No. 863,822. PATENTED AUG. 20, 1907.

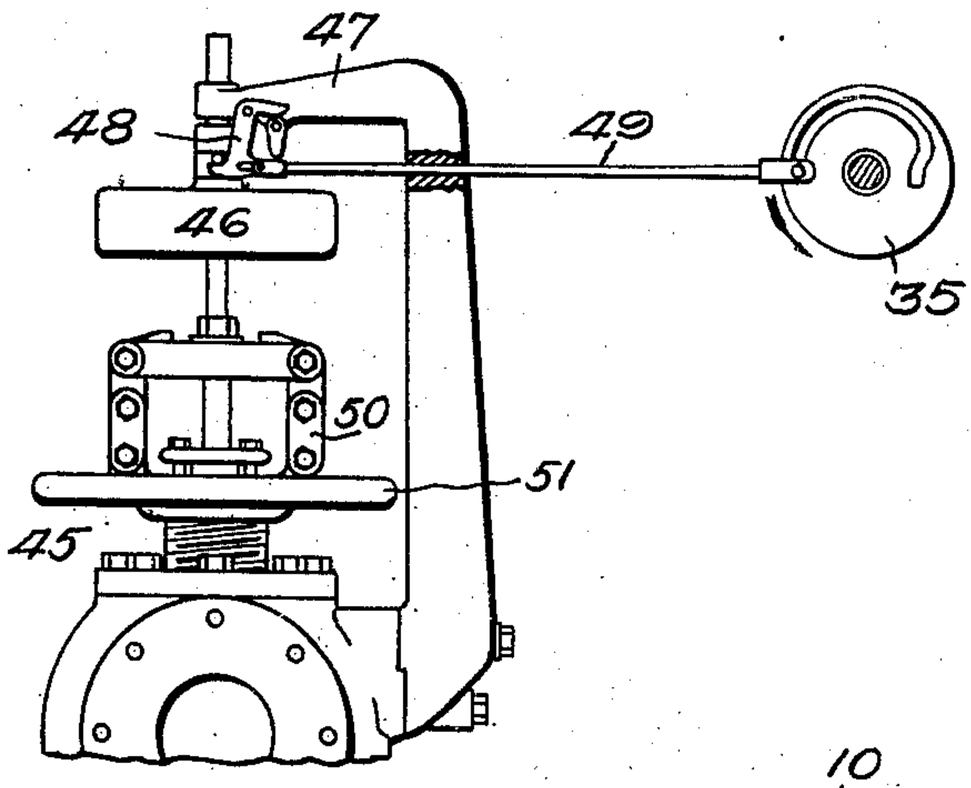
C. H. WORSEY.

GOVERNING MECHANISM.

APPLICATION FILED JAN. 25, 1906.

2 SHEETS—SHEET 1.

Fig. 8.



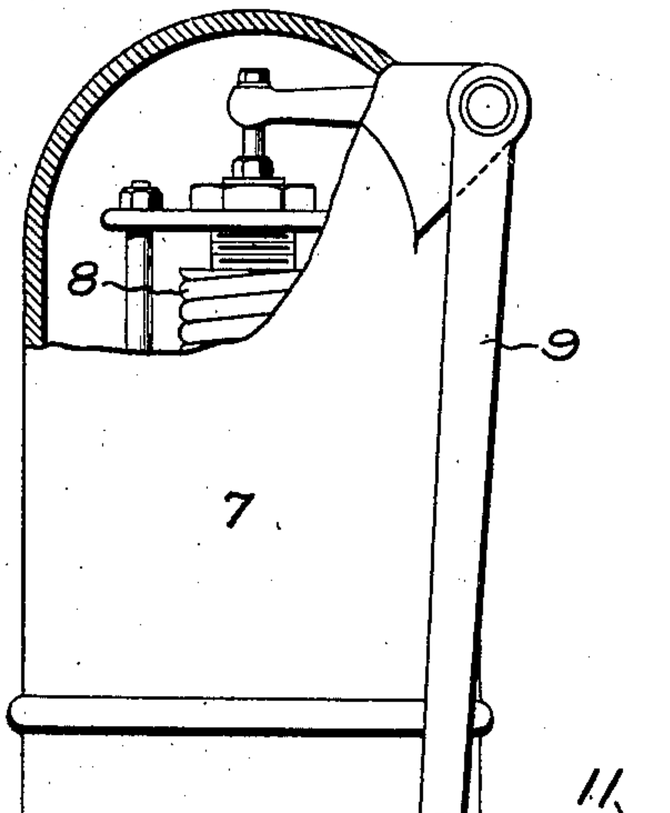


Fig. 1.

