mounted on the pivot 37. The latch 36 is weighted on the left-hand end, to cause it to engage with the shoulder when the weight-arm is reset. Both it and the shoulder are provided with removable hardened steel plates to prevent wear. The latch 36 is extended toward the front, as is clearly indicated in plan, Fig. 4. To the right-hand end of the latch is secured a chain 38 whereby it may be tripped manually when it is desired to let the weight fall and completely shut off the supply of steam to the turbine. Mounted on the latch carrying spindle 37 is an arm 39, to the free end of which is secured the adjustable connecting-rod 40. In the connection between the rod and the arm is a certain amount of lost-motion to effect a hammer blow action to insure the release of the weight. The inner end of the rod is adapted to be acted upon by the emergency governor 41, Fig. 9, when the speed of the turbine becomes excessive. Commonly this emergency governor is set to operate on a ten per cent. increase in speed above the normal rating of the machine. In order to reset the mechanism after the weight-arm 23 is tripped, the clevis 25 is provided with a resetting handle 42.

The action of the pilot valve controlling the hydraulic motor will now be described.

The motor is provided with ports 43 and 44, Figs. 2 and 4 leading to opposite ends of the cylinder. Disposed vertically and at right angles to the axis of the motor is the pilot valve 16 mounted in a valve casing 45 that is bolted to the motor cylinder. The pilot valve is of the balanced piston type, and fluid is admitted to the space between the piston heads by the pipe 46. So long as the valve stands in the position shown in the drawings the supply of fluid to the cylinder is cut off, because the supply ports 47 and 48 leading to the passages 43 and 44 are closed. Assume however that the speed of the turbine increases, the outer end of the governor-actuated lever 6 will rise and its motion is transmitted to the valve-operating lever 17 by means of the connecting rod 18. Raising the valve admits fluid to the right-hand end of the cylinder and opens the left-hand end to the exhaust pipe 49. This causes the piston to start into motion and close the valve more or less through the connecting-rod 14, actuator 15, lock 27 and clevis 25. Just as soon as the piston starts into motion, the cross-head 13 also starts, and this movement is communicated to the bell-crank lever 20 and to the vertically disposed connecting-rod 19. When the piston has moved the desired amount the action of the follow-up device will restore the pilot valve to its central or initial position. The action of the said device is as follows, the motor or piston being in some intermediate position. Assuming that the governor, on an increase in speed, has moved the lever 17 around the pivot 51, which for the moment is fixed, until it has opened the pilot valve by raising it, the motor

starts into operation and this movement causes the cross-head 13 to move bell-crank lever 20 which in turn lowers the pivot 51, the pin 52 now acting as a fulcrum. The downward movement of the left-hand end of the lever 17 restores the pilot valve to its initial or normal position and cuts off the supply of fluid under pressure to the motor. This causes the piston to stop and at the same time be locked in position by reason of the fact that there is a body of non-compressible fluid on each side of the piston-head. This action is repeated each time the speed increases, and the extent of movement of the motor piston will always bear a definite relation to the movement of the lever 6 of the shaft governor. Conversely, when the speed decreases owing to the increase in load, the pilot valve is pushed downward by means of the lever 17 which opens the right-hand end of the cylinder to the exhaust and admits high-pressure fluid to the left-hand end and the piston starts into motion in a direction from left to right. At the same time the cross-head 13 moves with the piston and in so doing moves the bell-crank lever 20 about its pivot. This causes the point of fulcrum of the lever 17 to be changed from pivot 51 to pivot 52 and the upward movement of the rod 19 lifts the outer end of the lever 17 and restores the pilot valve to the position shown in Fig. 3, or, in other words, to its normal position where all the ports are closed and the piston is locked. Upon a further increase in load, the action is again repeated. It will thus be seen that in the normal operation the valve is opened and closed in a step-by-step manner, assuming the load to be of a gradually increasing or decreasing nature.

The action of the emergency mechanism will now be described.

