No. 815,743. PATENTED MAR. 20, 1906.

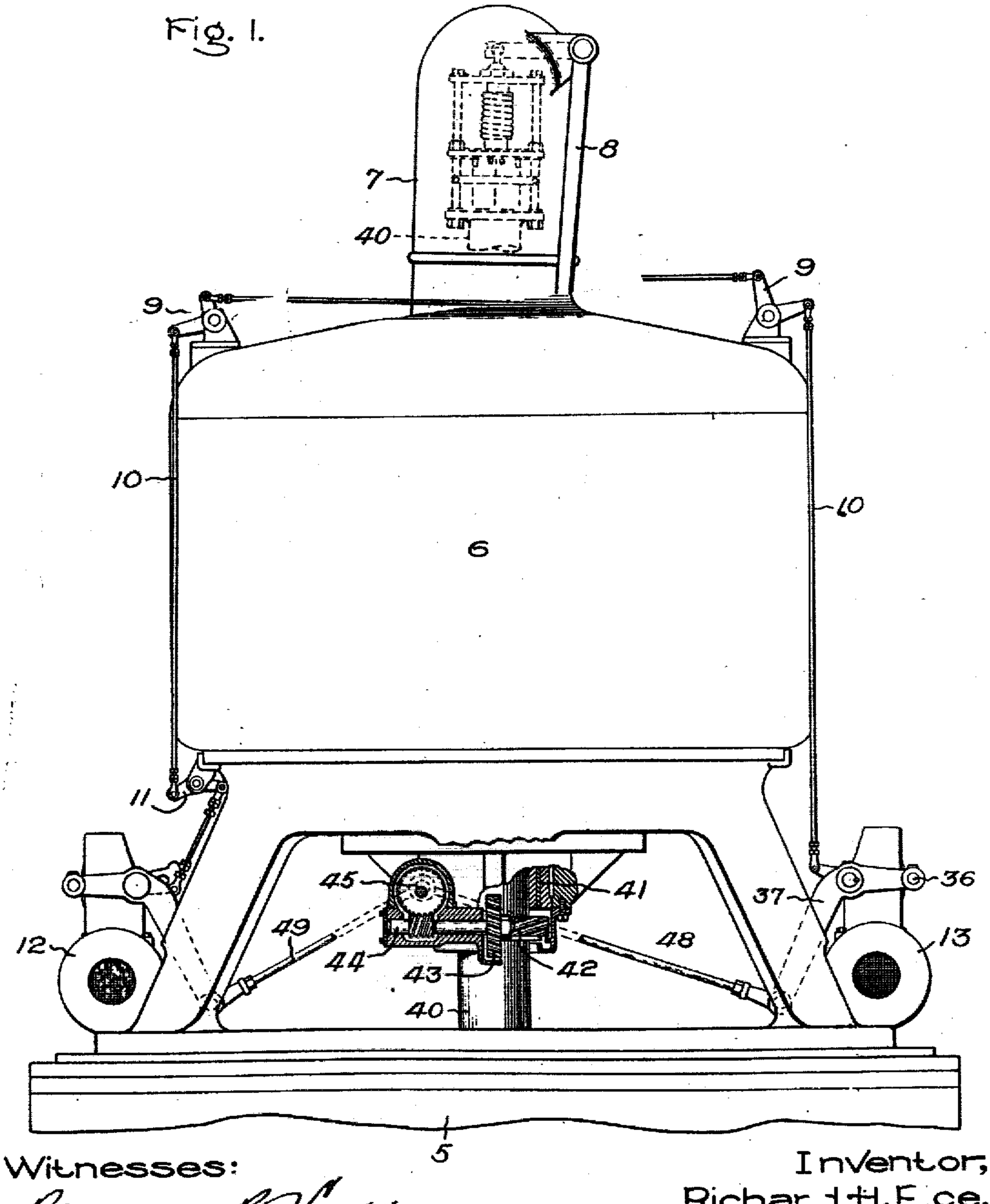
R. H. RICE.

