R. H. RICE.

GOVERNING MECHANISM FOR TURBINES.

APPLICATION FILED DEC. 14, 1906.

957,902. Patented May 17, 1910.

4 SHEETS—SHEET 1.

Fig. 1.

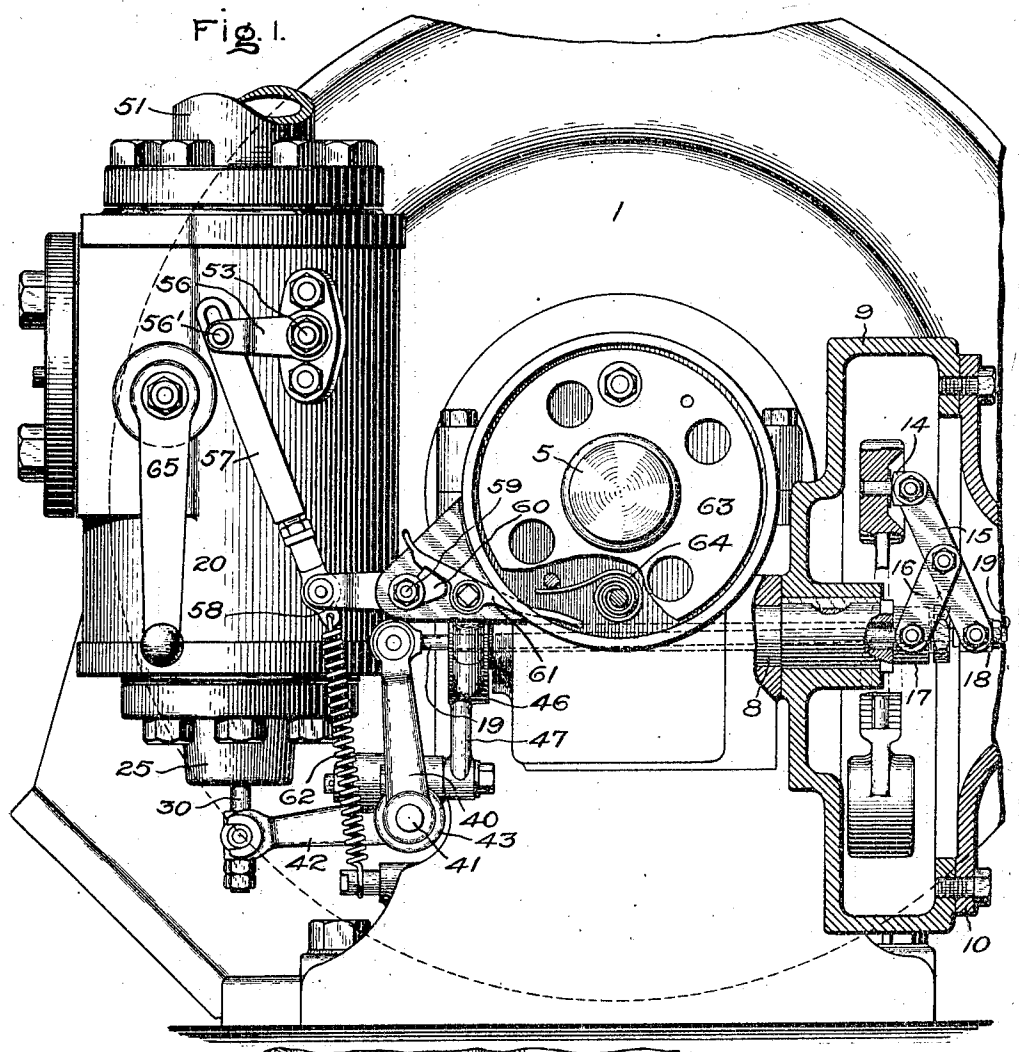
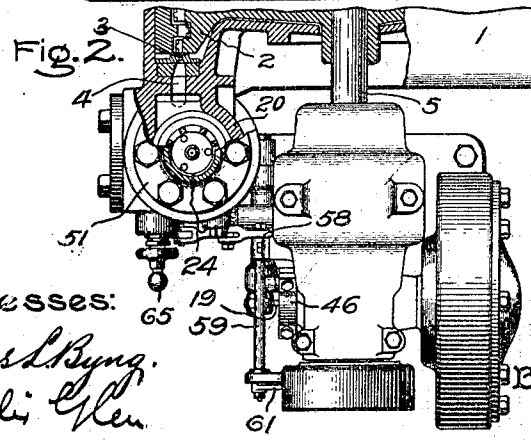


Fig. 2.



