No. 881,870. PATENTED MAR. 10, 1908.

R. H. RICE.

ELASTIC FLUID TURBINE.

APPLICATION FILED DEC. 24, 1906.

4 SHEETS—SHEET 1.

Fig. 1.

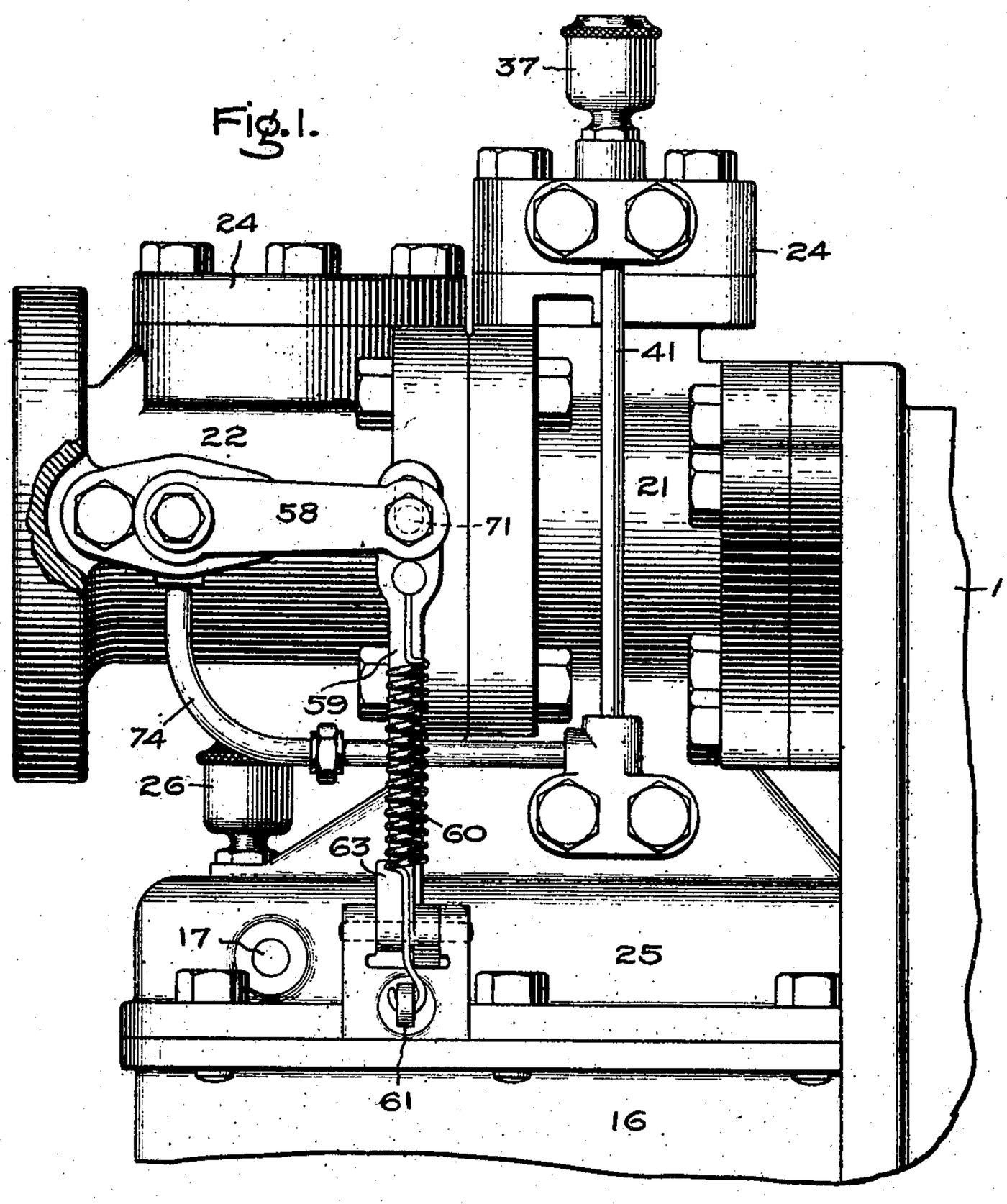


Fig. 2.

