No. 858,540. PATENTED JULY 2, 1907.

R. H. RICE.

GOVERNING MECHANISM FOR TURBINES.

APPLICATION FILED NOV. 2, 1906.

5 SHEETS—SHEET 1.

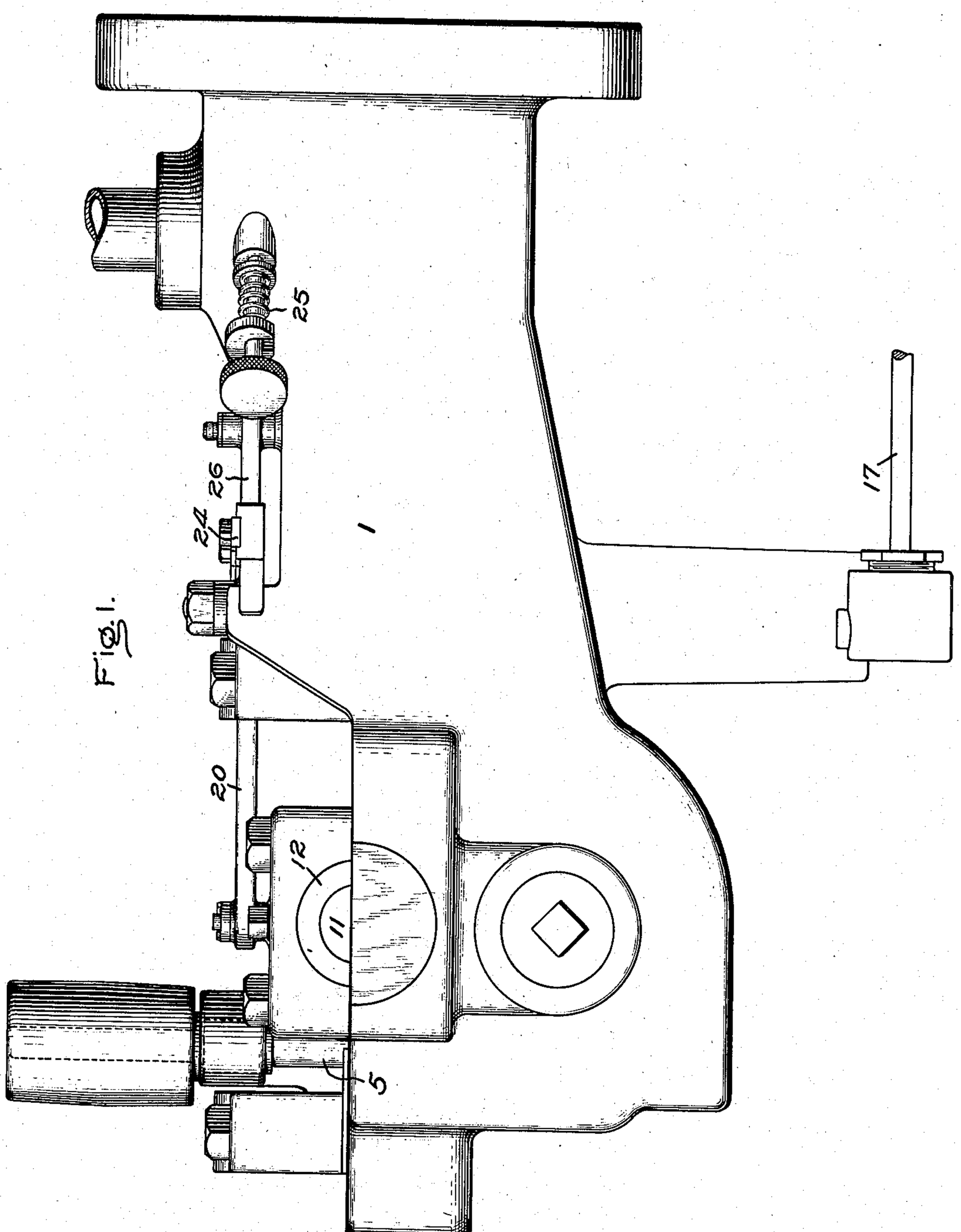


Fig. 1.

Witnesses:
Marcus L. Byng.
George A. Thornton.

Inventor,
Richard H. Rice,
By Albert G. Davis
Att'y.

No. 858,540. PATENTED JULY 2, 1907.