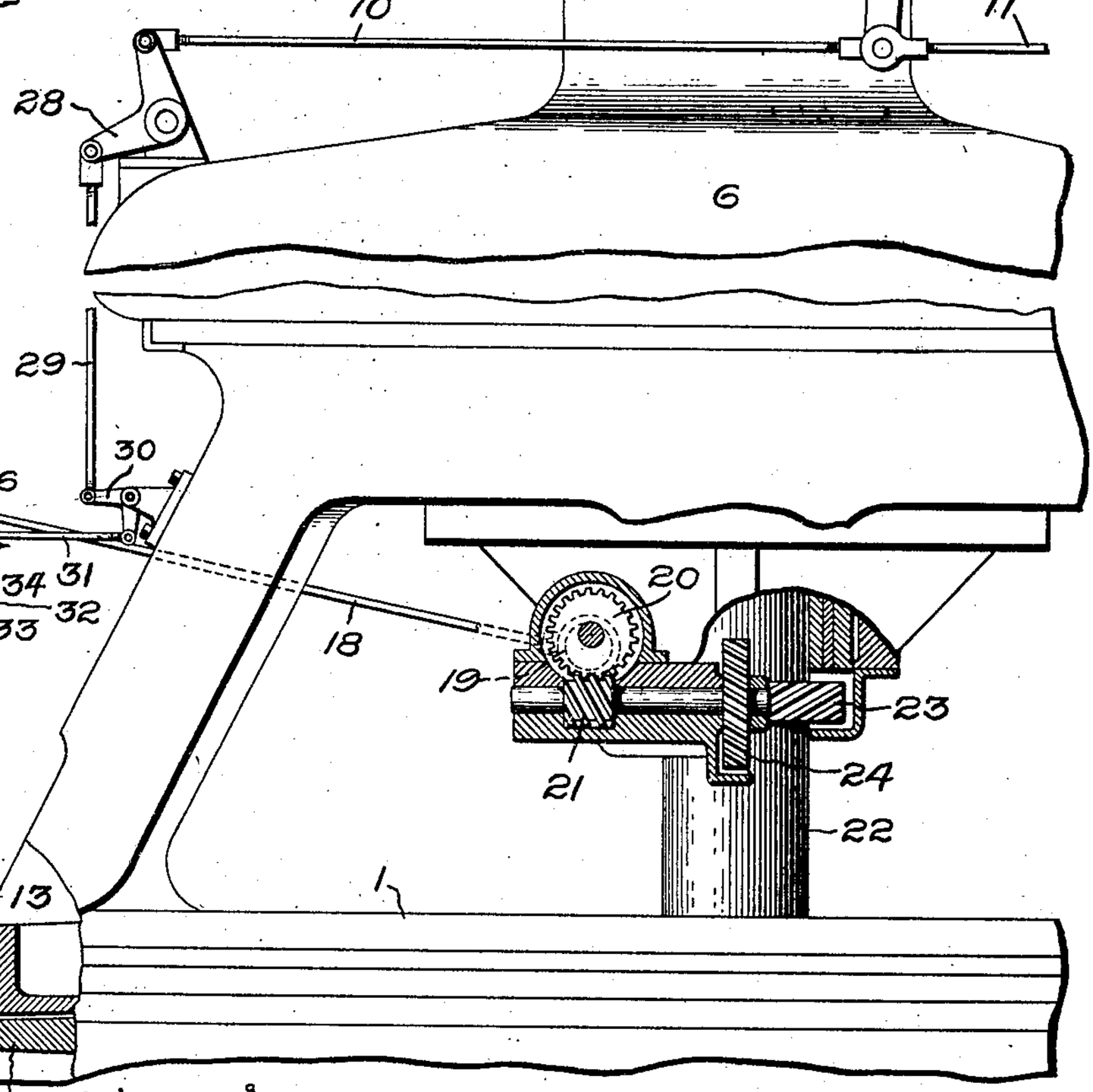
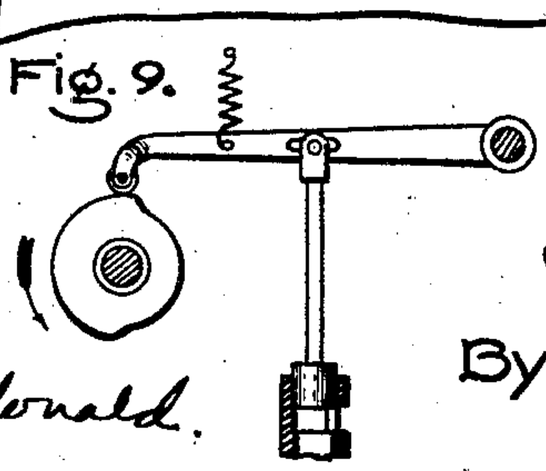


Fig. 9.



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2 SHEETS—SHEET 2.

Fig. 5.