GOVERNING MECHANISM FOR TURBINES.

APPLICATION FILED SEPT. 1, 1905.

3 SHEETS—SHEET 1.

Fig. 1.



Witnesses:
Benjamin B. Hull
Helen Alford

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

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3 SHEETS—SHEET 2.

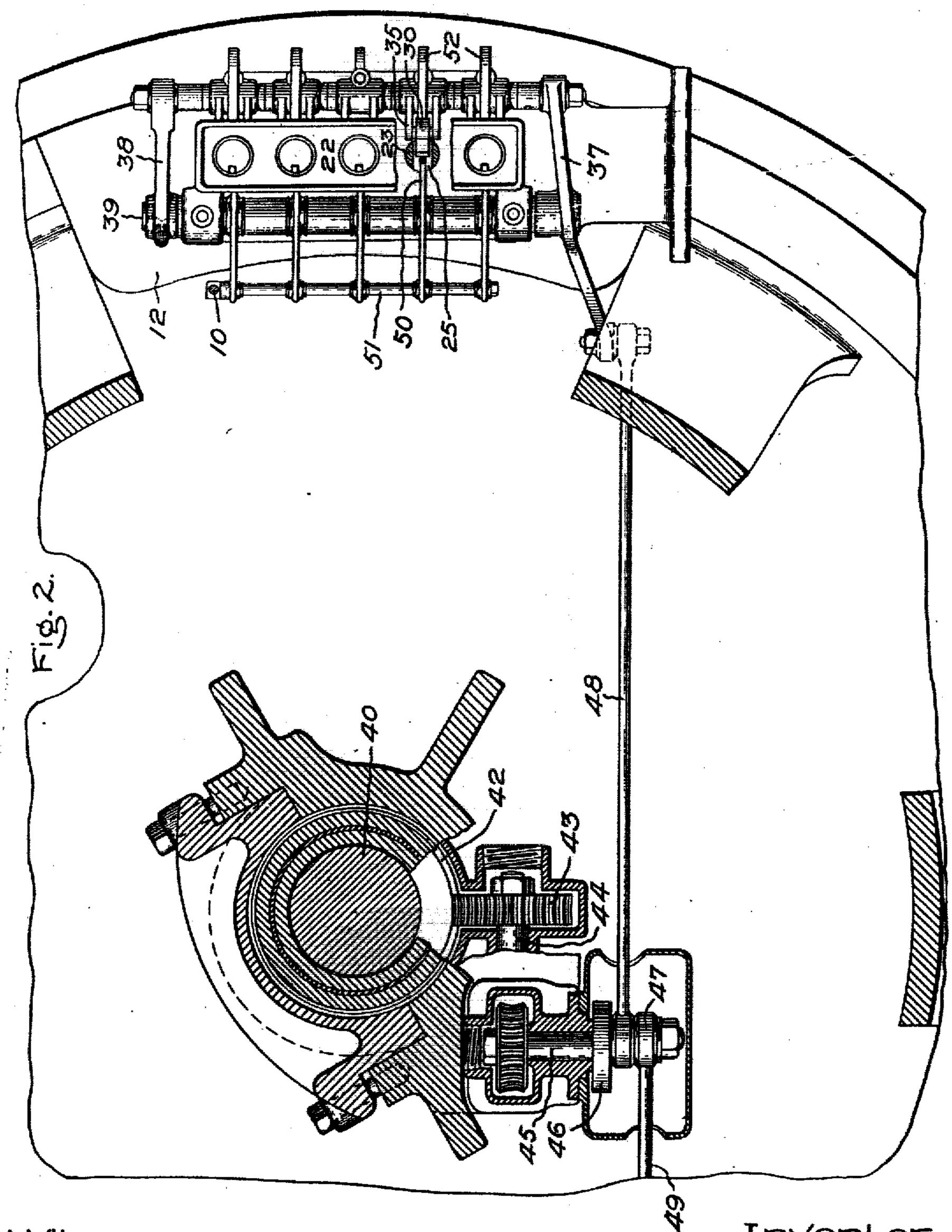

Fig. 2.

