W. KIESER.

GOVERNING MECHANISM FOR ELASTIC FLUID TURBINES.

APPLICATION FILED OCT. 29, 1906.

957,889. Patented May 17, 1910.

3 SHEETS—SHEET 1.

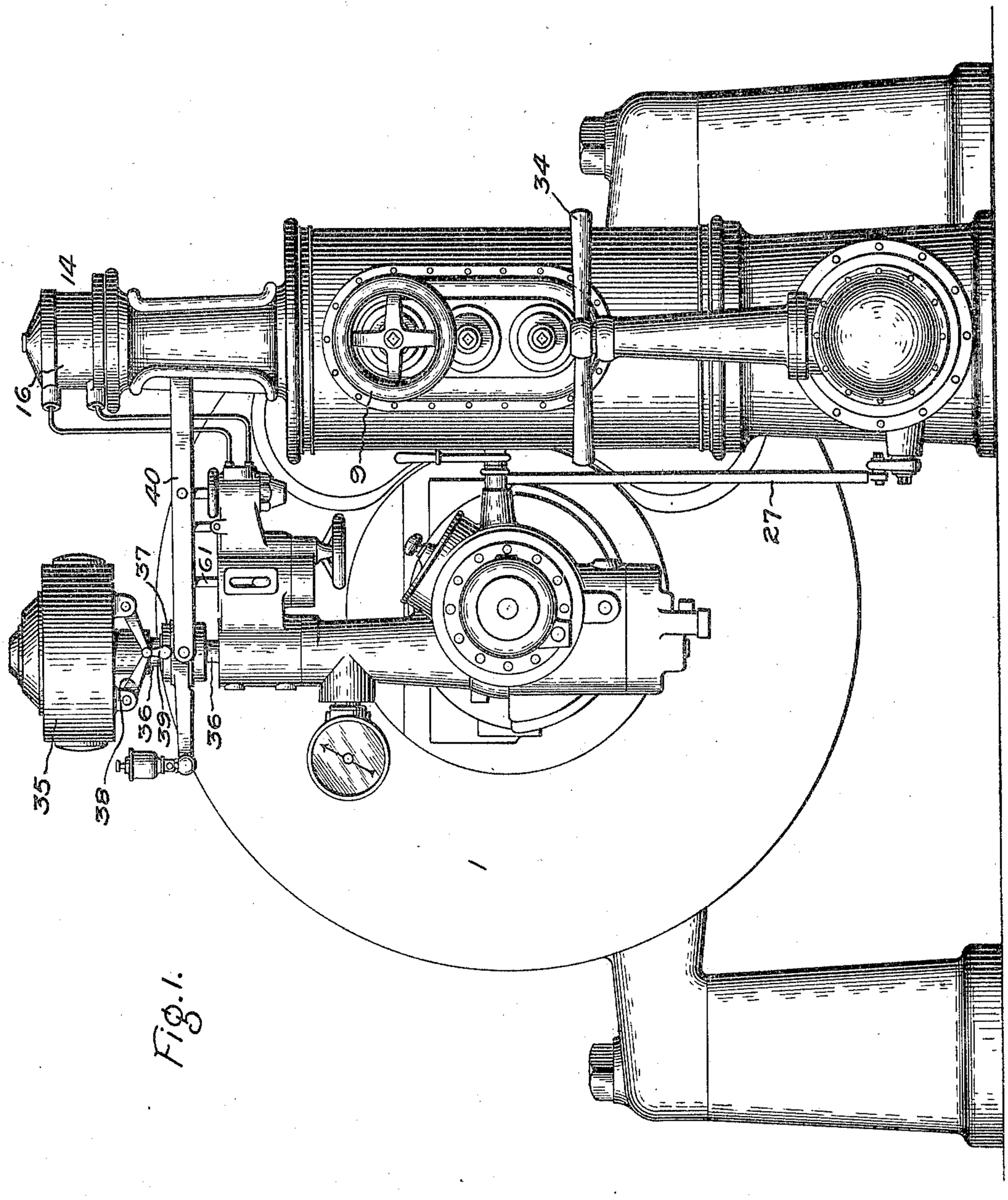

Fig. 1.

