

No. 781,731.

PATENTED FEB. 7, 1905.

N. LOMBARD.
GOVERNOR.

APPLICATION FILED JUNE 29, 1904.

8 SHEETS—SHEET 1.

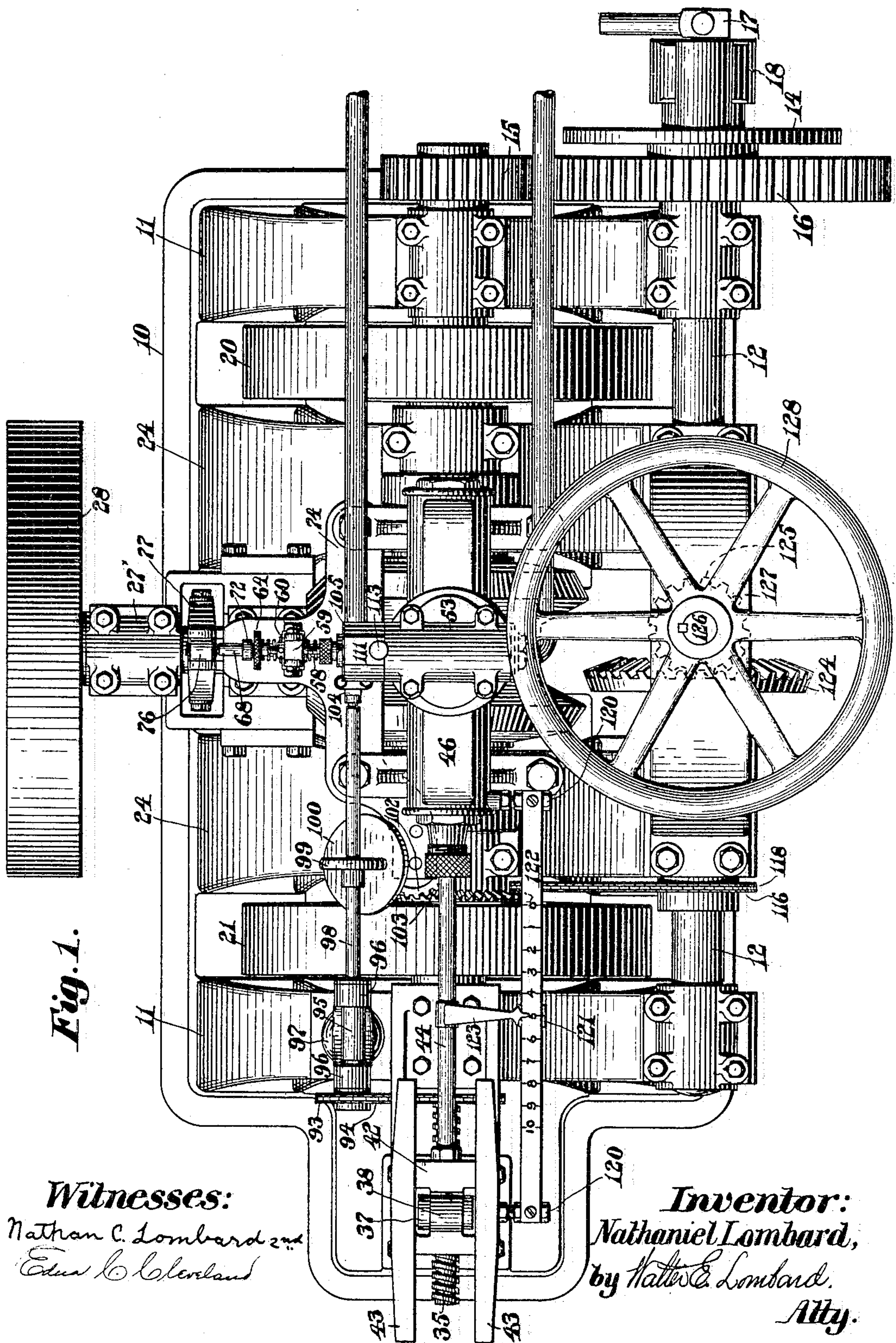


Fig. 1.

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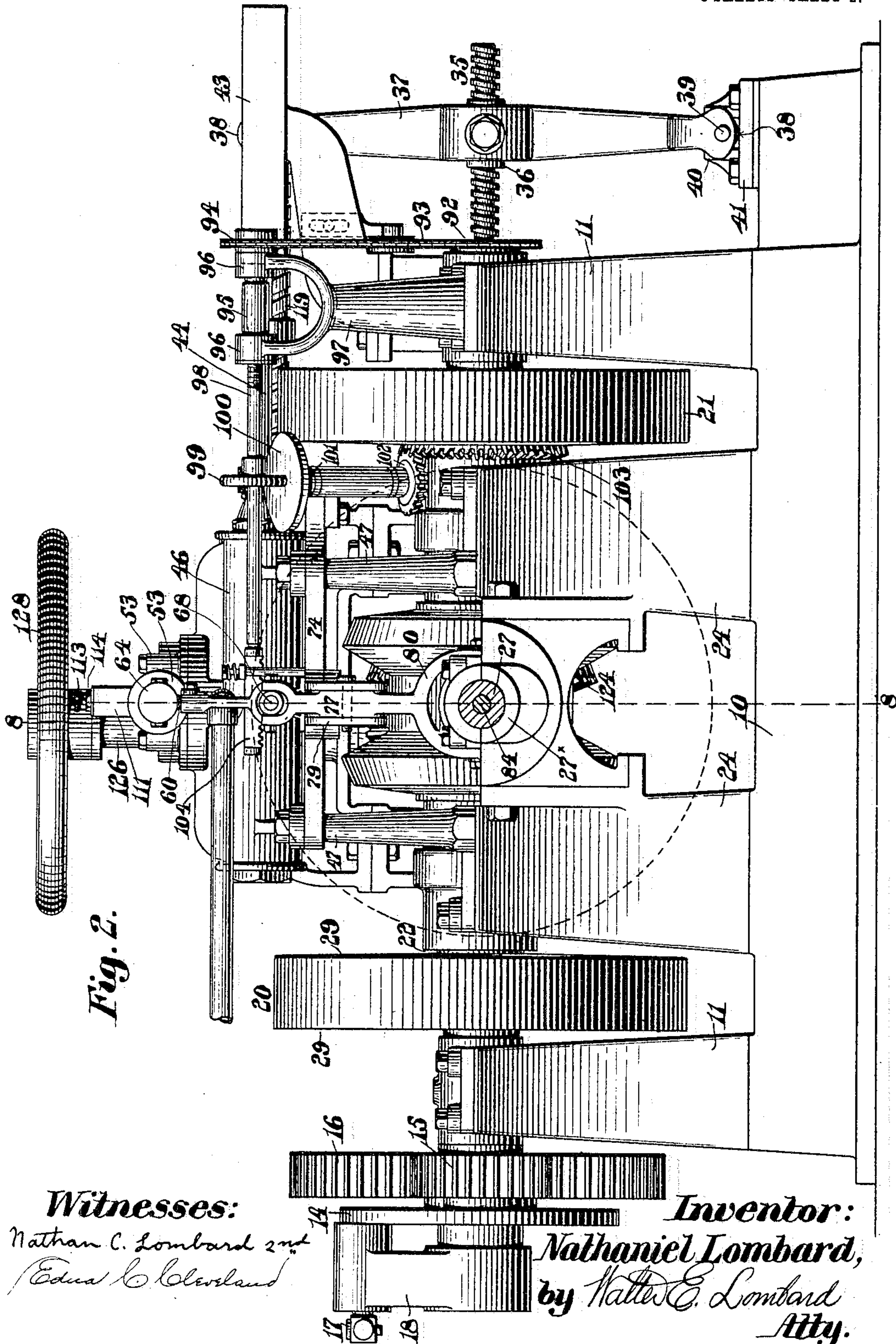
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8 SHEETS—SHEET 2.