Witnesses:
Benjamin B. Bruce
Helen Alford

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

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3 SHEETS—SHEET 3.

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Fig. 3.

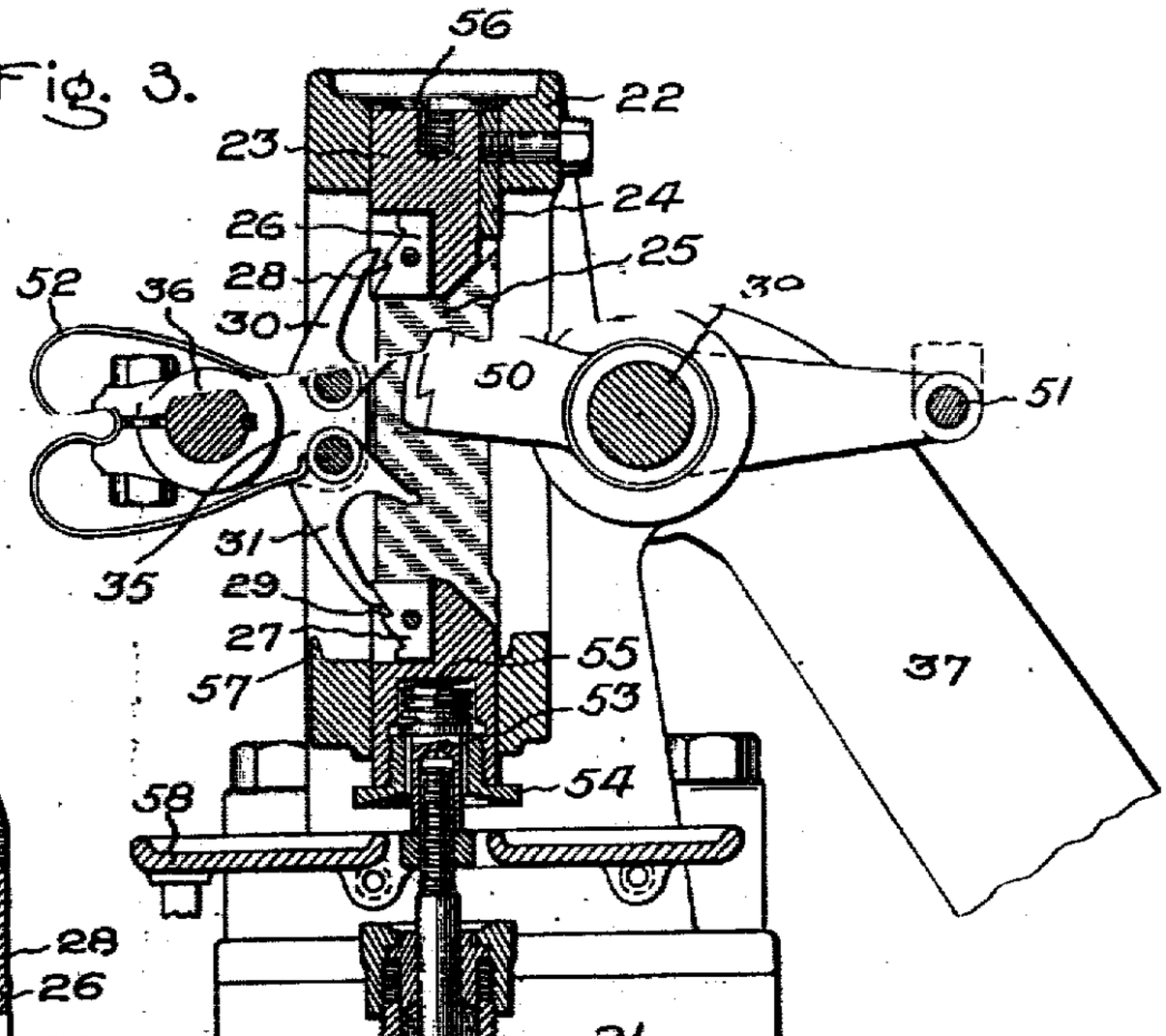
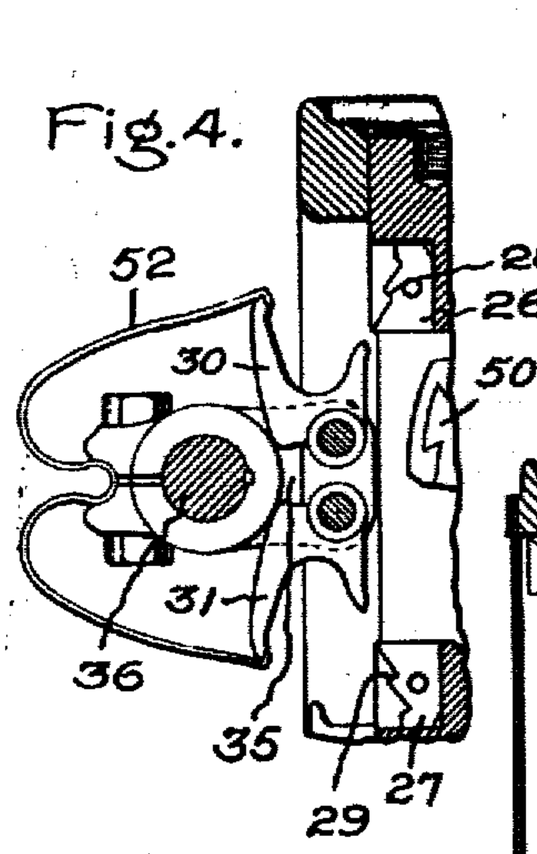