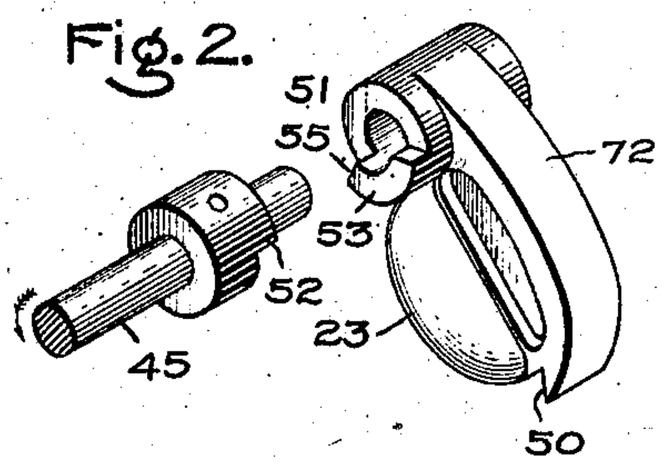
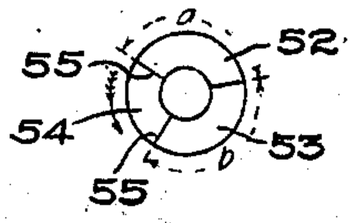


Fig. 3.



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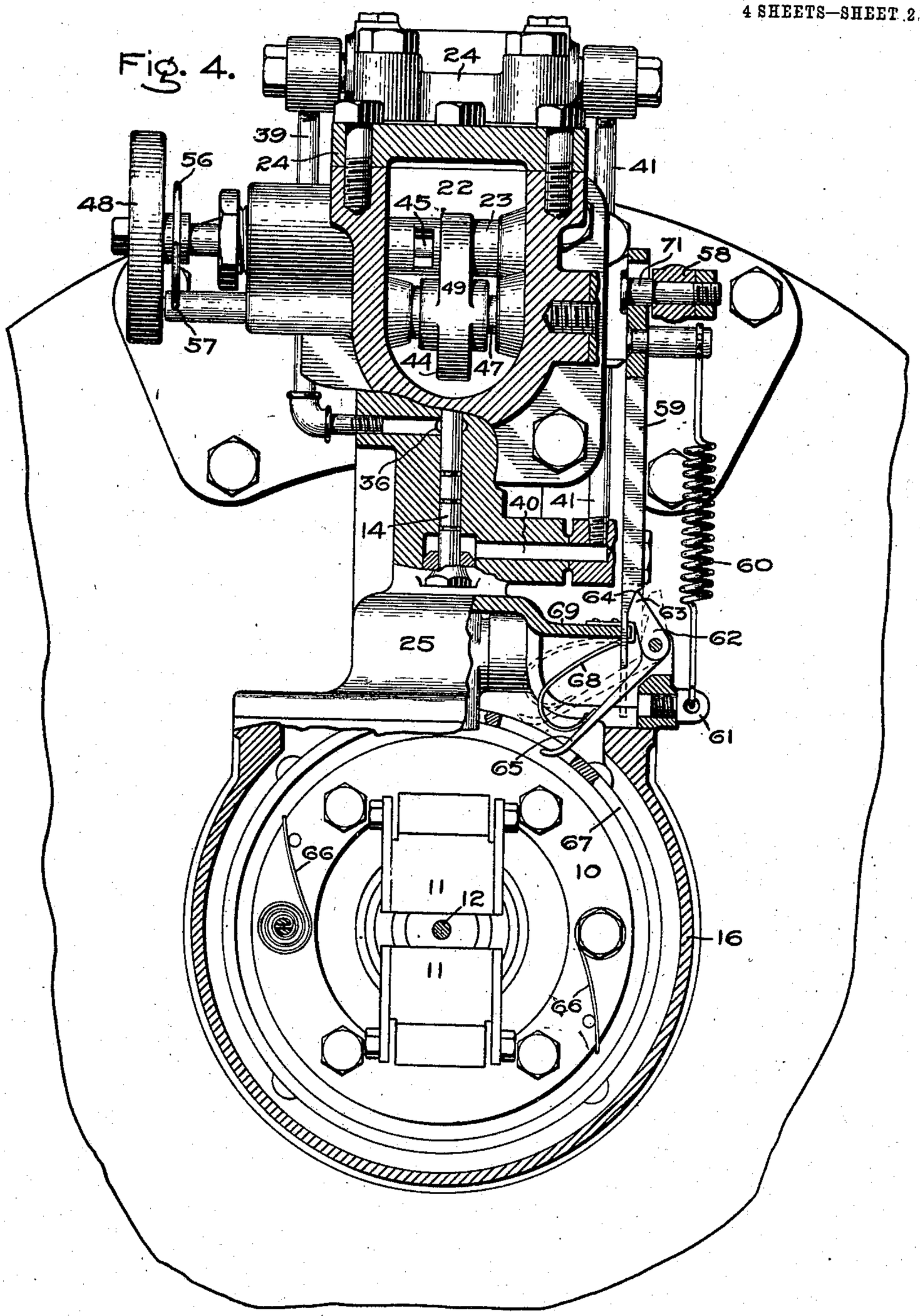
4 SHEETS—SHEET 2.