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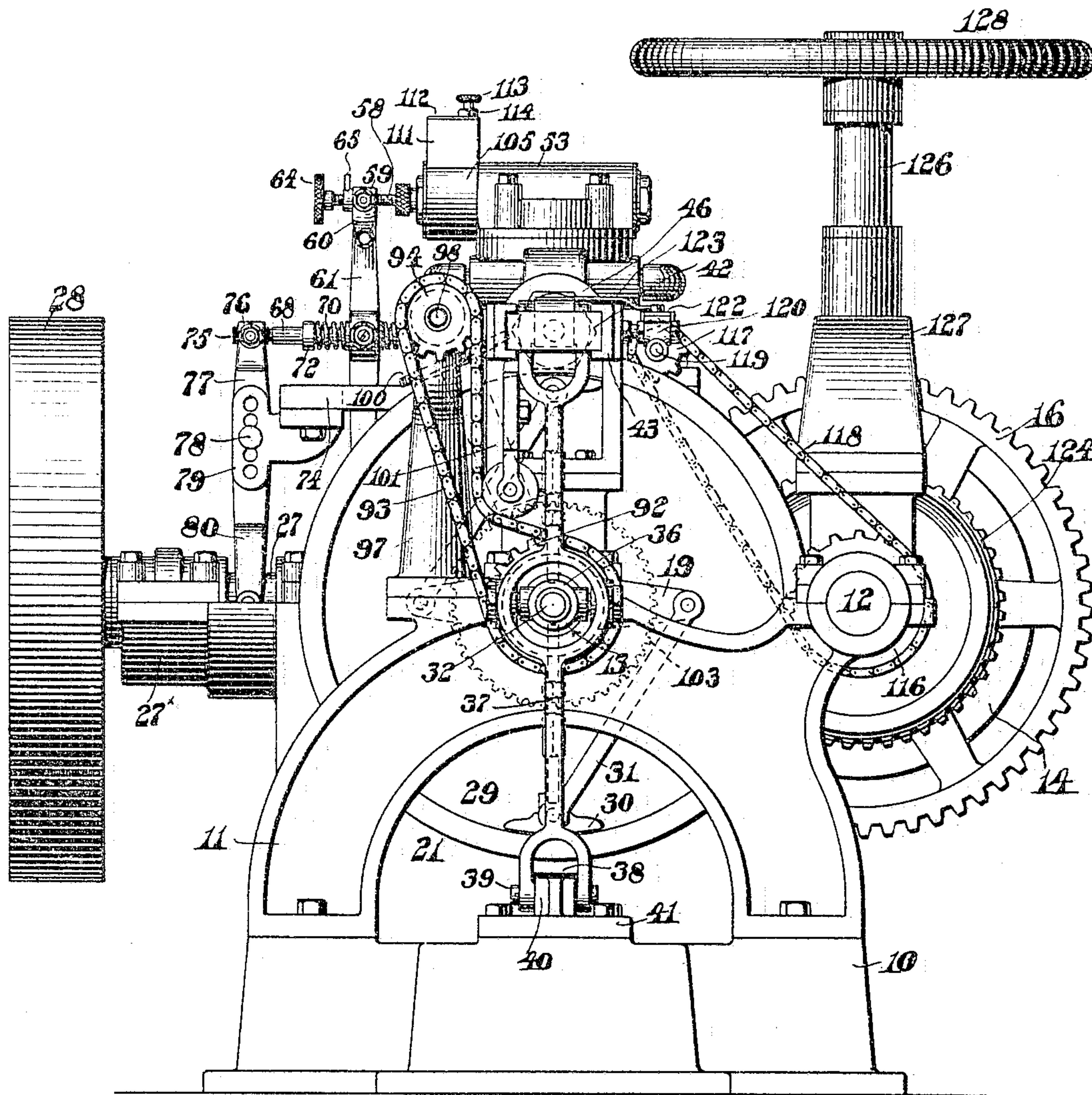
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8 SHEETS—SHEET 3.

Fig. 3.



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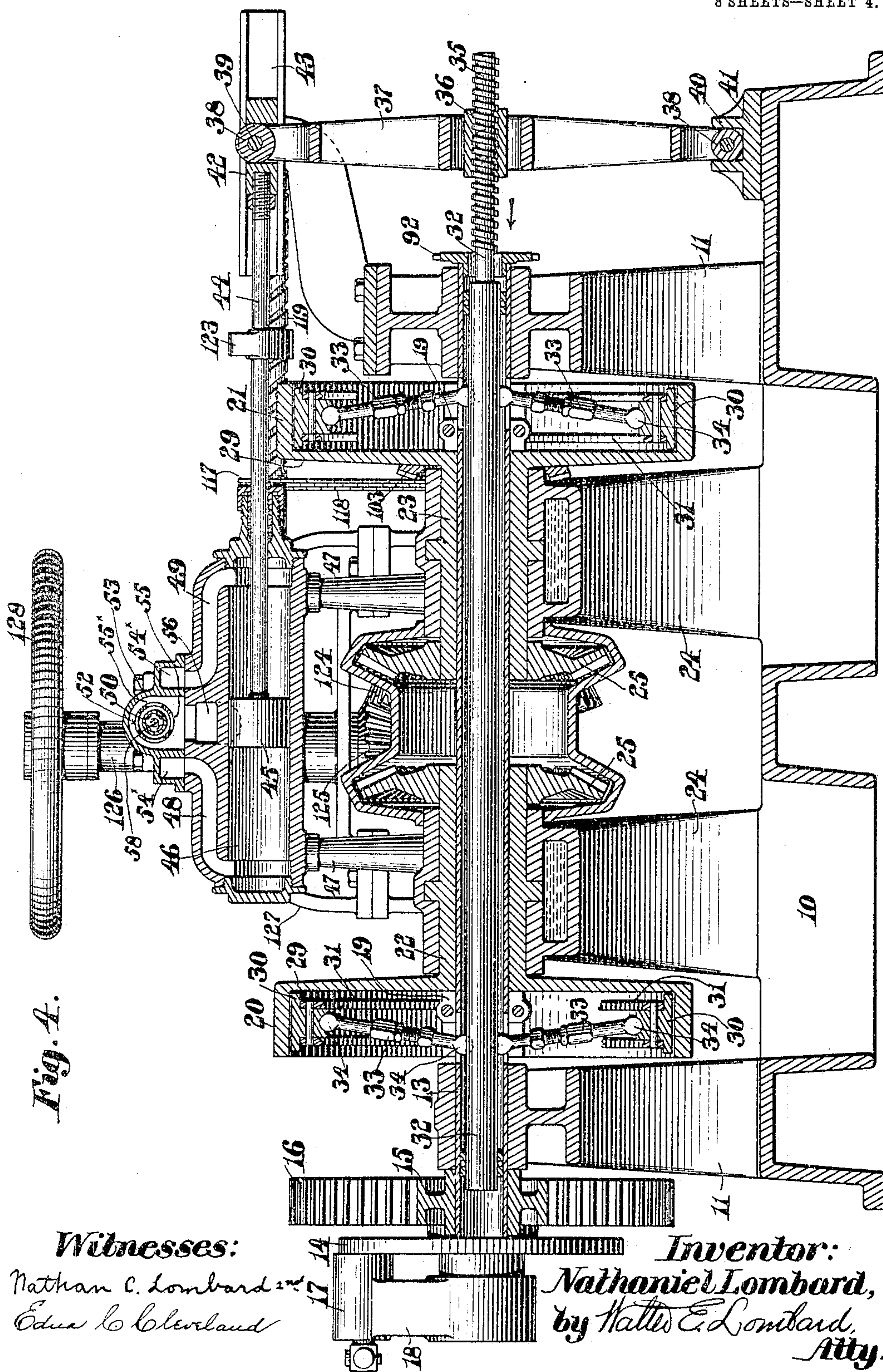
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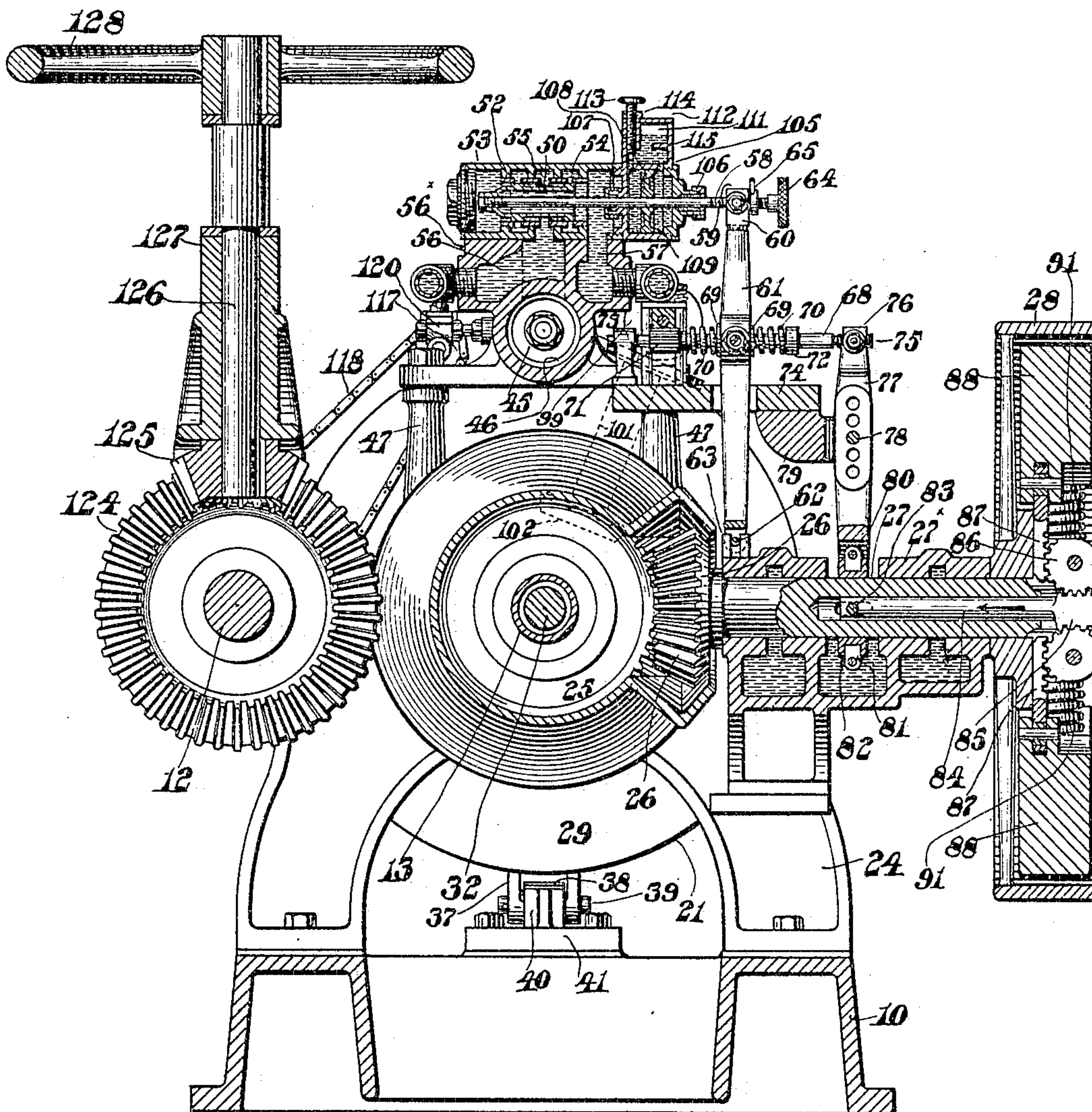