Fig. 4.



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Witnesses:
Benjamin B. Lucas
Helen Alford

Inventor;
Richard H. Rice,
By Albert G. 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. 815,743. Specification of Letters Patent. Patented March 20, 1906.

Application filed September 1, 1905. Serial No. 276,667.

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 relates to governing mechanisms for turbines wherein the nozzle-valves are mechanically and directly actuated, both in opening and closing, as the demand for energy increases or decreases, and is an improvement over that disclosed in my pending application, Serial No. 236,099, filed December 9, 1904.

The object of the invention is to improve the valve mechanism by simplifying the construction, decreasing the number of parts, and reducing the amount of machine-work, thereby reducing the initial cost and that of maintenance.

In carrying out my invention as many valves are provided as are necessary to handle the volume of motive fluid. The admission of any kind of motive fluid may be controlled by these valves; but for the purpose of this description I will refer to it as "steam." The valves are suitably arranged with respect to the nozzles or other steam-admitting devices. The valves may control the admission of steam to the turbine or the passage of steam between stages, or both. The actuating mechanism for each valve is the same as that of any other valve, so a description of one will suffice for all. Each valve is provided with a suitable stem for actuating it. The stem preferably, but not necessarily, includes a spring outside of the steam-space, which insures the proper seating of the valve without pounding. The end of the stem is elongated and arranged to coöperate with the actuating mechanism. This elongation may be formed integral with the stem or separate therefrom. By preference the stem is made in two parts, one of which passes through the valve-chest and is connected to the valve and constitutes the stem proper, while the other serves as a part of the actuating mechanism and may be termed a "cross-head." Considered in its broadest aspect, the stem includes both the stem proper and the cross-head, while in a more limited aspect the stem and cross-head may be considered as separate elements. The cross-head is moved longitudinally by dogs that are mounted on a motor which is constantly moved to and fro by a suitable means. One at a time these dogs directly engage and move the cross-head and by so doing obviate the use of the pivotally-supported cam-plate, devices for holding the cam-plate in definite positions, &c., of the prior application. By obviating the use of the cam-plate the number of parts is decreased, the amount of machine-work is materially reduced, and the parts made of a more simple and durable character. The cross-heads for the valves are slotted longitudinally to receive the ends of the actuating-dogs and also of the shield-plates, that determine whether or not the dogs shall engage and move the valves. A shield-plate is provided for each valve to determine the action of the dogs thereon, and these are set one behind the other to insure successive movements of the valves, both in opening and closing. The shield-plates are pivotally supported on one side of the stems, and the motor or steam-lever has the same pivot, while the operating parts thereof are situated on the opposite side of the stem, thereby greatly simplifying the construction and reducing to a minimum the amount of space required by the parts. This arrangement has the very great advantage of having the valve parts alined with guides above and below the actuating devices. The steam-levers are constantly moved to and fro (in the present instance the motion is a rocking one about a given axis) by a crank and connecting-rods driven from the main shaft of the turbine being governed. The shield-plates have a common support which is pivotally supported and connected by rods with a governor responsive to load changes. The spindles for the steam-levers and shield-plates and also the guides for the cross-heads are carried by a frame that is detachably secured to the valve-chest. The cylindrical guides for the cross-heads are disposed in parallel relation and can be finished by successive operations on the same drilling-machine. The bearings for supporting the spindles for the steam-levers and the shield-plates are formed in the same casting with the guides, and being at right angles thereto it is a simple matter to