Fig. 4.



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4 SHEETS—SHEET 3.

Fig. 5.

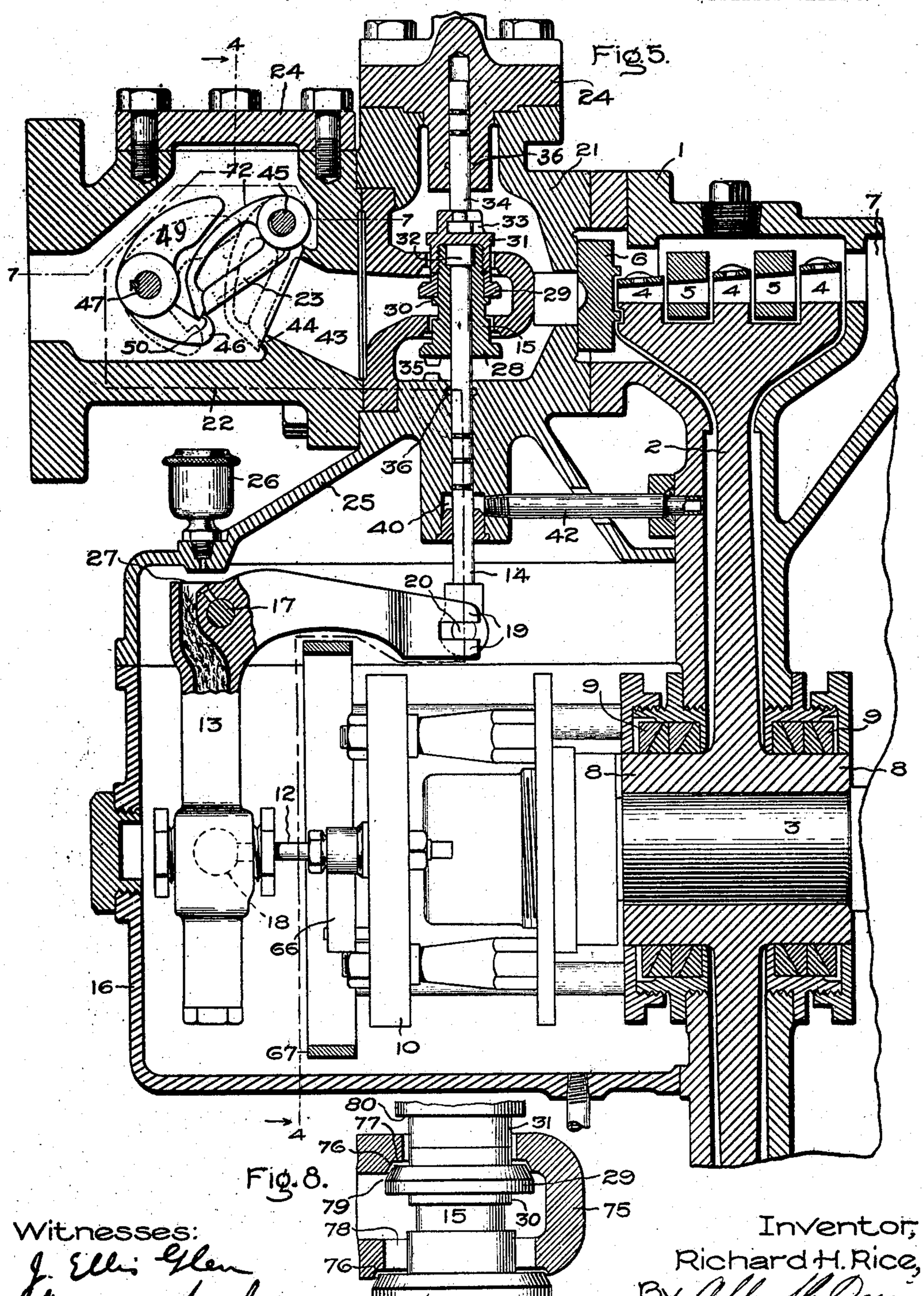

Fig. 8.

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4 SHEETS—SHEET 4.

