W. KIESER.

GOVERNING MECHANISM FOR ELASTIC FLUID TURBINES.

APPLICATION FILED APR. 3, 1906.

957,888. Patented May 17, 1910.

3 SHEETS—SHEET 1.

Fig. 1

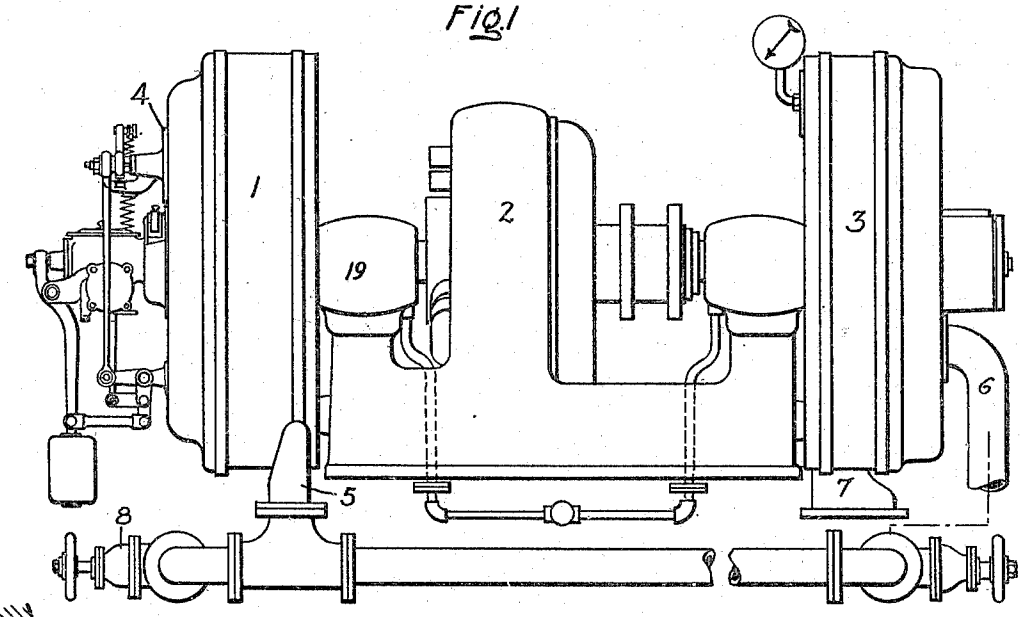


Fig. 3

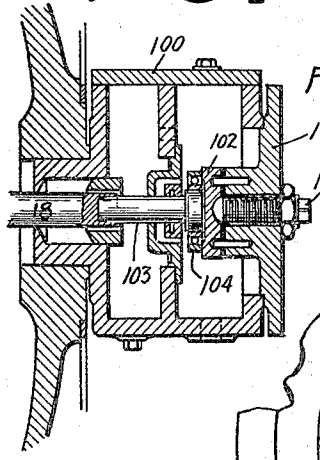
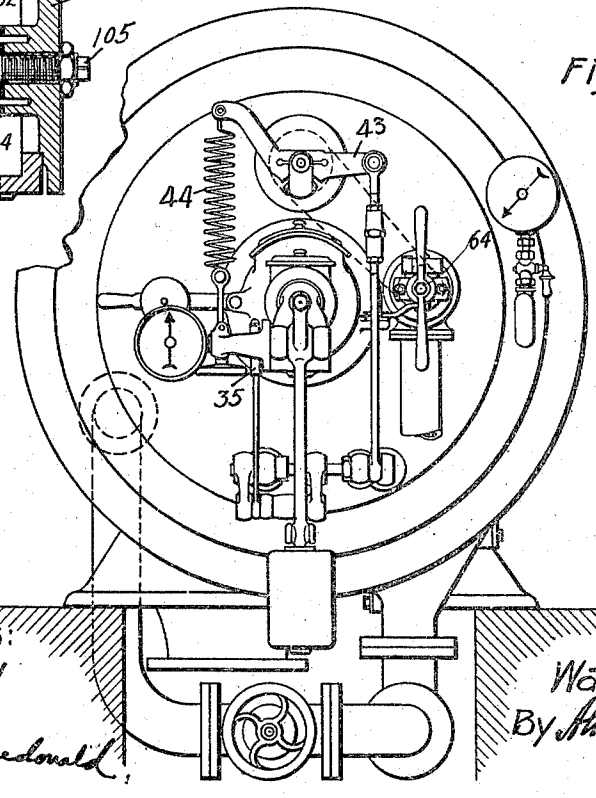


Fig. 2



Witnesses:
Helen Alford
Alex. F. Macdonald

Inventor:
Walter Kieser,
By Albert G. Davis
Atty.