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8 SHEETS—SHEET 5.

Fig. 5.



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8 SHEETS—SHEET 6.

Fig. 6.

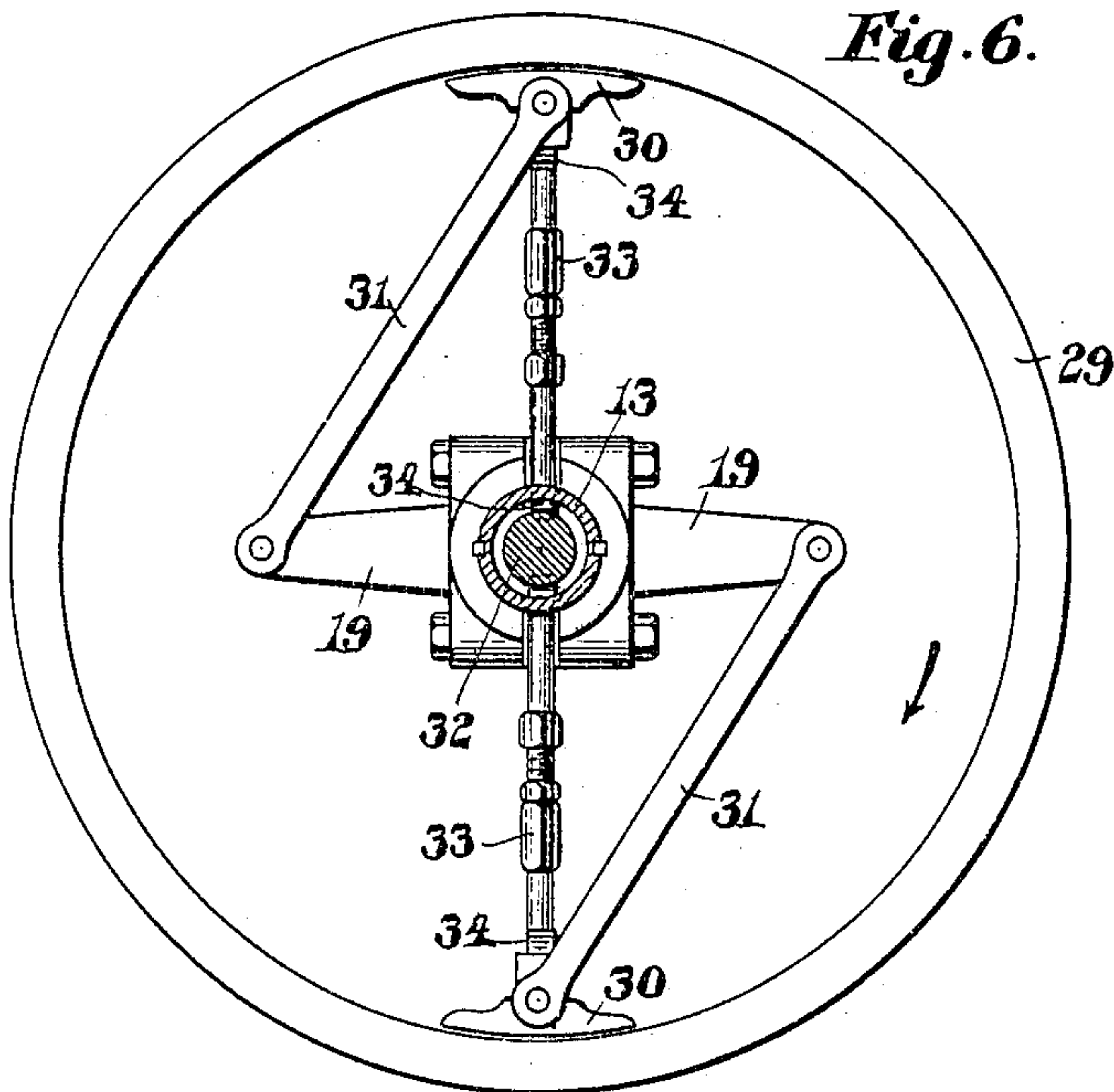
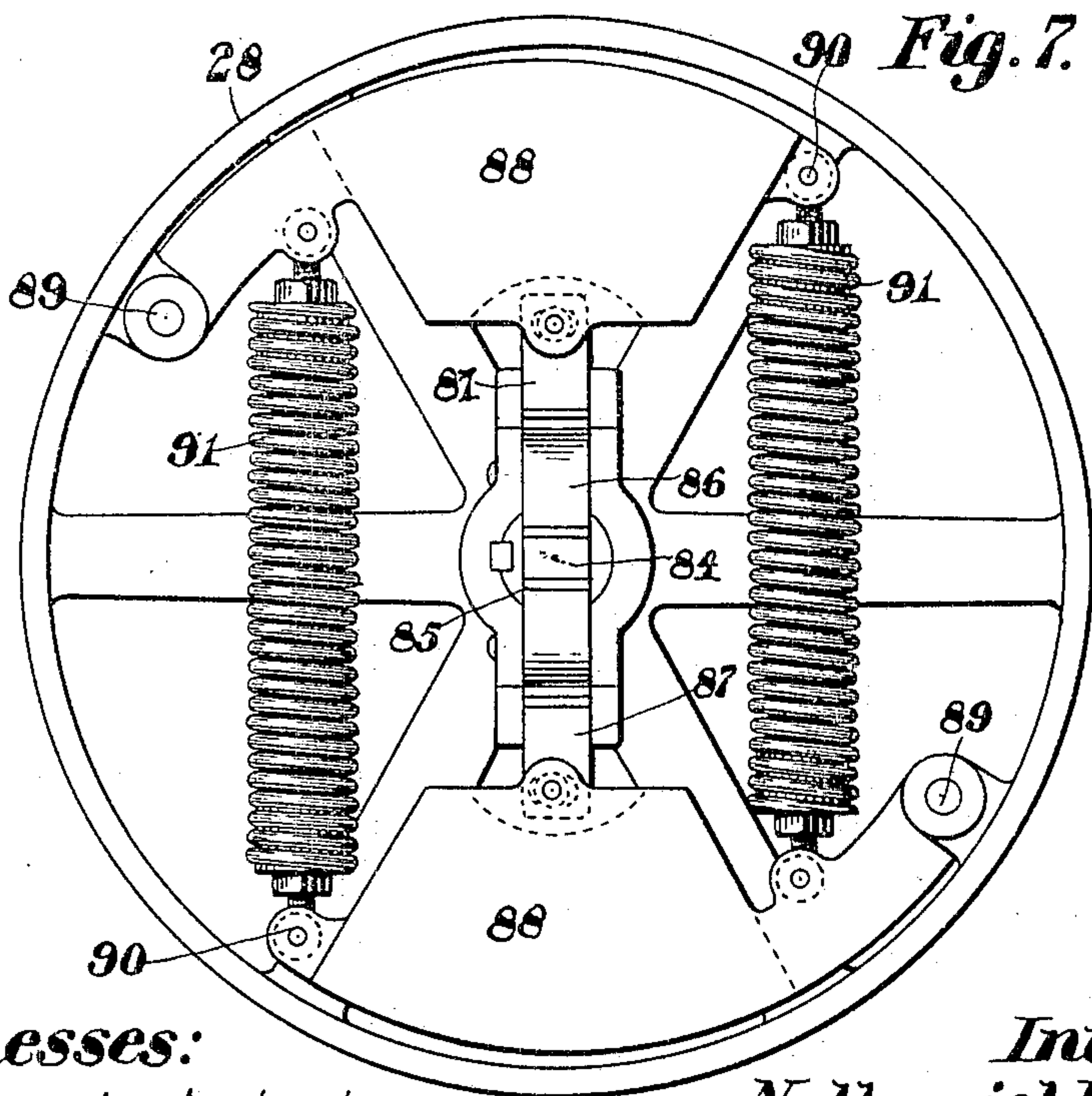