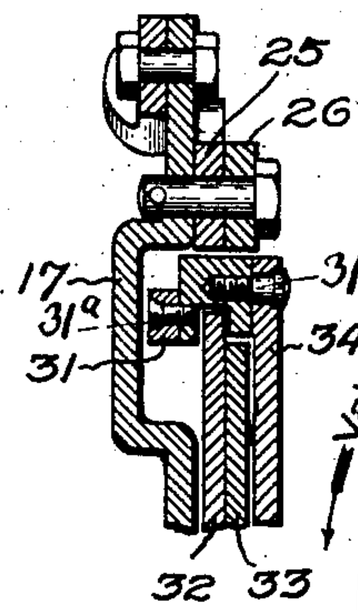


Fig. 2.

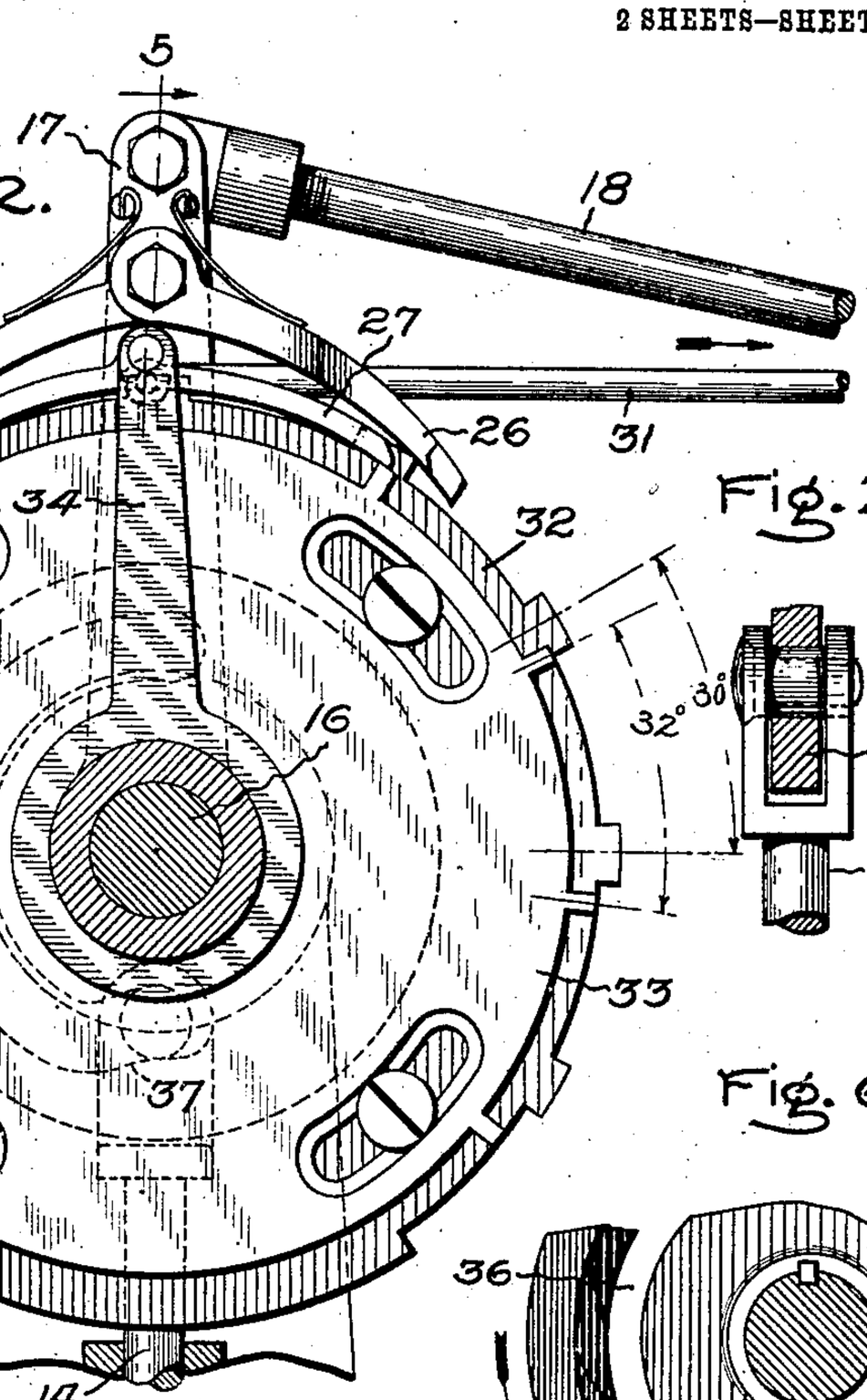


Fig. 7.

Fig. 4.