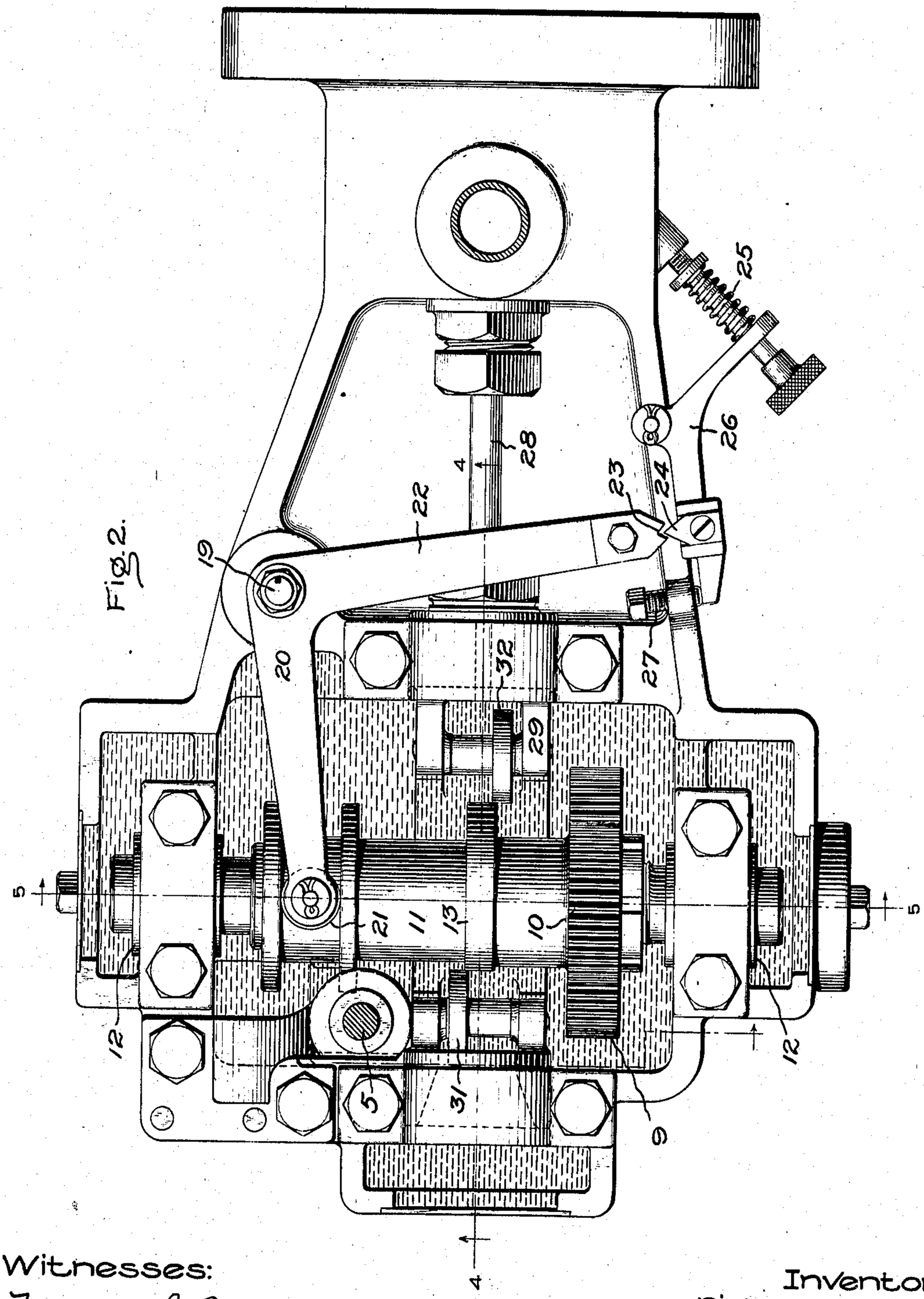
R. H. RICE.

GOVERNING MECHANISM FOR TURBINES.

APPLICATION FILED NOV. 2, 1906.

5 SHEETS—SHEET 2.

Fig. 2.



Witnesses:
Marcus L. Byng.
George F. Thornton.

Inventor,
Richard H. Rice,
By Albert G. Davis
Atty.

No. 858,540. PATENTED JULY 2, 1907.

R. H. RICE.

GOVERNING MECHANISM FOR TURBINES.

APPLICATION FILED NOV. 2, 1906.

5 SHEETS—SHEET 3.

Fig. 3.