Fig. 7.



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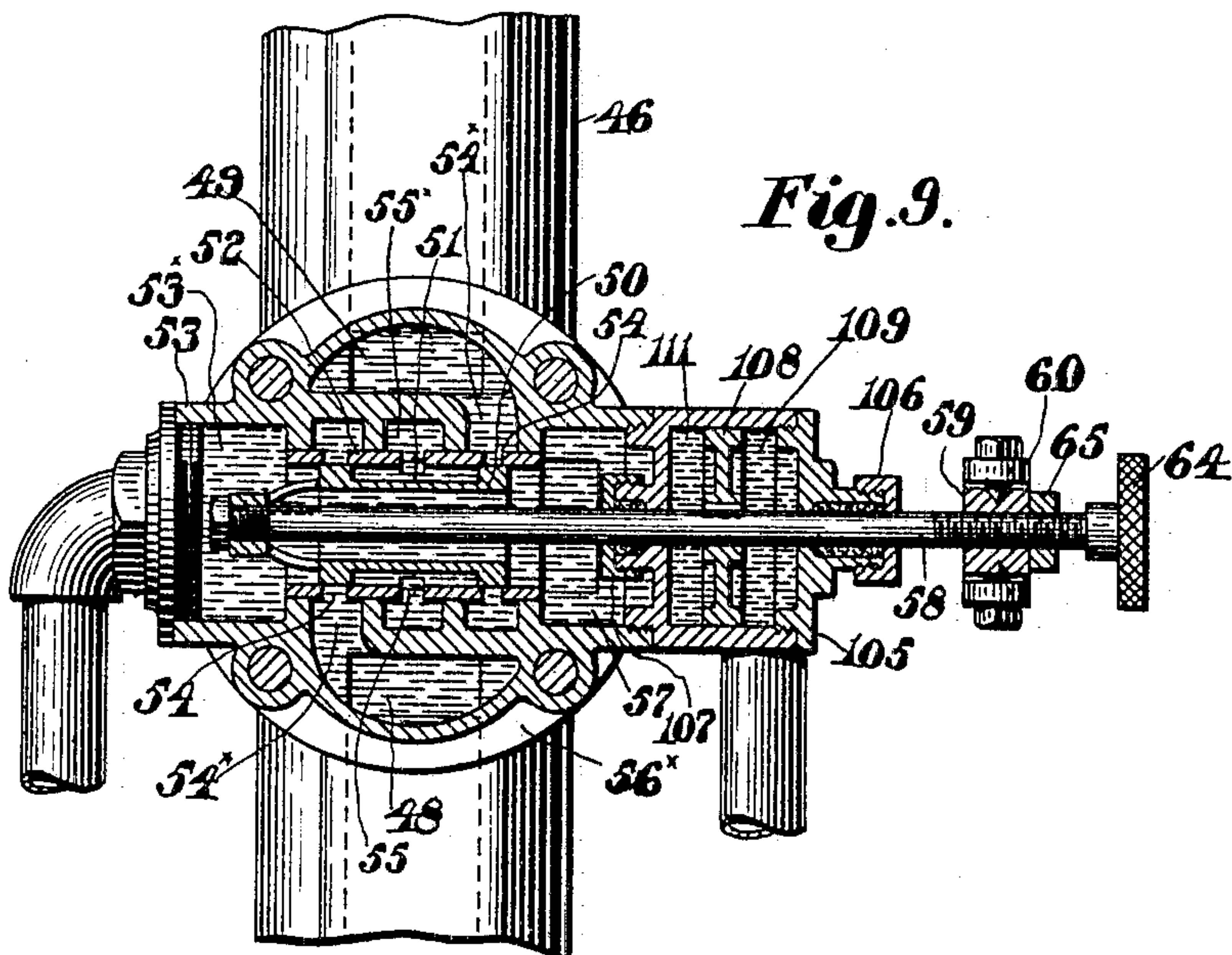
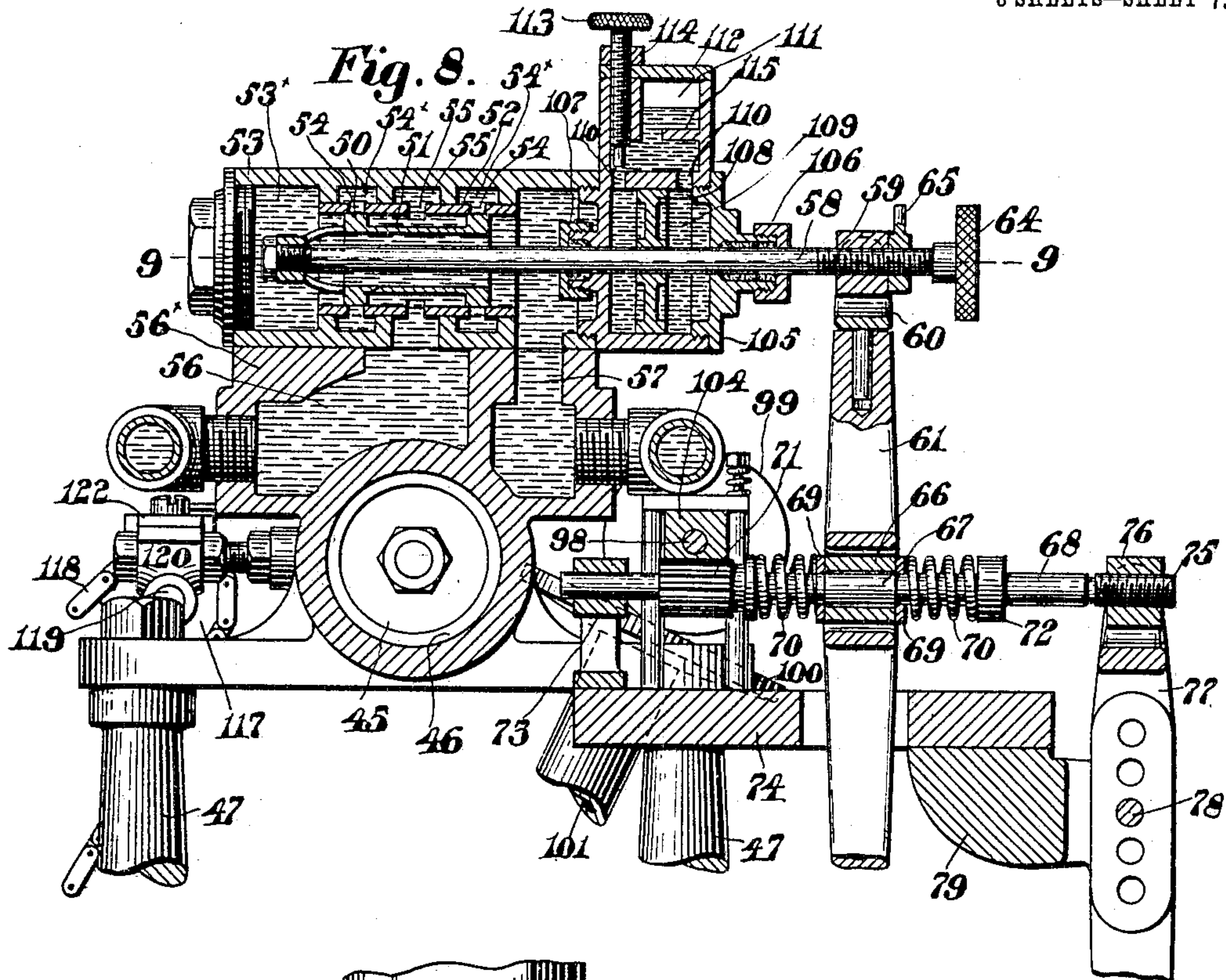
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8 SHEETS—SHEET 7.



