No. 768,116. PATENTED AUG. 23, 1904.

B. M. DUTTON.

STEAM TURBINE.

APPLICATION FILED OCT. 7, 1903.

NO MODEL. 3 SHEETS—SHEET 1.

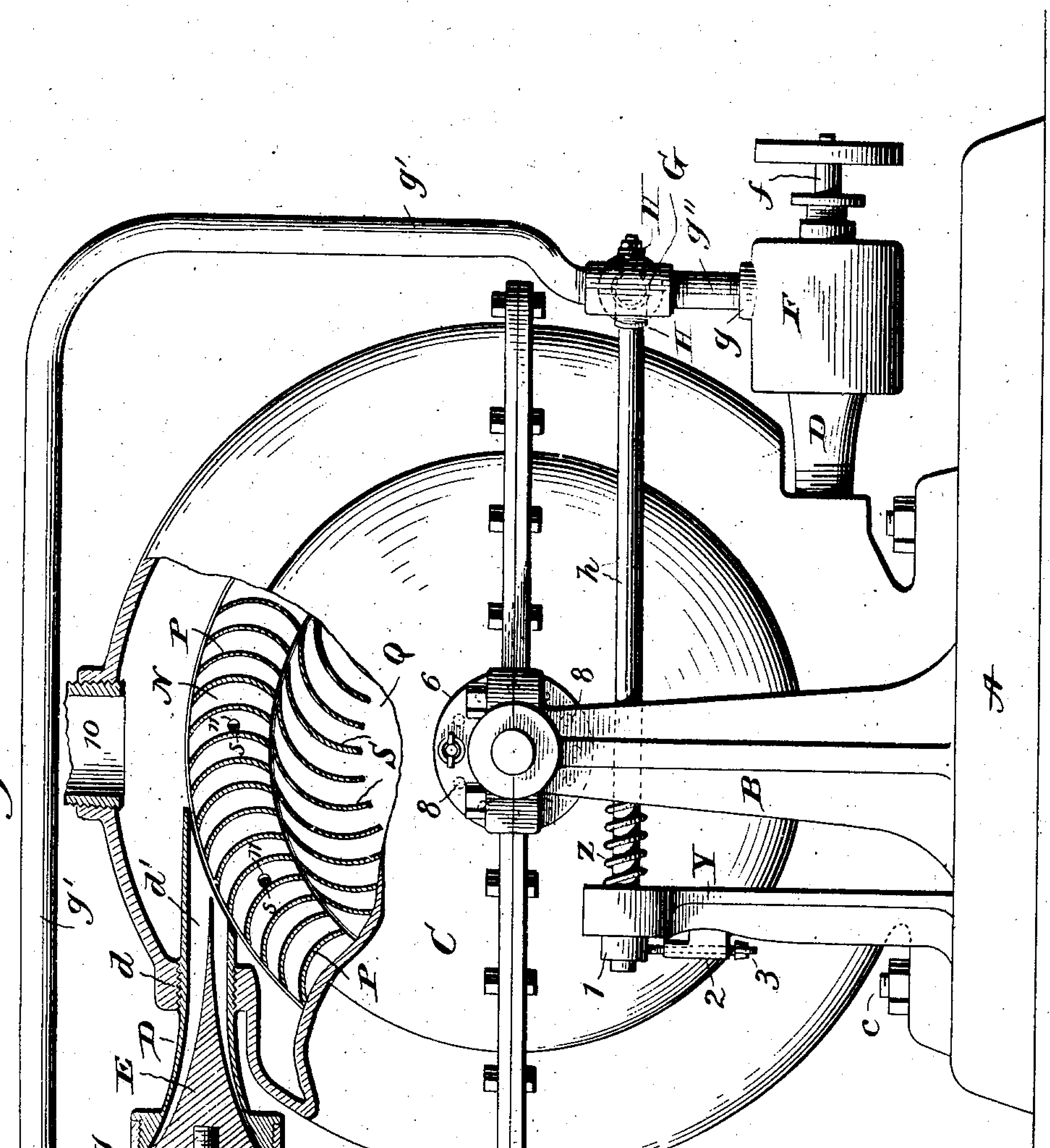

Fig. 1.

Witnesses:

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3 SHEETS—SHEET 2.