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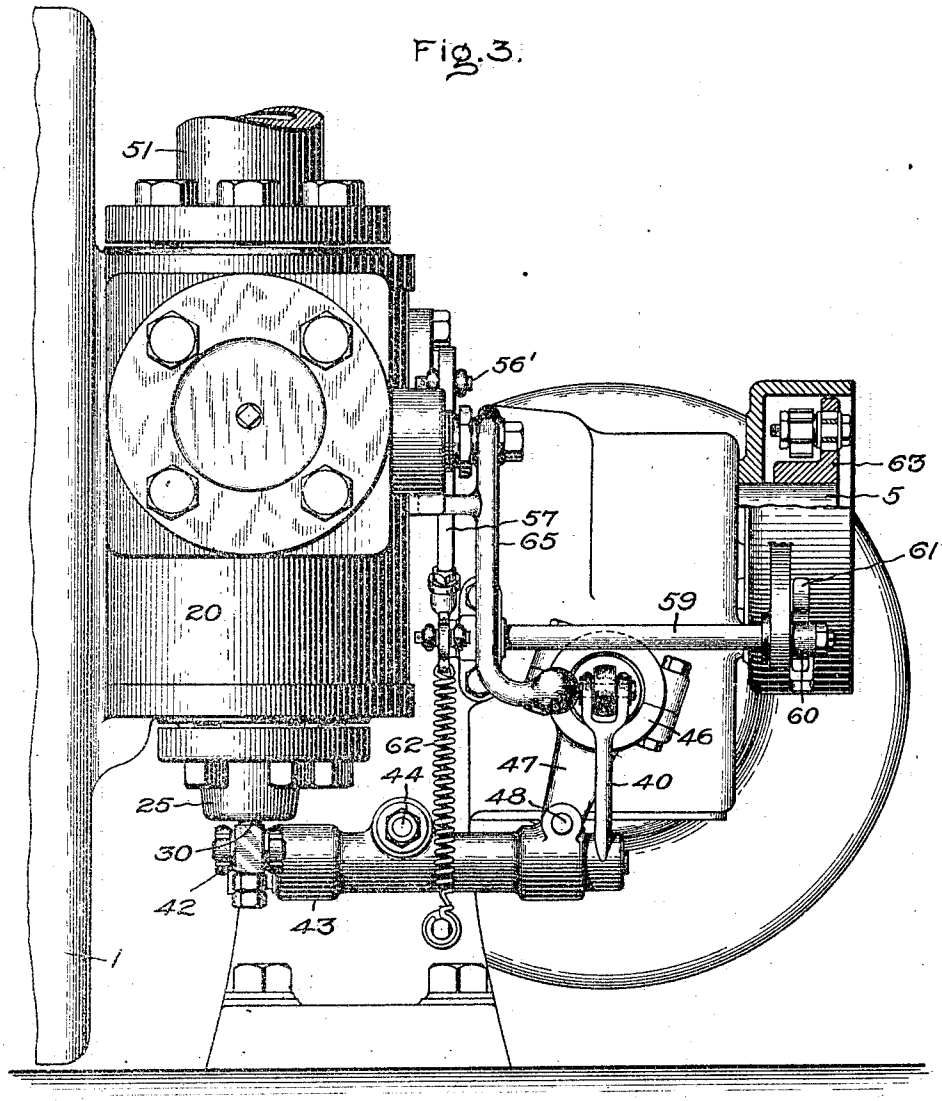
4 SHEETS—SHEET 2.

Fig. 3.