Assuming that the parts are in the position shown, that is to say, with the butterfly valve 8 fully open, and the speed of the main shaft of the turbine has increased above the normal by a predetermined amount, the emergency governor 41 will actuate the trigger 42 and permit the springs 43 to move the rod 40 (Fig. 3) to the right inflicting a hammer blow on the latch 36. This will move the latch out of engagement with the shoulder 35 on the weight-arm and the weight 22 being suspended on the free end of the arm will cause the latter to fall. After the weight-arm has moved through a certain limited distance, it will strike the roller (Fig. 5) on the end 30 of the locking device and by its impact overcome the tension on the spring 29 and pull the locking device 27 out of the notch 28. A continued movement of the weight-arm will cause it to strike the clevis 25 and since the latter is rigidly keyed to the valve spindle, it will cause the latter to turn and shut the valve. In resetting the apparatus the weight 22 is lifted until the latch 36 can reëngage the shoulder 25. The next step is to raise the clevis 25 by means of the handle 42 and permit the lock 27 to enter the notch 28 in the actuator when the parts will be again ready for normal operation.

It is to be noted that the action of the emergency mechanism in no way affects the position or limits the operation of the hydraulic motor and its connected parts. It is also to be noted that the weight can close the regulating or throttle valve without regard to its position due to the movement of the hydraulic motor. This is obvious, since the weight-arm must first throw out the lock 27 before it hits the fork and just as soon as the latch is thrown out the hydraulic motor is disengaged from the valve spindle and has no control thereon until the apparatus has been reset. I regard this as being an essential feature of the invention.

Referring to Fig. 7, a turbine is shown in plan view, with a number of hand-operated valves 55. Each of these valves controls one, two or more nozzles or nozzle sections which discharge fluid against the bucket wheels. The construction and arrangement of these valves is best shown in Fig. 8, wherein 56 is the valve, 57 the rod for actuating it, and 61 the upper end of a port or passage leading to a nozzle or other fluid discharging device. The rod 57 is provided with a packing 58 to prevent leakage. The valve is operated by means of a lever 59 pivoted in a bracket 60, the latter being mounted in the casing of the turbine.

It will be noted that the hydraulic motor is capable of moving the regulating valve to and fro as the load changes, while the weight and attached parts are constrained from acting. On the other hand, the action of the weight is in no way retarded or controlled by the position of the motor piston and therefore of the valve. This means that while both motors work on the same valve, neither interposes an additional load on the other and each performs its function at the proper time, and both coöperate to govern the turbine in accordance with speed changes.

I have described the regulating valve as being normally actuated by fluid pressure as a source of relay power, but it is to be understood that other forms of relay devices may be substituted therefor of a mechanical, electrical or other nature under the control of a load-responsive device.

The type of valve may be varied to suit the conditions of service; instead of being of the character shown, it may be arranged to move to and fro over a series of ports, each port being connected to one or more fluid-discharging devices.

It will be seen that the throttle valve 8 constitutes a primary regulator which is moved by a fluid actuated motor under the control of the speed governor, and that the

manually actuated valves 56, located in the annular valve chest 2, form secondary regulators for controlling the number of ports or passages in service supplying steam or other motive fluid to the nozzles or other fluid discharging devices.

The specific construction of the emergency governor shown in Fig. 9, is not claimed herein because it forms the subject matter of a separate application.

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, the combination of a valve which serves both as a regulating and a shut-off valve, a mechanism for moving the valve in a manner to regulate the passage of fluid, a device responsive to load changes for controlling the action of said mechanism, and a second speed responsive device for suddenly actuating the valve under predetermined conditions.

2. In a governing mechanism, the combination of a valve which serves both as a regulating and a shut-off valve, a source of relay power for moving the valve for regulating purposes, a speed-responsive device controlling the action of said source on the valve, and a means for suddenly actuating the valve under predetermined conditions.

3. In a governing mechanism, the combination of a valve, a motor for automatically adjusting it to vary the passage of fluid to the apparatus being governed, a second motor which under predetermined increase in speed conditions suddenly closes the valve, and a speed governor for controlling the second motor.

4. In a governing mechanism, the combination of a valve, a motor for automatically moving the valve in a manner to vary the passage of fluid to the apparatus under control, a lock for connecting the motor and valve, and a second motor which by its movement first releases the lock and thereafter closes the valve under predetermined increased speed conditions.

5. In a governing mechanism, the combination of a valve capable of assuming intermediate positions, a motor for actuating it that is also capable of assuming intermediate positions, a source of power for the motor, a governor for the motor, a second motor independent of the valve for operating it under predetermined conditions, which has two positions only corresponding to the open and closed positions of the valve, and means connecting the second motor and the valve in such manner that the motor moves a full stroke each time it is operated irrespective of the position of the valve.