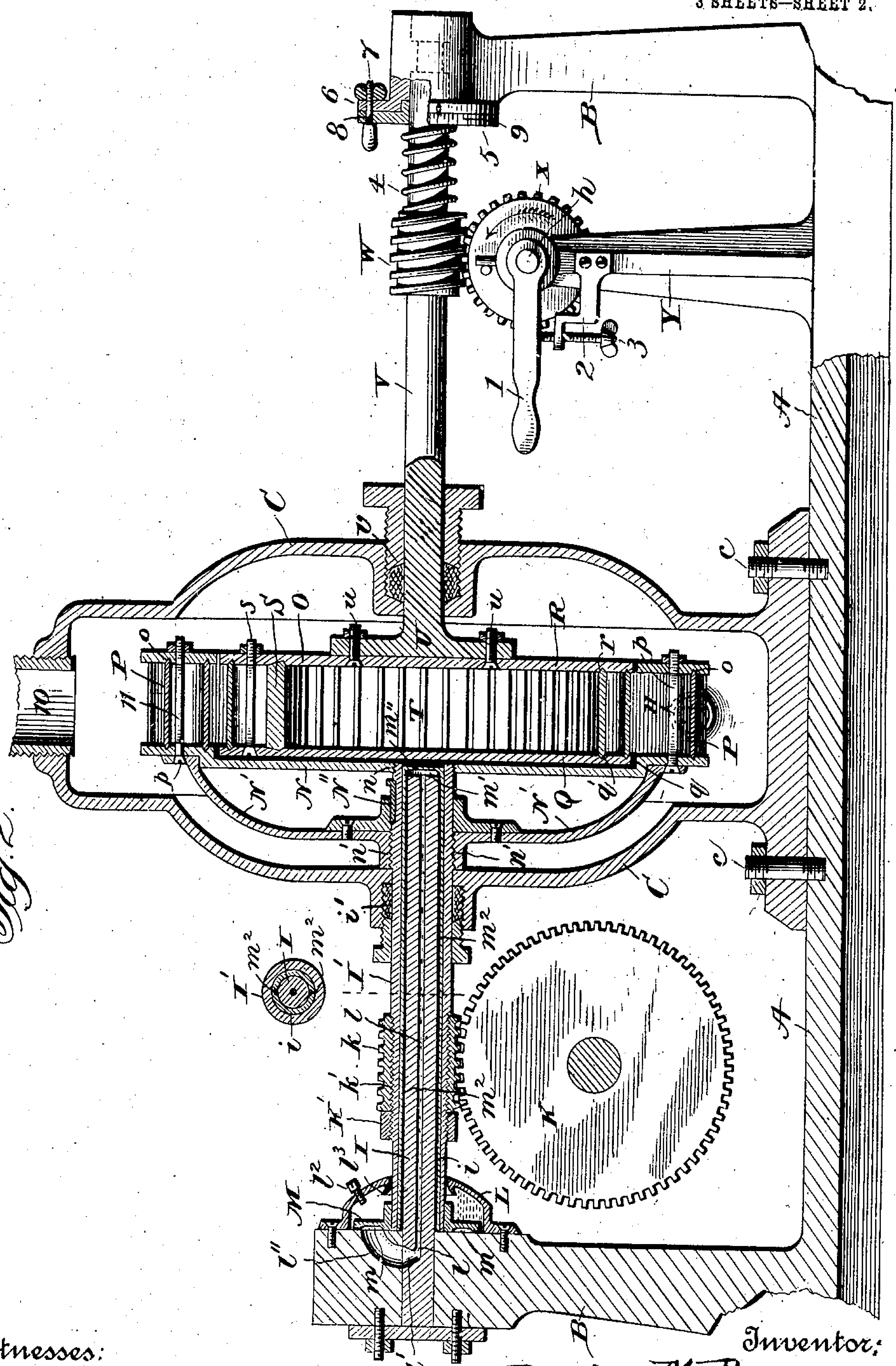

Fig. 2

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NO MODEL. 3 SHEETS—SHEET 3.

Fig. 3.

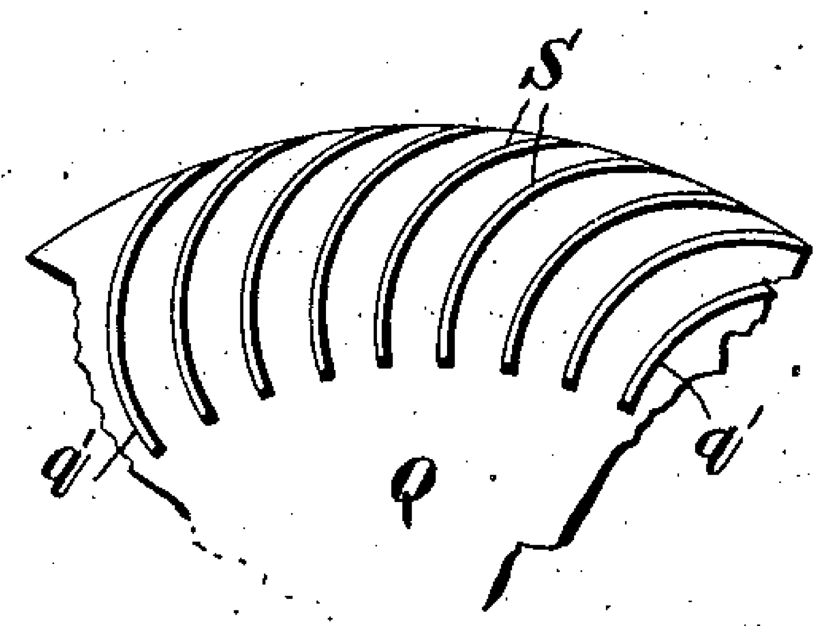

Fig. 4.