W. KIESER.

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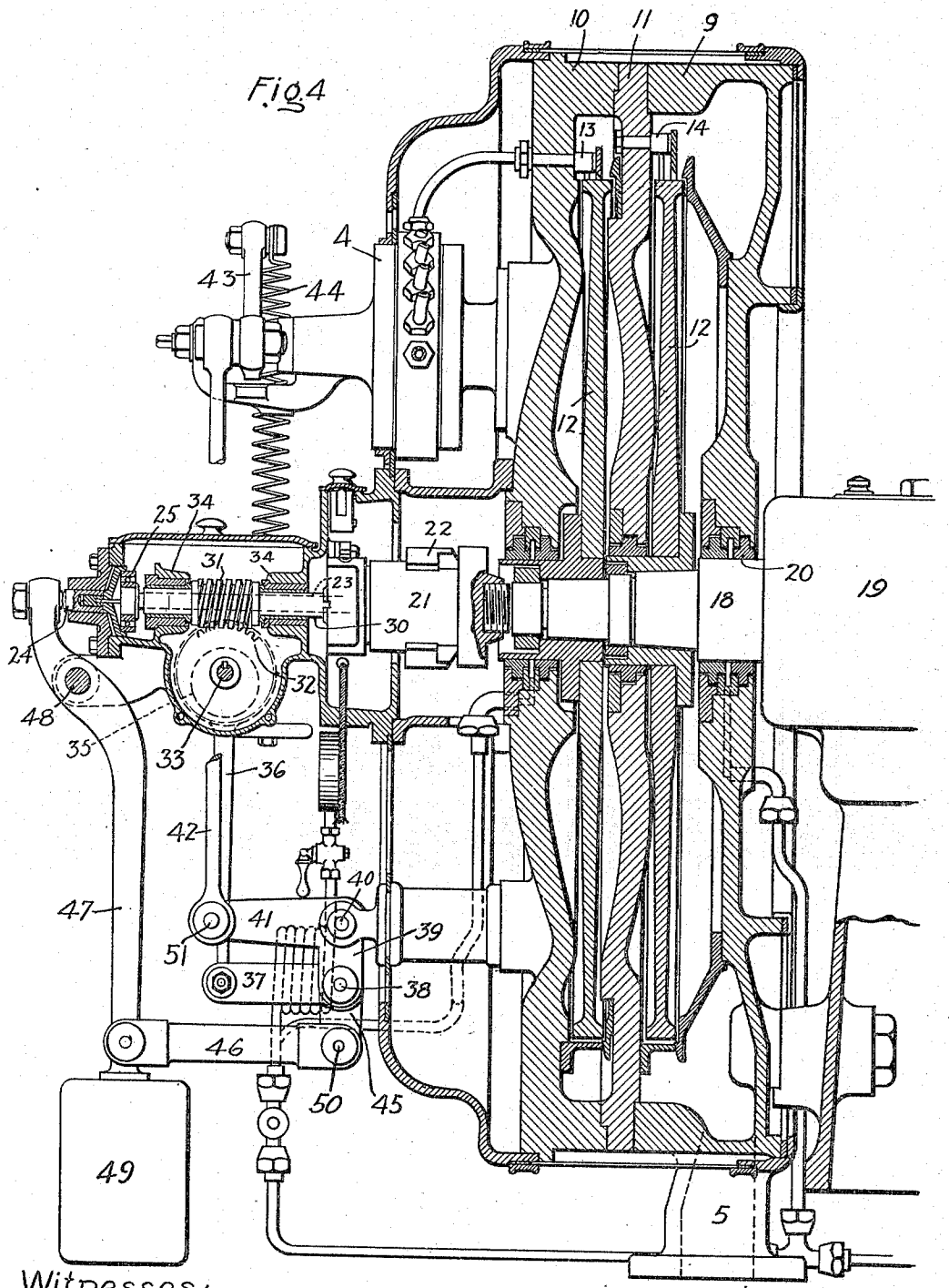
3 SHEETS—SHEET 2.