6. In a governing mechanism, the combination of a valve capable of assuming intermediate positions, a motor directly connected thereto for varying the passage of fluid, a second motor acting on the valve through a lost-motion connection, and means responding to the speed changes for disconnecting the first motor from the valve and allowing the second motor to close it.

7. In a governing mechanism, the combination of a valve, a motor for adjusting it to vary the passage of fluid to the apparatus being governed, a load-responsive device for moving the valve in a step-by-step manner both in opening and closing, and a second motor acting independently of the first for suddenly closing the valve.

8. In a governing mechanism, the combination of a valve, a motor for adjusting it to vary the passage of fluid to the apparatus being governed, a load-responsive device for moving the valve in a step-by-step manner both in opening and closing, a second motor acting independently of the first for suddenly closing the valve, and a speed-responsive device which controls the second motor.

9. In a governing mechanism, the combination of a valve, a motor for adjusting the valve to vary the passage of fluid to the apparatus being governed, a speed-responsive device for regulating the motor, a follow-up device to prevent over-travel of the motor, a second motor acting independently of the first for suddenly closing the valve, and a means for disconnecting the first motor from the valve and permitting the second motor to act thereon.

10. In a governing mechanism, the combination of a pivotally supported valve, a reciprocating motor, a means for transforming the rectilinear movement of the motor into an oscillating movement of the valve, a second motor for suddenly closing the valve irrespective of the position of the first motor, and a speed-responsive device for controlling the action of the second motor.

11. In a governing mechanism, the combination of a valve, a fluid-actuated motor capable of assuming intermediate positions for moving the valve, a pilot valve responding to load changes for controlling the motor, and a weight for suddenly closing the valve in response to predetermined conditions.

12. In a governing mechanism, the combination of a valve, a fluid-actuated motor capable of assuming intermediate positions for moving the valve, a pilot valve responding to load changes for controlling the motor, a follow-up device for preventing over-travel of the motor, a weight for suddenly closing

the valve, and a means responding to abnormal conditions for releasing the weight and permitting it to fall and close the valve.

13. In a governing mechanism, the combination of a valve, a motor, a source of relay power therefor, an actuator for the valve connected to and moved by the motor, a means normally connecting the actuator and the valve, a second motor acting independently of the first through a lost-motion for closing the valve, the said motor being arranged to first break the connection between the actuator and the valve, and a device for releasing the second motor and permitting it to break the connection and close the valve.

14. In a governing mechanism, the combination of a valve, a spindle therefor, an actuator loosely mounted on the valve spindle, a device rigidly connected to the valve spindle, a lock carried by the device for rigidly connecting the actuator and the valve spindle, a motor for moving the actuator and through it the valve, and a means for controlling the movements of the motor.

15. In a governing mechanism, the combination of a valve, a spindle therefor, an actuator loosely mounted on the valve spindle, a device rigidly connected to the valve spindle, a lock carried by the device for rigidly connecting the actuator and the valve spindle, a motor for moving the actuator and through it the valve, a means for controlling the movements of the valve, and a second motor which releases the lock and actuates the valve.

16. In a governing mechanism, the combination of a valve, a motor, a locking device for connecting the movable element of the motor and the valve, a weight, a pivotally supported arm therefor, a latch for holding the arm in a raised position, and a means for releasing the arm and permitting the weight to fall and release the lock and move the valve.

17. In a governing mechanism, the combination of a valve, a motor capable of assuming intermediate positions for moving the valve, a follow-up device for preventing over-travel of the motor, a second motor having two positions, a latch for restraining the second motor, a speed-responsive device for starting and stopping the first motor, and a second speed-responsive device for tripping the latch and permitting the second motor to operate and disconnect the first motor from and shut the valve.

18. In a governing mechanism, the combination of a throttle valve supported by a spindle, a motor for moving the valve to and fro to throttle the admission of fluid to the apparatus being governed as the load changes, an actuator loosely mounted on the valve spindle, a clevis secured to the valve spindle, a lock carried by the clevis which normally connects the motor and the actuator, an arm loosely mounted on the spindle and acting to release the lock and close the valve by a hammer blow, a weight for moving the arm, and a speed-responsive device for releasing the weight and permitting it to suddenly close the valve.