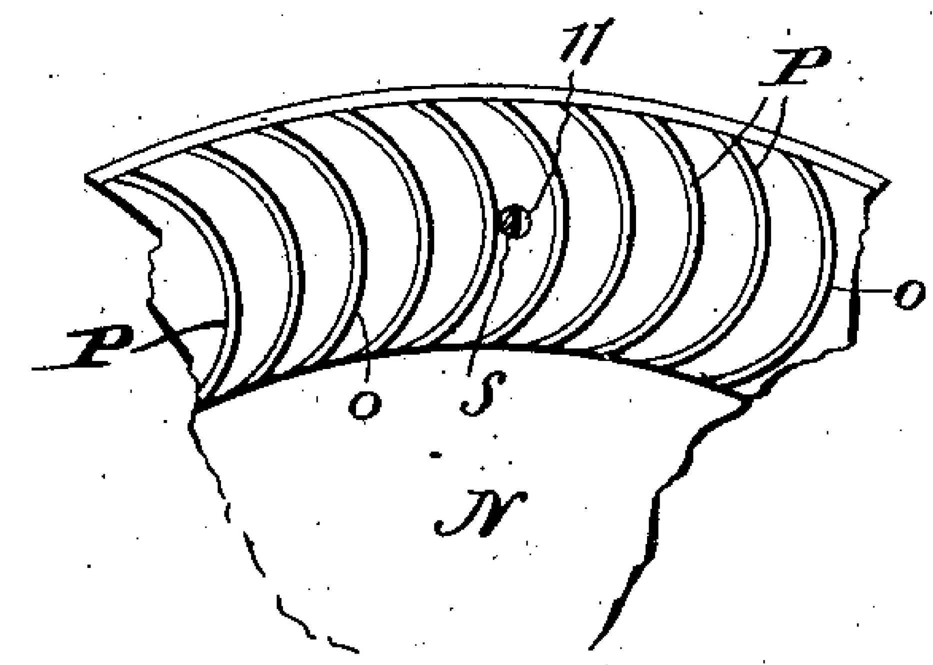

Fig. 5.