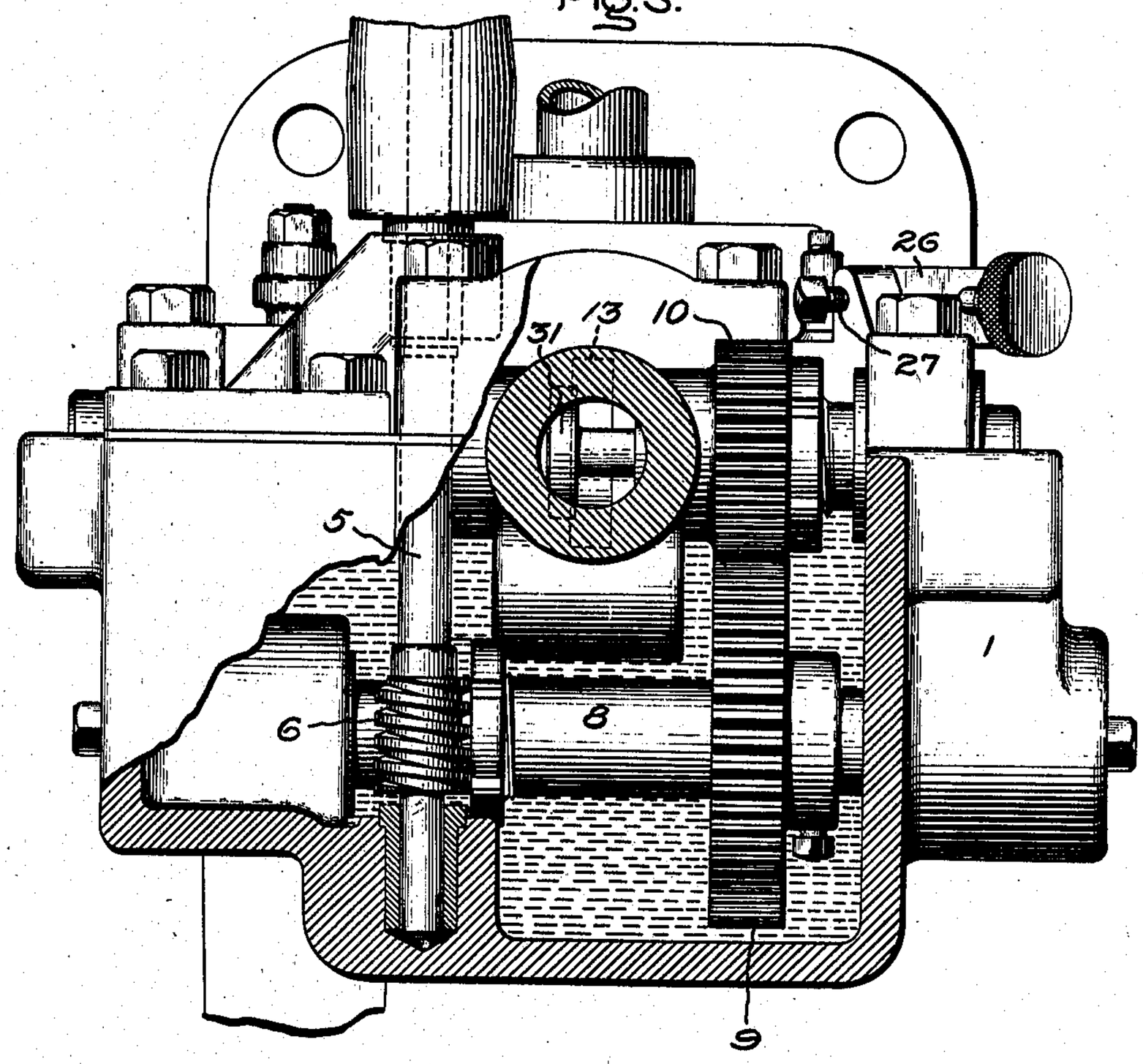
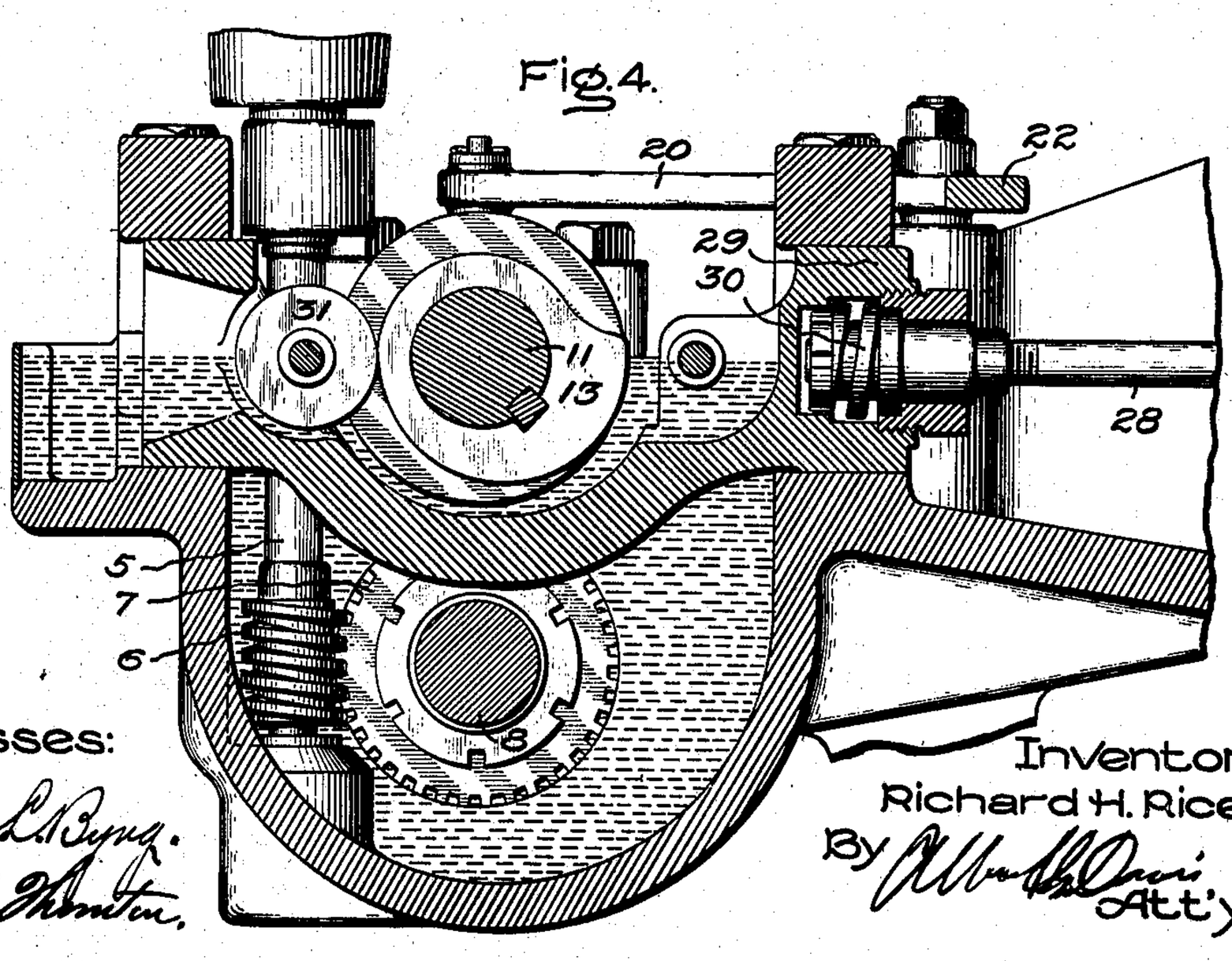


Fig. 4.



