J. WILKINSON.

GOVERNOR FOR ELASTIC TURBINES.

APPLICATION FILED DEC. 22, 1902.

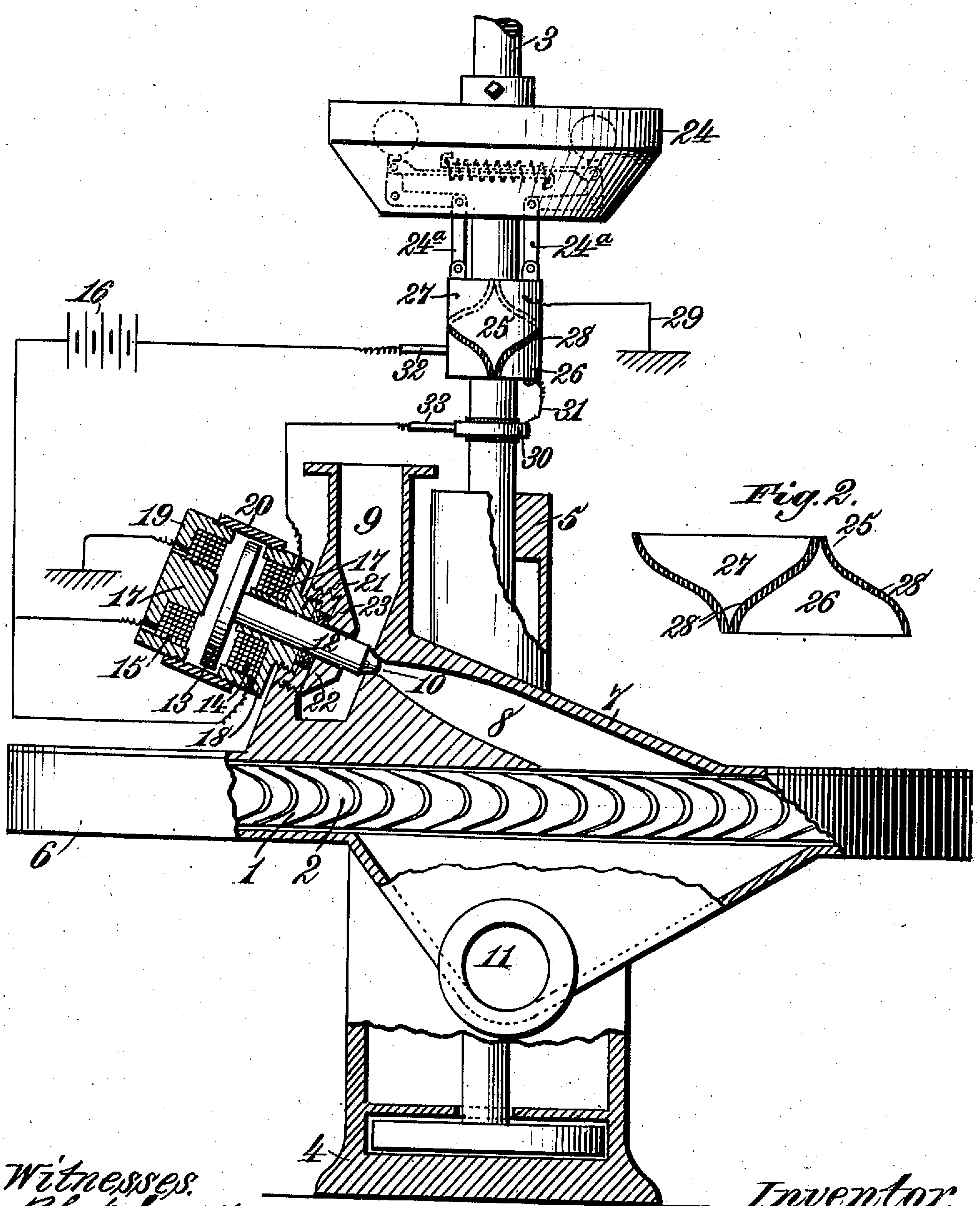
915,716.

Patented Mar. 16, 1909.

3 SHEETS—SHEET 1.

Fig. 1.

Fig. 2.



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3 SHEETS—SHEET 2.

Fig. 3.