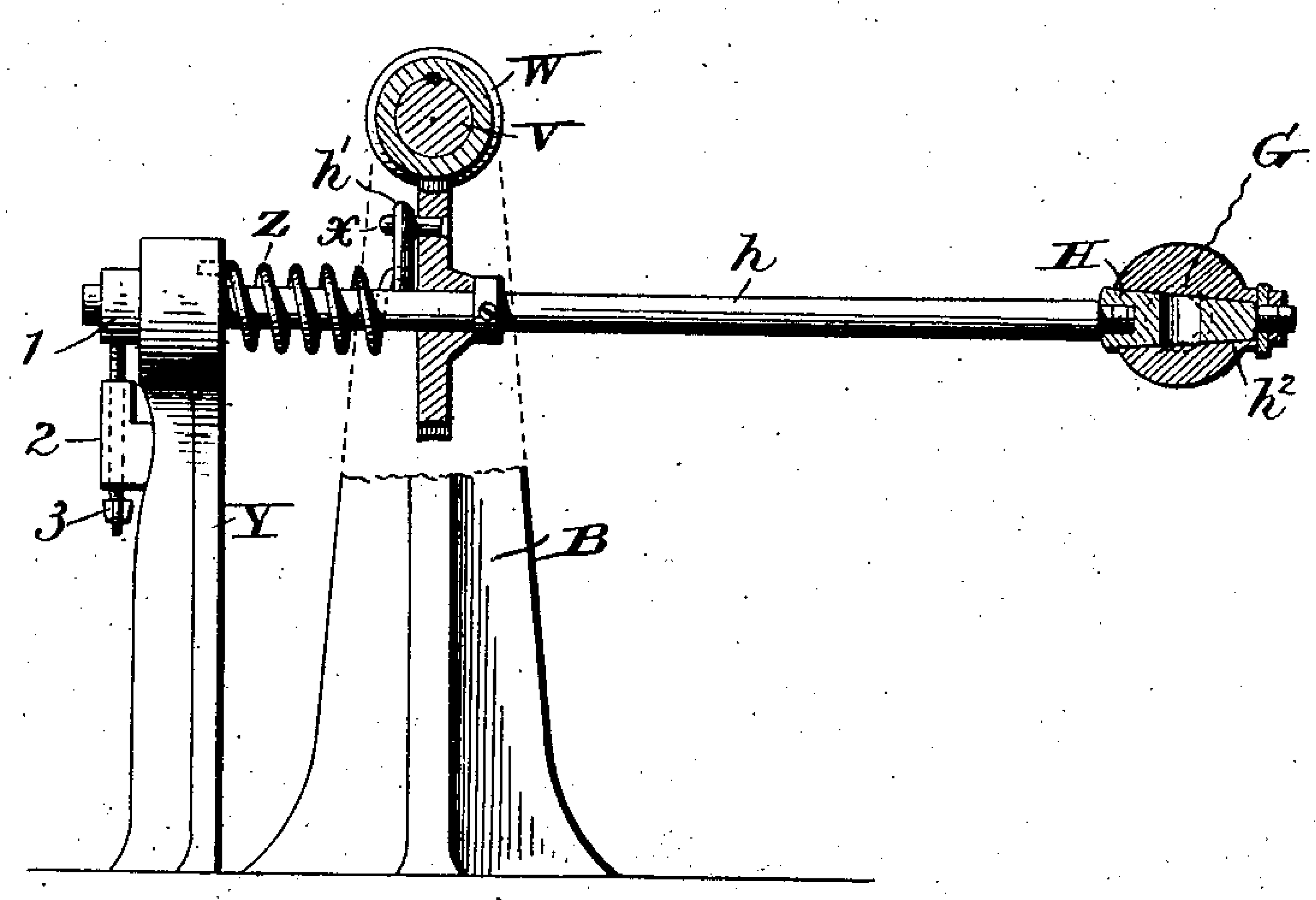

Fig. 6.

Witnesses:
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No. 768,116. Patented August 23, 1904.

UNITED STATES PATENT OFFICE.

BURTON M. DUTTON, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR OF ONE-HALF TO W. L. COOK, OF PHILADELPHIA, PENNSYLVANIA.

STEAM-TURBINE.

SPECIFICATION forming part of Letters Patent No. 768,116, dated August 23, 1904.

Application filed October 7, 1903. Serial No. 176,103. (No model.)

To all whom it may concern:

Be it known that I, BURTON M. DUTTON, a citizen of United States, residing at Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented certain new and useful Improvements in Steam-Turbines, of which the following is a specification, reference being had therein to the accompanying drawings.

This invention relates to a rotary turbine or impact-engine adapted to receive its impulse from the impact of a working fluid, the same being designed more particularly for the utilization of steam.

The invention comprehends a turbine provided with a rotatable member and its operatively associated parts so arranged that said member will receive both the initial or primary and a secondary impact from the working fluid.

The invention also contemplates, in combination with the rotary member above mentioned, the provision of an inner deflecting member arranged therewithin, and preferably an automatically-operable governor connected with said deflecting member.

The invention still further embraces a novel type of nozzle the peculiar characteristics of which render the use of the same especially advantageous in a turbine of the character herein defined.

The novel details in the construction and arrangement of the several parts of the turbine will be apparent from the detailed description hereinafter when read in connection with the accompanying drawings, forming part hereof, and wherein a convenient embodiment of the invention is illustrated. It is, however, to be understood that in any future interpretation as to the scope of the invention the same is in no sense to be limited to any structural elements which may be shown or described, excepting in so far as any such may be specifically included in the hereto-appended claims, the disclosures made herein being simply for the purpose of facilitating the impartation of a full understanding of the invention and it being obvious that many changes and alterations may be made without in the least departing from the spirit of the invention.

In the drawings, Figure 1 is an elevation of the turbine, a part of the casing being broken away and the nozzle being shown in vertical longitudinal section. Fig. 2 is a transverse vertical section taken through the center of the machine. Figs. 3 and 4 are segments respectively illustrating in a fragmentary manner the supporting-disks for the impact-blades of the inner and outer members, the blades in each instance being shown in section. Fig. 5 is an end view of the governor, parts being shown in section and others broken away, also showing in section the supply-pipe for the working fluid and the valve therein; and Fig. 6 is a detail perspective.

Referring more specifically to the drawings, A designates a supporting base or platform, and B standards projecting upwardly therefrom, C representing the casing of the turbine bolted at c or otherwise secured to the base A, said casing being relatively flat and of substantially circular contour. The casing at points adjacent to its top and bottom and at opposite sides thereof is provided with interiorly-threaded bores *d* for the reception of correspondingly exteriorly threaded nozzles D, the latter constituting inlets for the steam. A specific description of one of the nozzles will suffice for both. From the section in Fig. 1 it will be seen that the nozzle D is bored, as at *d'*, with a progressively-decreasing curvature, commencing at a point approximately at right angles to the axis of the nozzle and terminating in a plane parallel with said axis, whereby the bore gradually diminishes from its inlet to its discharge end. Adapted to be reciprocated within the bore just described is a conical-shaped plug or valve E, the base of which in cross-section is equal to and preferably slightly greater than the greatest cross-section of the bore *d'* and its surface graduating to a point slightly in the rear of the smallest cross-section of said bore. The greater tapering of the plug or valve relative to the bore of the nozzle leaves an annular passage-way therebetween.

F is a valve-casing through which an adjustable screw-threaded operating-stem *f* for the plug or valve passes, the valve-casing of both nozzles being provided with inlet-openings g in communication with the respective branches g' g'' of a steam-supply pipe G, running from the boiler. (Not shown.) I provide the supply-pipes G with a regulating-valve H, which is in the nature of an ordinary turning plug provided with an operating-stem h, this valve to be reverted to hereinafter.