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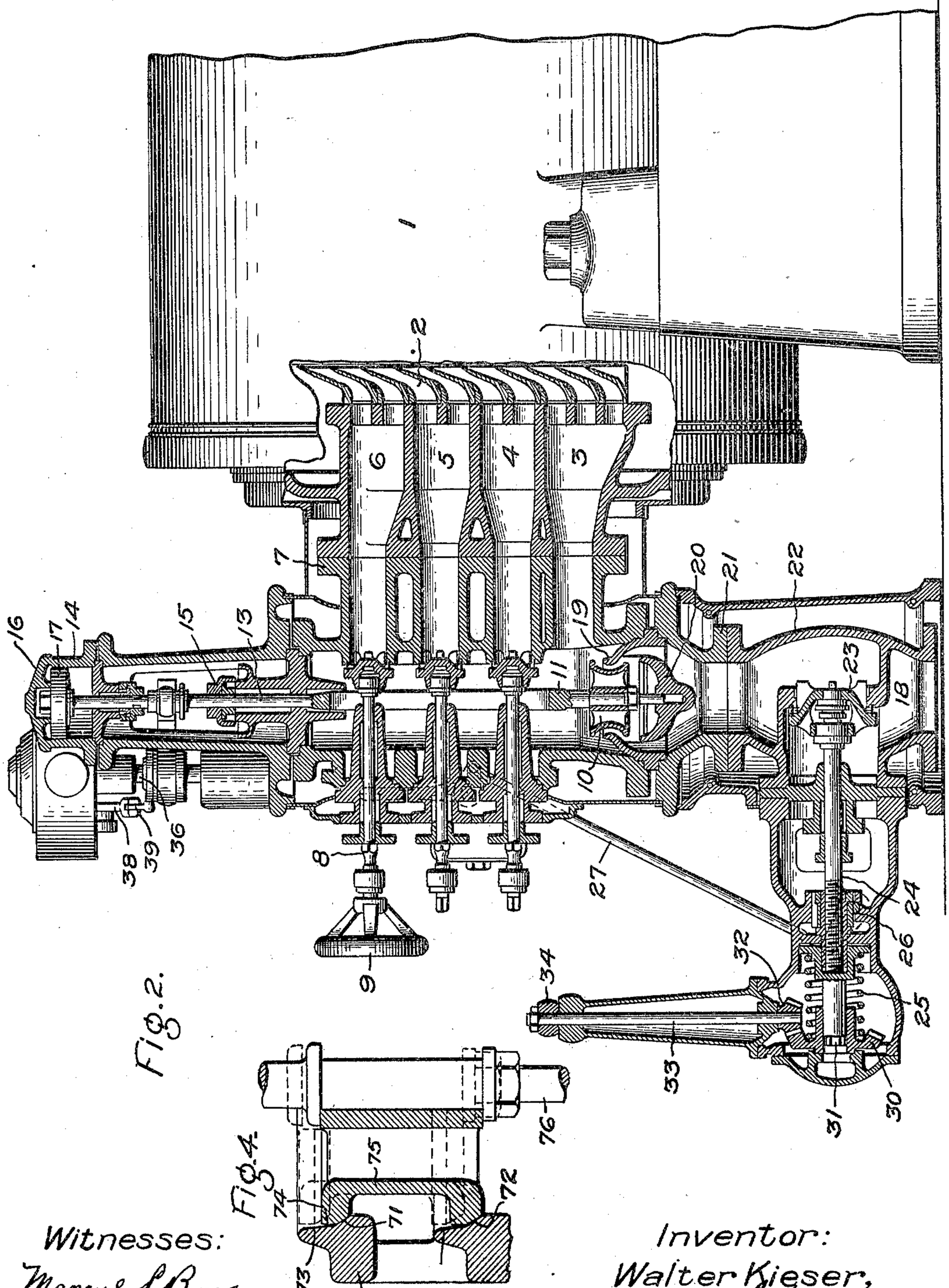