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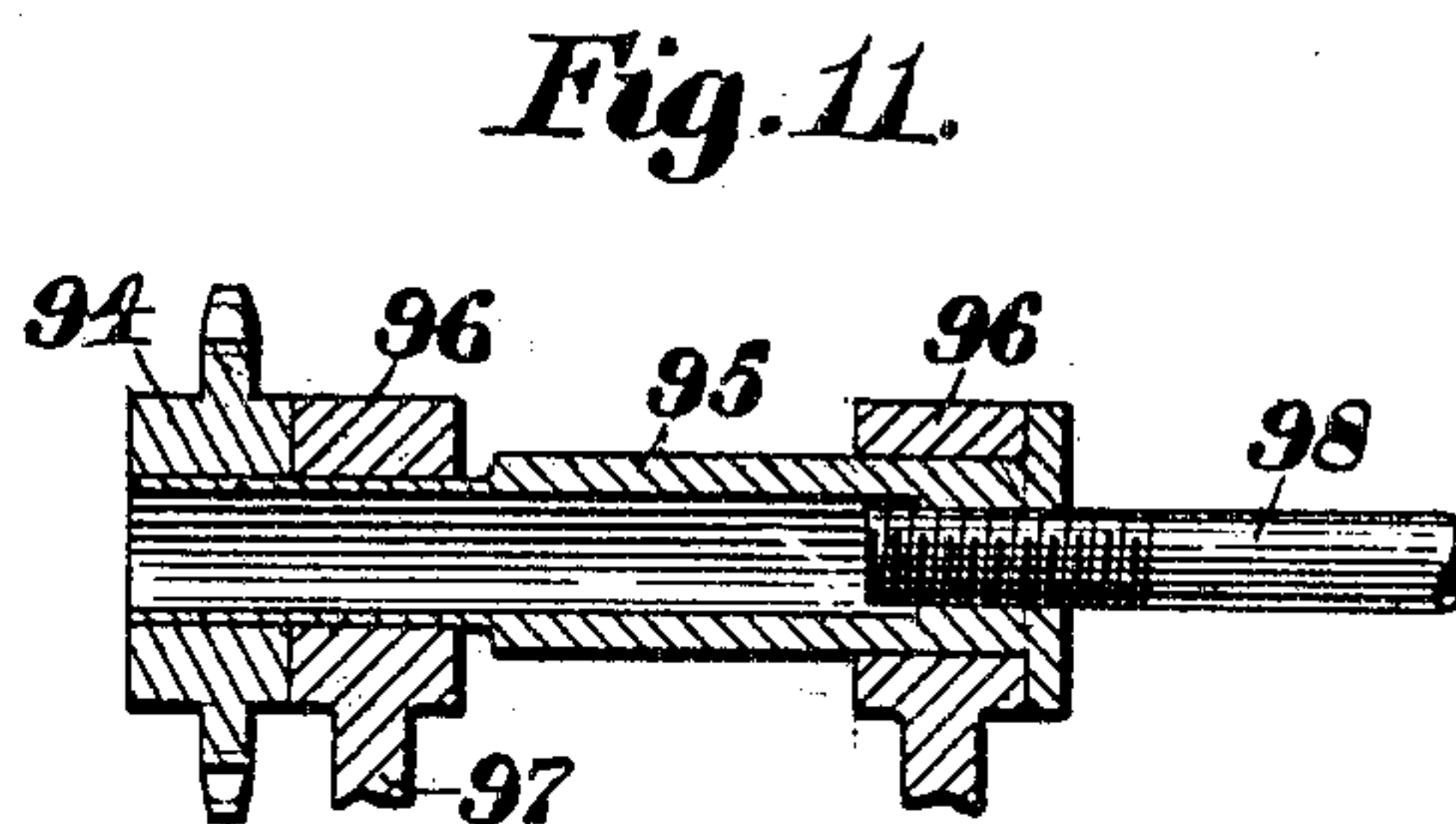
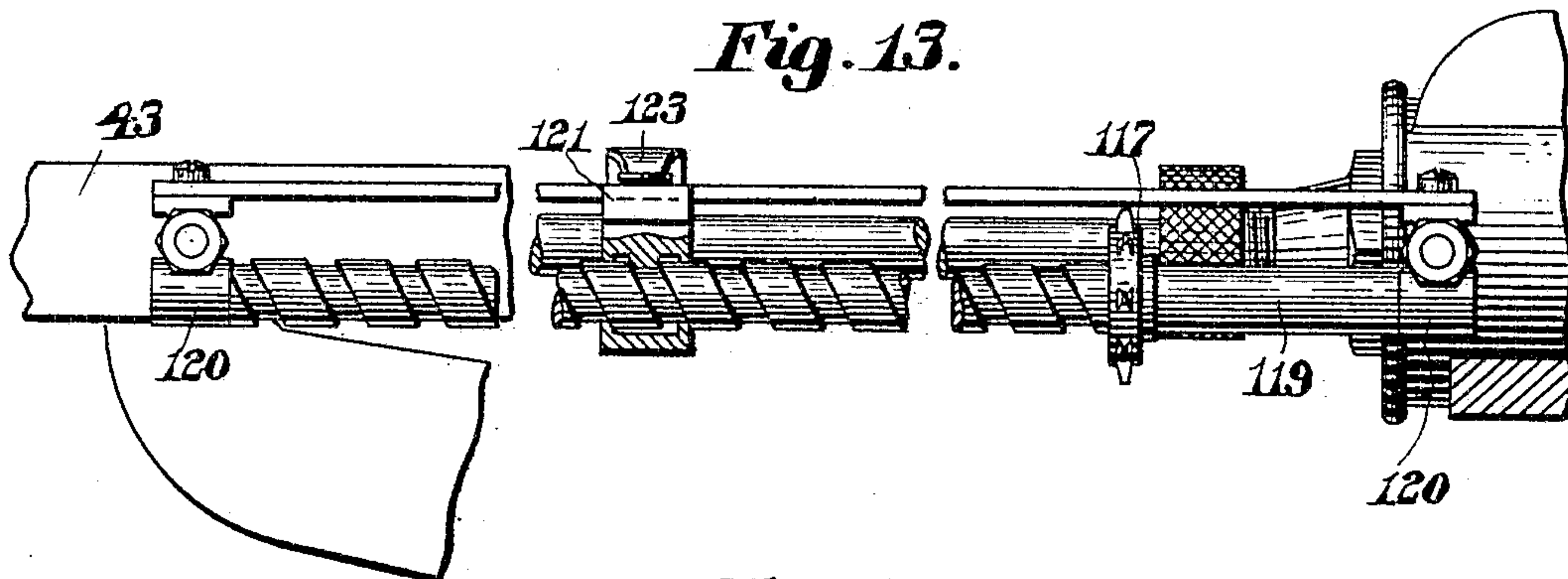
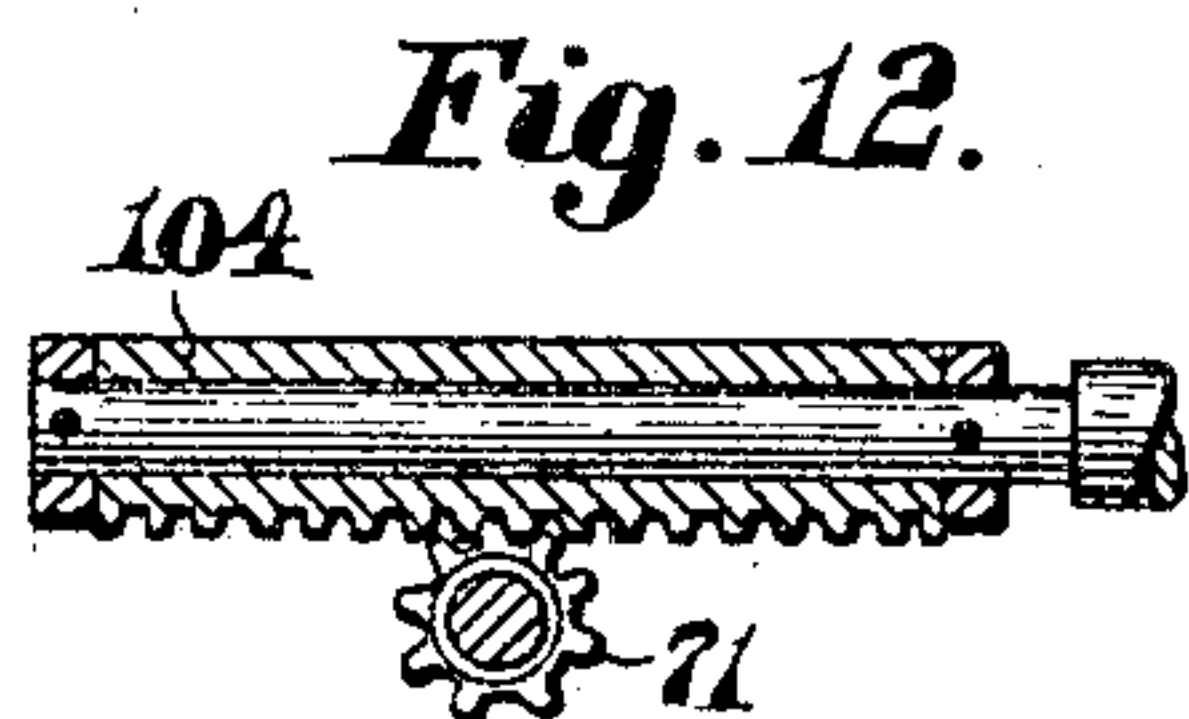
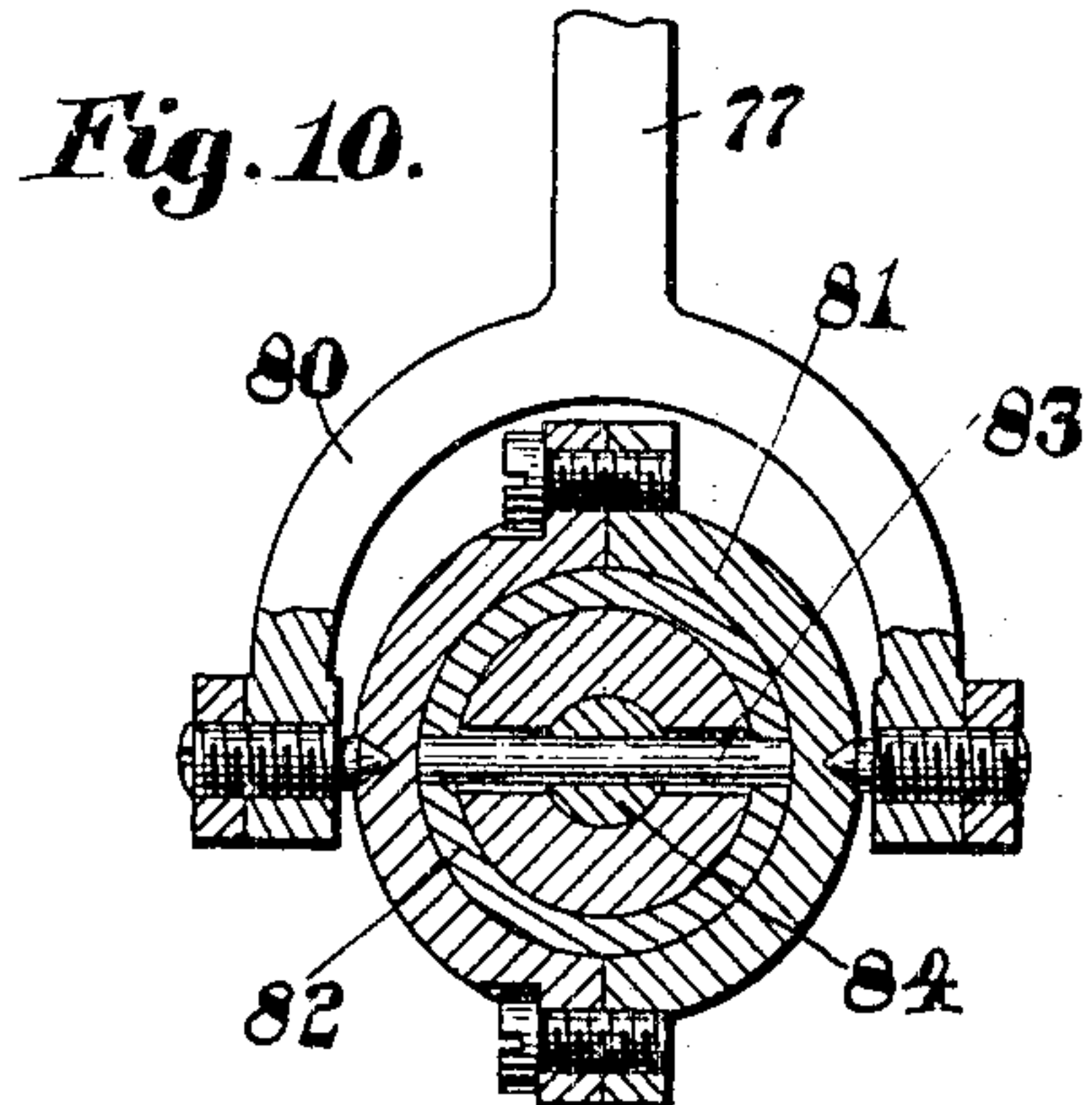
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8 SHEETS—SHEET 8.