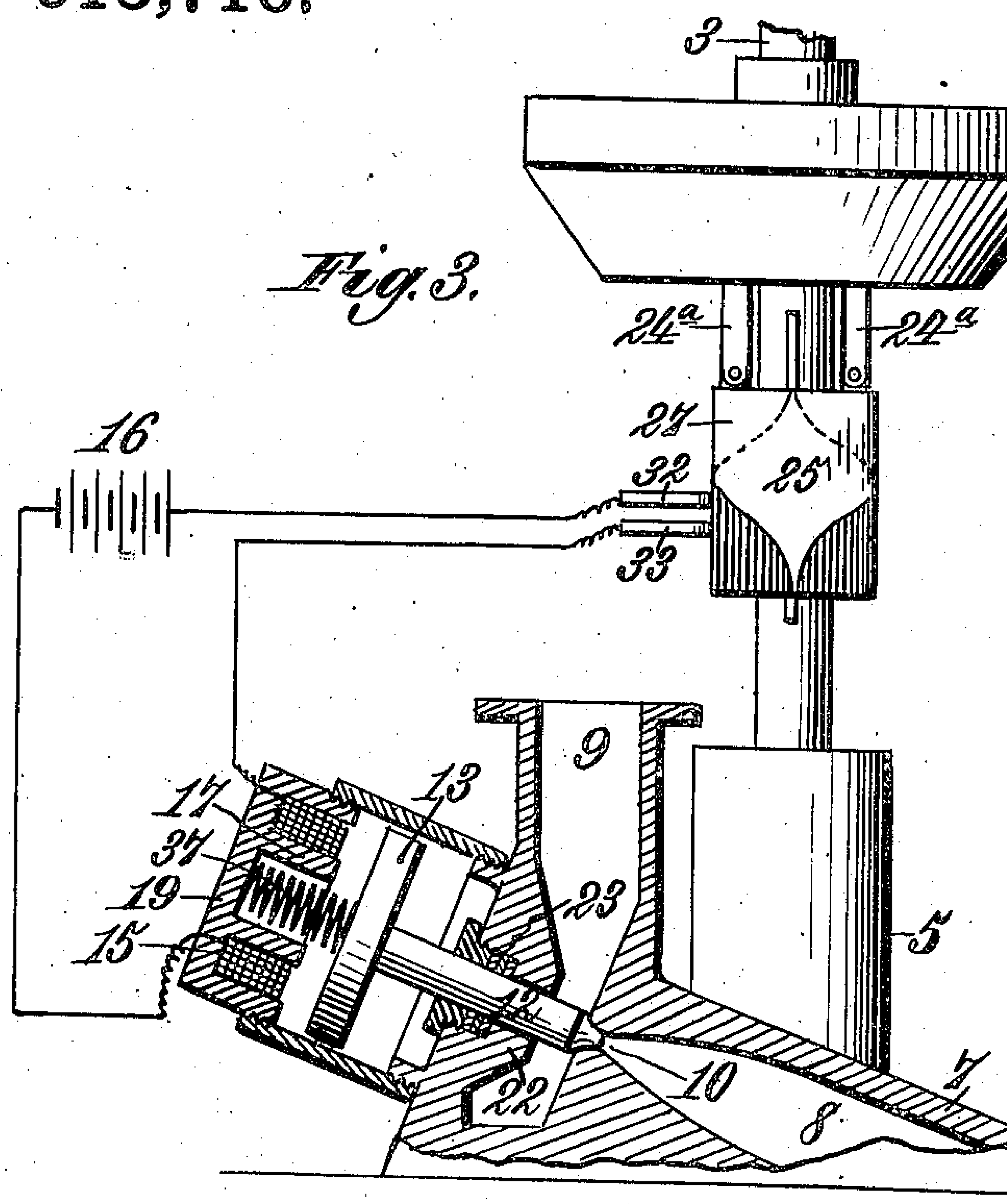


Fig. 4.

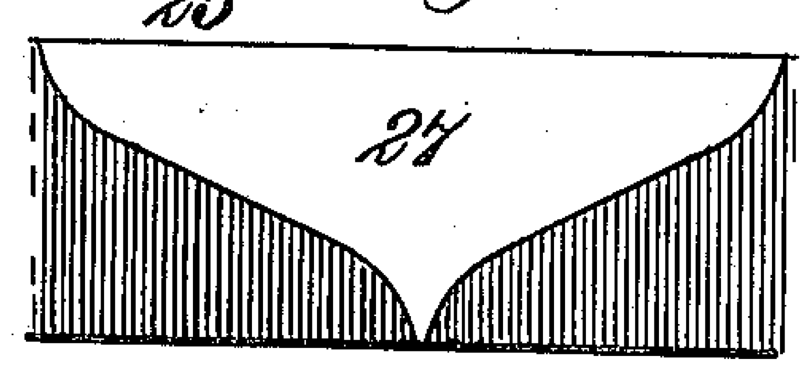


Fig. 5.