machine them. Moreover, the character of the work is so simple that it can be done by even relatively unskilled workmen.

By having the parts above specified supported by a frame separable from the valve-chest and having the valve-stems and cross-heads separable the actuating mechanism can readily be removed or replaced without disturbing the valves. By making the individual pieces counterparts no trouble is experienced in substituting a new piece for an old or damaged one. Each moving part is provided with generous bearing-surfaces to reduce wear, and the dogs and the parts cooperative therewith are hardened. The upper part of the frame, containing the guides for the cross-heads, contains a tray from which lubricant is fed to certain of the wearing-surfaces.

In the accompanying drawings, which illustrate one embodiment of my invention, Figure 1 is a view in side elevation of the upper part of a turbine of the Curtis type with a generator mounted above and driven by it. Fig. 2 is a plan view, partially in section, of the valve mechanism and the gearing for actuating it. Fig. 3 is a section through one of the admission-valves on the actuating mechanism; and Fig. 4 is a detail view showing the dogs moved to a position which will permit of the valve-stem being removed or permit of a valve being cut out of service without affecting the remainder.

Referring to Fig. 1, 5 represents the upper end of a steam-turbine, and 6 the electric generator supported and driven by it. The top of the generator is provided with a dome 7, that contains a speed-responsive device mounted on the main shaft. Motion from the speed-responsive device is transmitted to the valve mechanism by a bell-crank lever 8, which in turn is connected by the levers 9 and connecting-rods 10, the connecting-rods being provided with suitable turnbuckles for the purpose of adjustment. Owing to the fact that one valve mechanism is located on one side of the machine and the second valve on the opposite side, a lever 11 is provided to cause the movements of the parts to be in the proper direction. These rods and levers are connected to the shield-plates, as will hereinafter appear. 12 and 13 represent the valve-chests, mounted on opposite sides of the turbine.