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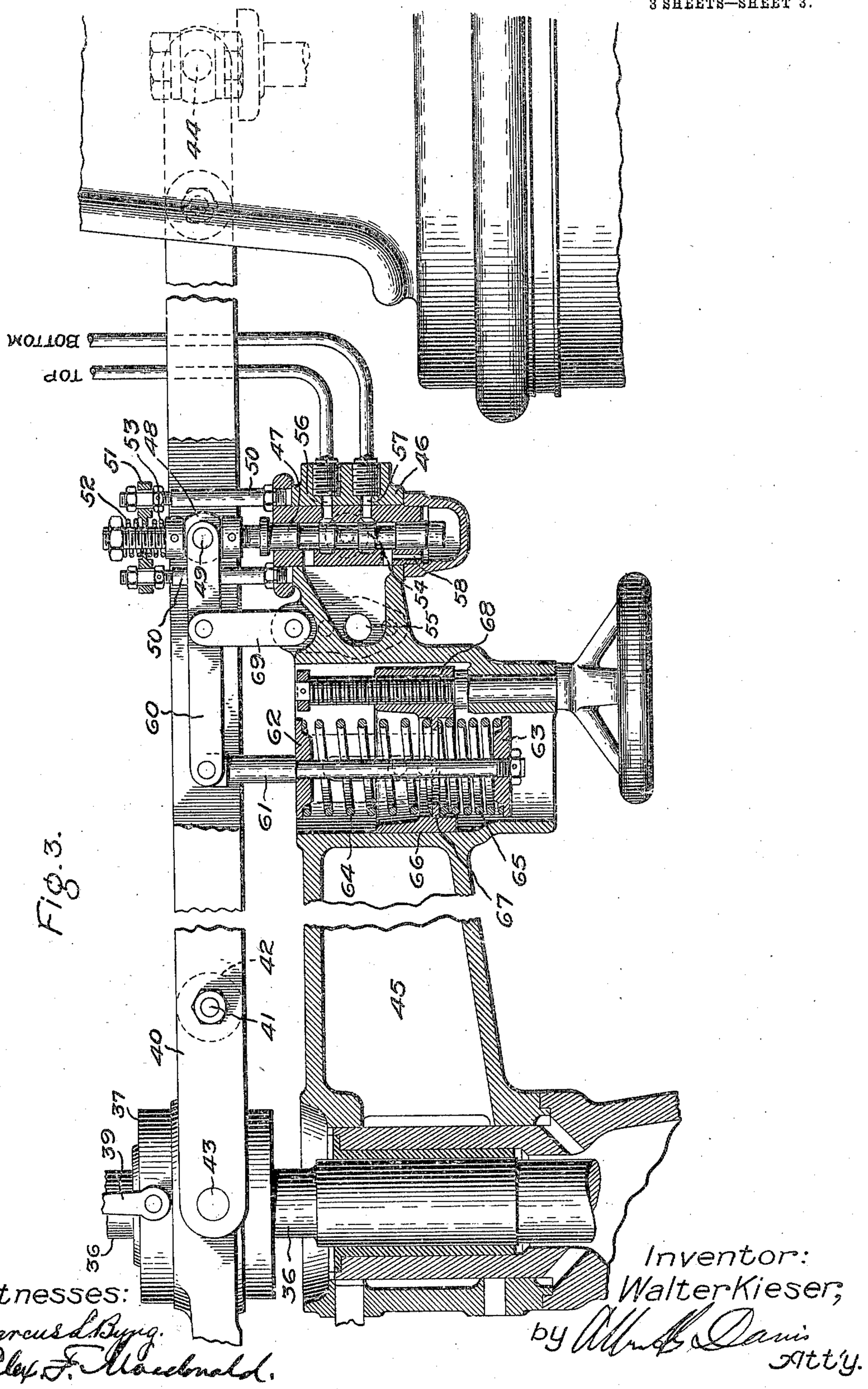

Fig. 3.

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UNITED STATES PATENT OFFICE.

WALTER KIESER, OF BERLIN, GERMANY, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

GOVERNING MECHANISM FOR ELASTIC-FLUID TURBINES.

957,889. Specification of Letters Patent. Patented May 17, 1910.

Application filed October 29, 1906. Serial No. 340,995.

To all whom it may concern:

Be it known that I, WALTER KIESER, a citizen of Switzerland, residing at Berlin, Germany, have invented certain new and useful Improvements in Governing Mechanism for Elastic-Fluid Turbines, of which the following is a specification.

The present invention relates to governing mechanisms for elastic fluid turbines, and has for its object to provide an improved governing mechanism which is simple and rugged in construction, and which will efficiently regulate the passage of motive fluid through the turbine.

For a fuller understanding of what I consider to be novel and my invention, attention is directed to the accompanying description and claims appended thereto.