Fig. 4



Witnesses:
Helen A. Gould
Alex. F. Macdonald.

Inventor:
Walter Kieser,
By Albert G. Davis
Att'y.

W. KIESER.

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3 SHEETS—SHEET 3.

Fig. 5

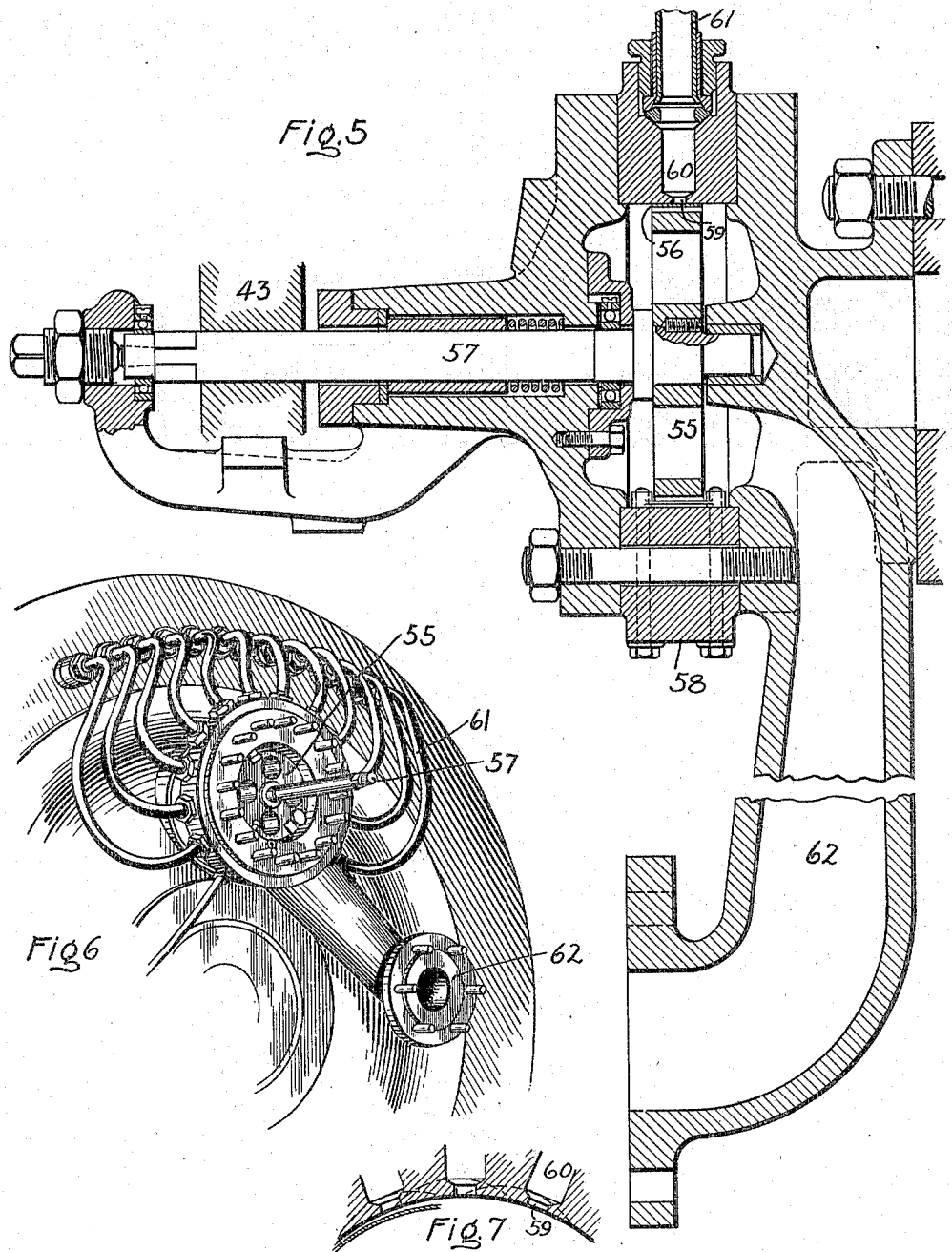

Fig 6

Fig. 7

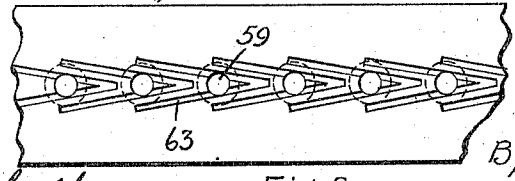

Fig. 8

Witnesses:
Helen Orford
Alex. F. Macdonald.