Referring now to Fig. 3, 12 represents the valve-chest which is bolted to the head 14 of the turbine. The interior of the turbine is divided into stages or wheel-compartments by suitable diaphragms, each stage containing a wheel 15, having one, two, or more rows of peripheral buckets 16. When two or more rows of wheel-buckets are provided for each stage, intermediate buckets 17 are situated between each two rows of wheel-buckets. Steam is admitted to the buckets by the sectionalized expanding-nozzle 18, the latter being bolted to the under side of the valve-chest 12. Mounted in the valve-chest is a plurality of valves 19, each having a stem 20, comprised, essentially, of two parts, one of which extends through the packing 21, while the other is mounted in a frame 22, that is bolted to the upper side of the valve-chest. For convenience the upper portion 23 of the valve-stem may be termed a "cross-head." This cross-head is provided with guides in the frame 22 and is prevented from turning by the feather or spline 24. The cross-head is provided with a slot or cut-away portion 25. This may be centrally located or at one side, as desired. The upper and lower ends of the slot are arranged to receive hard-steel blocks 26 and 27. These blocks are provided with shoulders or projections 28 and 29, which cooperate with the dogs 30 and 31. The blocks are held in place by transverse pins and may be readily removed and new ones substituted in case of wear. The dogs 30 and 31 are pivotally mounted between arms 35, carried by horizontal rod 36. The arms are keyed to the rod 36, that extends at right angles to the plane of the valve-stem, and is connected to the lever 37 at one end (see Fig. 2) and lever 38 at the opposite end. These levers are mounted to turn with the rock-shaft or spindle 39. The lever 37, shaft 36, lever 38, and shaft 39 form, in effect, a frame, which frame carries all of the dogs of the several valves. For convenience these parts are termed a "motor" or "steam-lever." The lever 37 is in motion constantly while the turbine is running, and acting through the medium of the dogs it performs all of the work of opening and closing the valves.

In Figs. 1 and 2 is shown more particularly the means for actuating the steam-lever. 40 represents the main shaft of the turbine, and just below the middle bearing 41 is a spiral gear 42, that in turn meshes with a gear 43, carried by a horizontal shaft 44. Between this shaft and the shaft 45, which drives the crank-disk 46, is suitable gearing. The disk 46 is provided with a crank 47, and connected to said crank and to the steam-levers 37 are connecting-rods 48 and 49.

Loosely mounted on the spindle 39 are as many shield-plates 50 as there are valves. These shield-plates are so arranged that they engage with the inner or short lugs or ends of the dogs 30 and 31 and cause them to engage or be held away from the blocks 26 and 27. With the parts in the position shown the upper dog 30 is held out of operation and the movements of the steam-lever have no effect. Neither will the downward motion of the dog 31 have any effect, because the valve 19 is closed. Assume, however, that the shield 50 moves downward to a position where it will hold the lower dog 31 out of engagement with.

the block 27. Then the next upstroke of the steam-lever will cause the upper dog 30 to engage the shoulder 28 and raise the cross-head and open the valve. All of the shield-plates 50 are connected together by the tie-rod 51, Figs. 2 and 3, and the latter is connected, by means of the connecting-rod 10 and lever 9, with the bell-crank lever 8 to the shaft-governor. From this it follows that as the speed changes, due to the changes in load, the position of the shield-plates will be changed. These plates are so adjusted with respect to each other that in normal operation the opening and closing of the valves is successive as distinguished from simultaneous. By suitably arranging these shield-plates two or more valves can be opened together. When the load variation is greater than can be taken care of by a single valve, two or more valves will open or close simultaneously, because the shield-plates will set the dogs of two or more valves in operative position. By making the width of the shield-plate 50 such that it will be out of engagement with the dogs 30 and 31 for a portion of the stroke of the steam-lever one of the valves can be made to open and close once for every stroke of the steam-lever, thus giving a pulsating action to the valve which is doing the regulating. The regulating-valve will then have a definite periodicity—that is to say, it will open and close a definite number of times per minute; but no attempt is made to regulate the periods that the valve is open or closed. Each valve is so constructed and arranged that it can in turn function as a "regulating-valve" and open and close once for each stroke of the actuator. By means of this the total number of valves required for a given machine can be materially reduced. Under ordinary conditions one or more valves will be open and one or more valves closed and at least one valve opening and closing more or less frequently to do the regulating. In the construction shown the regulation can be accomplished only by a change in speed; but in the event of the shield-plates being such that a valve can open and close at each stroke of the steam-lever the regulation will be accomplished to a limited extent without a change in speed. The dogs 30 and 31 are normally moved into operative position by the spring 52, which is common to both dogs. The free ends of the spring are turned over slightly, so that when it is desired to cut a valve out of service the dogs 30 and 31 can be held in an inoperative position, as shown in Fig. 4. With the parts arranged in this manner the movements of the steam-lever have no effect on the cross-heads or the valve connected thereto. This feature is also of value in that it permits of the cross-head and valve being removed without taking the dogs off of their support. The slot or cut-away portion of the cross-head is so arranged that by disconnecting the tie-rod 51 from the shaft-governor the shield-plates 50 can be swung about the axis of the shaft 39 until they clear the side of the cross-head. Each cross-head is secured to the valve-stem proper by means of a screw-threaded head 53, which in turn is held between a screw-threaded nut 54 and a compression-spring 55. The spring insures the proper seating of the valve 19. By removing the nut 54 and throwing back the dogs 30 and 31 and swinging the shield-plate 50 upward out of the way the cross-head can be removed. The valve can be removed by first taking off the packing 21 and then raising the valve-stem, it being assumed that the cross-head has been previously removed.