When the conical valve or plug E is thrust forwardly by means of its operating-stem f, the same acts to close the ingress of the working fluid to the nozzle, the reverse movement of the valve opening the annular passage therearound, permitting ingress of the working fluid into such passage. The annular passage, as shown, is relatively narrow in cross-section at its inlet end and widens toward its discharge end; but by reason of its greater diameter at its inlet end the aggregate area at this end is greater than obtains at its outlet end, thus furnishing a path of exit for the compressed working fluid by which the lateral stress or pressure in such fluid is deflected by contact with the curved walls of the nozzle to the line of spouting. As this lateral stress of the fluid is thus deflected it results in an accelerated velocity of the outflow, which in turn results in the narrowing of the area required for such flow, inasmuch as the peculiar formation of the nozzle confines the fluid to a solid jet which will produce an impact conserving almost the entire energy of compression upon the line of spouting, whereby more efficient energy transference is secured.

I is a stub-axle secured against rotation to the standard B at the left of the machine, Fig. 2, and projecting inwardly from said standard, and I' is a rotatable shaft having an interior sleeve or bushing i surrounding the stub-axle, this shaft being the driven shaft of the turbine and projecting at its inner end into the casing C of the turbine through a stuffing-box i'. The driven shaft may impart motion to any desirable mechanism, simply a convenient connection therefor being shown, the same including a gear-wheel K, arranged to be engaged by a spiral screw or worm k, slipped over the outer end of the shaft I' and engaged therewith through the instrumentality of the threaded connection k', the worm being locked in position by a nut K', also slipped over the end of the shaft and threaded thereto.

To afford a suitable means of lubrication, the stub-shaft I is bored longitudinally, as at l, the inner end of said bore communicating with an upwardly-extending funnel or mouth l', which in turn registers with an oil-duct l'' in the upper end of the standard B.

L is an oil-cup secured to the upright provided with a plugged fill-opening l^2, said cup being adapted to receive oil up to approximately the level shown, an inturned flange l''' preventing exit of oil from the cup around the shaft I. Secured to the shaft, so as to rotate therewith, is a plate M, provided with pockets m in the face thereof which opposes the inner face of the standard B, said pockets being arranged in circular series and adapted to register with the oil-duct l'', whereby the plate when rotating with the shaft will carry a quantity of oil from the lower portion of the cup L up to and discharge the same in the oil-duct. The bore l in the stub-axle I opens at its inner end into a chamber m', situated between the end of the stub-axle and the closed end m'' of the rotary shaft I'. From this chamber the oil feeds over the working surface of the stub-axle through the longitudinal grooves m^2 in the bushing i.

Upon the end of the shaft I' and within the casing C, I mount a disk N, the same being secured to the shaft, so as to rotate therewith, through the medium of a threaded coupling n, and a curved supporting-plate N', also fixed to the shaft I' against independent movement relative thereto by the threaded connection n' and spline N''. Opposite the disk N a flat ring O is arranged at a suitable distance therefrom, and fitting within semicircular grooves o in the inner faces of the disk and ring are a series of semicircular vanes or blades P, held in place by transverse bolts and nuts p engaging the curved plate N' and passing through the disk N and ring O. These vanes terminate tangentially of the periphery of the wheel, which we will term the "structure" constituted by the disk and ring, and are arranged to receive the impact of the working fluid from the nozzle D in the line of their termini, whereby such fluid is deflected to an angle of approximately one hundred and eighty degrees, or a reverse turn, by following the concave surfaces of the vanes or blades. This wheel is the active or revolving outer member of the machine. The inner member is constructed as follows: Q and R are oppositely-disposed disks arranged within the wheel or outer member, the first-mentioned disk, Q, being seated in an offset portion q of the disk N and the last-mentioned disk, R, being disposed in vertical line with the ring O, whereby the inner faces of the operating portions of the disks N and Q and the disk R and ring O are respectively flush with each other. The inner faces of the disks Q and R are provided with grooves q' and r. Curved to a quadrant and fitting within these grooves are a series of correspondingly-curved vanes or blades S, held in place by bolts and nuts s passing transversely through the disks Q and R. For supporting the inner member in proper operating relation to the other parts of the turbine a head U is secured thereto by any suitable means, preferably bolts u, and projecting from the head is a shaft V, extending through the stuffing-box v in the casing C, the outer end thereof being supported by the upright B. That the securing-bolts p and s may offer as little obstruction as possible to the working fluid passing between the various blades or vanes the intermediate portions of said bolts are flattened, as at 11, said flattened portions fitting snugly against the convexed side of the blades. The blades of both the outer and inner members are of course arranged in circular series, and the outer ends of the blades S terminate at a tangent reverse of that of the inner ends of the blades P of the outer member. The inner ends of said blades S converge into the radii of the circle in which they are set. The disks Q and R of the inner member are solid and constitute and inclose an interior centrally-located chamber T, into which the inflow of fluid is forced by the energy it may contain after the initial impact with the outer member. This inflow is conducted radially inward by deflection with the static blades of the inner member (it being understood that the inner member is normally stationary) and converging to the center creates a compression commensurate with its velocity, resulting in an outflow in all drections. The outflow in turn is deflected by contact with the inner vanes, so as to direct the flow tangentially to the inner termini of the active vanes P, whereby an additional impact is secured upon the outer revolving member. It will thus be seen that the inner member serves the dual function of directing both the inflow and outflow from the chamber T. It is also to be appreciated that the initial impact from the nozzle is at high velocity and that it is a physical law that energy transfer by impact or collision can never be complete where disparity of mass obtains unless the impelled component is invested with a velocity sufficiently near that of the impelling component as to bring the two components to the correct relation. Therefore in a turbine in which a simple impact only is secured the velocity or rate of revolutions would of necessity be so high in order to bear the proper relation to the spouting velocity of the working fluid as to generate a destructive or dangerous centrifugal force. On the other hand, a turbine of the slow-speed type in order to secure an economical energy transfer from a commensurately low spouting velocity must of necessity carry a cumbersome or structural complication of vanes in order that the required area of action may be secured to afford a constant stress sufficiently great to care for the load. It is a mean between these two principles or types that I have devised the engine hereinbefore described, in connection with which latter it may be further pointed out that in the initial impact when the engine is so geared as to allow a high rate of revolution the disparity between the spouting velocity of the working fluid and the peripheral velocity of the wheel is so great as to leave a considerable percentage of energy conserved by the working fluid, and it is this energy, as has been explained, which converges into the central chamber T and creates a radial outflow which has simultaneous action with the concaved surface of all of the blades P carried by the outer revolving member. This outflow may be readily proportioned, whereby the same will bear a proper velocity relation required to secure almost complete energy transfer.