In the accompanying drawings which illustrate one of the embodiments of my invention, Figure 1 is an end view of an elastic fluid turbine fitted with my improved governing mechanism; Fig. 2 is a section through the governing valve and the hydraulic motor for actuating it; Fig. 3 is a detail view, principally in section, of the pilot valve for controlling the hydraulic motor, and also of the adjustable governor opposing springs, and Fig. 4 is a detail view of an improved form of main throttle valve.

1 represents the turbine which may be of any suitable construction. As shown, it is of the Curtis type. Steam or other elastic fluid is admitted to the bucket wheel by the sectionalized nozzle 2. I have shown the nozzle sections as being of the expanding type, but it is to be understood that the invention is applicable to turbines having non-expanding nozzles, and also to turbines having discharging devices of other forms. As shown, the nozzle sections are divided into groups, Fig. 2, each group receiving its motive fluid from a separate port. In the particular embodiment shown, ports 3, 4, 5 and 6 are provided. The port 3 is arranged to supply motive fluid to three nozzle sections and the remaining ports each to two nozzle sections, but the number can be increased or decreased as desired. The ports 3 to 6 inclusive communicate with corresponding ports formed in the valve chest 7. Ports 4 to 6 inclusive are opened or closed by manually actuated valves 8, of which three are shown, but the number can be increased or decreased as desired. These valves may be actuated by a detachable handle 9 or other means. In the operation of the turbine, these valves will be opened one after the other by the station attendant as the load increases, and closed one after the other by the attendant as the load decreases. It is not intended to open and close these valves for minor changes in load, but only for material changes, such as commonly occur from time to time during the day in the operation of steam plants supplying energy to lighting, railway and power circuits. For this reason the manually actuated valves will be referred to as secondary controlling or regulating devices.

The primary controlling device comprises a double-seated balanced throttle valve 10 mounted within the valve chest and attached to a rod 11. The latter is provided with a tail-piece acting as a guide for the lower end, and an extension 13 on the upper end that is united with the piston of the hydraulic motor 14. The portion of the rod 11 extending through the valve chest is slotted, and the stems of the manually actuated valves 8 extend through said slot. The object of slotting the rod and passing the valve stems through the slot is to reduce the size of the apparatus as a whole. Where the extension 13 passes through the head of the valve chest, it is provided with an adjustable packing gland 15.

The motor 14 comprises a cylinder 16, a piston 17, an entrance port at the upper end of the cylinder and an exhaust port at the lower end. The pipes for admitting fluid, such as oil under pressure, to the cylinder, are best shown in Fig. 1. The piston being directly connected to the throttle valve through the parts 13 and 11, it follows that as the piston changes its position, that of the throttle valve will be correspondingly changed. When the piston is in the extreme upper position, as shown in Fig. 2, the maximum amount of steam will flow from the supply conduit 18 to the turbine, and intermediate positions of the piston and valve will admit a correspondingly decreased amount of steam. When the piston is in its lowest position, the upper surface of the valve will engage the seat 19, while the lower surface of the valve will engage the seat 20. The seats 19 and 20 are formed on the same member, and said member is securely held between the valve chest and

a flanged coupling 21. By reason of this construction, only one set of bolts is required, and these pass through the flanges of the chest and the coupling.

To the lower end of the flanged coupling is attached the casing 22 of the emergency valve mechanism, the latter including a valve 23 having a screw-threaded stem 24. The valve is continually urged toward its seat by a compression spring 25 and is normally held open by a trigger 26 which is under the control of a speed responsive device driven by the turbine. When the speed of the machine exceeds a predetermined amount, the emergency governor, acting through the rod 27 and connected parts, releases the lock and permits the compression spring 25 to close the valve. For the purpose of opening the valve, a beveled gear 30 is splined on an extension of the valve spindle. This gear meshes with a pinion 32 carried by the upright spindle 33. At the top of the spindle, the handle 34 is provided for rotating the gears. Surrounding the valve stem is a nut 31 which is splined to prevent it from rotating with the valve spindle, and is normally held against longitudinal movement by the emergency trigger 26. The construction of the emergency valve and controlling mechanism therefor is not claimed herein, since it forms the subject matter of a separate application, Serial No. 400345, filed, November 2, 1907. The means for opening and closing the emergency valve are inclosed in a suitable casing, which casing is attached to that of the emergency valve.

The means for actuating the pilot valve of the hydraulic motor will now be described.