Witnesses:

Marcus L. Byng.

George H. Johnston.

Inventor,

Richard H. Rice,

By Albert G. Davis

Att'y.

No. 858,540. PATENTED JULY 2, 1907.

R. H. RICE.

GOVERNING MECHANISM FOR TURBINES.

APPLICATION FILED NOV. 2, 1906.

5 SHEETS—SHEET 4.

Fig. 5.

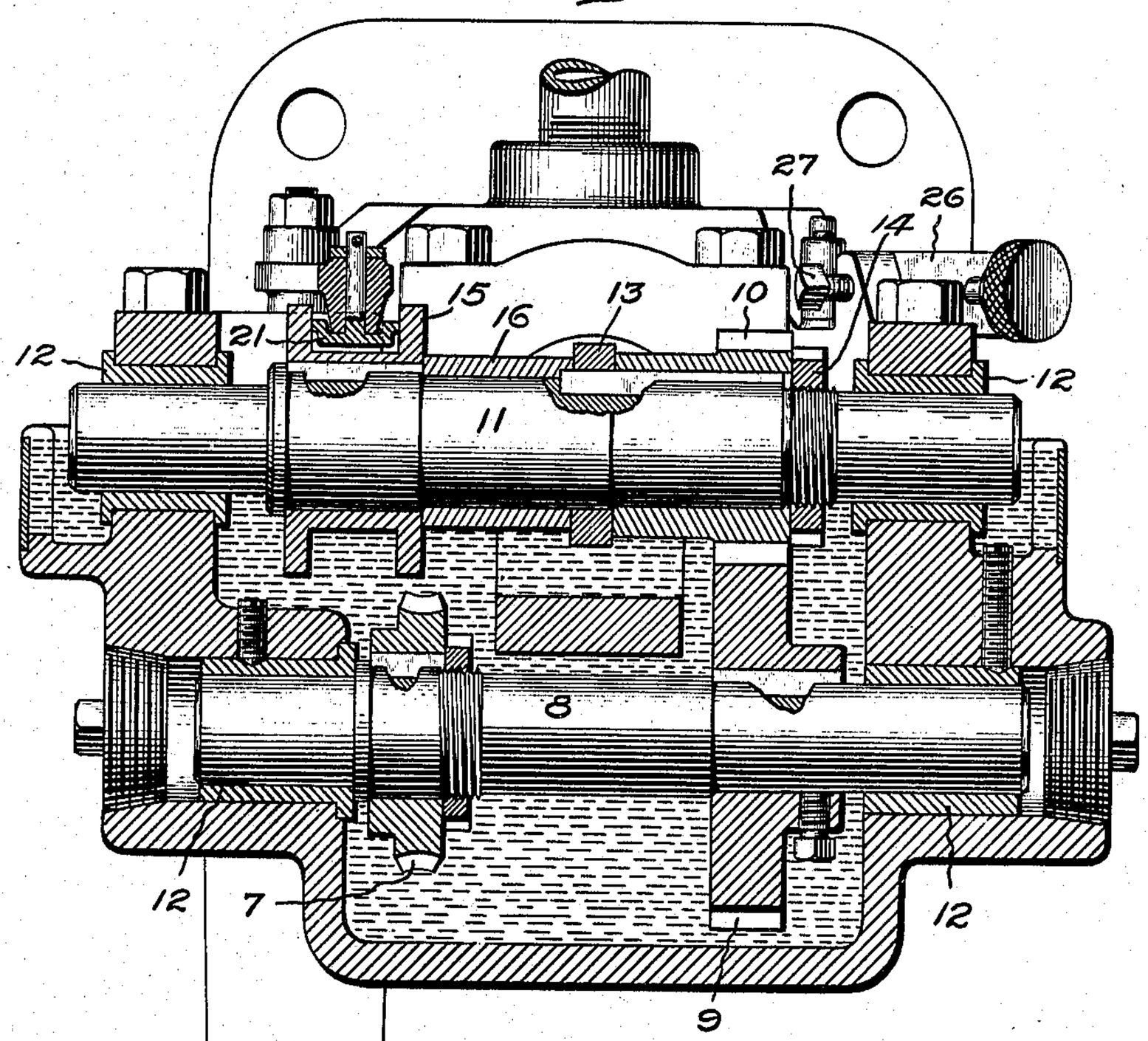
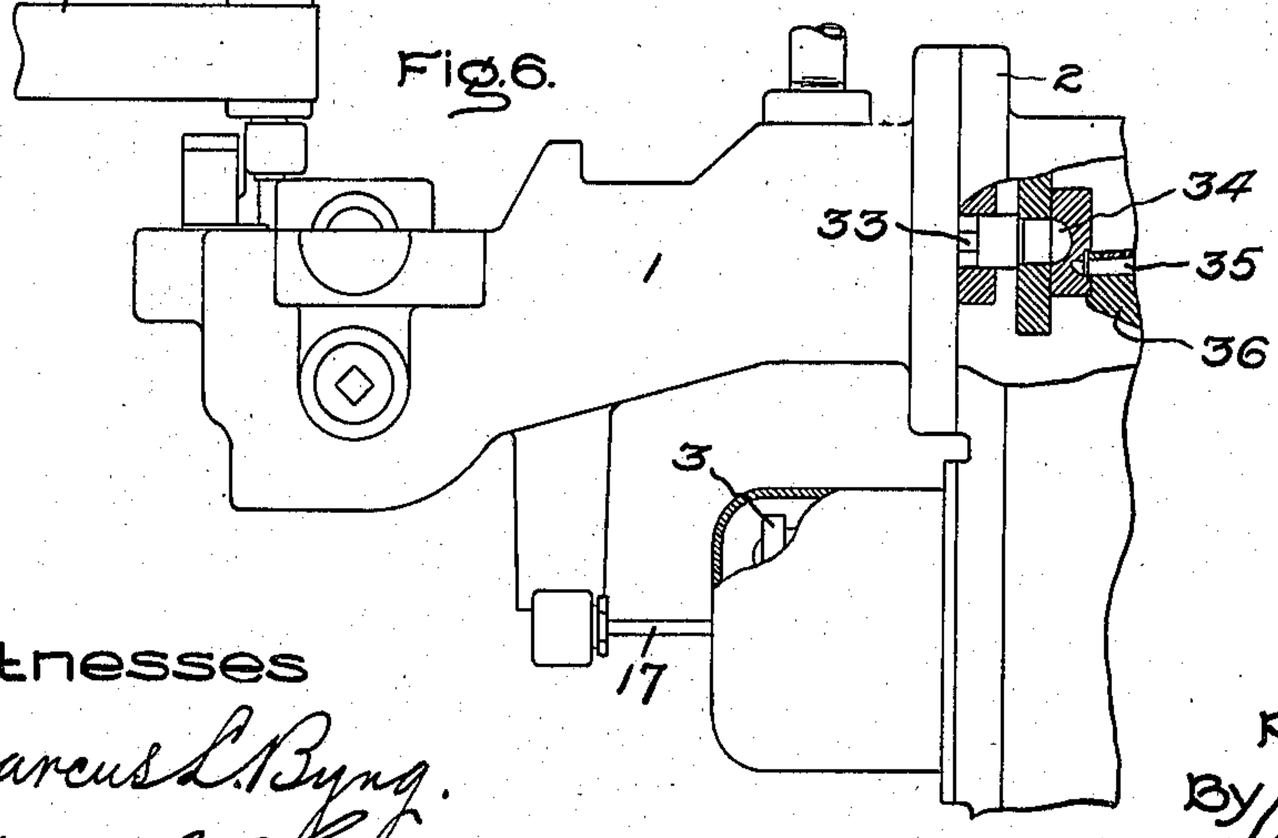