Fig. 6

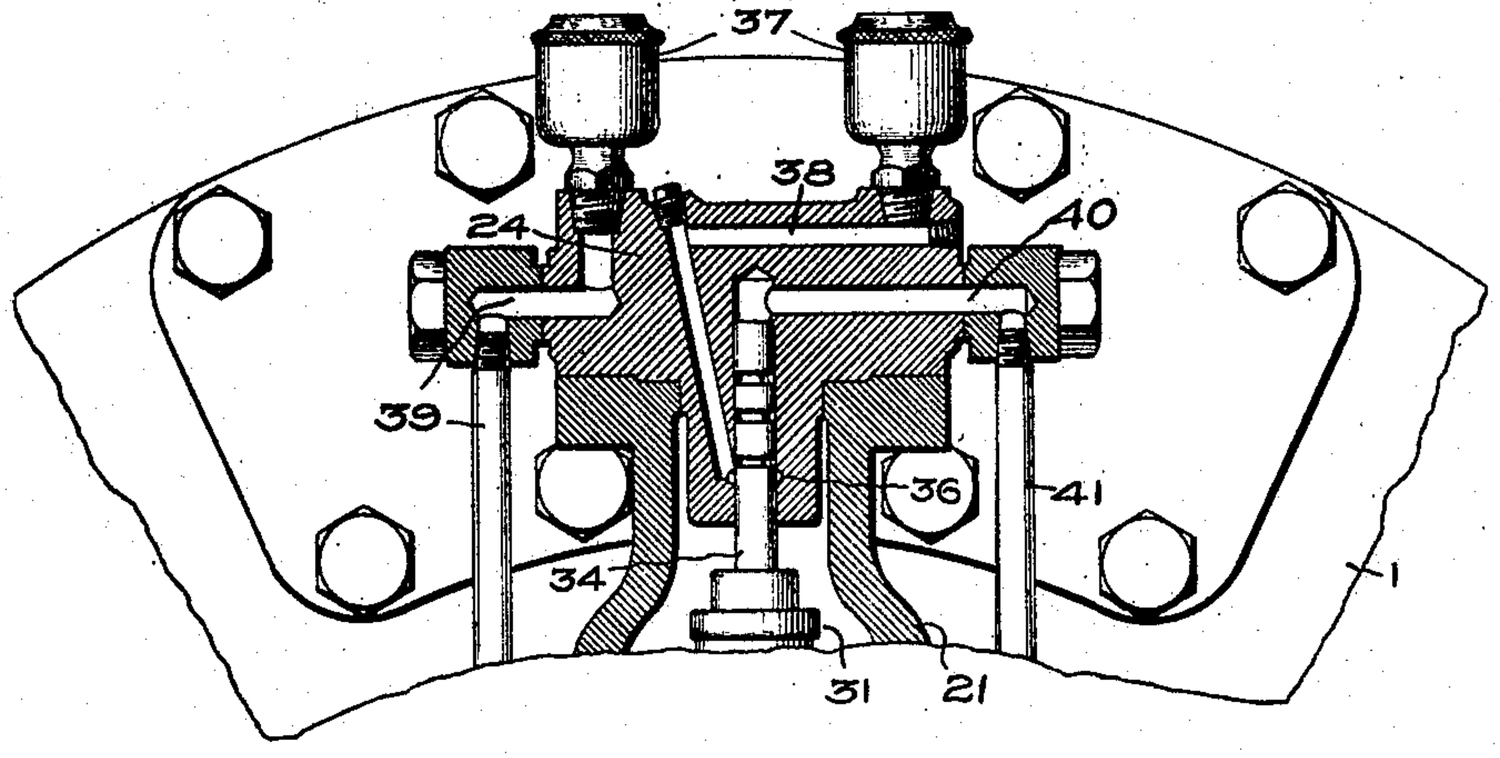
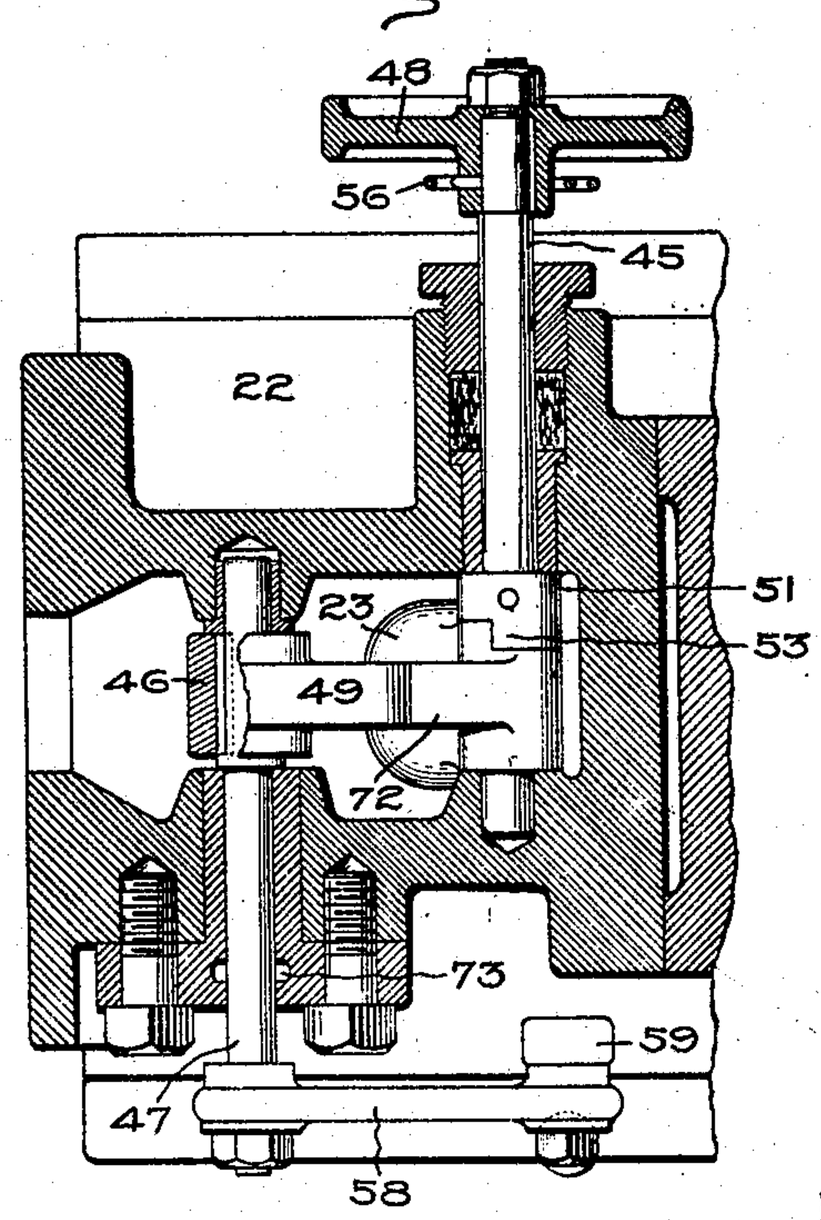