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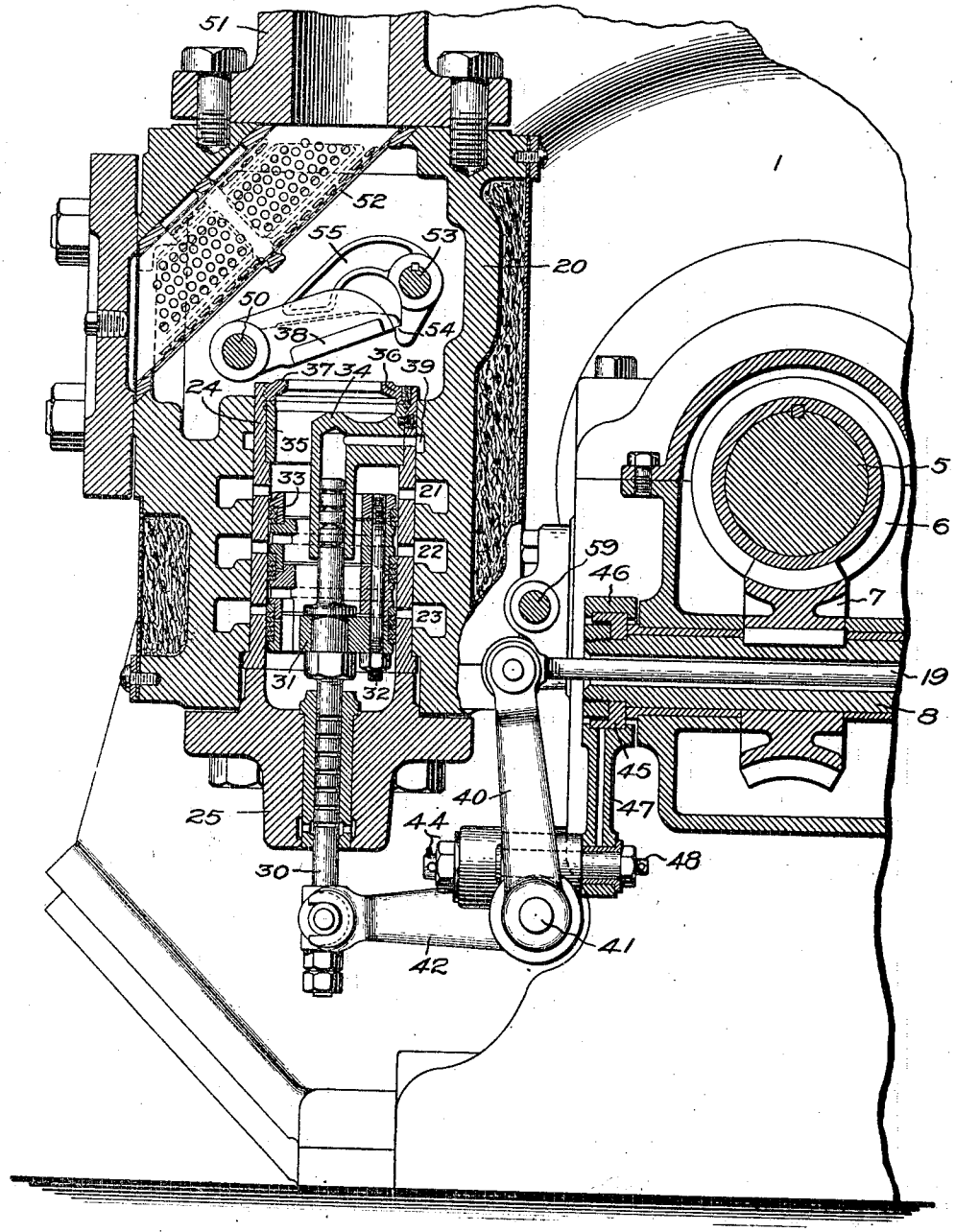
4 SHEETS—SHEET 3.

Fig. 4



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4 SHEETS—SHEET 4.

Fig. 5.