The inner member not only acts as a deflector in the manner which has thus far been pointed out, but the same is also associated with certain other instrumentalities whereby it acts as a highly-sensitive governor.

Referring now more particularly to Figs. 2, 3, and 5, a worm W is secured to the shaft V, so as to rotate therewith, said worm being arranged to engage with a gear-wheel X, carried by a transversely-arranged shaft *h*, which constitutes the operating-stem for the valve H in the fluid-supply pipe G, hereinbefore referred to. The outer end of the shaft *h* is rotatably supported in a bracket Y, projecting upwardly from the base A. The gear-wheel X is loose upon the shaft *h*, whereby the shaft may be operated independently of the gear-wheel when found expedient. Around the shaft *h* is a coiled spring Z, the outer end of which is rigidly secured to the bracket Y, while the inner end thereof is connected to the arm or projection *h'* of the shaft *h*. This spring is for the purpose of creating a tension in the direction of the arrow, Fig. 2, whereby the arm *h'* forcibly contacts a pin *x*, projecting laterally from the face of the gear X. Outside of the bracket Y and rigidly secured to the protruding end of the shaft or valve-stem *h* is a lever 1. 2 is an offset arm secured to the bracket Y, the same being provided with a bearing for a thumb-screw 3, the function of which is to act as a stop whereby the limit of downward movement of the lever 1 is adadjusted, consequently restricting the movement of the shaft *h* and the valve H, carried thereby, as is obvious. 4 is a spring coiled about the shaft V, designed for receiving the stress of the inner member of the turbine and in this capacity acts as a counterbalance, as will more clearly hereinafter appear. One end of this spring is rigidly secured to the worm W, and the opposite end thereof is correspondingly attached to a disk 5, the shaft V working loosely through this disk. The disk 5 may be rotated upon the shaft V to properly regulate the tension of the spring 4 by means of an opposing disk 6, rigidly mounted upon the upright B, and the bolt-and-nut fastening device 7, adapted to pass through a suitable aperture in the disk 6 and any one of a series of apertures 8 in the disk 5, arranged in circular series, whereby they may duly register with said aperture in the disk 6. The disk 5 may carry any convenient or preferred scale or registering device whereby the adjusted tension of the spring 4 may be indicated, a scale 9 being shown in Fig. 2

for this purpose. The function of the spring 4 is, as stated, to set up a counter-stress to that of the inner member of the turbine. An increase of the load upon the engine tends to slow down the speed of the outer or working member or wheel, thereby reducing its capacity to absorb the energy of the initial impact to a degree commensurate with the reduction of speed, and this at a ratio apropos will increase the stress of impact upon the inner member both as to egress and ingress. Therefore the inner member will revolve against the counter stress of the spring 4 until a point is reached at which the progressively-increasing resistance of the spring will establish an equilibrium with the force upon the inner member of the turbine, which puts the spring under tension. The increase of stress upon the inner member being commensurate with the decrease of ingress in the load and rotating the shaft V, it will, through the medium of the worm-wheel W rotating with the shaft, turn the gear-wheel X in the direction opposite to that shown by the arrow, whereby the pin x on the gear-wheel contacting with the arm h' on the shaft or valve-stem h in the path of its movement will carry said arm around with the gear X, thereby correspondingly rotating the valve-stem h against the tension of its spring Z and opening the valve h^2 to a degree proportionate to the increase of load. The function of the lever 1 is to open the valve H by hand when occasion may require, as when the full efficiency of the engine is desired—for instance, in starting up under full load.