Inventor:
Walter Kieser,
By Albert G. Davis
Atty.

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.

957,888. Specification of Letters Patent. Patented May 17, 1910.

Application filed April 3, 1906. Serial No. 309,688.

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 mechanism for elastic-fluid turbines, and has for its object to provide a mechanism of improved construction and operation.

In the accompanying drawings illustrating one of the embodiments of the invention, Figure 1 is a side elevation of a four-stage turbine with an electric generator between the parts of the turbines; Fig. 2 is a front end view showing the governing mechanism; Fig. 3 is a sectional view of a thrust bearing for the low-pressure end; Fig. 4 is a longitudinal section of two stages of the turbine on the high-pressure end; Fig. 5 is a sectional view of the band valve controlling the admission of steam to the first-stage nozzles; Fig. 6 is a perspective view of the valve chest and pipes leading therefrom to the nozzles; Fig. 7 is a detail sectional view showing the annular valve seat; and Fig. 8 is a developed view of the valve seat.

1 represents the first two stages of a four-stage turbine, which are located on one side and assist in driving the revolving element of a dynamo-electric machine 2. The last two stages are represented at 3 and a shaft common to the turbines and the dynamo is provided. The casings of the turbine are attached to the frame of the dynamo or generator, as shown more particularly in the lower right-hand corner of Fig. 4. Steam is admitted to a high-pressure stage from the valve chest 4 and is exhausted from the second stage by the conduit 5 which is connected with the admission conduit 6 of the low-pressure stages. Steam is discharged from the last stage by the conduit 7 which can lead to the atmosphere or to a condenser. Valves 8 are provided so that two of the stages can be cut out and the machine operated non-condensing on the first two stages if desired. The arrangement of the high-pressure stages and the low-pressure stages is such that any tendency to thrust on one end is counterbalanced by an equal and opposite thrust on the opposite end.

Referring particularly to Fig. 4, the construction of the turbine will be described. The high-pressure and the low-pressure portions of the turbine are the same in general construction, so that a description of the high-pressure sections will be sufficient. The casing is made in two principal parts 9 and 10 which are separated by a diaphragm 11 in a manner to form two chambers. In each of these chambers is located a bucket wheel 12. These wheels are provided with U-shaped peripheral buckets of the well-known Stumpf construction. Steam or other elastic fluid is discharged to the first wheel by the admission nozzles 13 and by stage nozzles 14 to the second wheel. The steam is discharged from the individual nozzles or nozzle sections, strikes the buckets on the left-hand side and is discharged on the right-hand side. After the steam passes through the first wheel it collects in the surrounding chamber and passes through the stage nozzles 14 from which it is discharged against the buckets on the second-stage wheel. The exhaust from the second stage is carried off by the conduit 5. The bucket wheels are mounted upon a shaft 18 and the latter is carried by bearings 19 mounted on the frame of the dynamo. Between the outer walls of the casing and the shaft and also between the diaphragm and the shaft are packings 20 of suitable construction to which steam or other fluid is admitted by conduits.

In Fig. 3 is shown a thrust bearing for use where the opposed arrangement of the stages is insufficient to fully balance the end thrust, or where it is deemed desirable for any other reason. In the present case it serves to take care of unbalanced thrust and to fix the position of the shaft so that the speed governor can function properly, *i. e.*, move the plunger 24 (to be referred to later) by an amount dependent upon the load. Without this or an equivalent device the valve mechanism would not operate properly. 18 represents the main shaft at the low-pressure end of the turbine, and inclosing it is a casing 100. The right-hand end of the casing is closed by a cover 101 carrying the hardened steel plate 102, the latter being prevented from turning by dowel pins. On the end of the secondary shaft 103 seated