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UNITED STATES PATENT OFFICE.

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GOVERNOR.

SPECIFICATION forming part of Letters Patent No. 781,731, dated February 7, 1905.

Application filed June 29, 1904. Serial No. 214,671.

To all whom it may concern:

Be it known that I, NATHANIEL LOMBARD, a citizen of the United States of America, and a resident of Worcester, in the county of Worcester and State of Massachusetts, have invented certain new and useful Improvements in Governors; of which the following is a specification.

This invention relates to mechanism for controlling the speed of various motors, and more particularly to such governors which serve to apply power from an auxiliary source to effect a movement of the valve, gate, or other regulating devices, and is an improvement upon the inventions described in Letters Patent No. 736,276, issued to me August 11, 1903, and Letters Patent No. 754,469, issued to me March 15, 1904.

It consists in certain novel features of construction and arrangement of parts, which will be readily understood by reference to the description of the drawings and to the claims to be hereinafter given.

Of the drawings, Figure 1 represents a plan view of a governor embodying the features of this invention. Fig. 2 represents a rear elevation of the same, a portion of the driving mechanism being shown removed therefrom. Fig. 3 represents a left-hand elevation of the same. Fig. 4 represents a longitudinal central vertical section looking toward the front of the machine. Fig. 5 represents a sectional elevation of the same, the cutting plane being on line 5 5 on Fig. 4. Fig. 6 represents a face view of one of the clutch mechanisms. Fig. 7 represents an end elevation of the driving-pulley and the controlling mechanism contained therein. Fig. 8 represents a central vertical section of the piston and controlling-valve therefor, the cutting plane being on line 8 8 on Fig. 2. Fig. 9 represents a horizontal sectional detail of the controlling-valve, the cutting plane being on line 9 9 on Fig. 8. Fig. 10 represents a sectional detail of one of the primary driving-shafts and its slidable coacting member. Fig. 11 represents a sectional elevation of the mechanism for operating the controlling-rod. Fig. 12 represents a sectional

detail of the rack and pinion operated by the opposite end of the controlling-rod; and Fig. 13 represents a detailed elevation of the indicator mechanism, a portion of the gate-indicator being broken away. Figs. 8 to 13, inclusive, are drawn to an enlarged scale.