Fig. 7.



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UNITED STATES PATENT OFFICE.

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

ELASTIC-FLUID TURBINE.

No. 881,870. Specification of Letters Patent. Patented March 10, 1908.

Original application filed June 7, 1905, Serial No. 264,059. Divided and this application filed December 24, 1906. Serial No. 349,243.

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 Elastic-Fluid Turbines, of which the following is a specification.

This application is a division of my application Serial No. 264,059, filed June 7, 1905, and is filed in response to a requirement for division made by the United States Patent Office under Rules 41 and 42 of office practice.

The present invention relates to prime movers or motors, such for example, as elastic fluid turbines. Its object is to improve the construction of the turbine and to provide an improved governing mechanism which will operate to regulate the admission of motive fluid to the turbine under normal load changes and entirely shut off the supply under emergency conditions, as when a critical speed of rotation is reached.

In the accompanying drawings which illustrate one embodiment of the invention, Figure 1 is a partial side view of an elastic fluid turbine; Fig. 2 is a perspective view of the emergency valve and its spindle, and shows the lost-motion device which permits the valve to close suddenly; Fig. 3 is a diagram of parts of the lost-motion device; Fig. 4 is a transverse section through the governing mechanism on line 4, 4, of Fig. 5 looking in the direction indicated by the arrows; Fig. 5 is a vertical longitudinal section through the emergency valve chest, the regulating valve, the governor casing and through part of the turbine proper; Fig. 6 is a vertical section of the upper portion of the regulating valve chest; Fig. 7 is a section through the emergency valve chest on line 7, 7, of Fig. 5; and Fig. 8 is a detail view of the regulating valve and its seats.

Referring to the drawings, 1 represents the casing of the turbine inclosing a bucket-wheel 2 which is mounted on a shaft 3, Fig. 5. On the periphery of the wheel is arranged one or more rows of buckets 4 against which the motive fluid is directed. When more than one row of wheel buckets are employed, as in the present illustration, intermediate buckets 5 are arranged between the rows extending partially or entirely around the wheel. These intermediate buckets may be stationary or movable as desired, their function being to change the direction of flow of the motive fluid as it passes from a preceding to a succeeding row of wheel buckets. The buckets receive steam or other elastic fluid from suitable discharge devices, such as nozzles or nozzle sections, arranged adjacent the periphery of the wheel in the plate 6 or other support. These nozzles may be expanding or non-expanding, as preferred. The motive fluid passes from the buckets into an exhaust conduit 7 which may lead to another set of nozzles and buckets if the turbine be of the multi-stage type, or to a condenser, or to the atmosphere. On the shaft 3, or the hubs 8 of the wheel, are packings 9 for preventing the escape of fluid from the casing.