in the main shaft is a head surrounded by rings 104 between which is a row of steel balls, the outer rings being in contact with plate 102. The plate 102 is adjusted axially by means of the adjusting screw 105. If desired, lubricant under pressure may be admitted through a suitable pipe to the space between the cover and the plate 102. The governing mechanism comprises an elastic band valve arranged to cover and uncover nozzles or nozzle sections or ports leading thereto as the load on the turbine changes. One end of the valve is attached to a stationary part and the other to a drum by means of which it is wound and unwound. The drum is mounted on a spindle and the latter is provided with an actuating lever. The valve spindle is connected through a system of levers and connecting rods with an eccentric or other device for imparting a vibratory motion to a portion of the valve, which motion throttles the admission of steam to one or more ports or nozzles.

In order to make provision for changes in load it is necessary to change the number of nozzles or nozzle sections in service. The mechanism above described is insufficient for the purpose, because a given point on the drum would vibrate to and fro between fixed limits. In other words, the region of throttling would be constant. To fulfil the conditions caused by load changes, a speed-responsive device is provided which modifies the action of the eccentric or other device on the valve spindle by changing the region of vibration of the valve, the extent of said vibration remaining the same or substantially the same as before. To state the matter in a different way, the parts may for example be so related for a given load condition, that a point on the valve spindle and drum vibrates three degrees above and three degrees below a neutral point located in a horizontal plane passing through the axis of the valve spindle. Now, assuming a load change which moves the neutral point five degrees from the horizontal, the vibration will take place as before but it will cover three degrees above and three degrees below the new position of the neutral. Further load changes will advance the neutral point from a horizontal plane or cause it to approach said plane as the case may be, the vibration taking place as before but in a different region. By properly proportioning the parts the amount of throttling which takes place for any given vibration can be varied at will. It is to be understood that the vibrating does not affect the entire valve at any one time during normal load conditions because a portion of it is held against the ported wall of the steam chest by the pressure of the steam therein. That is to say, owing to the nature and construction of the valve and its actuator the portion directly coöperating with certain parts is vibrated to produce throttling while the adjacent portion is held against the wall of the steam chest.

Mounted on the end of the shaft is a speed-responsive device for instance of the well known Laval type comprising a cylindrical support 21 and centrifugally acting weights 22 carried thereby and an opposing spring. The motion of these weights is transmitted through the spindle 23, shown in dotted lines, to the plunger 24. Included in this transmission is a ball thrust bearing 25. As the speed of the turbine changes, the plunger 24 moves to and fro to change the adjustment of the weighted lever and other parts, as will appear later. As shown the parts are in the position they normally occupy when stationary.

Mounted on the end of the speed governor is a sleeve 30. On the sleeve is formed a worm 31 which meshes with a worm wheel 32, the latter being mounted upon a low-speed shaft 33 extending at right angles to the axis of the main shaft. The wheel is inclosed by a suitable oil-containing casing that forms a part of the inclosure for the worm. The driving sleeve 30 is supported between suitable bearings 34. On the left-hand end of the low-speed shaft 33, as you face the machine, is an eccentric 35 or other equivalent device which is kept constantly in motion by the worm and worm wheel. Mounted for engagement with the eccentric is an eccentric strap carried by the eccentric or vibrating rod 36. The lower end of the vibrating rod is attached to a horizontally-extending lever 37, the latter having an adjustable pivot 38 which is carried by a lever 39 keyed or otherwise secured to the pivot 40 that is mounted in bearings fixed to turbine casing. Keyed or otherwise secured to said pivot 40 is a horizontally-disposed lever 41 and the latter is connected at its free end by a connecting rod 42 with the right-hand end (Fig. 2) of the lever 43 which actuates the spindle of the elastic band valve. The opposite end of the lever 43 is provided with a spring 44 which tends at all times to wind the valve and open the ports. The spring also serves to counterbalance the weight of the levers, rods, etc., wholly or in large part.