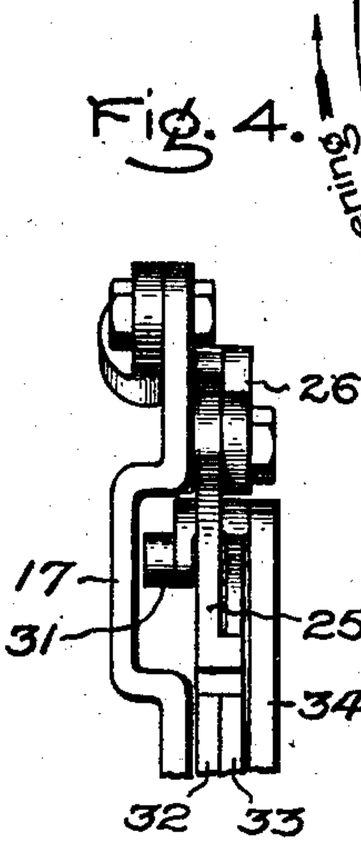
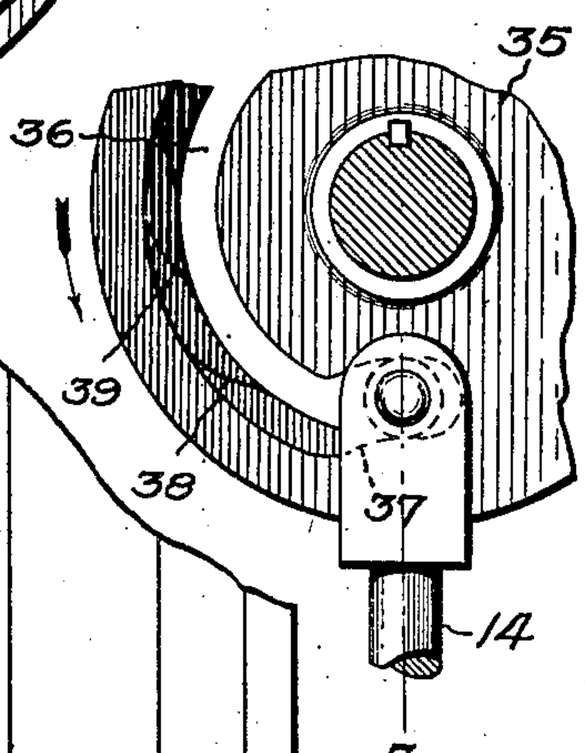
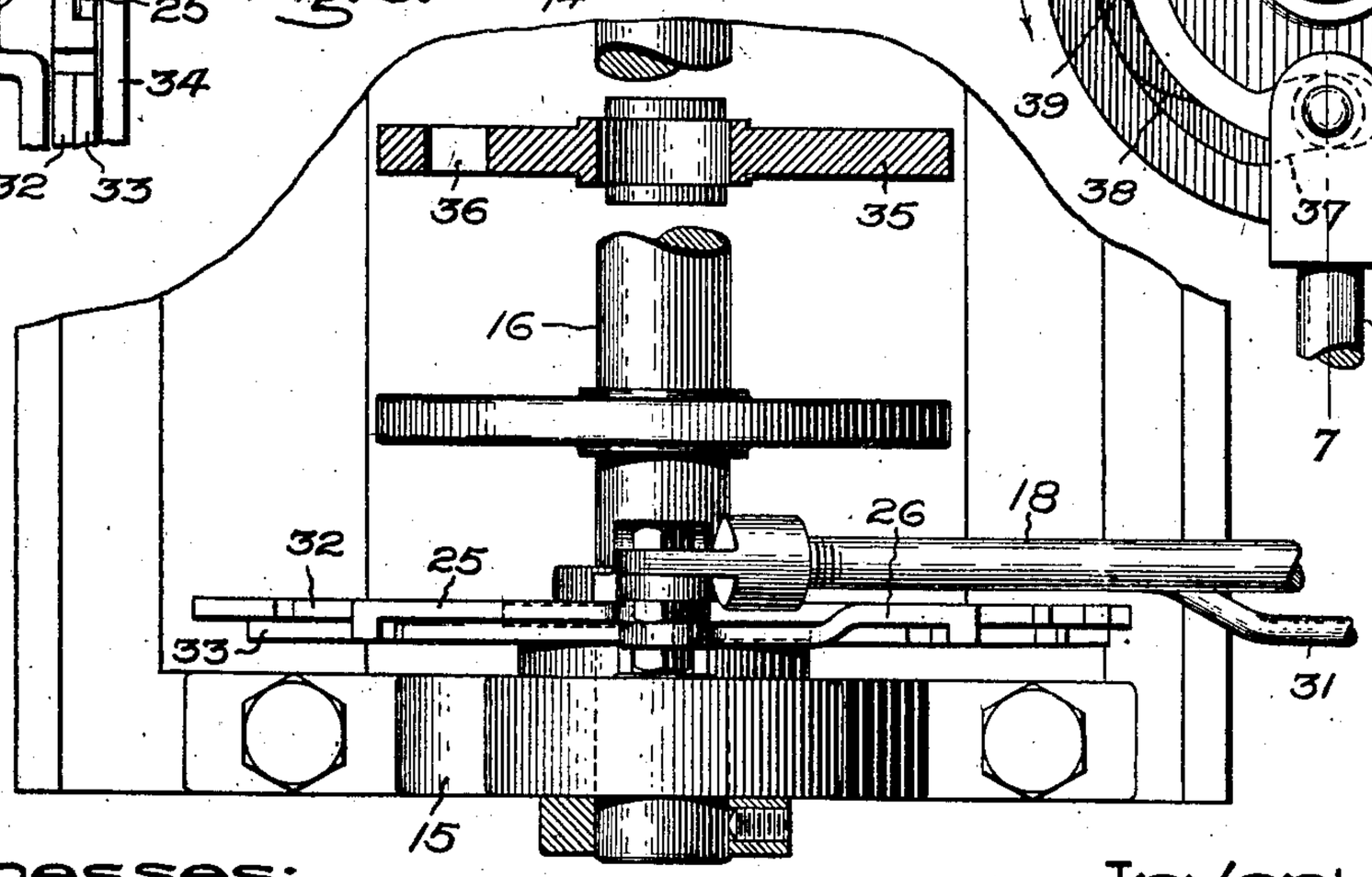