Secured to the shaft 3 in any suitable manner is a frame 10, Figs. 4 and 5, which carries the governor weights 11, the weights being omitted in the latter figure for convenience of illustration. The weights are adapted to act against a weighted and yielding abutment as is usual in governors, and to impart longitudinal motion to a stem 12 arranged in axial alinement with the shaft 3. The movement of the stem 12 is transmitted by a bell-crank lever 13 to the stem 14 of the regulating valve 15. The arms of the bell-crank lever preferably form an integral structure which is mounted in the governor casing 16 with the vertical arm extending transversely of the stem 12 and the horizontal arm extending over the governor toward the turbine casing and connecting at its end with the valve stem. The pivot 17 of the lever is located at its elbow so that the oscillations due to the action of the governor are converted into vertical reciprocations of the valve stem. In order to afford the necessary flexibility, and form a slip joint, a ball-and-socket joint 18 is provided between the stem 12 and the lever, the joint also detachably connecting them. The end of the horizontal arm of the lever is formed with parallel jaws 19, in which are freely movable trunnions 20 carried by the lower end of the valve stem. The head which carries the trunnions is removably secured to the stem.

Arranged above the governor in overhanging relation thereto, is a regulating valve chest 21 and a valve chest 22 containing an emergency valve 23. These chests are pref-

erably made separate and bolted together. The regulating valve chest is in turn bolted to the periphery of the turbine casing adjacent the nozzles. To permit access to the interior, each chest is provided with a removable cover 24. The lower portion of the regulating valve chest is expanded, Fig. 5, to form a top or cover 25 for the governor casing. On this portion of the casing is an oil cup 26 arranged in line with the vertical arm of the lever 13. This arm is hollow and is provided with a mouth 27 at its upper end into which lubricant is fed from the cup. The arm contains cotton waste or other suitable absorbent which keeps the ball-and-socket joint 18 properly lubricated. Sufficient lubricant creeps out from this joint to the adjacent parts of the governor to lubricate them.

The regulating valve is of the balanced type. It comprises a sleeve 28 formed with an annular flange at its lower end. This flange serves as one valve disk and a collar 29, fitted around the sleeve and resting on a shoulder 30, serves as the other valve disk. The flange and the collar both have the same area exposed to the motive fluid on the inlet side. The collar 29 is secured in place by a cap 31 which screws on the externally threaded upper end of the sleeve. The valve stem 14 extends through the interior of the sleeve and has at its upper end a shouldered portion 32 which may be a removable collar and is in engagement with a counter-bore at the upper end of the sleeve. This portion 32 and the cap 31 coöperate to prevent endwise movement of the valve on its stem. The cap 31 is provided with a transversely extending slot 33, Fig. 5, having overhanging jaws which engage the end of the guide stem 34. The parts may be disengaged by a side-wise movement. The seat for the valve comprises an annular member U-shaped in vertical cross-section which is supported in a shouldered recess 35, in one face of the regulating valve chest, and is held in the recess by a projection on the emergency valve chest. This arrangement permits the seat to be readily removed for regrinding or other purposes, and does away with bolts or nuts for securing said seat. The stems 14 and 34 of the valve, are provided with a number of annular grooves which collect the moisture escaping from the valve chest and form hydraulic packings. Lubricant for the stems is fed to small annular passages or chambers 36 in the walls surrounding the stems, and feeds therefrom along the stem with the escaping moisture. As shown in Figs. 5 and 6, the chambers 36 are supplied from oil cups 37 on the cover of the regulating valve chest. One cup supplies lubricant through the conduit 38 to the guide stem 34, and the other cup supplies the valve stem through the conduit and pipe 39, Figs. 4 and 6. At the outer ends of the stems are collecting chambers 40 for the condensed steam or moisture which escapes along the stems from the valve chests. These two chambers are joined by a pipe 41 so that the upper chamber may drain into the lower. From the lower chamber the water of condensation passes through a pipe 42, Figs. 4 and 5, to the turbine casing.