Fig. 6.



Witnesses
Marcus L. Byng.
George A. Thornton

Inventor,
Richard H. Rice,
By Albert G. Davis
Att'y.

No. 858,540. PATENTED JULY 2, 1907.

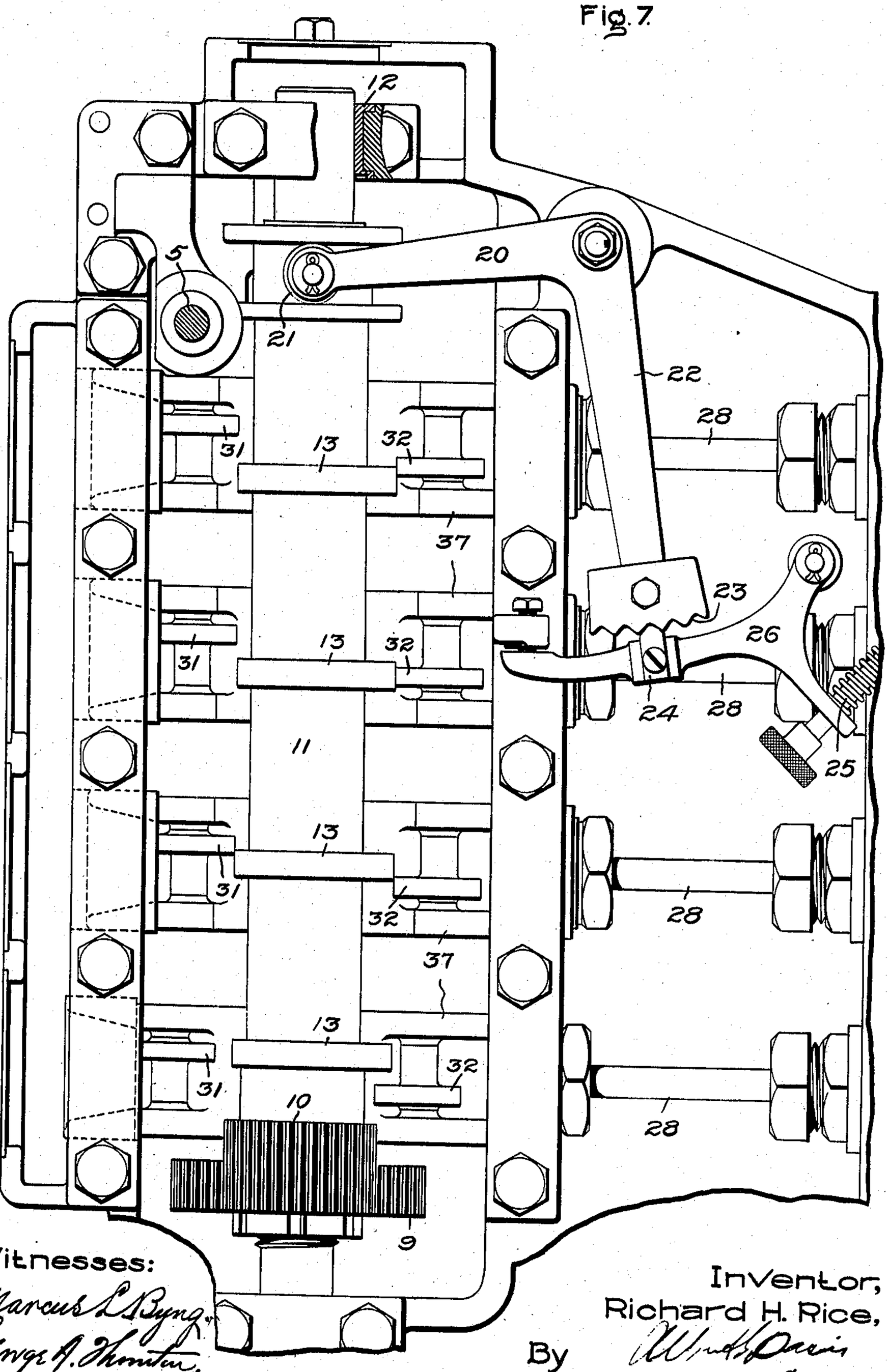
R. H. RICE.