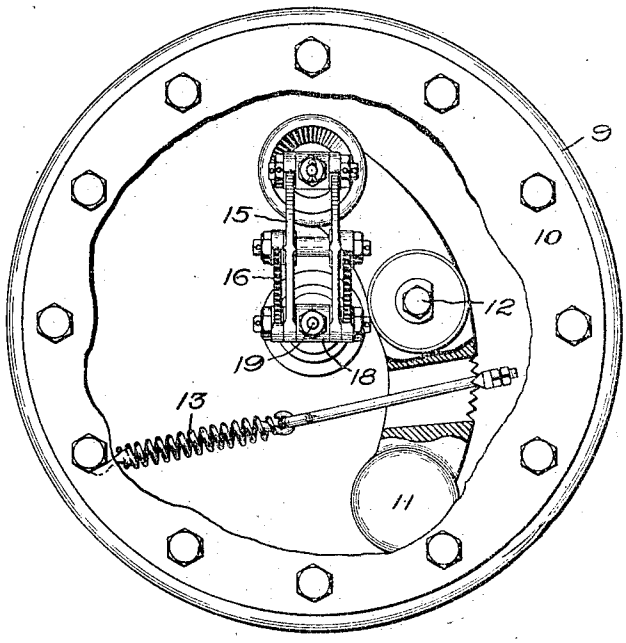
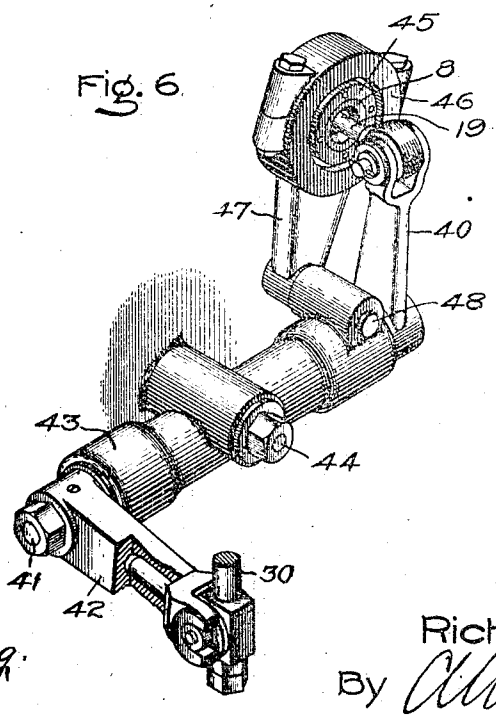


Fig. 6.



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UNITED STATES PATENT OFFICE.

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GOVERNING MECHANISM FOR TURBINES.

957,902. Specification of Letters Patent. Patented May 17, 1910.

Application filed December 14, 1906. Serial No. 347,761.

To all whom it may concern:

Be it known that I, RICHARD H. RICE, a citizen of the United States, residing at Lynn, county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Governing Mechanism for Turbines, of which the following is a specification.

The present invention relates to governing mechanism for steam turbines and more especially to those wherein a piston valve is moved to and fro over a series of ports, each of the latter supplying steam to one, two or more nozzles or nozzle sections.

The object of the invention is to provide a governing mechanism of improved construction which will efficiently regulate the admission of elastic fluid to a motor and at the same time be free from objectionable internal friction.

The scope of my invention will be fully set forth in the specification and the claims appended thereto.

In the accompanying drawings which illustrate one of the embodiments of my invention. Figure 1 is an end view of a turbine; Fig. 2 is a plan view of the same on a reduced scale with certain of the parts broken away; Fig. 3 is a side elevation of the governing mechanism; Fig. 4 is a section through the piston valve that regulates the admission of elastic fluid to the nozzles or other fluid discharging devices; Fig. 5 is a detail view of the speed governor; and Fig. 6 is a perspective view showing a means for vibrating the governing valve to overcome static friction.

1 represents the casing of the turbine having an exhaust conduit and containing a wheel 2, Fig. 2, having one, two or more rows of wheel buckets. Steam or other elastic fluid is admitted to the wheel by nozzles or other discharging devices 3, of which there may be as many as desired. These nozzles may be formed in the same or in different structures. Motive fluid is supplied thereto by means of ports 4 that are under the control of a valve or valves, as will appear more fully hereinafter. The bucket wheel is mounted upon a shaft 5; the latter being provided on its outer end with a worm 6, Fig. 4, meshing with a worm wheel 7 mounted on a transverse low speed hollow shaft 8.