Fig. 3.

Fig. 6.





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UNITED STATES PATENT OFFICE.

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GOVERNING MECHANISM.

No. 863,822. Specification of Letters Patent. Patented Aug. 20, 1907.

Application filed January 25, 1906. Serial No. 297,736.

To all whom it may concern:

Be it known that I, CHARLES H. WORSEY, 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, of which the following is a specification.

The present invention relates to governing mechanism for turbines, and more particularly of the elastic fluid type wherein a plurality of separately or successively actuated valves are employed to control the admission of steam or other elastic fluid, through the nozzles or other discharging devices.

The present invention has for its object to improve the construction of such governing mechanisms, whereby they are rendered mechanically simple, of few parts and occupy only a restricted amount of space.

In the accompanying drawings which illustrate one of the embodiments of my invention, Figure 1 is a partial side elevation of a turbine of the Curtis type, fitted with my improved governing mechanism; Fig. 2 is an enlarged detail view of the means employed to actuate the cam shaft; Fig. 3 is a partial plan view showing the cam shaft and parts affixed thereto; Fig. 4 is a partial view in side elevation of the vibrating lever with the actuating dogs carried thereby; Fig. 5 is a sectional view taken on line 5—5 of Fig. 2, looking in the direction of the arrow; Fig. 6 is a detail view of the cams employed to actuate the nozzle valves; Fig. 7 is a detail view taken on line 7—7 of Fig. 6; Fig. 8 is a detail view showing an emergency or shut-off valve operated by the same mechanism which operates the admission valves; and Fig. 9 is a detail view showing a lever interposed between the cam and its nozzle valve.

1 represents the upper end of a Curtis turbine of the vertical shaft type. The illustration shows a part of a multi-stage machine, but the invention is also applicable to a single stage machine. Mounted within the casing of the turbine is one or more wheels 2, each having one or more rows of peripheral buckets 3. Where two or more rows of wheel buckets are used, a row of intermediate buckets 4 is provided between each two rows of wheel buckets. Situated above the buckets and in line therewith is a nozzle 5 which may be of the expanding or non-expanding type. This nozzle converts the pressure of the motive fluid into a velocity and delivers it to the wheel buckets, the latter abstracting the energy therefrom by successive operation. Instead of using nozzles, fluid discharging devices of any suitable character may be provided. The admission of fluid to these discharging devices is controlled by separately actuated valves. One valve may be arranged to control one nozzle passage or a number greater than one, as desired.

Mounted on top of the turbine is a stool 5, which supports the electric generator 6, the latter being provided with a cover having a dome 7 inclosing the speed-responsive device 8. Pivotally supported by the dome and connected to the movable abutment of the shaft governor is a bell-crank lever 9. The lower end of the lever is connected to the governing mechanism by rods 10 and 11; rod 10 being connected to the valve mechanism on the left-hand side of the machine and rod 11 to the mechanism (not shown) on the right-hand side.

The problem presented in governing mechanisms of this character, stated in general terms, is to govern the turbine by a plurality of separately actuated valves, a part of which are normally open, a part normally closed, and at least one valve opening and closing frequently for regulating purposes. The actuating mechanism for the valve is so arranged that the valves can open and close one after the other in response to changes in position of the shaft governor caused by variations in load.