Similar characters designate like parts throughout the several figures of the drawings.

The numeral 10 designates a suitable base-plate on which is journaled in standards 11 a shaft 12 for connection with the gate or regulating device for controlling the speed of a motor—as, for example, a turbine-wheel—which shaft may be appropriately termed a “motor-controlling” shaft. In the standards 11 may be also journaled a preferably hollow actuating-shaft 13 for the motor-controlling shaft, they being conveniently connected by spur-gears 15 and 16, the latter having secured thereto a disk 14, which is preferably releasably fixed to the shaft 12 by some such connector as a pin-clutch 17, carried by an arm 18, fast upon the shaft and engaging an opening in the disk 14.

The actuating-shaft 13 has keyed or otherwise secured to it the laterally-projecting arms 19, forming a part of the inner members of clutches or connectors 20 21, the outer members of which are fixed to or formed integrally with driving-shafts 22 23, respectively, which are here shown as hollow, surrounding the actuating-shaft and journaled in the standards 24, supported from the base-plate between the standards 11. The driving-shafts may be conveniently rotated in opposite directions by a bevel-gear 25, meshing with a bevel-gear 26, fixed to a shaft 27, conveniently journaled in a bracket 27*, supported by the standards 24 and rotated at the desired speed from any suitable source of power through a pulley 28. The outer member of each clutch 21 may consist of a flanged disk 29, while the inner coacting members in each case may consist of a pair of shoes 30, supported by arms 31, articulated to the laterally-projecting arms 19, and between these shoes 30 and the operating-rod 32 are interposed adjustable connectors 33. Either end of each connector 33 is pro-

vided with a disk 34, one of which fits into a socket or recess in the shoe 30, while the other fits into a socket or recess in the operating member 32, slidably mounted in the hollow actuating-shaft 13. These adjustable connectors 33 are radial at all times to the axis of the operating member 32, but longitudinally when in normal position. Their outer ends are inclined slightly toward each other. On one end of the operating-rod 32 is the screw-thread 35, which coacts with the nut 36, said nut being articulated in an opening in the lever 37. The ends of the lever 37 being bifurcated have mounted therein trucks 38 upon the pins 39. The truck 38 upon one end of the lever 37 coacts with extensions or guides 40 on the plate 41, mounted upon the base-plate 10, and the other end of the lever 37, with its truck 38 coacts with a block 42, slidably mounted in the guides 43, forming a part of the standards 11.

It is obvious from an inspection of the drawings that whenever the central portion of the operating-rod 32 is moved in a direction away from one of the clutches 20 21 the inner ends of the connector 33 of that clutch will be moved to a more nearly vertical position, causing the shoes 30 to coact with the flange of the outer clutch member 29, thereby insuring the rotation in unison of the operating member 32 and the actuating-shaft 13 with the outer clutch member 29. As soon as the operating member 32 returns to its normal position the shoes 30 will move out of contact with the flange of the outer clutch member 29, and the actuating-shaft 13 and the operating member 32 will cease to revolve. The direction of rotation of the actuating-shaft 13 and the operating member 32 depends upon which pair of clutch members 20 21 is in coacting position, it being understood that the outer clutch members are continuously driven in opposite directions.

To actuate the lever and move the operating-rod in one direction or another to operate either of the clutches as may be necessary to impart the necessary regulating movement, the block 42 has mounted therein upon one end a connector 44. Upon the other end of this connector is mounted a piston 45, operating within the cylinder 46, said cylinder being supported upon uprights 47 from the standards 24. To either end of this cylinder hydraulic or other pressure may be admitted through passages 48 49. To control the admission of power in the cylinder is a valve 50, having upon its outer periphery a central groove 51, said valve reciprocating within a casing 52, supported in a chest 53, mounted upon the cylinder 46. The casing 52 is provided with a series of openings 54 55, communicating with annular passages 54* and 55*, formed in the inner periphery of the chest 53. The passages 54* and 55* are suitably arranged to admit the pressure supplied through a passage 56 in the body 56*, supported upon the

upper part of the cylinder 46, to either one of the passages 48 49, and at the same time they permit the pressure to be exhausted from the cylinder through a passage 57. It is obvious from an inspection of Figs. 4, 8, and 9 that the passage 48 communicates with an annular passage 54*, and when the valve 50 is at its extreme of movement to the left of Figs. 8 and 9 it will communicate, through the annular passage 55*, with the admission passage or chamber 56, thus admitting pressure from the chamber 56 to the left of the cylinder 46. At the same time the other annular passage 54* will be uncovered by the valve 50, and the pressure at the right of the piston 45 will pass through the passage 49, through the annular passage 54* to the exhaust-chamber 57. When the valve 50 is at the opposite end of its stroke, the admission-chamber will communicate with the passage 49 in a similar manner, while the passage 48 will communicate with the chamber 53* and thence through the center of the tubular valve 50 with the exhaust-chamber 57.

To cause a movement of the valve 50, there is secured upon its inner end a connector 58, the other end of said connector being provided with a screw-thread and passing through a block or nut 59, articulated in a bifurcated support 60, adjustably mounted upon one end of a lever 61, said lever having upon its opposite end a bifurcated portion, with a pin 62, engaging the extensions or guides 63, projecting upwardly from the bracket 27*. To enable the valve 50 to be adjusted with respect to its casing 51, the connector 58 has upon its end a knurled head 64, by which the connector 58 may be rotated in the nut 59 when the check-nut 65 is released, thereby permitting the valve to be moved to any desired position relative to the casing 52. To cause a movement of the lever 61, said lever is provided with an opening intermediate its ends, in which is articulated a member 66. The member 66 has slidably mounted therein a slightly-enlarged portion 67 of a connector 68. The pivoted member 66 coacts with washers 69, said washers being held normally in position against shoulders, formed by the enlarged portion 67 upon the connector 68, by springs 70, resting against shoulders secured to said connector consisting of the gear 71 and collar 72.

One end of the connector 68 is mounted in bearings 73 on a supporting-plate 74, supported upon the uprights 47 from the standards 24. The opposite end of the connector 68 is provided with a screw-thread 75, coacting with a nut 76, articulated in the end of a lever 77, fulcrumed at 78 in a bifurcated bracket 79, secured to said supporting-plate 74. The lower end of the lever 77 is bifurcated, as at 80, the bifurcated end of which engages with a split collar 81 upon the grooved collar 82, movable endwise upon the driving-shaft 27, this endwise movement being secured by a pin 83 extending through slots in the shaft

27 and passing through a slidable member 84, which member is located within a central bore of said driving-shaft 27 and has its outer end provided on two sides with a series of rack-teeth 85. The teeth 85 of the slidable member 84 engage with toothed segments 86, pivoted to the hub of the driving-pulley 28 at right angles to the slidable member 84, each segment 86 meshing with a slidable rack 87, the outer end of which is articulated to a centrifugal weight 88, pivoted at 89 to a boss upon the inner periphery of the pulley 28. The outer end of each weight 88 is provided with ears 90, to which is secured a spring 91, the opposite end of said spring 91 being articulated to the opposite weight at a point intermediate of its fulcrum and its end.

It will be readily seen that any sudden change in the action of the load will be transmitted to the pulley 28 and through the mechanism already described to the valve 50, and a sudden jump would seriously impair the efficiency of the governor, even if such parts were not damaged, and to obviate this there is mounted upon the chest 53 at a point midway between the valve 50 and the nut 59 a casing 105 and forming one end of the chest 53, said casing 105 having upon its outer end a gland or stuffing-box 106, and extending within the chest 53 is a similar stuffing-box 107. Upon the connector 58 is secured a piston 108, which is movable longitudinally therewith in a cylinder 109, formed by the casing 105, filled with any suitable fluid. There is provided at either end of the cylinder 109 a passage 110, communicating with a chamber 111, formed in the upper portion of the casing 105, the fluid extending nearly to the top of the same. The upper end of the chamber 111 is provided with a cover 112, by which access may be secured to said chamber for the purpose of replenishing the fluid contained therein, said cover being held in position by a member 113 and lock-nut 114. The member 113 is threaded into a lug in the chamber 111 and provided at its lower end with a reduced portion to fit one of the passages 110. Within the chamber 111 there is a deflecting-plate 115, extending over the other passage 110, to prevent the stream of fluid from being projected against the cover 112.