On the right hand end of the low speed shaft is a governor, Fig. 1, comprising a casing 9 having a cover 10 for shielding the internal mechanism. The construction of the governor is best shown in Fig. 5, wherein 11 represents a weight acting by centrifugal force and inertia to move the throttle valve. The weight arm is pivoted at 12 and the outward movement of the weight is in opposition to the extension spring 13. On the end of the arm opposite the weight is a stud 14, Fig. 1, to which is pivoted a lever 15 forming a part of a toggle. To this lever is pivoted a link 16, the opposite end of which is attached to a collar 17 rotating with the low speed or governor shaft 8. The outer end of the lever 15 is attached to a trunnion block 18 containing a cylindrical opening through which the valve actuating rod 19 extends. The block is held in place by nuts screwed on the rod. As the weight arm swings about its pivot 12 the lower or weighted end, Fig. 5, being heavier than the other, will move outwardly and cause the upper end to move inwardly toward the axis of the governor shaft 8. This action causes the outer end of the lever 15 to move the rod 19 longitudinally to the right and raise the valve and decrease the admission of motive fluid to the turbine, as will appear more fully hereinafter. This movement is opposed by the spring 13 which tends to move the piston valve to a position to admit more steam. The mass of metal in the weight-arm is so distributed that its moment of inertia exerts a steadying effect acting to prevent the rapid shifting of the position of the arm to the limit of its movement as the speed changes, while at the same time its angular inertia is more rapid and powerful than the action of centrifugal force at the moment of change in speed. That is to say, upon a sudden change in speed of the bucket wheel due to a change in load, the governor arm tends to rotate at its former speed about its center of gravity subject to the constraint of the pivot for a brief interval and the effect of the mass distribution also prevents hunting or excessive fluctuation in speed and in the amount of motive fluid admitted. Moreover a governor constructed on this plan is much more powerful than one acting only by centrifugal force.

Referring more particularly to Fig. 4 the construction of the governing valve and the

mechanism for connecting it with the speed governor will be more fully described. 20 represents the steam chest, which may be cast integral with the turbine casing or bolted thereto as desired. It is provided with a vertically disposed cylindrical opening containing ports 21, 22 and 23. Located within the cylindrical opening is a finished sleeve 24 containing ports of definite shape and size and registering with those formed in the casing. By means of this construction the valve ports can be accurately formed in a piece that is easy to make, and expensive machining on the valve casing is unnecessary. In the present construction three sets of ports are provided in the sleeve which are so spaced with respect to the valves that they will be uncovered one after the other and covered in a similar way. Each of the ports 21, 22 and 23 is connected to one, two or more sections of a sectionalized nozzle, or to one, two or more independent nozzles or other devices, as best suits the requirements. The underside of the valve chest is provided with a head 25, through which extends the stem 30, the latter having grooves formed therein to reduce the leakage. Mounted on the stem is a balanced piston or support 31 built up of separate parts carrying the valves, which are united by a plurality of axially extending bolts 32. It will thus be seen that each valve has its own support and the supports in turn are united in a manner to form a balanced piston. Between the sections of the valve are rings 33 forming the valve faces which determine the amount of steam passing through the ports in the sleeve 24 to the wheel buckets. As shown, the ports 21 and 22 are fully open, and port 23 is about to open. Steam has access to both ends of the piston and thus balances it. The upper end of the stem extends into a guide 34 and makes a good fit therewith. The guide is carried by a cylindrical member 35 that is seated on a shoulder formed on the inside of the sleeve 24. It is retained in place by a ring-like nut 36 having a seat 37 on its upper surface for the emergency or shut-off valve 38. The opening above the valve stem is connected to the port 39 which is open to the atmosphere. By reason of this construction it will be seen that the piston valve itself is balanced and also the stem by reason of the fact that both ends are exposed to atmospheric pressure.

Motion from the governor is imparted to the regulating valve or valves by means of the horizontal reciprocating rod 19 which is pivotally connected to the upright lever 40. This lever is carried by the rock-shaft 41 also carrying the horizontal lever 42, the latter being connected to the valve stem by a pin-and-slot connection. It will be noted that the levers 40 and 42 are united by the shaft 41 to form a bell-crank. As the speed of the turbine varies, the rod 19 will be moved to and fro and the position of the regulating valve changed to regulate the admission of motive fluid.