The rectangular frame 22, that carries the cross-heads and acts as a guide 24, is provided with a small tray 56 at the upper end and a similar tray 57 below the dogs. These trays supply lubricant to the surface of the cross-heads. Situated below the cross-heads and extending at right angles thereto is a tray 58, that collects any lubricant which may leak around the cross-heads. The said tray may or may not be connected by a pipe to a suitable reservoir.

The present invention is shown in connection with admission-valves only; but my invention is not limited thereto, since it is applicable to stage-valves as well. By duplicating the apparatus it can be used for actuating stage-valves. I may use the apparatus shown for stage-valves only and use a different form of apparatus for controlling the admission. The stage-valves may be operated by the same or a different mechanism from that employed to actuate the steam-lever of the admission-valves.

In machines requiring only one regulating-valve the same type of apparatus may be employed; but only a single set of actuating devices will be necessary.

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 mechansim for turbines, the combination of a valve having an open and a closed position but no intermediate, a motor which is constantly in motion for opening and closing the valve, independent dogs which engage the valve and transmit motion from the motor to the valve, and a governor for causing the proper action of the dogs with respect to the valve.

2. In a governing mechanism for turbines, the combination of a plurality of valves, a motor common to the valves that has a con-

stant to-and-fro motion, dogs carried by the motor which engage each of the valves and open and close them, a means for each valve that determines the action of the dogs thereon, and a governor for controlling the said means.

3. In a governing mechanism for turbines, the combination of a plurality of valves, stems therefor, an actuator for each valve that is continually moving to and fro, dogs carried by each actuator, one of which opens the valve and the other closes it, a shield for regulating the action of each pair of dogs, the shields being arranged to normally cause successive operation of the dogs and valves, and a governor that controls all of the shields.

4. In a governing mechanism for turbines, the combination of a valve, a stem therefor containing a slot, an actuator which enters the slot and opens or closes the valve, and a device responsive to load changes which also enters the slot and controls the effect of the actuator on the stem.

5. In a governing mechanism for turbines, the combination of a valve, a slotted stem therefor, an actuator, dogs carried by the actuator which enters the slot and open or close the valve as load conditions demand, and a shield that also enters the slot and controls the action of the dogs on the stem.

6. In a governing mechanism for turbines, the combination of a valve, a stem therefor, a rocking lever, dogs carried by the lever, one of which engages with the stem and opens the valve while the other closes it, and a governor for determining which dog shall be in service.

7. In a governing mechanism for turbines, the combination of a valve, a cut-away stem therefor, a rocking lever, dogs carried by the lever and extending into the cut-away portion of the stem, the dogs acting directly on the stem to open or close the valve, and a shield-plate that also enters the cut-away portion and controls the action of the dogs.

8. In a governing mechanism for turbines, the combination of a plurality of valves, an actuator for each valve, devices for controlling the effects of the actuators on the valves, a support which is common to actuators and is located on one side of the plane of the valves, a support which is common to the controlling devices and is located on the opposite side of the plane of the valves, and a governor which regulates the action of the devices and is itself responsive to changes in load.