In carrying out the invention a lever is provided that is constantly vibrated by the mechanism driven by the shaft of the turbine. On the vibrating lever are two pawls or dogs adapted to engage with a toothed wheel, and by a ratchet effect move a cam shaft in one direction or the other, depending upon which dog is in operation, the action of the dogs being controlled by the shaft governor. Each valve is provided with its individual cam and the cams are all mounted on the same shaft. The working surfaces of the cams are so arranged that the valves open one after the other and close in like order.

The specific means for carrying out the invention in the present embodiment is as follows: 12 represents the valve-chest containing a plurality of valves 13, each having a stem 14, the outer end of which is adapted to engage with a cam that will be hereinafter described. Mounted on the valve-chest is a frame 15 in which is supported the cam-carrying shaft 16. Loosely mounted on the shaft is a lever 17, Fig. 2, that is constantly vibrated to and fro by the connecting rod 18. The inner end of the connecting rod is arranged to receive the crank-pin 19 carried on a disk driven by the gear 20, the gear in turn meshing with a pinion 21 mounted on a shaft extended at right-angles to the main shaft 22 of the turbine. On the main turbine shaft is a spiral gear 23 driving a pinion 24, the latter being mounted on the same shaft with the pinion 21. The arrangement of the gearing is such that the number of strokes imparted to the vibrating lever 17 is considerably less than the number of revolutions per minute of the turbine shaft. In practice about one hundred strokes per minute will be found to be satisfactory.

Mounted on the vibrating lever. are independently

acting dogs 25 and 26, the dog 25 being arranged to close the valves one after the other, and dog 26 to open them. These dogs are controlled by a shield-plate 27, and the shield-plate is moved to and fro in accordance with changes in speed of the turbine. Motion is imparted to the shield-plate and its supporting lever 34 by the governor-actuated rod 10, bell-crank lever 28, rod 29, bell-crank lever 30 and rod 31. The mechanism on the other side of the turbine for actuating the shield-plate in the second set of valves is the same except that the relation of the parts is reversed.

Referring to the second sheet of drawings, the detail construction will be described. 16 represents the longitudinally extending cam shaft upon which is rigidly mounted a toothed disk 32. Mounted on this disk and adjustable thereon by means of suitable screws and slots, is a toothed disk 33. The arrangement of the teeth on the two disks is such that the pitch distance between them is greater on the disk 33 than on the disk 32. The object of this arrangement is to insure the return of the shield-plate 27 to a position corresponding to that shown in Fig. 2 after the disk 32 has been rotated step-by-step a certain definite amount in either a clockwise or anti-clockwise direction. In the present arrangement, when the disk 32 is rotated in a clockwise direction, it tends to open the valves one after the other, and when rotated in an anti-clockwise direction, to close them. Two or more valves can be arranged to operate simultaneously, if desired.

Loosely mounted on the shaft 16 in front of the disks is a lever 34 which is free to move to and fro as the rod 31 is moved by the governor. The shield-plate 27 is pivotally secured to the lever 34, and is also pivotally connected to the rod 31 in the manner best shown in Figs. 2 and 5. By setting the pivot 31^a uniting the rod 31 and the shield-plate below the pivot 31^b uniting the shield-plate and lever 34, I provide an arrangement whereby the ends of the shield-plate will be depressed by the governor just as soon as they pass off of the teeth on the disk 33. The object in this is to permit the dogs 25 and 26 to drop freely into operative positions at the proper times. As shown, the shield-plate is of sufficient length to extend from the center of one tooth of the disk 33 to the center of the second tooth beyond on the same disk. The dogs 25 and 26 being loosely mounted on the vibrating lever 17 have a tendency at all times to drop down and engage with the teeth on the disk 32. In the position shown they are prevented from engaging those teeth which are shielded or protected by the shield-plate 27, hence the lever 17 can be vibrated to and fro without changing the position of the disk or the valves.

Mounted on the shaft 16, as shown in Figs. 3 and 6, are cams 35, each provided with a cam slot 36 having a portion concentric with the axis of the shaft and a portion 37 that is non-concentric. Preferably, the latter portion of the cam is so arranged that the opening of the valve will be relatively quick in order to prevent cutting. The active portions of the different cams are successively advanced as shown at 38 and 39, Fig. 6, this figure being so made that one cam after the other is seen through the slot of the first cam.