In any governing mechanism having a valve which at times is stationary and at other times changes its position by short distances the valve is liable to stick more or less due to the static friction of the parts as well as from other causes and its motion is sometimes resisted by the fluid flowing rapidly through the ports. I obviate this objection by providing a means that keeps the valve or valves in constant vibration, the length of each of said vibrations in the present embodiment being very short. This feature of my invention is carried out in the following manner: the rock-shaft 41 forming a part of the mechanical connection between the governor and valve or valves, instead of being mounted in a fixed bearing is mounted in one that is constantly vibrated and in this manner vibration is imparted to the valve or valves. The construction is best shown in Fig. 6 wherein 40 and 42 represent the levers connected by the rock-shaft 41, the latter being mounted in a bearing 43 which is pivotally supported by the stud 44. In order to vibrate the bearing an eccentric 45 is mounted on the left-hand end of the governor or low-speed shaft 8, the latter making a certain number of revolutions per unit of time, Figs. 4 and 6. Surrounding the eccentric is a strap 46 secured to a rod 47. On the end of the rod is a pin 48 entering a boss on the bearing. It will be observed that the axis of the rock-shaft and that of the bearing support are at right angles to each other, and also that the rock-shaft is free to move as the load changes while the bearing 43 is constantly vibrated by the rotation of the eccentric. The governor will therefore set the piston with its valves in different positions for different loads, and the eccentric will vibrate the valves in whatever position they occupy. To state the matter in other words, the eccentric imparts vibratory motion to the piston and other parts and the governor changes the region in which this action takes place. The length of the vibrations may be great or small as desired to meet the governing conditions; the eccentric being constructed to give the desired throw. Obviously the connections between the levers, rods, etc., must be of a suitable nature to permit of this vibratory motion. In the present embodiment of the invention provision is made for this by leaving a suitable space between the governor rod 19 and the bore of the tubular low-speed shaft and by pivotally uniting the right-hand end of said rod, Fig. 1, with the governor.

The mechanism employed to prevent the

turbine from racing will now be described: Mounted on the spindle 50 is an emergency valve 38, (Fig. 4) arranged to engage the seat 37 under certain conditions and prevent the entrance of steam from the supply pipe 51. The front of the valve chest opposite the valve is made removable for the purpose of inspection and repair and also to give access to the removable strainer 52 for the steam. Situated above the valve and keyed to a spindle 53 is a latch for holding the valve open. It comprises a shoulder 54 arranged to engage the end of the valve and a portion 55 which has the double function of assisting to close the valve and reset the latch. When the portion 54 of the latch is withdrawn the same motion causes the portion 55 to strike the top of the valve and start it downward. On the other hand, when the valve is opened by manually rocking the valve spindle 50, the top of the valve will engage the portion 55 of the latch and cause the portion 54 to move under and receive the outer end of the valve when lowered.

Referring now to Figs. 1 and 3, the construction of the emergency valve operating mechanism will be described. The spindle 53 carrying the latch extends through the valve chest, and fixed to the end thereof is a lever 56 having a pin-and-slot connection 56′ with the adjustable link 57. The connection 56′ is such as to cause a hammer blow for insuring the release of the latch and also for closing the valve. The lower end of the link is connected to the lever 58 securely mounted on the rock-shaft 59. On the front end of the shaft is a dog 60 arranged to engage the trigger 61 and hold the lever 58 against the tension of the spring 62. When the trigger is released the spring exerts a sudden downward pull on the link 57, and by reason of the pin and slot connection 56′ imparts a blow to the end of the lever 56, thereby releasing the valve 38 (Fig. 4), as described. The same action also imparts a blow to the valve. The trigger is pivotally mounted on a projection formed on the cylindrical inclosure around the emergency governor 63, the latter comprising a clock-spring 64, the free end of which is arranged to reach out and strike the trigger when the speed exceeds a certain predetermined amount.

For resetting the emergency valve after steam is cut off from the conduit 51, the valve spindle is provided with a handle 65. When the valve is shut this handle stands to the left of the position shown, and it is then swung to the right until the part 55 and spindle 53 raise the end of the lever 56 and with it the link 57 against the action of the spring 62. When raised sufficiently high the trigger 61 engages the dog 60 after which the handle 65 is moved back to the position shown in Fig. 1 and the turbine is again ready for operation.

It will be seen that the piston has a plurality of separate valves mounted one above the other to cut the fluid-discharging devices into and out of service in predetermined order. From this it follows that the eccentric and connected mechanism will positively vibrate not one but all of the valves. It so happens in the present embodiment of the invention that the valves are all mounted on a common support, but in so far as the idea of vibrating them is concerned, they could have independent supports, and unless the claims specify a single support they are not to be construed as so limited.