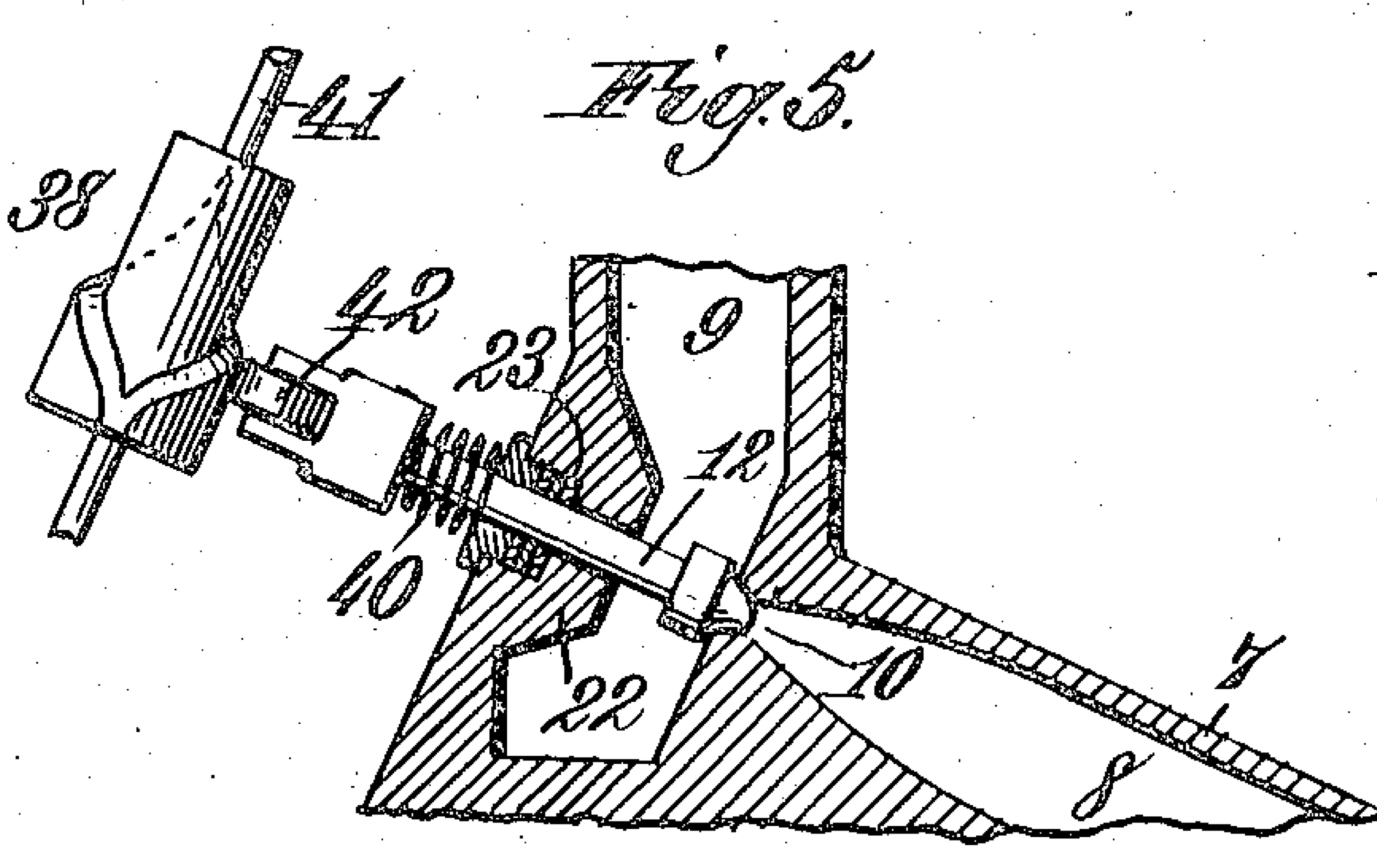


Fig. 6.

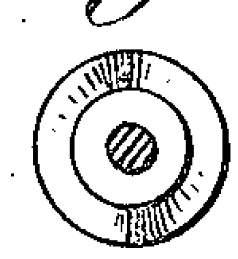
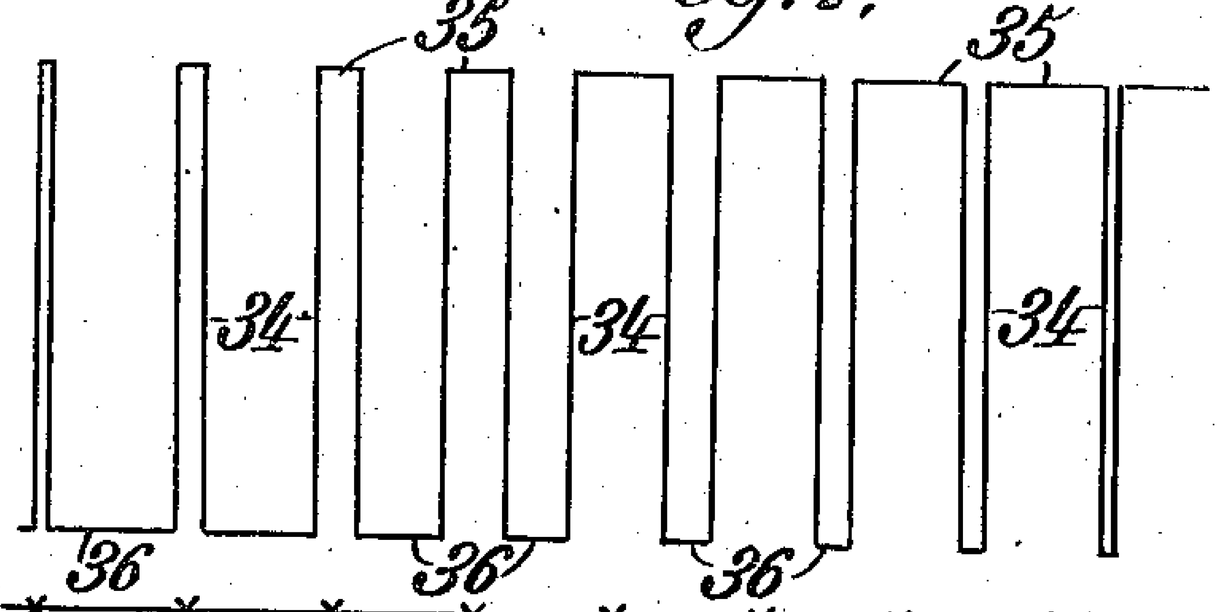


Fig. 7.