19. In a governing mechanism for turbines, the combination of a throttle valve, a motor for automatically adjusting the position of the valve in response to changes in load, a second motor for closing the valve under abnormal conditions, and one or more valves for varying the number of fluid-discharging devices in service.

20. In a governing mechanism, the combination of a throttle valve, a motor for shutting it suddenly in response to abnormal conditions, a fluid-actuated motor for moving the valve to throttle the admission of fluid to the apparatus being governed, a pilot valve responding to speed changes for starting and stopping the motor, a cross-head connected to the movable element of the motor, a speed-responsive device, a lever connected to the said device and the pilot-valve, and a lever and connecting-rod between the first-mentioned lever and the cross-head for restoring the pilot valve to its neutral position when the movable element of the motor has moved an amount corresponding to the movement of the speed-responsive device and stopping the motor.

21. In a governing mechanism, the combination of a valve, a motor for automatically moving it to and fro to regulate the admission of fluid to the apparatus being governed, a second motor for suddenly closing the valve, a device for restraining the second motor, and a manually actuated means for releasing the said device and permitting the second motor to operate.

22. In a governing mechanism, the combination of a valve for regulating the passage of motive fluid, a hydraulic motor moving the valve for regulating purposes, and a weight which drops and shuts the said valve under emergency conditions.

23. In a governing mechanism, the combination of a valve for regulating the passage of motive fluid, a hydraulic motor moving the valve for regulating purposes, a connecting means between the motor and valve, and a weight which falls and suddenly closes the valve, which weight, in falling, first renders the connecting means ineffective and then closes the valve.

24. In a governing mechanism for elastic fluid turbines, the combination of fluid discharging ports, one or more secondary regulators for varying the number of ports in service, a primary regulator which acts independently of the secondary regulators and varies the passage of motive fluid through

the open ports, a motor for actuating the primary regulator, and a governor for controlling the motor.

25. In governing mechanism for elastic fluid turbines, the combination of fluid-discharging ports, one or more secondary regulators for varying the number of ports in service, a valve which acts independently of the secondary regulators and varies the passage of motive fluid through the open ports, a fluid-actuated motor for moving the valve, and a governor-controlled regulator for the motor.

26. In governing mechanism for elastic fluid turbines, the combination of fluid-discharging ports, one or more secondary regulators for varying the number of ports in service, a valve which acts independently of the secondary regulators and is adapted to assume intermediate positions between full open and closed for throttling the admission of elastic fluid to the turbine, a motor connected to the valve and capable of assuming intermediate positions between the ends of its strokes, and a governor for controlling the movements of the motor.

27. In governing mechanism for elastic fluid turbines, the combination of fluid-discharging ports, one or more secondary regulators for varying the number of ports in service, a valve capable of assuming intermediate positions for varying the passage of motive fluid through the open ports, a motor capable of moving the valve to said intermediate positions, a governor controlling the motor, and a follow-up device for preventing over-travel of the motor.

28. In governing mechanism for elastic fluid turbines, the combination of fluid-discharging ports, one or more secondary regulators for varying the number of ports in service, a valve capable of assuming intermediate positions for varying the passage of motive fluid through the open ports, a fluid-actuated motor for moving said valve to its intermediate positions, a pilot valve controlling the motor, a governor for the motor and a device for restoring the pilot valve to its normal position which is actuated by the motor.

29. In governing mechanism for elastic fluid turbines, the combination of fluid-discharging ports, one or more secondary regulators for varying the number of ports in service, a valve capable of assuming intermediate positions for varying the passage of motive fluid through the open ports, a motor capable of moving the valve to said intermediate positions, a governor controlling the motor, and a follow-up device actuated by the motor itself for preventing over-travel of the valve.

30. In a governing mechanism for turbines, the combination of a regulating valve, a motor, the movable member of which is connected to the valve, a chest for the valve, one or more secondary regulating valves also mounted in the chest for cutting ports into and out of service, and a governor for controlling the motor.

In witness whereof, I have hereunto set my hand this 30th day of December, 1905.

OSCAR JUNGGREN.

Witnesses:

BENJAMIN B. HULL,

HELEN ORFORD.