The action of the mechanism is as follows: Assuming that lever 17 is moving forward and back with a predetermined number of strokes per minute,—so long as the parts occupy the position shown, no change in the number of valves in service will be made, but if the load decreases, the rod 31 will be pulled to the right, as indicated by the arrow, and with it the shield-plate 27 and its support 34. On the next stroke to the right of the vibrating lever 17 the end of the dog 25 will fall in behind the tooth 40 which has been uncovered by the shield-plate, and the next stroke of the lever to the left will cause the dog to move the toothed disk 32 and the disk 33 mounted thereon anti-clockwise. Simultaneously with this action, the shaft 16 is moved and with it a cam 35. The movement of the cam will cause one of the cam faces at the critical point of the regulation to close one of the valves 13 through the stem 14. Assuming that the closing of one valve is sufficient to satisfy the new load conditions, the parts will assume a position corresponding to the one shown in Fig. 2; but if not, either the dog 25 or the dog 26 will engage one of the teeth on the disk 32 and rotate the cam shaft to the right or the left, as the case may be, and increase or decrease the amount of motive fluid supplied to the buckets. If it were not for the shield-plate, the dogs 25 and 26 would either rock the disk and the supporting shaft back and forth for each stroke of the vibrating lever or else one of the dogs would continually ratchet the toothed disk in one direction. It will thus be seen that the shield-plate not only determines which dog shall become active, but also it insures the proper movement of the shaft 16 and the actuating cams.

A device of this character depends for its operation on a change in speed of the turbine shaft. The change in speed from no-load to full-load conditions is small, but since there is a difference, and since it is necessary for the successful operation of the mechanism, it follows that the shield-plate assumes a new position for each change in speed. To compensate for this, the teeth on the disk 33 are spaced apart by an amount somewhat greater than the distance between the teeth on the disk 32. Assuming that the teeth on the disk 32 are spaced 30 degrees apart and that the successive positions of the shield-plate are 2 degrees apart for each predetermined change in speed, then the teeth on the disk 33 will be 30 degrees apart plus the amount of said change, or 32 degrees. With the relation of parts illustrated, the movement of the vibrating lever 17 is 60 degrees or 30 degrees each side of a vertical plane. A certain change in speed of the turbine shaft causes the governor to shift the shield-plate by 2 degrees. This permits one of the dogs to move the disk 32, and with it the disk 33, and since the shield-plate has been moved 2 degrees by the governor, the difference in pitch of the teeth of the two disks will be sufficient to compensate for this change and reset the shield-plate. In other words, the teeth on the disk 33 are set behind those on the disk 32 by an amount sufficient to cause them to move under the ends of the shield-plate and locate it in a position corresponding to that of Fig. 2, where the dogs 25 and 26 are held out of engagement with certain of the teeth, such as 40, for example. If the speed changes again, either up or down, this same action is repeated; the teeth on the disk 33 restoring the shield-plate to

its normal position. I have stated that the teeth on one disk may be 30 degrees apart, and those on the other 32 degrees, but I have used these merely for the purpose of illustration, and the number of degrees may be increased or decreased on one disk or both.

It is desirable to shut down the turbine upon a predetermined increase in speed, say, for example, 10 per cent. In order to do this, I provide a shut-off valve 45 located in the steam pipe leading to the valve-chest. This valve may be operated by hand for normal conditions, and by a weight 46 for emergency conditions. The weight is normally suspended from the arm 47 by hooks 48. To the hooks 48 I attach a rod 49 and the opposite end of this rod is provided with a roller which is located in a cam slot in one of the cams 35. The location of the active part of this cam is such that when the speed exceeds the predetermined maximum, the shaft 16 will have been moved to a point to cause the working surfaces of the cam to pull the rod to the right and withdraw the hooks from under the weight, permitting the latter to fall and collapse the toggle 50 and close the valve. The hammer-blow delivered by the weight at the start is sufficient to collapse the toggles and overcome the static friction and start the valve into motion. The parts may be re-set by lifting the weight and causing the hooks to engage therewith. The hand-wheel 51 is rotated in a direction to move it downward until the toggles are straightened, after which the motion is reversed and the valve is opened. The apparatus is then in condition for service.

From the foregoing it will be seen that the valve mechanism as a whole is very simple in that only one vibrating or steam lever is necessary, which, acting through two dogs and a disk, controls all of the regulating valves and also the emergency or shut-off valve. In the present arrangement four admission valves and one shut-off valve are shown, but the number can be increased or decreased, as desired. It is also possible to operate only a single valve with the construction shown, and I aim to embrace such a use in the claims.

I have described the invention in connection with admission valves only, but it is to be understood that the invention is susceptible of a wider application in that it may be used to operate valves between stages of multi-stage turbines, or it may be employed to operate both admission and stage valves. It may also be used in connection with turbines of other types than the one shown.

I have shown each valve as being actuated by a cam, but it is to be understood that I may use other devices for this purpose. It is also to be understood that these valves may be operated directly, as shown, or indirectly, through levers 41, Fig. 9, or equivalent devices when I desire to multiply the power or motion, or change the relation of the parts.

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 valves controlling the passage of fluid, a cam for each valve, a toothed disk for moving the cams which is common thereto, a constantly vibrating lever, means for transmitting motion from the vibrating lever to the toothed disk, and a device responsive to load conditions for controlling the action of said means.