Referring again to Fig. 4, the lower vertically-extending lever 45 is rigidly connected to the horizontally-extending lever 37 to turn about the pivot 38 and the two levers in effect form one bell-crank lever. The same is true of the upper levers 39 and 41. They are made of separate pieces however for convenience. Attached to the lower end of the vertically-disposed lever 45 is a link 46 the outer end of which is attached to the weight-carrying lever 47. The lever is supported near its upper end

by the pivot 48 and is normally pressed toward the governor-actuated plunger 24 by reason of the location of the weight 49 with respect to the pivot. Mounted in the lever in line with the plunger 24 is an adjusting screw whereby the relation of the parts can be adjusted. As the plunger 24 moves to and fro due to changes in speed of the turbine shaft brought about by changes in load, the weight 49 will be swung toward or away from the turbine. As the speed increases, due to a decrease in load, the weight 49 will be moved toward the turbine. This means that the pivot 50 which unites the lever 45 and the rod 46 will be moved to the right. This will also throw the pivot 38 slightly to the right, and the pivot 51 uniting the upper bell-crank lever with the rod 42 will be dropped slightly, and since the upper end of the connecting rod 42 is connected to the valve-operating lever 43 of the valve spindle, Fig. 2, it follows that the right-hand end of said lever will be depressed against the action of the spring 44 and unwind the drum (in other words expand the valve) and therefore decrease the amount of steam admitted. In addition to the movements due to the governor, the vibrating rod 36 is continually moving up and down and with it the lower horizontal lever 37, and since the pivot 50 acts as a fulcrum the up-and-down motion of the vibrating rod 36 will cause the levers 39 and 41 to swing about the pivot 40 and in so doing impart a vibratory motion to the connecting rod 42 which in turn vibrates the lever 43 and causes it to slightly wind and unwind the elastic valve.

Assuming that the plunger 24 retreats, due to an increase in load, it will be followed by the adjusting screw on the upper end of the lever 47, thus permitting the lower end of the lever and the weight 49 to move to the left, resulting in a new position for the pivot 50 at the left of the one previously referred to. This means that the pivot 38 will occupy a new position at the left of the previous one. Since the pivot 50 for a given load condition is fixed by reason of the plunger 24 engaging the upper end of the lever 47 and the weight 49 holding it at the bottom and the pivot 40, being a fixture, it follows that the movements of the vibrating rod 36 and the lower bell-crank lever 37—45 will vibrate the upper bell-crank lever 39—41 and with it the connecting rod 42 and the valve-actuating lever 43. The vibration of the lever will now take place on each side of a new neutral point which is angularly displaced a certain number of degrees in a counter-clockwise direction from the one previously referred to. The drum will by this action wind up the valve slightly and increase the amount of steam admitted. A further increase in load accompanied by a decrease in speed will cause the valve-operating lever 43 to vibrate through a new angular position the center of which is a predetermined number of degrees behind the one previously mentioned. To state the matter in another way, the position of the weight 49 is determined by the speed governor acting through the lever 47. Once this weight assumes its position for a given load it, owing to its abutment, acts as an abutment or stop and thus fixes the position of pivot 50. The latter then becomes the fulcrum for the arm 45 of bell-crank lever 37—45. The result of this will be to rock the arms 39, pivot 40, arm 41 and rod 42 that is connected to the valve.

Referring to Figs. 5 to 8 inclusive, the construction of the valve will be described. 55 represents the drum for winding and unwinding the flexible valve 56. The drum is mounted on a spindle 57 to which the lever 43 is attached. The opposite ends of the spindle are mounted in suitable bearings. The drum is surrounded by a casing comprising a ring 58 having a plurality of ports 59 (Fig. 7) communicating with the passages 60 and through pipes 61 with the nozzles. Steam enters the turbine through the conduit 62 which communicates with the interior of the valve chest. Owing to the drum being provided with axially-extending openings, the pressures on opposite sides are balanced. As the drum winds and unwinds the valve, the latter is caused to cover and uncover the ports 59. On referring to Figs. 7 and 8, it will be noted that these ports have a special construction. Each of the ports is located near the apex or junction of the two branches of a V-shaped groove or slot 63 cut in the face of the valve seat. These grooves taper in depth from both ends toward the ports being deepest at the ports. By reason of this construction a throttling action takes place every time a port is opened or closed, and cutting of the surfaces is avoided. A combined emergency and throttle valve 64 controls the supply of steam through the conduit 62 to the valve chest 4.