The emergency valve chest communicates with the regulating valve chest through a port 43, and the inlet end of the port is finished to form a seat 44 for the emergency valve, Fig. 5. The valve is of the swinging type and is loosely mounted on a horizontal spindle 45 located above the seat so that the valve has a tendency to close under the action of gravity. A certain amount of play is provided between the valve and its spindle so as to insure proper seating. The valve is held open by an oscillating latch or lock 46 which, when released, permits the valve to close. The latch is mounted within the chest and rocks with a shaft 47 suitably journaled in the walls of the chest. The spindle 45 extends through the wall of the valve chest and carries a hand-wheel 48 by which the valve may be reset. The hand-wheel is made with smoothly finished surfaces so that it cannot be fastened in a position to hold the valve open. This reduces the liability of accidents due to a careless attendant.

To permit the lock to be raised to its normal or set position simply by the turning of the hand-wheel, a projection or finger 49 is formed on the lock and disposed in the path of movement of the valve so that when the latter is raised, the valve wipes against the projection, and throws the lock under the lip 50 of the valve, Figs. 2 and 5. To allow the valve to fall suddenly, without moving the hand-wheel and spindle with it, a lost-motion device 51, Figs. 2 and 3 is provided. This device comprises overhanging lugs or projections 52 and 53 formed respectively, on the hub of the valve and on a collar keyed to the valve spindle. Either or both of these projections are less than 180° measured on the arcs *a* and *b*, Fig. 3, thus leaving a sector-shaped space 54 between the surfaces 55 through which the lug 53 is capable of moving during the closing of the valve before engaging the other lug. When it is desired to open the valve, the supply of steam to the emergency valve chest is cut off. Then the hand-wheel and spindle are turned in the direction indicated by the arrow, Figs. 2 and 3, which causes the projection 52 to move toward and engage the projection 53 at the surface 55, and by continued movement to raise the valve.

In order that the projection 52 may automatically disengage and return to its normal position, a spring 56 is arranged at or near the hand-wheel, one end being anchored at

57 and the free end attached to the hand-wheel or spindle. During the opening movement of the valve the spring is placed under stress so that as soon as the operator releases the hand-wheel, the projections 52 and 53 disengage and thus allow the valve to fall freely when the latch is released. A suitable packing is provided around the valve spindle, Fig. 7, to prevent leakage from the chest.

The device for releasing the lock or latch under abnormal or emergency conditions, comprises the following:—On the shaft 47, outside the casing, is an arm or crank 58, Figs. 1, 4 and 7, which is actuated by a suddenly-acting-weighted member that preferably has the form of a longitudinally movable rod or actuator 59, Figs. 1 and 4. This rod is actuated by a contractile spring 60, (or its equivalent), which is secured at one end to the rod, and at the other end to a suitable anchor 61 on the governor casing. At the lower end, or at any other suitable position, a trigger 62 is arranged which is adapted to hold the rod or actuator in its set or energized position. The trigger is provided with a nose 63 which engages the notch 64 in the rod so as to hold the latter in set position. The trigger is also provided with an arm 65 which extends through the wall of the governor casing to a point within where it lies in the path of one or more centrifugally acting springs or other devices 66, Figs. 4 and 5, which are mounted on the governor frame 10. The free ends of the springs are deflected outwardly at excessively high speeds and strike the outer end of the arm 65, thus releasing the nose 63 from the notch 64, and permitting the rod 59 to operate under the influence of the spring 60 to rock the shaft 47 by means of the crank or arm 58. The contact of the rod with the arm 58 is in the nature of an active blow which suddenly releases the lock or latch 46 and causes the projection 49 thereof to impart a hammer blow directly to the valve, insuring its sudden closure. Around the path of the centrifugally-acting springs 66 is a stationary ring 67 which acts as a damper to prevent undue vibration of the ends of the springs after they have struck and released the trigger.

The trigger is provided with a spring 68, Fig. 4, which resets it during the operation of resetting the emergency valve without attention on the part of the operator. The spring is made of a flat strip in the form of a loop, one end being anchored on an extension or portion 69 of the governor casing, and the free end being secured to the arm 65 of the trigger. The fixed end of the spring is disposed adjacent the nose of the trigger and is shaped to form a stop for the trigger when it is reset, Fig. 4. When the nose and the stop are thus engaged, the rod 59 is prevented from moving under the tension of its spring, but when they are released by the trigger being thrown to the position shown in dotted lines, the rod is free to move. After the rod has operated, the trigger is held in the position indicated by dotted lines by the rod itself. In this position the trigger spring 68 is flexed so that the trigger will automatically return to its normal position when the rod is raised to its normal position during the setting of the emergency valve.