GOVERNING MECHANISM FOR TURBINES.

APPLICATION FILED NOV. 2, 1906.

5 SHEETS—SHEET 5.

Fig. 7.



Witnesses:
Marcus L. Byng.
Geo. A. Hunter.

Inventor,
Richard H. Rice,
By Wm. H. Davis
Att'y.

UNITED STATES PATENT OFFICE.

RICHARD H. RICE, OF SWAMPSCOTT, MASSACHUSETTS, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

GOVERNING MECHANISM FOR TURBINES.

No. 858,540. Specification of Letters Patent. Patented July 2, 1907.

Application filed November 2, 1906. Serial No. 341,673.

To all whom it may concern:

Be it known that I, RICHARD H. RICE, a citizen of the United States, residing at Swampscott, 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 has for its object to provide an improved governing mechanism for turbines which is simple and rugged in construction, efficient in operation, and requires the minimum amount of work of the speed responsive device.

In the accompanying drawings which illustrate certain of the embodiments of my invention, Figure 1 is a side elevation of the valve gear; Fig. 2 is a plan view of the same; Fig. 3 is a front elevation partially broken away; Fig. 4 is a vertical section taken on line 4—4 of Fig. 2; Fig. 5 is an axial section taken on line 5—5 of Fig. 2; Fig. 6 is a diagrammatic view showing the relation between the speed governor and valve mechanism, and Fig. 7 is a plan view of an embodiment of the invention as applied to a turbine having a plurality of regulating valves.

1 represents the casing for the valve actuating mechanism which is bolted or otherwise secured to the turbine casing 2 as shown in Fig. 6. The turbine may be of any approved type, the one shown being an impact turbine, but the invention is not limited thereto. Mounted on the main shaft of the turbine is a speed responsive device 3, Fig. 6, for causing the opening and closing of the valve or valves as will appear hereinafter. The shaft for actually performing the work of opening and closing the valves is driven by the belt 4 or equivalent means from the turbine or separate source of power.

Referring now to Figs. 3 to 6 inclusive, 5 represents the vertically-disposed shaft driven by the belt 4, previously referred to, and carrying a worm 6 at its lower end arranged to mesh with the teeth of the worm wheel 7. This worm wheel is mounted on the secondary horizontal shaft 8, the latter being supported by suitable bearings 12 carried by the casing 1. Mounted on the secondary shaft is a gear wheel 9 meshing with the gear 10 carried by the cam shaft 11. By means of this arrangement the cam shaft is constantly rotated while the turbine is in operation, but at a reduced speed, owing to the interposed gearing. The cam shaft is mounted in suitable bearings 12 carried by the casing and is free to move axially in response to movements of the shaft governor. Surrounding the shaft and keyed to it is a cam 13, of suitable shape to open and close the regulating valve or valves or other regulating device or devices. This cam may be made an integral part of the shaft or it may be made separate as shown, if desired. I prefer to make it separate so that it can be readily removed and a new one substituted in case of wear or damage. The gear 10 is also keyed to the cam shaft and is provided with an elongated hub which engages one side of the cam and acts as an abutment therefor. The gear is held against longitudinal movement on the shaft by a spanner or other nut 14. At the opposite end of the cam shaft is a grooved collar 15 which is seated against a shoulder on the shaft and is prevented from rotating independently thereof by a key. Between the collar and the cam is a spacing ring 16. It will thus be seen that the parts are so arranged that when the nut 14 is screwed up all of the parts on the shaft will be firmly seated. The cam shaft is so mounted in the bearings 12 that it is free to move endwise to shift the cam into or out of engagement with the member for opening the valve and the member for closing it. In order to accomplish this shifting in response to changes in load, the shaft governor 3 acts through the connecting rod 17, Fig. 6, the arm 18, the latter being mounted on the lower end of the vertically extending rock shaft 19, Fig. 2, and lever 20. The lever 20 carries a roller 21 at its outer end which is located in the groove in the collar 15. As the speed governor rocks the shaft 19 to-and-fro, its motion is communicated by the lever 20 to the collar which in turn moves the cam 13 in one direction or the other from the central position shown. With a construction of this kind it is desirable under certain conditions to provide a means for insuring a certain definite or step-by-step movement in an axial direction of the valve operating cam, since otherwise the edges of the cam, or those of the members co-operating with the cam, may be injured. As one embodiment of this feature of the invention, a lever 22, Fig. 2, is provided, which for convenience is made a part of the lever 20 and thus forms a bell crank. On the outer end of the lever 22 is a notch 23, and interlocking with the notch is a spring pressed projection 24. The notch is preferably formed in a removable piece and said piece may be made adjustable if desired and also the piece carrying the projection.