The valve mechanism is shown applied only to one admission valve, but it can be duplicated if desired and also be applied equally well to valves for one or more stages. The same mechanism can be used to actuate the admission and stage valve or valves, or a separate mechanism can be provided for the purpose.

The invention is described in connection with a turbine of the jet type, since it has great utility in that connection, but it can be used in connection with other types of machines, for example those of the reaction type, where no nozzles are employed and the motive fluid is admitted through suitable ports to the buckets or vanes. In the em-

bodiment of the invention illustrated the valve spindle rocks about its axis, but the invention is not to be construed as limited to this unless the limitation is specifically stated in the claims, since the spindle may move in a different manner.

The devices for reducing the rotation losses and for restricting the flow of motive fluid toward the shaft, the combined emergency and stop valve, and the construction and arrangement of the nozzles are not claimed herein, because they form the subject matter of divisional applications, Serial No. 400,345 of Nov. 2, 1907, and Serial No. 340,512, of Oct. 25, 1906, filed in compliance with the requirement for division made by the Patent Office under Rules 41 and 42 of Office practice.

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 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 the valve chest having a ported wall, a valve which opens and closes the ports one after another as the demand for motive fluid changes, means for vibrating a portion of the valve over certain of said ports, and a device responsive to load variations for changing the portion of said valve which is vibrated.

2. In a governing mechanism, the combination of a valve-chest having a ported wall, a valve which opens and closes the ports one after another as the demand for motive fluid changes, means for constantly vibrating the valve over a portion of said ported wall in a manner to throttle the passage of motive fluid, a speed responsive device, and means acted upon by the speed responsive device for changing the region of vibration of the valve from one portion of the wall to another so as to coöperate with different ports.

3. In a governing mechanism, the combination of a valve chest having a ported wall, an elastic band valve for controlling the passage of motive fluid through said ports, means for winding and unwinding the valve to open and close the ports including a spindle for the valve which is rotatably mounted, a device connected to the spindle for vibrating said means to move the valve over a portion of the ports, and a speed responsive device for changing the region of vibration of said valve with respect to the ports as the load changes.

4. In a governing mechanism, the combination of a valve chest having a wall that is provided with a plurality of ports of similar function, a valve which is common to and opens and closes the ports one after another as the demand for motive fluid changes, a power-driven means for constantly vibrating a portion of the valve over some of said ports and a device responsive to load conditions for varying the portion of the valve which is vibrated and thereby varying the throttling effect through different ports for different load conditions.

5. In a governing mechanism, the combination of a ported wall, a valve, a spindle for the valve which is rotatably mounted, means for oscillating the spindle about its axis to vibrate the valve with respect to the ports, a driving device for said means, and a speed responsive device for modifying the action of the valve vibrating means.

6. In a governing mechanism, the combination of a wall having a plurality of ports, a valve which opens the ports one after another as the demand for motive fluid increases and closes them one after another as the demand decreases, means for vibrating a portion of the valves over certain of the ports, a speed responsive device, and a weighted lever and connections coöperating with said device for changing the region of vibration of the valve from one section to another.

7. In a governing mechanism, the combination of a wall having a plurality of ports, a valve which opens the ports one after another as the demand for motive fluid increases and closes them one after another as the demand decreases, means for vibrating the valve with respect to certain of said ports at any predetermined time, a weighted lever and connections for changing the region of vibration of the valve from said ports to others, and a speed responsive device controlling the action of the weighted lever.

8. In a governing mechanism, the combination of a wall having a plurality of ports, a valve common thereto which opens and closes the ports one after the other as the demand for motive fluid changes, a source of power, a speed responsive device, a system of levers and connecting rods connected to the source of power for moving the valve, a means tending at all times to move the valve in a direction to open the ports, and a means actuated by the speed responsive device for changing the relative positions of the pivots of said system of levers and rods to vary the region of movement of the valve.

9. In a governing mechanism, the combination of a valve, an actuating spindle therefor which is rotatably mounted, a lever mounted on the spindle, a driving connection which is directly connected to the lever and is constantly in motion for vibrating the spindle, and a speed-responsive device for modifying the movements of the driving

connection so as to change the region of vibration of the valve spindle.