I have shown my invention in connection with admission valves, but it is to be understood that it can be used in connection with stage valves used to control the passage of steam or other elastic fluid from one stage to another of a multi-stage turbine.

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, a governor for controlling the valve, a lever, means connecting the lever to the governor and to the valve for transmitting motion from said governor to said valve, a pivot for the lever, and a device for oscillating the pivot about an axis at an angle to the axis of said pivot to thereby vibrate the valve and overcome its static friction.

2. In a governing mechanism, the combination of a valve, a governor, a mechanical connection between the governor and the valve for transmitting movements of the former to the latter, said connection including a pivoted member, and a means acting to constantly vibrate the pivot of said member about an axis at an angle to the axis of said pivot independently of the positions assumed by the governor for moving the valve.

3. In a governing mechanism, the combination of a valve, a speed governor for actuating the valve, a connection between the governor and the valve including a lever, a fulcrum for the lever, and means for constantly vibrating the fulcrum about an axis at right angles to the axis of said fulcrum.

4. In a governing mechanism, the combination of a valve, a speed governor for actuating the valve, a connection between the governor and valve including a shaft hav-

ing levers mounted thereon and connected to the valve and governor, and a means for vibrating the shaft about an axis at an angle to the axis of said shaft.

5. In a governing mechanism, the combination of a valve, a governor, a connection between the governor and valve for moving the latter, including a rock-shaft, a movable support for the shaft having its axis at an angle to that of the shaft, and a means for moving the support about its axis.

6. In a governing mechanism, the combination of a valve, a governor, a rock-shaft, levers mounted on the shaft, one of which is connected to the governor and the other to the valve, a bearing for the shaft, a pivot on which the bearing is movable, and a means for vibrating the bearing on its pivot.

7. In a governing mechanism, the combination of a plurality of valves, a governor, a mechanical connection between the governor and the valves which includes a pivoted member for adjusting the valves to meet the load requirements, and a constantly running eccentric for vibrating the pivot of said member about an axis at an angle to the axis of said pivot.

8. In a governing mechanism, the combination of a valve, a governor, a shaft, a lever mounted on the shaft, a connection between the governor and the lever, a connection between the lever and the valve, a bearing in which the shaft is rotatably mounted, a pivotal mounting for the bearing, and means for constantly vibrating the bearing about its pivot.

9. In a governing mechanism, the combination of a plurality of valves arranged to regulate the passage of motive fluid, a low-speed shaft, a governor driven thereby for actuating the valves, means connecting the governor and the valves which includes a rock-shaft and a pivoted bearing for said shaft, and an eccentric also driven by the low-speed shaft for vibrating the said bearing about its pivot to thereby vibrate the rock-shaft and valves.

10. In a governing mechanism, the combination of a plurality of valves arranged to regulate the passage of motive fluid, a support common to the valves, a low-speed shaft, a governor driven thereby, a mechanical connection between the governor and the support, for actuating the valves, said connection including a lever and a fulcrum for said lever, and a device which constantly vibrates said fulcrum about an axis at an angle to the axis of said fulcrum to thereby vibrate said connection and the valves.

11. In a governing mechanism, the combination of a valve, a hollow shaft, a bearing for the shaft, means for rotating the shaft, a governor mounted on one end of the shaft, a second shaft arranged adjacent the opposite end of the first shaft with its axis at right angles to the axis of said first shaft, a lever mounted on the second shaft and connected to the valve, a rod passing through the hollow shaft and having its ends pivotally connected to the lever and the governor, a bearing for the second shaft, a pivotal mounting for said bearing having its axis at right angles to the axis of the second shaft, and an eccentric mounted on the end of the hollow shaft adjacent said second shaft and connected to the bearing for oscillating it about its pivot.

12. In a governing mechanism the combination of a steam chest, a balanced piston valve therein, a rod for the valve one end of which projects outwardly through the wall of the chest, a guide for the other end of the rod located within the chest, means for equalizing the pressure on opposite ends of the rod, a governor, and a connection between the governor and the projecting end of the rod.

In witness whereof, I have hereunto set my hand this eleventh day of December, 1906.

RICHARD H. RICE.

Witnesses:
JOHN A. McMANUS, Jr.,
HENRY O. WESTENDARP.