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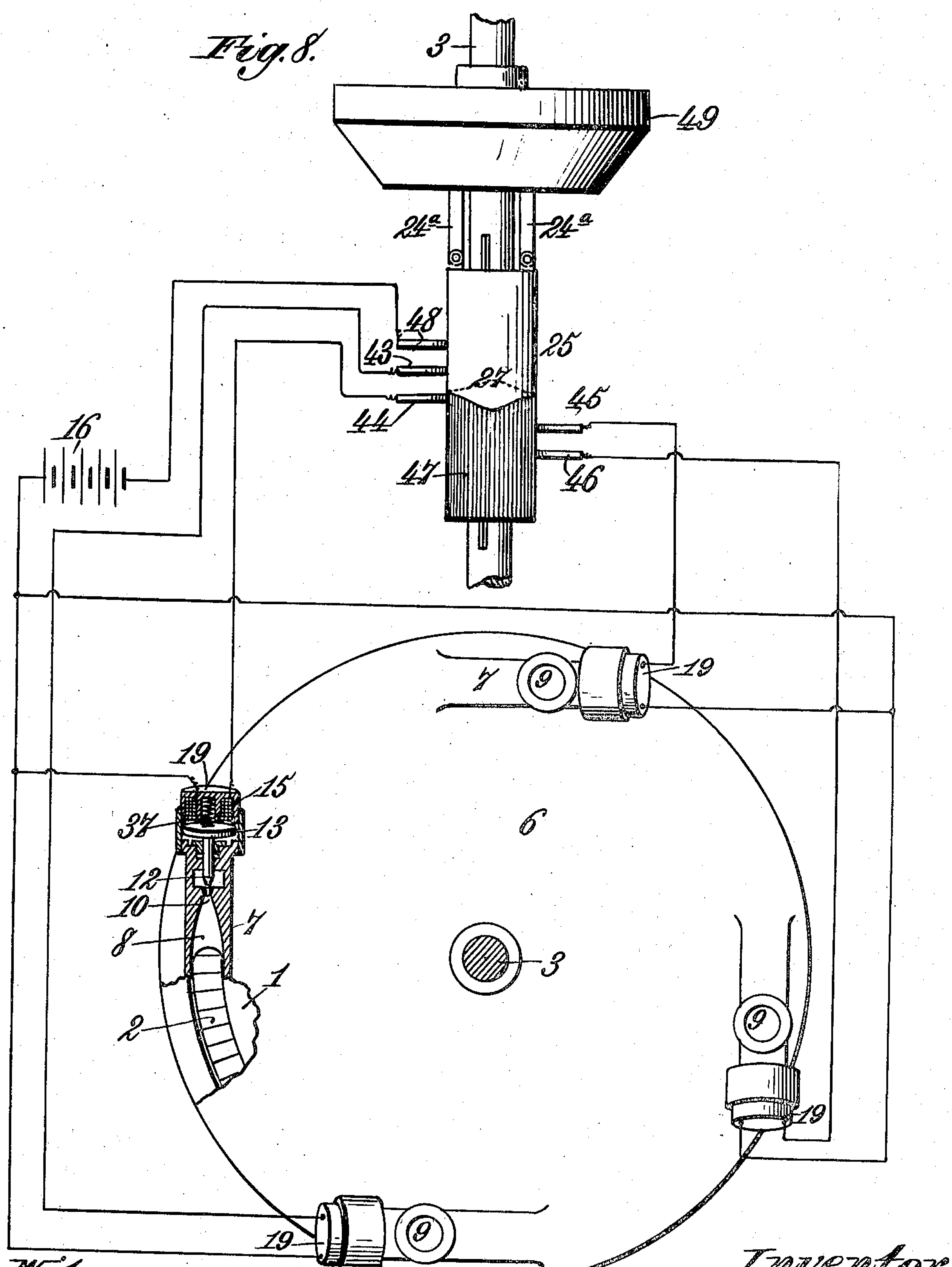
3 SHEETS—SHEET 3.

Fig. 8.



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UNITED STATES PATENT OFFICE.

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GOVERNOR FOR ELASTIC TURBINES.

No. 915,716. Specification of Letters Patent. Patented March 16, 1909.

Application filed December 22, 1902. Serial No. 136,229.

To all whom it may concern:

Be it known that I, James Wilkinson, a citizen of the United States, residing at Birmingham, in the county of Jefferson and State of Alabama, have invented certain new and useful Improvements in Governors for Elastic Turbines, of which the following is a specification.

My invention relates to an improved regulation for elastic fluid turbines in which a rotor or wheel, provided with peripheral vanes, is rotated by an elastic fluid discharged against the vanes from one or more nozzles, arranged at an acute angle to the side of the rotor.

Broadly considered, it is the purpose of my invention to vary the supply of motor fluid to the turbine in accordance with its requirements by the provision of cut off valve means which act, without throttling the fluid, to vary its periods of flow, effecting an intermittent cut off of the supply and driving the rotating element by means of intermittent blasts of fluid which deliver a mean power proportioned to the load.

According to my invention, as illustrated in its simplest form the elastic fluid is admitted to the turbine supply nozzle in pulsations or blasts by means of an oscillating valve, which is controlled in its movements by a governing mechanism, sensitive to the speed of rotation of the turbine shaft, and designed to maintain a constant speed of rotation of the shaft under varying conditions of load, by governing the periods of rest at each end of the valve's stroke. By this means, I admit to the nozzle impulses or blasts, uniform in volume because the valve opens fully each time it is oscillated, but varying in mass because the period, during which the valve is maintained thus fully opened, is regulated according to the load. These impulses of uniform volume are transformed in the nozzle into blasts of uniform velocity at the point of delivery from the nozzle, so that the efficiency of the turbine is controlled by a regulation of the mass of elastic fluid admitted, without altering its volume or the velocity at which it impinges against the vanes of the rotor. Any desired means may be utilized to effect this intermittent cut off action of the nozzle valve, such means acting either to actuate the valve directly or through the instrumentality of relay power means. Also within the scope of my invention the nozzle and valve may be of any desired construction and may be duplicated or multiplied in the same machine.

In the accompanying drawings I show several illustrative forms of valve controlling mechanism, one utilizing electro-magnets to both open and close the valve under the control of a speed governor; a second utilizing a spring and magnet to move the valve; and a third showing the direct application of power from a governor shifted cam to a valve to intermittently and fully open it for varying intervals.