9. In a governing mechanism for turbines, the combination of a valve having a stem, an actuator for the valve that is located on one side of the stem, a pivot for the actuator located on the other side, and a device for controlling the action of the actuator, the axes of the pivot and the controlling device coinciding.

10. In a governing mechanism for turbines, the combination of a plurality of valves, stems therefor, actuators for the valves located on one side of the stems, a frame that carries the actuators and is pivotally supported on the opposite side of the stems, devices for causing the actuators to normally act on the valves successively, which are located on the side of the stems opposite the actuators, and a speed-responsive device which moves the controlling devices.

11. In a governing mechanism for turbines, the combination of a valve, a cut-away stem therefor, an actuator for the valve that enters the cut-away portion, and a device that also enters the cut-away portion for controlling the action of the actuator on the valve, the said actuator and device being so constructed and arranged that they can be moved out of the cut-away portion when it is desired to remove the valve-stem.

12. In a governing mechanism for turbines, the combination of a valve having a cut-away stem, an actuating and controlling device therefor which extend toward each other and coöperate within said cut-away portion, and supports for the actuator and device about which they can be moved to withdraw them from said cut-away portion when it is desirable to remove the valve-stem.

13. In a governing mechanism for turbines, the combination of a valve, a slotted stem therefor, an actuator and controlling device which coöperate within the slot to move the valve, and guides for the stem located on each side of the actuator and controlling device.

14. In a governing mechanism for turbines, the combination of a valve, a divided stem therefor, a spring interposed between the parts to insure proper seating of the valve, a moving support, dogs carried by the support which engage and move the stem, and a shield for controlling the action of the dogs.

15. In a governing mechanism for turbines, the combination of a plurality of valves, a chest containing the valves, a frame mounted on the chest and containing guides for the valve-stems, an actuator for each valve, a pivotally-supported frame which carries all of the actuators, and shield-plates for controlling the actuators that are also carried by the frame.

16. In a governing mechanism for turbines, the combination of a valve, a cylindrical stem for the valve having a cut-away portion, a means for preventing the stem from turning, a dog for opening the valve, a dog for closing it, and a shield for governing the action of the dogs.

17. In a governing mechanism for turbines, the combination of a plurality of valves, stems therefor, a frame through which the stems extend, trays formed in the frame for supplying lubricant to stems, a re-

ceptacle which collects the lubricant after it acts on the stems, and actuators for opening and closing the valves.

18. In a governing mechanism for turbines, the combination of a valve, a stem therefor, a cross-head that is detachably secured to the stem, a slot therein, an actuator that extends into and moves in the slot for opening and closing the valve, and a means for controlling the effective action of the actuator.

19. In a governing mechanism for turbines, the combination of a valve controlling the passage of fluid through the turbine, an actuator therefor which is constantly in motion, a spiral gear mounted on the shaft of the turbine, a driven gear meshing therewith, a shaft for the driven gear which revolves slower than the turbine-shaft, a worm thereon, a worm-wheel, a crank driven by the said wheel and connected to the actuator, a housing for the gearing carried by a bearing of the turbine and situated in line with the valve, a speed-governor, and a device moved by the governor which controls the action of the actuator on the valve.

20. In a governing mechanism for turbines, the combination of valve-chests located on opposite sides of the machine, valves in the chests, actuators for the valves pivotally supported on the chests, means for connecting and disconnecting the valves and actuators in response to load changes, a gear mounted on the turbine-shaft at a point between the valve-chests, a second gear meshing with the first for reducing the speed, other gearing driven by said second gear for further reducing the speed which is connected to the actuators, and a support for the driven gears located at a point between the valve-chests.

In witness whereof I have hereunto set my hand this 23d day of August, 1905.

RICHARD H. RICE.

Witnesses:
DUGALD MCK. MCKILLOP,
JOHN A. MCMANUS, Jr.