10. In combination, a fluid actuated motor, a chest having a wall with a plurality of ports, a valve which opens and closes the ports one after the other as the demand for motive fluid varies to control the passage of motive fluid therethrough, a spindle for the valve which is rotatably mounted, a low-speed shaft driven by the moving element of the motor, a rod which is constantly vibrated by the shaft, levers and a connecting rod for transmitting motion from the vibrating rod to said spindle to vibrate the valve, means tending at all times to move the valve in a direction to open the ports, and a speed-responsive device driven by the motor for changing the position of certain of the pivots of the lever and connecting rod to change the region of vibration of the valve.

11. In a fluid actuated motor, the combination of a vibrating valve, a speed-responsive device driven by the motor, a lever, a weight which tends to move the lever in a given direction, a connection between the device and the lever for moving it in the opposite direction, a driving connection between the movable element of the motor and the valve for vibrating it including pivoted members, and a connecting rod between the weighted lever and the driving connection for varying the position of certain of its pivots to vary the region of vibration of the valve.

12. In a fluid-actuated motor, the combination of a speed-responsive device, a vibrating valve for controlling the passage of motive fluid therethrough, a bell-crank lever having a fixed pivot, a rod connecting one end of the lever with the valve to vibrate it, a second bell-crank lever supported by the first, a rod vibrated by the motor and connected to one end of the second lever, a pivot for the other end of the lever, and a means for transmitting motion from the speed-responsive device to the other end of the second bell-crank lever to vary the position of said pivot and change the region of vibration of the valve.

13. In a governing mechanism, the combination of a valve, a means for vibrating the valve through a path of constant extent, a means changing the region of vibration of the valve without varying the extent of said vibration, and an elastic medium which tends at all times to move the valve in one direction.

14. In a governing mechanism, the combination of an elastic band valve, a means for constantly winding and unwinding the valve by a certain amount, a means independent of the first and responding to speed changes for moving the valve, a spring which tends at all times to move the valve in one direction, and a weight that acts as an abutment and is moved by the means responsive to speed changes.

15. In a governing mechanism, the combination of a plurality of ports, a valve which opens the ports one after the other as the demand for motive fluid increases and closes them one after the other as the demand decreases, a governor for setting the valve in response to load changes, and a means for vibrating the valve at each of its positions.

16. In a governing mechanism, the combination of a plurality of ports, a valve which opens and closes the ports one after the other as the demand for motive fluid changes, an actuating spindle for the valve, a governor for moving the spindle to and fro in response to load changes, and a means for vibrating the valve each side of a neutral position for each new position assumed by the actuating spindle.

17. In a governing mechanism, the combination of a plurality of similar ports, a valve which opens and closes the ports successively, a spindle for the valve which is rotatably mounted, a source of power, a lever and connections between the source and the valve spindle for vibrating the valve, and a governor which adjusts the region of vibration of the valve and determines the neutral point of its vibration.

18. In a governing mechanism, the combination of a wall having a plurality of ports, a valve controlling the passage of motive fluid through said ports, means for vibrating the valve over the ports comprising two bell crank levers one of which is pivoted at the junction of its arms to the end of an arm of the other bell-crank lever, and a device connected to one of the levers for imparting a constant movement thereto, a speed responsive device, and means connecting said device with the bell crank levers to vary the relative position of the fulcrums and thereby change the region of vibration of the valve.

19. In a governing mechanism for turbines, the combination of a valve for controlling the admission of steam to the turbine, a spindle for moving the valve which is rotatably mounted, a lever mounted on the spindle, a rod connected at one end to the lever, a bell crank lever connected to the other end of the rod, means for oscillating the valve spindle comprising a bell crank lever pivotally connected at the junction of its arms to the end of one arm of the first mentioned bell crank lever, an eccentric driven by the main shaft of the turbine, a rod connecting the eccentric with one arm of the second bell crank lever, a link pivoted at one end to the other arm of said second lever, the pivot acting as a fulcrum for said lever, a lever pivoted to the other

end of the link, a weight for moving the lever and link in one direction, a speed responsive device, and means connecting said device with the weighted lever so that the device can move the fulcrum of said second lever in opposition to the weight to change the region of oscillation of the spindle.

In witness whereof, I have hereunto set my hand this 17th day of March, 1906.

WALTER KIESER.

Witnesses:
JULIUS RUMLAND,
ALFRED WOLF.