As a further development of my basic idea of a pulsatory non-throttling control of the motor fluid supply to the turbine, I have adapted one of the forms of valve controlling mechanism described above to effect a part constant and part pulsatory control of the fluid supply. In other words, I may elect, instead of passing the fluid through a single or subdivided or even a plurality of nozzles and intermittently cutting off the whole supply under less than full load conditions, to vary this supply by successively opening or closing part of said nozzles and holding them open or closed while one is being intermittently cut off to provide for a fine regulation of the supply between load conditions which demand the full opening or closing of another nozzle. By this means I admit simultaneously constant and pulsatory blasts of motor fluid which are proportioned to the load, my governing mechanism having an universal control over the supply.

In the accompanying drawings illustrating my invention;—Figure 1, is a side view of a turbine, partly broken away and in section, showing my improved governing mechanism, employing two electro-magnets to effect and control the oscillation of the valve. Fig. 2, shows the contact plates on the governor collar removed therefrom and unrolled to more clearly illustrate their construction and arrangement. Fig. 3, is a modification of the governing mechanism, wherein a coiled spring is substituted for one of the electro-magnets. Fig. 4, is a plan view of the curved surface of the governor collar, broken away along a vertical line and unrolled. Fig. 5, illustrates a further method of oscillating and governing the valve by mechanical, instead of electro-magnetic means. Fig. 6, is a detail view of the cam shown in Fig. 5. Fig. 7, is a diagrammatic view to illustrate the action of the valve throughout the range of travel of the governor collar. Fig. 8, illustrates the application of my invention to a turbine having a plurality of induction nozzles, which, for convenience, is shown in plan while the shaft and governing devices are broken away and shown in elevation, with the proper electrical connections to the nozzles of the turbine.

The same reference numerals refer to the same parts throughout the drawings.

The rotor 1, with peripheral concavo-convex vanes 2, is rigidly fixed to the main turbine shaft 3, vertically disposed and suitably mounted in the frame with bearings 4 and 5. The casing 6 of the rotor has an induction nozzle 7 mounted on its upper side, near the periphery thereof, and provided with an expansion passage 8 of increasing area toward its discharge end, so disposed that it delivers the elastic fluid at an acute angle against the vanes 2. Fluid pressure from any suitable source of supply is conducted to an inlet passage 9, from which it enters the expansion passage 8 through a jet 10, and, after being directed against the rotating vanes, is exhausted through a port 11, either to the open air or to a condenser.

The construction of the turbine which may be simple or compound with a plurality of rotating rows of vanes and stationary intermediates, and the design and operation of the nozzle and other parts is of the usual character and therefore forms no essential part of my present invention, which relates more specifically, to the devices hereinafter described for producing and regulating a pulsatory feed of the elastic fluid.

The fluid pressure is admitted in impulses or blasts by means of an oscillatory cut off valve 12, with its forward end reduced to seat tightly against and close the supply end 10 of the nozzle, and having at its other end an enlarged circular head 13, which serves as an armature and is alternately attracted by the electro - magnets 14 and 15, between which it moves. Their coils are energized from a battery 16, and wound around the cores 17 of the recessed casings 18 and 19, suitably insulated from each other by a sleeve 20, of brass or other non-magnetic material, having a screw threaded engagement with the casings whereby a cylinder is formed in which the armature 13 oscillates freely. The core 17, of the casing 18, and the sleeve 21 integral therewith, have a central opening through which the valve stem passes. This sleeve is externally screw threaded for engagement within the recessed opening for the valve in the wall 22 of the inlet passage 9 opposite the supply end 10 of the nozzle. This wall is thickened and enlarged here to form a guide for the valve stem, extending inwardly toward the nozzle. I provide packing rings 23, for the valve, which are retained in position by the sleeve 21 acting as a gland.

I regulate the oscillation of the valve by a centrifugal governing device, mounted on the shaft 3, and comprising a governor 24 and a governor controller-device which, as shown in the drawings, is a collar 25, that revolves with the shaft and is shifted endwise upon it by the action of the governor weights through the connecting arms 24ª. Upon the surface of this collar and suitably insulated therefrom, are two tapered contact plates 26 and 27, which run to a point at one end and at the other nearly encircle the collar. They are similarly shaped and inversely placed on the collar, as will appear by reference to Fig. 2, and have a strip of insulation 28 between their abutting edges, so that they form a two-part sleeve with tapering lines of insulation passing in opposite directions from a point on the lower edge of the collar to a diametrically opposite point on the upper edge thereof.

The plate 27 is machine grounded by wire 29, and a collector ring 30, fixed to the shaft 3 from which it is suitably insulated, is electrically connected to plate 26, by a wire 31. The battery 16 has one pole connected to a stationary contact brush 32 engaging the collar 25, the other pole having a split circuit, one side leading through magnet coil 15, machine ground and wire 29 to plate 27, the other side leading through magnet coil 14, brush 33 in circuit therewith and engaging the collector ring 30, and wire 31 to plate 26. When brush 32 engages contact plate 27, the electro-magnet 15 will be placed in circuit with the battery and energized, while the magnet 14 is not in circuit which is broken at plate 26, therefore the armature 13 is attracted to magnet 15 carrying with it the valve 12 and opening the jet 10, so that pressure is admitted to the nozzle 7 from the passage 9. On the other hand, when brush 32 engages contact plate 26, as shown in the drawing, the circuit will be through magnet 14, which will attract the armature and seat the valve.