Referring to Fig. 1, 35 represents a centrifugal governor of any approved type, that is driven by a vertical shaft 36, Fig. 3, from the main shaft of the turbine through suitable speed reducing gearing. Mounted on the low speed shaft 36 is a sliding collar 37, or equivalent device, which is connected to the governor weights by levers 38 and links 39. Pivotally connected to the collar is a horizontal governor lever 40, which, for convenience, is made of two parallel members connected by bolts 41 and separated by space blocks 42, shown in dotted lines, Fig. 3. The right hand end of the lever is connected to the piston rod by the pivot 44, the arrangement of parts being such that, when the governor collar moves up or down, the lever moves about the pivot 44 as a fulcrum. Just as soon as the motor piston starts into operation, the fulcrum of the lever shifts from the pivot 44 to the pivot 43 carried by the governor collar 37.

Mounted on the end of the bracket 45, extending laterally from the casing surrounding the low speed shaft, is a valve casing 46 containing a balanced piston relay or pilot valve 47, for controlling the hydraulic motor. The upper end of the valve stem passes through a trunnion block 48, and the latter is connected by the pivots 49 with the horizontal governor lever, so that the motion of the lever is transmitted to the pilot valve. Situated above and below the trunnion block and engaging therewith are collars for transmitting motion from the governor lever to the valve stem. This arrangement forms a part of a follow-up mechanism to restore the pilot valve to its normal position and prevents over-travel of the motor and throttle valve. Without such a device, the governing mechanism would tend to hunt, *i. e.*, the motor piston, and consequently, the throttle valve would tend to move too far each time the load changed to supply the exact amount of steam required for any given condition of load.

Mounted on the valve casing 46, and rising vertically therefrom, are two pillars 50 supporting at their upper end a plate 51 forming an abutment for the compression springs 52 and 53. The tension of these springs can be adjusted by changing the vertical position of the plate 51 and the nut on the end of the valve stem and the nuts on the pillars. The object of these springs is to form a cushioning device between the governor lever and the pilot valve. The valve casing is provided with an admission port 54, shown in dotted lines, for high pressure fluid and an exhaust port 55. The heads of the piston valve are arranged to control the passage of fluid leading to the ports 56 and 57, the former communicating with the upper side of the piston and the latter with the under side. The heads of the piston and the seats therefor are so arranged that there is little or no overlap. With the parts in the position shown, the ports 56 and 57 are closed and the piston of the motor is therefore held between two bodies of incompressible fluid, one located above and the other below the piston. Assuming that the piston valve is raised, it will admit high-pressure fluid to the port 56 and to the upper side of the piston; at the same time, the port 57 is uncovered and placed in communication with the exhaust 55. In order to fully balance the pilot valve, a passage 58 is provided communicating with a chamber into which the lower end of the valve projects at one end, and with the exhaust 55 at the other.

From time to time, it becomes necessary, for various reasons and particularly for cutting turbines into and out of service when arranged to drive a common load, to vary the speed at which the turbine will run. In order to do this, I provide a means for changing the force opposing the governor weights. In the present embodiment of my invention, this is carried out by the follow-

ing means: Located between the members of the horizontal governor lever is a lever 60 that is connected to the pilot valve stem on the right hand end by the pivots 49. To the left hand end of the lever is pivoted a rod 61. This rod is provided with a shoulder to receive the head 62 at its upper end, and a nut at its lower end, forming a seat for the head 63. Surrounding the rod 61 are two compression springs 64 and 65 acting in opposition to each other. Between these springs is located an adjustable abutment 66 comprising a cylindrical member guided in its vertical movements by the walls of an enlargement in the bracket 45, and provided with a shoulder 67 between the upper and lower springs. The abutment is provided with a lateral extension through which a screw-threaded spindle 68 extends. Rotating the hand wheel on the end of the spindle in one direction or the other increases the tension on one spring and decreases the tension on the other. In this manner either the upper or the lower spring can be arranged to have a greater or less tension. The lever 60 is supported at an intermediate point by a pivot supported by a vertical link 69, so that any movement of the main horizontal lever either up or down from the central position will be opposed by one of the springs.