2. In a governing mechanism, the combination of a plurality of valves controlling the passage of fluid, a cam for opening and closing each of the valves, a toothed disk common to the cams and valves, a shaft common to the disk and cams, a lever mounted on the shaft for rocking it, dogs carried by the lever which are arranged to move the disk in one direction or the other in response to load changes, a lever loosely mounted on the shaft, a shield-plate pivotally supported thereon, a speed-responsive device, and a connection between the speed-responsive device and the shield-plate.

3. In a governing mechanism, the combination of a valve controlling the passage of fluid, a cam for opening and closing the valve, a toothed disk for operating the cam, a vibrating member, dogs carried thereon arranged to engage the disk, a shield-plate moving in response to load changes, and a second toothed disk which coöperates with the shield-plate to control the dogs, the teeth on the disks being of different pitch.

4. In a governing mechanism, the combination of a valve for controlling the passage of fluid, a toothed disk for opening and closing the valve, a member which is constantly vibrating, dogs carried by said member and arranged to engage the teeth on the disk, a pivoted shield-plate responsive to changes in load for controlling the action of the dogs on the toothed disk, a support therefor, and means movable with the disk for re-setting the pivoted plate after the valve is moved.

5. In a governing mechanism, the combination of a valve for controlling the passage of fluid, a toothed disk for opening and closing the valve, a member which is constantly vibrating, oppositely acting dogs carried by the said member, one being arranged to move the disk in one direction step-by-step and the other to move it in the opposite direction step-by-step, a device responsive to speed changes for controlling the action of both dogs, and a toothed means that engages with the device and restores both dogs to a normal position after the valve has been moved.

6. In a governing mechanism, the combination of a valve for controlling the passage of fluid, a toothed disk for opening and closing the valve, a vibrating member, oppositely acting dogs carried by said member and arranged to engage the toothed disk, a shield-plate controlling the action of the dogs which is adapted to be moved a predetermined number of degrees for a predetermined change in speed, and a means provided with teeth that restores the shield-plate to its normal position after the valve is moved, the teeth on said means being separated by a greater angular distance than the teeth on the disk to compensate for the movement of the shield-plate due to a change in speed.

7. In a governing mechanism, the combination of valves arranged to control the passage of fluid, a toothed means for opening and closing the valves successively, a vibrating member, oppositely acting dogs carried by the said member and arranged to engage the teeth of the said member and move it step-by-step, a pivotally supported shield-plate for controlling the action of the dogs, a shaft governor, and a connection between the shaft governor and the shield-plate which rocks the shield-plate about its pivot.

8. In a governing mechanism, the combination of a plurality of valves controlling the passage of motive fluid, an actuator for each of the valves, a shaft common to the actuators, a toothed disk mounted rigidly on a shaft for moving all of the actuators, a vibrating lever freely moving about the axis of the shaft, dogs carried by the lever which are arranged to engage the teeth on the disk and move it in one direction or the other as the load changes, a second lever also movable about the axis of the shaft, a shield-plate carried by the second lever for controlling the action of the dogs in response to changes in speed, and a means for restoring the shield-plate to its normal position after one or more of the valves have moved.

9. In a governing mechanism, the combination of a valve controlling the passage of motive fluid, a speed responsive device, a vibrating member, means for connecting the vibrating member to the valve under the control of the speed responsive device, a shut-off valve, and a means for releasing the shut-off valve which is actuated by the vibrating member.

10. In a governing mechanism, the combination of a plurality of admission valves, a means for operating each of the valves, a toothed disk common to said means, a vibrating member, dogs carried by the vibrating member adapted to engage with and actuate the disk, a shut-off valve, a device for actuating it, a means controlling said device which is actuated by the toothed disk, and a speed-responsive device which is common to the admission and the shut-off valves.

11. In a governing mechanism, the combination of an admission valve, a toothed disk for opening and closing the valve, a member which has a constant to-and-fro motion for moving the disk, a shield-plate for controlling the action of said member on the disk, a speed-responsive device for controlling the action of the shield-plate, and a second toothed disk which is smaller in diameter than the first for restoring the shield-plate to a neutral position after the valve has been moved in response to a change in speed.

12. In a governing mechanism, the combination of a valve, a device which has a constant to-and-fro movement, dogs carried thereby, a toothed means for opening and closing the valve arranged to be actuated by the dogs, a pivoted shield-plate controlling the dogs, a speed-responsive device, and a connection between the speed-responsive device and the shield-plate that positively tilts the plate on its pivot to permit the dogs to operate.

In witness whereof, I have hereunto set my hand this twenty third day of January, 1906.

CHARLES H. WORSEY.

Witnesses:
JOHN A. MCMANUS, Jr.,
PHILIP F. HARRINGTON.