As the rotor revolves, driven by the fluid pressure delivered against its vanes from the nozzle, the collar 25 and its governing mechanism will turn with the shaft 3, and brush 32 will alternately engage the contact plates 26 and 27, causing the battery to energize the magnets 14 and 15 in turn. It is therefore evident that the valve, through its armature 13, will be moved back and forth between these magnets once during each complete revolution of the governing device, alternately opening and closing the nozzle 10 and admitting thereto impulses or blasts of fluid pressure.

Since the valve is designed to open fully each time its armature is attracted by the magnet 15, it can have no electrically controlled intermediate positions which would wire draw the fluid admitted, hence the blasts will maintain an uniform volume in the nozzle passage, varying only with the pressure under which the fluid enters the jet, and therefore will be delivered at an uniform velocity against the rotor.

To maintain a constant speed of rotation of the turbine shaft under varying conditions of load, the periods of rest of the valve at each end of its stroke are automatically regulated by shifting the collar 25, and its contact plates, with relation to the stationary brush 32. This movement of the collar is effected by the centrifugal governor 24 in the manner hereinbefore described. Regarding 14 and 15 respectively as the valve closing and opening magnets, it is evident that the periods of rest and flow of the elastic fluid governed by the movements of the valve will correspond to the periods of excitation of these magnets during a revolution or cycle of the governing mechanism. If the turbine be running at a high speed under a light load, the governor will raise the collar 25 until brush 32 remains, during the greater portion of each revolution, in contact with the plate 26, hence the battery will energize the valve closing magnet for periods between which blasts of a minimum duration only will be admitted. Under a heavy load, the action is reversed and as the collar is lowered by the governor, the brush remains in contact with the plate 27 during increasing portions of each revolution, so that the valve opening magnet is energized for proportionately longer periods, until, under full load conditions, the magnet will be continuously energized and the valve held continuously open. Thus the impulses increase in duration relatively to the load, but since their volume and the proportions of the expansion passage 8 are unvarying, they will be delivered against the rotor at an uniform velocity.

In Fig. 7, a diagram illustrates the action of the valve throughout the range of travel of the governor collar, the height of the vertical lines 34 denoting volume and velocity of the impulses, the upper horizontal lines 35, the periods of fluid pressure activity during which the valve is open, and the lower horizontal lines 36 the periods of inactivity of the fluid pressure during which the valve is closed. The cycles or periods of complete revolution of the governing mechanism with relation to the valve's action are indicated on a horizontal line x—x below the diagram.

In Fig. 3 I show a modified arrangement for oscillating the valve by means of one electro-magnet 15, as in Fig. 1, which acts against a coiled spring 37, seated in a recess therefor in the core 17, to open the valve. Here the collector ring 30, is dispensed with and brushes 32 and 33 both engage the governor collar 25, which has a single contact plate 27. When these brushes are in contact with this plate, the battery circuit is closed through the magnet 15 and valve 12 is opened, compressing the spring 37, which seats the valve as soon as the magnet is deenergized. Obviously the spring may be substituted for the valve closing magnet 14 as well, without varying the operation of the regulating deviecs.

In Fig. 5 a governor controlled elongated cone 38 oscillates the valve against the action of a coiled spring 40, which normally maintains it in an open position. The cam shaft 41 is mechanically driven by the main turbine shaft 3, and the valve stem 12 may have an anti-friction roller 42, mounted in an enlarged head on said stem, to engage the cam. The shouldered portion of the cam is of uniform diameter and is designed so that as the cam or the stem 12 are adjusted relatively by the governor, the stem will be given an uniform oscillatory travel, being held in its valve open or valve closed position for periods which vary according to the relative point of engagement between it and the cam. Within the scope of my invention the governor may be called upon to adjust either part relatively to the other.

Fig. 8 shows my invention applied to a turbine provided with a series of expansion nozzles 7, having their valves oscillated preferably as shown in Fig. 3. Since it is desirable to regulate but one of the nozzles at a time, I vary the construction of the governor controlled collar 25, by elongating it sufficiently for the various contact brushes 43, 44, 45 and 46, to be so spaced that but one of them at a time shall engage the tapering end of the contact plate 27, the other brushes remaining continuously in engagement with either the insulated base 47, or the plate 27 above its taper. The battery brush 48 is arranged to continuously engage the contact plate 27. Thus as shown in the drawing, the brushes 43 and 44 maintain their respective valves continuously open, brush 45 oscillates the valve controlled thereby to regulate the turbine, and brush 46 maintains its valve continuously closed. By these means it is evident that I secure a combined regulation of constant and pulsatory blasts, for, as the governor collar moves up or down under variations in the load and consequent variations in the speed, it will throw on a greater or less number of constant blasts, which correspond to stated points of regulation determined by the power the nozzles are designed to deliver, and all variations intermediate these points will be compensated in the universal governor control of the oscillatory blast. Thus, if the nozzles be proportioned to deliver twenty horse power and the load be at 55 horse power, then two constant blasts will furnish 40 horse power and the governing mechanism will so control the duration of the blasts admitted by a pulsatory nozzle that it delivers the necessary 15 horse power to complete the required amount. Under these conditions, each stated point of regulation represents twenty horse power, intermediate which there is a regulation which moves continuously and acts universally, serving to bridge over from one stated point to another during variations in load. The governor 49 is constructed so that it can shift the elongated collar 25 and bring each of the brushes in turn in engagement with the taper of plate 27, when the turbine is acting under loads varying from a maximum to a minimum. At full load, the mechanism may be so arranged that it holds all the nozzles permanently open, and, when the load is off, permanently closed. The collar has, therefore, universal stationary operating positions throughout its range of travel, for at every point it will regulate the admission of pressure in exact proportion to the load, consequently it will have no dead points in its travel where it is not directly controlling the quantity of fluid admitted. The collar is adapted to move continuously in one direction during a gradually increasing load, and continuously in the opposite direction during a slowly decreasing load, whereas the tendency of other governing mechanisms is to move with varying rates of speed progression or with a step by step advance with the load.