As will be understood, the operation of the parts of the governor is such as to increase the opening of the valve H by a continued movement in the manner specified or in a reverse movement to decrease the opening of the valve, &c., according to the fluctuations of the load, it being remembered that the spring 4 is of sufficient tension to exert a counter stress, overcoming any tendency of the inner member to rotate under normal conditions, whereby said inner member is relatively stationary excepting under abnormal conditions.

10 represents the outlet from the casing C for the working fluid.

Having thus described the invention, what is claimed as new, and desired to be secured by Letters Patent, is—

1. In a turbine, movable inner and outer members provided with vanes, the outer member being rotatable independently of and around said inner member, and a governor actuated by the inner member.

2. In a turbine, a wheel provided with vanes, means for imparting an initial impact to said vanes, means whereby a secondary impact will also be imparted to said vanes, governor instrumentalities, and connections between said governor instrumentalities and the last-mentioned means and actuated thereby.

3. In a turbine, movable inner and outer members provided with vanes, one of said members being rotatable independently of and around the other member said other member being relatively stationary under normal conditions, and means actuated by said other member whereby the operating medium is controlled.

4. In a turbine, movable inner and outer members provided with vanes, said outer member being rotatable independently of and around said inner member, driven instrumentalities operatively associated with the outer member, and means actuated by the inner member whereby the operating medium is controlled.

5. In a turbine, movable inner and outer members provided with vanes, one of said members being rotatable independently of and around the other member, driven instrumentalities operatively associated with one of said members, and means actuated by the other of said members whereby the operating medium is controlled.

6. In a turbine, movable inner and outer members provided with vanes, one of said members being rotatable independently of and around the other member, said other member being relatively stationary under normal conditions, driven instrumentalities operatively associated with the rotatable member, and means actuated by said other member whereby the operating medium is controlled.

7. In a turbine, inner and outer members provided with vanes, the outer member being rotatable independently of and around said inner member, and said inner member being provided with an internal chamber normally opening only to the passages between its vanes, and means actuated by said inner member whereby the operating medium may be controlled.

8. In a turbine, inner and outer members provided with vanes, one of said members being rotatable independently of the other member and around the same, said other member having an internal chamber normally opening only to the passages between its vanes, and means actuated by said other member whereby the operating medium is controlled.

9. In a turbine, inner and outer members provided with vanes, one of said members being rotatable independently of the other member and around the same, said other member being relatively stationary under normal conditions and having an internal chamber normally opening only to the passages between its vanes, and means actuated by said other member whereby the operating medium is controlled.

10. In a turbine, inner and outer members provided with vanes, one of said members

being rotatable independently of and around the other member, said other member being relatively stationary and having an interior chamber normally closed save at points adjacent its vanes.

11. In a turbine, inner and outer members provided with vanes, the outer member being rotatable independently of and around said inner member, said inner member being relatively stationary and having an interior chamber normally closed save at points adjacent its vanes.

12. In a turbine, inner and outer members provided with vanes, one of said members being rotatable independently of and around the other member, and said other member having an interior chamber normally closed save at points adjacent to its vanes.

13. In a turbine, inner and outer members provided with vanes, the outer member being rotatable independently of and around said inner member, and said other member having an interior chamber normally closed save at points adjacent to its vanes.

14. In a turbine, inner and outer members provided with vanes, one of said members being rotatable independently of and around the other member, said other member being relatively stationary under normal conditions and yieldable under abnormal conditions.

15. In a turbine, inner and outer members provided with vanes, the outer member being rotatable independently of and around said inner member, said inner member being relatively stationary under normal conditions and yieldable under abnormal conditions.

16. In a turbine, inner and outer members provided with vanes, the outer member being rotatable independently of and around said inner member, said inner member being relatively stationary under normal conditions and having an internal chamber opening to the passages between its vanes, and means actuated by said inner member whereby the operating medium may be controlled by the movement of the inner member under abnormal conditions.

17. In a turbine, inner and outer members provided with vanes, one of said members being rotatable independently of and around the other member, said other member being relatively stationary under normal conditions and yieldable under abnormal conditions, and instrumentalities controlled by said last-mentioned member for controlling the operating medium.

18. In a turbine, inner and outer members provided with vanes, the outer member being rotatable independently of and around said inner member, said inner member being relatively stationary under normal conditions and yieldable under abnormal conditions, and means controlled by said last-mentioned member for controlling the operating medium.

19. In a turbine, inner and outer members provided with vanes, one of said members being rotatable independently of and around the other member, said other member being relatively stationary under normal conditions and yieldable under abnormal conditions, and instrumentalities controlled by said last-mentioned member for controlling the operating medium, including a shaft, a tensioning device therefor, a valve, and valve-actuating means operatively associated with said shaft.

20. In a turbine, inner and outer members provided with vanes, one of said members being rotatable independently of and around the other member, said other member being relatively stationary under normal conditions and yieldable under abnormal conditions, and instrumentalities controlled by said last-mentioned member for controlling the operating medium, including a shaft, an adjustable tensioning device therefor, a valve, and valve-actuating means operatively associated with said shaft.