The action of my improved governing mechanism is as follows: Assuming that the speed of the turbine increases due to a decrease in load or otherwise, the collar 37 will raise the left hand end of the lever 40 about the pivot 44 as a fulcrum, and with it, the pilot valve 47. This opens the port 56 communicating with the top of the cylinder of the hydraulic motor, and the piston therein starts into motion in a downward direction. The pivot 43, Fig. 3, now becomes the fulcrum about which the lever moves, owing to the fact that the pivot 44 on the right hand end of the lever is connected to and moves with the motor piston. Depressing the pivot 44 means that the pivots 49 and the pilot valve will also be depressed, and just as soon as this downward movement suffices to move the pilot valve over the ports 56 and 57, the motor will stop because the piston will be locked by bodies of incompressible fluid, one above and the other below the piston. This means then, that for every position assumed by the motor piston, the throttle valve has a corresponding position, and admits a predetermined amount of steam or other elastic fluid to the turbine. If the speed continues to increase, the collar will again rise, and the same action be repeated, the movement of the motor each time restoring the relay valve to its initial position, where it shuts off the entrance and exhaust of fluid from the motor cylinder. On the other hand when the load increases and the speed falls, the collar 37 moves downward and with it the pivot 43. Pivot 44 then acts as the fulcrum of the lever. This will depress the pilot valve and open the port 57, communicating with the under side of the piston, to the high-pressure fluid and open the port 56 communicating with the upper side of the piston to the exhaust. As soon as the piston starts into motion, the pivots 43 on the governor collar act as the fulcrum for the governor lever, and the pilot valve will be restored to its normal position by the upward movement of the throttle valve and motor piston. When the collar rises, it carries with it the pivot 49. As this pivot moves upwardly, the left hand end of the lever 60 is depressed, and the head 62 moving downwardly compresses the upper spring 64 to a greater or less extent, thus interposing a greater opposition to the governor weights. On the other hand, when the collar moves downwardly, the pivot 49 is depressed and the left hand of the lever 60 moves upwardly and further compresses the lower spring 65, which opposes the action on the centrifugal weights of the governor.

It is important to have a valve which is so arranged that it has a long travel with a gradually increasing opening, and with the seat so arranged that it will not be cut by the steam flowing through it.

In Fig. 4 is shown a type of throttle valve which I have found to be satisfactory in practice. 70 represents the valve casing having an upper conical seat 71 and a lower conical seat 72. Rising from the valve seats are walls 73 which flare outwardly a limited amount, and any cutting which takes place is limited to these surfaces and also to the cylindrical walls or surfaces 74 on the valve 75. In dotted lines is shown the position of the valve when open. The valve is provided with axial passages to balance it and a stem 76.

I have shown my invention as applied only to the admission valves of a turbine, but it is to be understood that it can be applied to the stage valves as well, and I aim to include such a use in the claims.

The invention is shown in connection with a so-called impact machine but it is to be understood that the invention can be used in connection with machines of the reaction type or those operating by impact and reaction. The shaft of the turbine can occupy a horizontal or an upright position, as desired. Changing the position of the shaft would naturally change the location of the various parts of the governing mechanism without however, changing the principle of operation.

The construction described is well adapted for machines differing greatly in size, which is, of course, a decided advantage in

that it greatly reduces the cost of manufacture, and simplifies the apparatus. For a great many sizes the governor, bracket, pilot valve, springs, etc., remain the same, the only difference being in the length of the governor lever. For the larger machines it is preferable to have a greater movement of the motor piston and throttle valve than for the small machine, and as the former are naturally larger in diameter than the latter, and the valves farther from the wheel axis, the increased length of the lever is easily and naturally obtained.

The governor is of the constant energy type so that the collar will be capable of exerting the same, or substantially the same force at every point in its travel. Changing the tensions of the springs 64 and 65 changes the number of revolutions per unit of time but does not change the characteristics of the governor. With the construction shown, a turbine can readily be governed within one-half of one per cent. speed variation due to load changes, and within two per cent. from no load to full load.

By applying the force of the springs 64 and 65 to the governor lever in the manner described, I am enabled to use short and relatively stiff springs, which is an important advantage. The total travel of the pivot 49 is purposely made small so that its movements up and down will not materially change the tension on the adjusting springs. When the governor lever is in the central position and the abutment 66 midway between the fixed abutments, the effect of the springs on the governor lever will be neutral, for one opposes the other.

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 turbines, the combination of a regulating valve, a motor for operating it, a governor controlled collar, a lever pivotally secured to a part of the motor and to the collar and supported thereby, a controller directly connected to and moved by the lever so that movements of the collar move the controller from its normal position and the motor restores it, and a spring means also connected to the lever and controller and subjected to changes in stress each time the controller is moved from its normal position.