The advantages secured by a regulation of the character described are too obvious to require further emphasis.

If desired the governing mechanism may be mounted on a counter shaft and rotated by suitable speed reducing gearing driven from the main shaft 3 of the turbine. By this means the action of the valve can be more accurately regulated. I also desire to reserve the right of substituting a solenoid, which moves the valve stem as its core, for the electro-magnet and its armature as shown in the drawings. If it is desired to provide the turbine with two or more rows of peripheral vanes, then the pressure of the elastic fluid should be only partly converted into velocity in the nozzle.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is:—

1. An elastic fluid turbine having a rotating element and a pulsating supply of motive fluid delivered at uniform velocity thereto, in combination with an impulse controlling regulating mechanism.

2. In an elastic fluid turbine, means to pulsate the fluid supply so as to materially vary its volume without affecting its velocity, and a governor controlling said means.

3. In an elastic fluid turbine, an induction nozzle means to vary the periods of flow of the motive fluid through said nozzle while maintaining the velocity of the fluid's efflux from said nozzle uniform, and a rotary element driven by said fluid.

4. In an elastic fluid turbine having a pulsatory supply of motive fluid, means to control the pulsations according to the load without affecting their velocity, and a rotary element driven by said fluid.

5. In an elastic fluid turbine, a nozzle in which the pressure of the fluid is converted into velocity by expansion, means to open and close said nozzle, and a governing device periodically actuating said means and opening said nozzle for periods varying with the load.

6. In an elastic fluid turbine having a constant supply of motive fluid under a full load, a nozzle, and governor controlled means having uniform movements at varying intervals to interrupt the flow of fluid through said nozzle when the load decreases, in combination with a rotatable bucket element adapted to be driven by said fluid.

7. In an elastic fluid turbine having a constant supply of motive fluid under full load, a nozzle, a valve having intermittent uniform opening movements to pulsate the fluid supply to said nozzle when the load decreases, and means to control the movements of said valve in accordance with the load, in combination with a rotatable bucket element adapted to be driven by said fluid.

8. In an elastic fluid turbine, an induction nozzle, a valve therefor, and means to intermittently actuate said valve to fully open and close said nozzle for all intermediate load conditions and pulsate a fluid supply without varying its velocity, in combination with a rotatable bucket element adapted to be driven by said fluid.

9. In an elastic fluid turbine an induction nozzle, an oscillatory valve admitting to said nozzle fluid pressure in pulsations of uniform volume and means to control the movements of said valve, in combination with a rotatable bucket element adapted to be driven by said fluid.

10. In an elastic fluid turbine an induction nozzle, an oscillating valve admitting fluid pressure in pulsations of uniform volume to said nozzle, and means to regulate the turbine by governing the periods of rest at each end of the valve's stroke according to the load, in combination with a rotatable bucket element adapted to be driven by said fluid.

11. In an elastic fluid turbine a nozzle and electro magnetic means to vary the periods of flow of the motor fluid supplied to said nozzle without affecting said fluid's velocity.

12. In an elastic fluid turbine a nozzle, an electrically oscillated valve having only opened and closed operating positions, and means sensitive to variations in the turbine's load to control the movements of said valve.

13. The combination with an elastic fluid turbine, of a nozzle, an oscillating valve admitting impulses of fluid pressure at an uniform volume to said nozzle, a governor, and electro-magnetic means controlled thereby to govern the periods of rest at each end of the valve's stroke.

14. The combination of an elastic fluid turbine, a nozzle, an oscillating valve admitting impulses of fluid pressure at an uniform volume to said nozzle, a governor, and electro-magnetic means controlled thereby to oscillate said valve and govern the periods of rest and flow of the elastic fluid according to the load, substantially as set forth.

15. The combination with an elastic fluid turbine, of an induction nozzle, an oscillating valve admitting impulses of fluid pressure at an uniform volume to said nozzle, a governor, and means controlled thereby and adapted to open said valve fully once during each cycle of action of the governing mechanism and maintain it open for a period of time varying according to the load, substantially as set forth.

16. The combination with an elastic fluid turbine, of an induction nozzle, an oscillating valve admitting impulses of fluid pressure at an uniform volume to said nozzle, a governor and electro-magnetic means controlled thereby for governing the periods of rest and flow of the elastic fluid according to the load, comprising two electro-magnets between which the valve stem oscillates as an armature, a battery and circuit connections to said magnets which are alternately broken and closed by the governor, substantially as set forth.

17. A regulating mechanism for turbines having a pulsatory feed of elastic fluid, comprising a valve, electro-magnets to oscillate said valve, a source of electrical energy and circuit connections therefrom through stationary brushes and governor shifted tapering contact plates, whereby each magnet is alternately energized during each revolution of the governor, remaining in circuit for a period which will vary the duration of the impulses according to the load, substantially as set forth.

18. A regulating mechanism for turbines having a pulsatory feed of elastic fluid, comprising a speed controlled governor, an oscillating valve, a battery, an electro-magnet suitably energized thereby and adapted to attract said valve to open it, means whereby the circuit is closed through said magnet a portion of each revolution of the governing mechanism varying according to the load, and means to seat said valve when the circuit is broken, substantially as set forth.