Referring to Fig. 5, the emergency valve and the latch are shown in their set or operative positions by full lines, and in their released or closed position by dotted lines. To open the valve, it is swung upward by means of the hand-wheel. The swinging of the valve actuates the latch causing, in turn, the crank or arm 58 keyed to the latch shaft 47 to swing upward and raise the actuator or rod, permitting the trigger to reset itself. It will be observed that in order to permit the latch to fall back from its extreme position to its operative position, a lost-motion must be provided between the arm 58 and the rod 59. For this purpose, the upper end of the rod is slotted and the pin 71 connecting the arm and the rod is arranged to move freely in the slot. Because of this lost-motion the latch will fall as soon as the operator releases the hand-wheel, and come to rest in position to engage the lip 50 of the valve. When the parts are in normal position, the pin 71 is at the bottom of the slot as shown in Figs. 1 and 4. Another important feature of this lost-motion connection between the actuator and the arm is that it allows the actuator to move a short distance to acquire momentum before engaging the arm, and thus produces a hammer blow effect. A web or abutment 72, Figs. 2 and 5, is formed on the emergency valve to receive the impact from the projection 49 on the lock, and also to properly position the lock with respect to the valve. This arrangement makes the lost-motion which has to be taken up in resetting the valve very small.

Any moisture that passes from the emergency valve chest along the shaft 47 is collected in an annular chamber 73, Fig. 7, from which it drains through the pipe 74 to the chamber 40 at the lower end of the regulating valve stem and thence to the turbine casing.

The regulating valve 15, Figs. 5 and 8, is so constructed that a suitable throttling action is secured and the impact and the reactive effects of the flowing steam do not disturb the balanced condition of the valve. The throttling action is due to the beveled portions of the disks 28 and 29, and the corresponding portions 76 of the seating-containing wall 75. Thus, when the horizontal surfaces 77 of the seat and the corresponding surfaces of the disk are separated by a

given distance, the width of the annular flow space between the beveled surfaces will be but substantially one-half that distance.

Steam flowing from the region 78, Fig. 8, impinges on the horizontal surface of the lower valve disk and tends to move it downward. Similarly, steam issuing from the region 79 passes over the surfaces 76 and 77 and flowing upward impinges on the annular surface 80, formed for this purpose, and balances the action just described. Thus, the balanced condition of the valve is not disturbed by the flow of steam when moved from its balanced closed position.

With the governing mechanism described, the normal load changes are taken care of by the regulating valve which with variations in speed, has a slight reciprocating or to-and-fro movement whereby the admission of motive fluid to the turbine nozzles is increased with decreasing speed of the turbine, and decreased with increasing speed. If, for any reason, the speed of rotation should become excessive, the emergency governor is called into play, thereby releasing the emergency valve and cutting off the entire supply to the turbine.

While a turbine of the well known Curtis type has been described, it is obviously within the scope of my invention to employ any other type of turbine, whether the same be of axial or radial flow type, or a combination of both types.

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. An elastic fluid motor comprising a movable element, a casing therefor, a device for discharging motive fluid against the movable element, in combination with a valve chest supported on the casing which delivers motive fluid to the discharging device, a regulating valve therein, a second valve chest supported by the first and in alinement therewith and with the discharging device, and an emergency valve in the second valve chest.

2. An elastic fluid motor comprising a rotatable element and a casing therefor, in combination with a speed-responsive device arranged exterior to the casing and in alinement with the axis of rotation, a casing for said device, a valve chest supported on the turbine casing, a regulating valve therein, a second valve chest which is carried by and is arranged in line with the first, and an emergency valve therein.

3. An elastic fluid motor comprising a rotatable element and a casing therefor, in combination with a speed-responsive device arranged exterior to the casing and in alinement with the axis of rotation, a casing for said device, a valve chest supported on the motor casing at a point situated at one side of the axis of rotation, a regulating valve therein, a second valve chest which is arranged in line with the first and overhangs the speed-responsive device, and an emergency valve therein.

4. In a governing mechanism, the combination of separate regulating and emergency valves, chests for the valves which communicate, and a member secured between the chests which contains seats for one of the valves.

5. In a governing mechanism, the combination of a balanced regulating valve, an emergency valve, communicating chests for the valves removably connected together, a recess between adjacent surfaces of the valve chests, and a removable member supported in the recess which contains seats for the regulating valve.

6. In an elastic fluid turbine, the combination of a bucket wheel, a casing therefor, a governing valve, a stem for actuating and guiding the valve, one or more conduits for conveying the fluid leaking around the stem to the casing, and a speed-responsive device for moving the valve.

7. In an elastic fluid turbine, the combination of a bucket wheel, a casing therefor, a governing valve, a stem for actuating and guiding the valve, means for lubricating the stem, one or more conduits which collect the motive fluid and lubricant leaking past the stem and discharge them into a casing in a region of reduced pressure, and a speed-responsive device for moving the valve.

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

RICHARD H. RICE.

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