2. In a governing mechanism for turbines, the combination of a regulating valve, a motor for operating it, a governor-controlled collar, a lever pivotally secured to a part of the motor at one end and to the collar at the other, a controller for the motor located between the ends of and connected to said lever, a second lever pivotally connected to the first, and a spring connected to the second lever which opposes the action of the governor.

3. In a governing mechanism for turbines, the combination of a low-speed shaft, a governor driven thereby, a collar actuated by the governor, a regulating valve, a hydraulic motor for actuating the valve, a lever pivotally connected to the collar and to a part of the motor and supported thereby, a pilot valve for the motor, a pivotal connection between the motor and pilot valve, and an adjustable yielding means acting on the governor through the lever for changing the speed of the turbine.

4. In a governing mechanism for turbines, the combination of a regulating valve, a speed governor controlling the action of the valve, and a device acting on the governor comprising opposed springs and an adjustable abutment between the springs for changing the effective action of the governor on the valve.

5. In a governing mechanism for turbines, the combination of a regulating valve, a speed governor controlling the action of the valve, a low-speed shaft for driving the governor, a casing for the shaft, a bracket mounted on the casing, springs for adjusting the effective action of the governor on the valve, an abutment mounted in the bracket and guided thereby which is situated between the springs, and a screw-threaded means also carried by the bracket for changing the position of the abutment.

6. In a governing mechanism, the combination of a valve chest having ports leading therefrom, a rod passing therethrough, a valve on one end of the rod, a governor-controlled motor on the other end, and one or more secondary regulating valves for the ports the stems of which pass through the chest and are adapted to receive a means for actuating them.

7. In a governing mechanism, the combination of a valve chest having ports leading therefrom, a slotted rod extending therethrough, a throttle valve connected to one end of the rod and a motor at the other, one or more secondary regulators, the stems of which extend through the slot in the rod, and means for actuating the secondary regulators.

8. In a governing mechanism for turbines, the combination of a turbine casing, a valve chest attached thereto and having outlet ports, a valve seat at the lower end of the chest, a throttle valve arranged to engage therewith, a motor mounted on the chest for actuating the valve, and one or

more secondary regulators for controlling outlet ports of the chest, the axes of the throttle valve and secondary regulators being at right angles to each other.

9. In a governing mechanism for turbines, the combination of a regulating valve, a motor for actuating it, a governor, a controller for the motor, a support on which the controller is mounted, a lever pivotally connected to the governor and also to the controller and motor, a spring means also carried by the support, and a lever which connects the spring means with the pivot that unites the governor and controller.

10. In a governing mechanism for turbines, the combination of a regulating valve, a motor for actuating it, a governor, a controller for the motor, a support on which the controller is mounted, a lever pivotally connected to the governor and also to the controller and motor, a spring means also carried by the support, a lever which connects the spring means with the same pivot that unites the governor lever and controller, a link which supports the second lever, and a means for adjusting the effective action of the spring means.

11. In a governing mechanism for turbines, the combination of a regulating valve, a motor for actuating it, a governor, a controller for the motor, a bracket on which the controller is mounted, a lever pivotally connected to the governor and controller, a movable abutment carried by the bracket, springs on each side of the abutment, a screw for adjusting the abutment between the springs, a second lever which transfers the effects of the springs to the governor, a pivot for the second lever carried by the bracket, and a cushioning device between the first lever and the controller.

12. In a governing mechanism, the combination of a valve casing, ports extending perpendicularly therefrom and supplying fluid-discharging devices, a regulating valve located at one end of the casing, a motor for actuating the valve located at the opposite end, individual valves for controlling the passage of motive fluid through the ports whose stems extend through the casing, a device that connects the motor and regulating valve and extends perpendicularly to the said stems, and a governor for controlling the action of the motor.

13. In a governing mechanism, the combination of a valve casing, ports leading therefrom, a regulating valve located at one end of the casing, a motor located at the opposite end, a slotted connector uniting the valve and motor, individual valves controlling the passage of fluid through the ports, stems for the said individual valves that extend through the slot in the connector, a pilot valve for the motor, a speed governor for actuating the pilot valve, and a means for preventing overtravel of the motor.

In witness whereof, I have hereunto set my hand this 24th day of October, 1906.

WALTER KIESER.

Witnesses:

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LEO C. FOSS.