19. A regulating mechanism for turbines having a pulsatory feed of elastic fluid, comprising an oscillating valve, an electro-magnet which attracts said valve as an armature to open it, a battery and circuit connections therefrom to said magnet through stationary brushes, a governor, a controller device revolving with said governor and vertically shifted thereby, a tapering contact plate mounted on said controller device which engages said brushes once each revolution closing the circuit to said magnet and opening the valve to admit impulses of fluid pressure, which vary in duration according to the relative position of said controller device to said brushes, and means to seat said valve when the circuit is broken, substantially as set forth.

20. In an elastic fluid turbine, a governing or regulating mechanism adapted to admit contemporaneously constant and pulsatory blasts of elastic fluid, which are proportioned to the load and used to develop mechanical power.

21. In an elastic fluid turbine having nozzle passages and valves therefor, a governing mechanism comprising a governor, means for operating said valves and a controller device moved by said governor, which actuates part of said valve operating means intermittently according to slight variations in the load.

22. In an elastic fluid turbine, a governing mechanism for controlling the admission of fluid pressure to a plurality of nozzles comprising means for admitting constant supply of fluid according to the load and a pulsatory supply varying in proportion to slight variations in the load.

23. In an elastic fluid turbine, a governing mechanism for controlling the admission of fluid pressure to a plurality of nozzles comprising means for admitting blasts uniform in volume to said nozzles and means to maintain a part of them open according to the load and part pulsatory according to slight variations in the load.

24. In an elastic fluid turbine, a plurality of nozzle passages, valves controlling the admission of pressure thereto, and a governing mechanism which oscillates a part of said valves to admit pulsations of fluid pressure which vary in duration with variations in speed, while it maintains the rest of said passages open or closed according to the load.

25. In an elastic fluid turbine, a plurality of nozzles, a valve for each nozzle, and means controlled sensitive to the speed of the turbine for progressively oscillating a part of said valves while it leaves the rest open or closed according to the load.

26. In a turbine, a controller mechanism comprising one or more supply valves, and a controller device therefor which presents a gradually varying portion thereof, as the load on the turbine varies, to the valve operating means which act responsive there-

to to hold said valve or valves fully open for gradually varying portions of each cycle of action of said mechanism.

27. In an elastic fluid turbine, a plurality of nozzles, a valve in each nozzle, a speed governor, and electro-magnetic means controlled thereby for oscillating a part of said valves and maintaining the rest open or closed according to the load.

28. In an elastic fluid turbine, a plurality of nozzles, valves for said nozzles, and speed governing mechanism for sweeping said valves open or closed as the load is thrown on or off, and for oscillating a part of said valves during a constant or slowly changing load.

29. In an elastic fluid turbine an induction nozzle, and a governing mechanism comprising a governor, means having only an open and closed position controlling the admission of fluid to said nozzle, and a governor shifted rotating controller device for said means.

30. In an elastic fluid turbine, a rotating member, stationary fluid supply passages, governor controlled valves controlling the admission of fluid pressure to said passages, and a governing mechanism that changes the position of its valve controller device proportionally and synchronously with all variations of load.

31. In an elastic fluid turbine, a plurality of induction nozzles, means to open and close said nozzles, and a regulating mechanism maintaining a continuous control over all said means and intermittently actuating a part of them.

32. In an elastic fluid turbine, a valve controlled induction nozzle, and a governing mechanism comprising a controller device, means actuating said device in continuous cycles of action, and means to actuate said valve with an uniform travel which are operatively energized by engagement with said controller device during varying portions of its successive cycles under a varying turbine load.

33. In an elastic fluid turbine, a plurality of induction nozzles, means to cut-off the flow of fluid through said nozzles, a rotating controller device constructed to intermittently actuate a part of said means during portions of its cycles of action, and means to rotate said device and adjust it and said nozzle opening means relatively to each other.

34. In an elastic fluid turbine having a plurality of induction nozzles, means to open and close said nozzles, and a governing mechanism comprising a controller device which engages all said means and controls them at full load to maintain the nozzles constantly open, and means sensitive to variations in the load to move an interrupting element into intermittent engagement with part of said nozzle opening means.

35. In a governing system, the combination of a rotary element, nozzles and valves therefor, with electric operating means for the valves, and a contact device capable of simultaneously energizing all the valve opening means at full load, and means for automatically actuating said contact device to intermittently energize each valve opening means in turn before cutting it out of circuit as the load decreases.

36. In a governing system, the combination of a turbine wheel, a nozzle admitting pressure thereto, a governor controlled valve for said nozzle, and a controller device which has a continuous tapering controller portion and which imparts to said valve full opening and closing movements to vary the total volume of fluid delivered to said wheel without affecting its velocity.

37. In a governing system, the combination of a turbine wheel, a plurality of nozzles admitting pressure thereto, a governor controlled valve for each nozzle, and a tapered rotating controller device shifted by said governor and adapted to oscillate said valves, to fully open and close said nozzles.

38. In a governing mechanism for turbines, a plurality of valve controlled fluid admission passages, valve operating means, and a governing device for controlling said means which moves in accordance with variations in the load and intermittently operates a part of said means while maintaining the rest passively under control.

39. In a governing mechanism for an elastic fluid turbine, a speed governor, a valve controller device, a valve adapted to be actuated through the instrumentality of said device and given movements of uniform travel at time intervals variable with the load.

In testimony whereof I affix my signature in presence of two witnesses.

JAMES WILKINSON.

Witnesses:

R. D. JOHNSTON,

R. D. JOHNSTON, Jr.