In order for the inclined walls of the notch 23 to move past the projection 24 in either direction it is necessary for the governor to overcome the tension on the spring 25, the latter acting through the lever 26 on the projection 24. An adjusting screw 27 is provided to adjust the position of the projection 24. By means of this construction all danger of the edges of the cam, or members co-operating therewith being injured is prevented. With a construction of this kind it is necessary on the one hand for the speed of the turbine to build up slightly in order for the governor to overcome the resistance offered by the parts 23, 24, 25 and 26. On the other hand when the speed falls, due to an increase of

load, there is a slight lag in the operation of the valve mechanism due to the fact that the governor has to overcome the opposition interposed by the parts 23 and 24. The resistance interposed by the step-by-step retarding device is not sufficient, however, to prevent the governing mechanism from holding the speed of the turbine constant within the prescribed limits of good regulation.

The regulating valve is provided with a stem 28 on the end of which is a cross head 29, and between the cross-head and the end of the valve stem is a coiled compression spring 30, Fig. 4, to prevent injury to the parts in case they are not accurately assembled, and to reduce the shock on the valve due to the opening and closing at the time the cam comes into service.

Mounted on the cross-head and slightly offset, Fig. 2, are two members 31 and 32 comprising rollers, the former being located on the left hand side of the cam shaft and the latter on the right. As shown, the rollers 31 and 32 are both in engagement with the cam 13; this means that for every revolution of the cam shaft, the valve is opened and closed. When the cam 13 is shifted so that it engages only with the roller 32, the valve will be closed and remain so until the cam shaft is moved either to the position shown or to a point where the cam clears the roller 32 and engages only the roller 31. In the latter case the valve will stay open until there is a change in speed. It is to be noted that all of the parts are submerged to a greater or less extent in oil so that the wear thereon is reduced to a minimum.

With the mechanism just described the admission of motive fluid to the turbine may be continuous or substantially so or the valve 33 may be opening and closing every few seconds or it may open and close for every rotation of the cam shaft. This action is dependent upon the load on the turbine relative to the amount of steam admitted when the valve is open and also upon the character of the load; that is whether it is steady or fluctuating.

In the present embodiment of the invention the motive fluid passes through a nozzle 34, Fig. 6, before striking a row of buckets 35 on the wheel 36 but it may pass through any other form of fluid-discharging device.

I have shown a retarding device which has been found to operate satisfactorily in practice but the invention is not to be construed as being limited thereto unless so stated specifically in the claims.

The invention is shown in connection with an admission valve, but it is also applicable for use in connection with valves between stages in a multi-stage turbine of any type where it is desired to regulate the passage of fluid at a point beyond the admission.

The particular construction of the cross-head, rollers, etc., can be varied without departing from my invention. The cross-head is shown as extending under the cam shaft, although it may extend over it if desired. Instead of using rollers other means may be employed to co-operate with the cam to actuate the valve, the principal feature being to provide a means located on one side of the axis of the shaft 11 co-operating with a cam to close the valve, and a second means located on the opposite side of the axis and co-operating with the cam to open the valve. In the present embodiment of the invention, the cam directly operates the valve; but if desired, the valve may be operated by a suitable motor and the mechanism described be employed to control the motor.

In Fig. 7 is shown an embodiment of the invention wherein a plurality of cams 13 are provided and mounted on the longitudinally movable cam shaft 11. Each cam co-operates with a separate cross-head 37 to open or close a valve, as the case may be. The cams 13 are so set with relation to the rollers that they come into play successively, and therefore open or close the valves one after the other. The retarding device in this figure differs from the one previously described in that the number of notches 23 is increased so that the cams 13 will be definitely brought into place one after the other. The lever 26 is provided with only one adjustable projection 24 which enters the notches 23 one after the other and causes the cam shaft 11 to be moved axially step-by-step from any given position. With a construction of this character under normal load conditions, certain of the valves will be open, certain of them closed, and at least one valve opening and closing more or less frequently to handle that fraction of the load which is greater than that satisfied by a certain number of open valves and less than one more than said number. For example, three valves might not supply the necessary amount of fluid and four would supply too much, hence the fourth valve would be opening and closing at more or less frequent intervals. The mechanism is also capable of properly governing the turbine where the load conditions can be satisfied with one valve, as previously described.

The position of the lower cam in Fig. 7 is such that the valve or regulator actuated thereby is in the open position, the next cam above is opening and closing its regulator each rotation of the cam shaft, and the two regulators above are closed because the cams are out of engagement with the rollers on the left hand side of the cam shaft. It is to be noted that the longitudinal movement of the cam shaft is in one direction for successively opening the valves and in the opposite direction for successively closing them. This means, starting from a given position, that a given cam can rotate without engaging either roller; moving the shaft longitudinally from this position will cause a cam to engage a roller and close a valve; continued longitudinal movement in the same direction will cause the cam to disengage the closing roller and engage the opening roller, and further longitudinal movement in the same direction will cause it to be disengaged from said opening roller. In other words, shifting a cam to one side of a given position will cause it to move the regulator in one direction; shifting it further in the same direction will move the regulator in the opposite direction, and still further movement in the same direction will cause the cam to be disengaged from the regulator. I may, and preferably do, so position the parts that a cam is opposite the closing roller of the first regulator in order that the admission of motive fluid may be entirely cut off from the turbine for a greater or less interval depending on the load. As the load increases the action of the parts will be as previously described.