21. In a turbine, inner and outer members provided with vanes, one of said members being rotatable independently of and around the other member, said other member being relatively stationary under normal conditions and yieldable under abnormal conditions, and instrumentalities controlled by said last-mentioned member for controlling the operating medium, including a shaft, and a tensioning device therefor.

22. In a turbine, inner and outer members provided with vanes, one of said members being rotatable independently of and around the other member, said other member being relatively stationary under normal conditions and yieldable under abnormal conditions, and instrumentalities controlled by said last-mentioned member for controlling the operating medium, including a shaft, and an adjustable tensioning device therefor.

23. In a turbine, inner and outer members provided with vanes, one of said members being rotatable independently of and around the other member, said other member being relatively stationary under normal conditions and yieldable under abnormal conditions, and instrumentalities controlled by said last-mentioned member for controlling the operating medium, including a shaft for said last-mentioned member, a valve, and valve-actuating means operatively associated with said shaft.

24. In a turbine, inner and outer members provided with vanes, one of said members being rotatable independently of the other member and around the same, said other member being relatively stationary under normal conditions and yieldable under abnormal conditions, and a counteracting tensioning device resisting the movement of said other member.

25. In a turbine, inner and outer members provided with vanes, one of said members being rotatable independently of the other member and around the same, said other member

being relatively stationary under normal conditions and yieldable under abnormal conditions, and a counteracting adjustable tensioning device resisting the movement of said other member.

26. In a turbine, inner and outer members provided with vanes, one of said members being rotatable independently of and around the other member and said other member having an interior chamber normally closed save at points adjacent to its vanes, and the vanes of said members being curved in reverse directions relative to each other.

27. In a turbine, inner and outer members provided with vanes, the vanes of said members being curved in reverse directions relative to each other and one of said members having an interior chamber normally closed save at points adjacent to its vanes.

28. In a turbine, inner and outer members provided with vanes, one of said members being rotatable independently of and around the other member, said other member being relatively stationary and having an interior chamber normally closed save at points adjacent to its vanes, and the vanes of said members being curved in reverse directions relative to each other.

29. A turbine-wheel comprising oppositely-disposed members provided with a circular series of curved grooves in their inner faces, curved vanes in said grooves, and means for clamping the members and vanes together comprising bolts and binding-nuts therefor, said bolts being reduced intermediate their ends for the purpose described.

30. A nozzle for turbines comprising an elongated tubular member having a curved bore gradually tapering from its inlet to its outlet end, in combination with a plug-valve comprising an elongated cone tapered from end to end, and of substantially the length of the tubular member arranged within said tubular member, the tapering of said cone being greater than the tapering of the bore of the tubular member, substantially as described.

31. A nozzle for turbines comprising an elongated tubular member having a curved bore gradually tapering from its inlet to its outlet end, in combination with a plug-valve comprising an elongated cone arranged within said tubular member, the tapering of said cone being greater than the tapering of the bore of the tubular member, and the base of the cone being of a diameter substantially equal to the inlet-opening of the bore of the tubular member.

32. In a turbine, inner and outer members provided with vanes, the outer member being rotatable independently of and around said inner member, the said inner member being provided with an internal chamber normally opening only to the passages between its vanes, and a feed-nozzle arranged tangentially of said outer member.

33. In a turbine, a rotatable member, a horizontal shaft therefor, and means for lubricating said shaft including a duct leading thereto, a fixed oil-cup through which said shaft passes, a movable means for conducting oil from the cup to said duct, and an inturned flange on the cup immediately adjoining the opening therein through which the shaft passes, for the purpose set forth.

34. A governor including a rotatable shaft, a gear thereon, a second gear meshing with said first-mentioned gear, a pin on said second gear, controlling means, and means in the path of said pin for operating said controlling means.

35. A governor including a rotatable shaft, a gear thereon, a second gear meshing with said first-mentioned gear, a pin on said second gear, controlling means, means in the path of said pin for automatically operating said controlling means, and independent means for manually operating said controlling means.

36. A governor including a rotatable shaft, a tension device therefor including a coil-spring, one end of which is connected to rotate with said shaft and the other end being fixed, and means connected to one end of the spring for initially adjusting the same at a predetermined normal tension thereof.

37. A governor including a rotatable shaft, a tension device therefor including a coil-spring, one end of which is connected to rotate with said shaft and the other end being fixed, means connected to one end of the spring for initially adjusting the same at a predetermined normal tension thereof, and controlling means operatively associated with said shaft.

38. In a turbine, inner and outer members provided with vanes, the vanes of the outer member being arranged in series concentric to the series of the vanes of the inner member, one of said members being rotatable independently of the other member and around the same, and the vanes thereof being adapted to receive an initial and also a secondary impact, and the vanes of the other member being arranged to deflect the operating medium to effect said secondary impact.

39. In a turbine, a wheel provided with vanes, means for imparting an initial impact to said vanes, means whereby a secondary impact will also be imparted to said vanes, governor instrumentalities, and connecting means between said governor instrumentalities and one of said means and actuated by the latter.

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

BURTON M. DUTTON.

Witnesses:

JOHN J. TURNER,

GEO. B. TURNER.