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 plurality of regulators, a rotating actuator for successively moving the regulators to or fro as the load conditions change, a driving means for the actuator, a device for imparting a step-by-step action to the actuator, and a load-responsive mechanism controlling the action of said device to cause successive operation of the regulators.

2. The combination of a regulator with a constantly rotating cam for actuating said regulator, means for transmitting motion from the cam to the regulator, a means for shifting the cam to one side of a given position to move the regulator in one direction and for shifting it further in the same direction to move the regulator in the opposite direction.

3. In a governing mechanism, the combination of a regulator, a constantly rotating cam for actuating said regulator, means for transmitting motion from the cam to the regulator, a means for shifting the cam to one side of a given position to move the regulator in one direction and for shifting it further in the same direction to move the regulator in the opposite direction, and a speed-responsive device for controlling said shifting means.

4. The combination of a regulator, a constantly rotating cam for actuating the regulator, means for transmitting motion from the cam to the regulator, and a means for shifting the cam to one side of a given position to move the regulator in one direction and for shifting it further in the same direction to move the regulator in the opposite direction and for shifting it still further in said direction to release the regulator from the cam.

5. In a governing mechanism, the combination of a valve, a constantly rotating cam for actuating the valve, means for transmitting motion from the cam to the valve, a means for shifting the cam to one side of a given position to move the valve in one direction and for shifting it further in the same direction to move the valve in the opposite direction and for shifting it still further in said direction to release the valve from the cam, and a speed-responsive device controlling said shifting means.

6. The combination of a regulator, a cross-head connected to the regulator having two oppositely disposed offset portions, a rotating cam located between said portions, and a speed-responsive means for shifting said cam to engage either or neither of said portions to open or close said valve or to permit it to remain open or closed.

7. In a governing mechanism, the combination of a plurality of valves, connections spaced apart for moving said valves, a rotating shaft, a plurality of cams on the shaft so spaced apart that they can engage the connections to open or close but one valve at a time, means for shifting the cams longitudinally to actuate the valves in successive order in either direction, and a speed-responsive device to control the shifting means.

8. In a governing mechanism for a turbine, the combination of a valve arranged to regulate the passage of fluid, a cam mounted in suitable bearings for opening and closing the valve, a member attached to the valve and located on one side of and co-operating with the cam for opening the valve, a second member also attached to the valve, and located on the opposite side of and co-operating with the cam for closing the valve, and a means for causing the cam to operatively engage the said members.

9. In a governing mechanism for turbines, the combination of a valve to regulate the passage of fluid, a member attached thereto which is active in opening the valve, a second member also attached to the valve which is active in closing the valve, a means located between the members for actuating them, and a governor for shifting the means axially into proper co-operative relation with said members as the load conditions change.

10. In a governing mechanism for turbines, the combination of a valve for regulating the passage of fluid, a constantly running means which opens or closes the valve as the load conditions demand, a governor, and a means which retards the action of the governor on said means to insure proper co-operation of the parts.

11. In a governing mechanism for a turbine, the combination of a valve arranged to regulate the passage of fluid, a cross-head attached to the valve and provided with a member which is active in opening the valve and a second member which is active in closing the valve, a means located between the said members for actuating them, and a device for shifting said means into proper co-operative relation with said members as the load conditions change.

12. In a governing mechanism for turbines, the combination of a valve to regulate the passage of fluid, a member attached to the valve for opening it, a second member also attached to the valve for closing it, an actuating means situated between the members and so arranged that when in a mid-position it will open the valve on one part of its movement and will close the valve on another part of its stroke, and a governor which shifts the actuating means either side of said position when the load conditions require the valve to be in its open or closed position.

13. In a governing mechanism for turbines, the combination of a regulating valve, a cross-head attached thereto, opening and closing members attached to the cross-head and offset from each other, a rotating actuator situated between said members, a speed governor that shifts the actuator axially and causes it to engage one member and disengage the other to actuate the valve.

14. In a governing mechanism for turbines, the combination of a regulating valve, a member attached to the valve for opening it, a second member attached to the valve for closing it, a cam located between the members for actuating them and the valve, a shaft carrying the cam, a driving connection for the cam carrying shaft which includes a speed-reducing means, and a governor for shifting the cam into and out of engagement with the said members as the load conditions change.

15. In a governing mechanism for turbines, the combination of a plurality of regulating valves, an opening and a closing member for each valve, a cam for operating each valve through its members, a shaft upon which the cams are set progressively so that they will engage the actuating members of the valves successively, and a governor for moving the shaft and cams axially to cause the latter to open and close the valves in succession.

16. In a governing mechanism for turbines, the combination of a plurality of regulating valves, an opening and a closing member for each valve, a cam for operating each valve through its members, a shaft upon which the cams are set progressively so that they will engage the actuating members of the valves successively, a governor for moving the shaft and cams axially to cause the latter to open and close the valves in succession, and a retarding means which causes the governor to move the shaft and the cams in a step-by-step manner.

17. In a governing mechanism for turbines, the combination of a plurality of regulating valves, a constantly moving actuator for moving the valves successively, a governor, and a retarding device for the governor which causes it to shift the actuator step-by-step, the said device comprising relatively movable parts, one of which yields after the pressure thereon reaches a certain amount.

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

RICHARD H. RICE.

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