It will be seen from the foregoing description that should any jump occur any movement of the piston in either direction will cause the fluid on one side of said piston to be displaced and forced through a passage 110 to the opposite side of said piston, and the rapidity with which the same acts depends upon the amount of opening of the passage 110. Under abnormal conditions the piston 108, through the connector 58, will cause the movement of the lever 61 to be retarded, a spring 70 at one side of the member 66, Fig. 8, being compressed to permit the free movement of

the connector 68 and the lever 77 by the centrifugal mechanism contained in the pulley 28.

In the normal position of the centrifugal mechanism (shown in Fig. 7) the weights 88 are somewhat removed from the peripheral flange of the pulley 28, and it is obvious that any increase of speed of the pulley will cause the weights 88 to be moved outwardly by the centrifugal action thereon, and this movement will impart, through the racks 87 and segments 86, a sliding movement of the member 84, which movement will impart, through the pin 83, passing through slots in the driving-shaft 27, a movement of the pivoted lever to cause the connector 68 to move the upper end of the lever 61 outwardly to move the valve 50, and thereby cause the piston 45, through its connector 44, to move the block 42 toward the cylinder 46, carrying with it the lever 37, causing the central portion of the operating member 32 to move away from the outer clutch member 21, thereby setting this clutch and causing a rotation of the hollow actuating-shaft 13. The decrease in speed of the pulley 28 will cause the weights to move toward the axis of the shaft 27 to operate the various members mentioned in the opposite direction to move the operating member 32 toward the opposite end of the governor.

To the left of the actuating-shaft 13 is secured a sprocket-wheel 92. (Shown at the right of Fig. 2.) This sprocket-wheel being keyed to the shaft 13 transmits any rotary motion thereof through the sprocket-chain 93 to a sprocket-wheel 94, secured to a revoluble member 95, mounted in bearings 96 in the bifurcated standard 97, secured to the standards 11. The revoluble member 95 is free to turn within the bearings 96, but is incapable of endwise movement. It is provided with a threaded bore which engages with the threaded end of the controlling-rod 98, this rod having secured to it a roller 99, which coacts with a revoluble disk 100, mounted upon a shaft 101, having secured to its opposite end a gear 102, meshing with a gear 103, secured to the outer member of the clutch 21, said gears 102 103 producing a continuous revolution of the disk 100, the speed of revolution depending entirely upon the speed of the driving member 29, to which the gear 103 is secured or of which it forms a part.

It is obvious from the foregoing description that the rotation of the actuating-shaft 13 may be in either direction, according to which pair of clutch members are operating, and this rotation in either direction of the actuating-shaft 13 is transmitted to the revoluble member 95, threaded to the controlling-rod 98, and it will be seen that a revolution of said revoluble member 95 in either direction will act upon said controlling-rod 98 to cause the roller 99 to be moved from its normal position diametrically across the disk

100, the length of movement in either direction depending entirely upon the amount of rotation accorded the actuating-shaft 13. The opposite end of the controlling-rod 98 is provided with a rack 104, the teeth of which mesh with the spur-gear 71, secured to and revoluble with the actuator 68, and it is obvious that any endwise movement of the controlling-rod 98 will effect a rotary movement of said connector 68, one end of which is threaded and engages the nut 76, articulated to the outer end of the lever 77, as already described. It is evident, therefore, that any increase or decrease of speed will be transmitted through the pulley 28 to the weights 88, pivoted thereto, and the action of these weights will be transmitted through the various mechanisms described to the actuating shaft 13, and continuing through the controlling-rod 98 the connector 68 will be rotated immediately in the nut 76 to increase or decrease the distance between said nut and the lever 61. As soon, however, as any changes in the relation of the various parts have been effected by the increase or decrease of the speed of the motor, so that the roller 99 has been moved diametrically across the disk 100, the revolution of this disk will act upon the roller 98 to rotate it in one direction or the other, depending to which side of the center the roller has been moved. The effect of the rotation of said roller 99, and consequent rotation of the controlling-rod 98, will be to cause the threaded end of said controlling-rod 98 to be rotated in the threaded sleeve 95, to thereby cause a return of the roller to its normal position central to said revoluble disk 100. The return movement of the controlling-rod 98 effects, through the medium of the rack member 104 and gear 71, a rotation of the connector 68, causing the threaded end thereof to coact with the nut 76 to return the levers 61 and 77 to their normal positions.

The motor-controlling shaft 12 is provided with a sprocket-wheel 116, connecting with a sprocket-wheel 117 by means of a chain 118, said sprocket 116 being mounted upon a shaft 119 in bearings 120, secured to the guides 43 and cylinder 46. The shaft 119 is provided with a threaded portion between the sprocket-wheel 117 and the bearings 120 upon the guides 43. Upon the screw portion of the shaft 119 is a threaded member 121, the upper end of the same being slotted to receive an indicating-plate 122, mounted in the upper side of the bearings 120, and said member 121 is adapted to slide along said plate 122 to indicate the position of the gate or other device being regulated. The plate 122 is provided with a scale upon its upper surface to cooperate with said member 121. There is also secured to the connector 44 a pointer 123, which indicates the position of the governor upon the plate 122.

As it may be desired at times to operate the

regulating mechanism by hand, the motor-controlling shaft 12 may carry fast upon it a bevel-gear 124, meshing with a bevel-pinion 125 on a spindle 126, turning in a support 127, provided with a hand-wheel 128, and when this hand-wheel is in use the pin-clutch 17 may be withdrawn from the disk 14 to disconnect the governor from the motor-controlling shaft.

The operation of this improved governor is as follows: With the parts in the relation here illustrated power is applied to the pulley 28 to drive the centrifugal mechanism left-handedly at such a rate that normally for the desired speed of rotation of the machine the weights of the centrifugal mechanism contained within said pulley will be retained substantially at the center of their range of movement, and the various screws, racks, and the roller 99 will also be at the center of their path. This condition continues until there is a change in the speed of the motor—as, for example, an increase. This results in causing the weights forming part of the centrifugal mechanism to move outwardly under the increased centrifugal force generated, and the racks 87, secured thereto, will be moved thereby, and operating through the segment 86 the slidable member 85 will be permitted to move in the direction indicated by the arrow on Fig. 5. This movement of the slidable member will operate upon the pivoted lever 77 to move the lower end toward the front of the machine while the upper end is moved in the opposite direction, thereby causing, through the power-cylinder piston 45, a movement of the operating-rod 32 in the direction indicated by the arrow on Fig. 4. This movement of the operating-rod 32 in a direction toward the left of Fig. 4 causes the clutch member 21 at the right of said figure to be set so that the actuating-shaft 13 and the operating member 32 will be rotated about their axes in unison with the clutch member 21 in the direction indicated by the arrow, Fig. 6, or toward the front of the machine. To counteract the effect of the power-cylinder upon the clutch to permit the return of the valve to its normal position and a consequent checking of the piston to stop the movement of the gate, the relative positions of the lever 37 and the operating-rod 32 are automatically changed in the following manner: As soon as the actuating-shaft begins its rotation through the connection made by the clutch 21 it also rotates the operating-rod 32. This causes the threaded end of said rod to move in the lever to the right, and this being in the opposite direction to the travel of the block 42 tends to release the clutch. As long as the piston continues its movement the rate of travel of the upper end of the lever will offset that caused by the operation of the rod 32 in the nut 36 and the clutch will remain in engagement; but as soon as the piston is checked by the re-

turn of the valve to its normal position this outward movement of the rod disengages the clutch, and the movement of the gate at once ceases until the valve again acts. This rotation of the actuating-shaft 13 will impart movement, through the gears 15 16, to the motor-controlling shaft and cause a closing movement of the gate, if, for example, a hydraulic system is being governed, or a similar operation upon such motor as may be connected with the shaft 13 and the speed of which it is desired to regulate. The rotation of the operating member 32 will cause a revolution of the member 95. As the weights move outwardly to effect a movement of the clutch members through the medium of mechanisms already described the controlling-rod 98 is moved in a direction that will operate the connector 68 to increase the distance between the nut 76 and the lever 61, so that the lever 61 will operate more promptly than it would act otherwise, thus operating the valve 50 immediately to effect a partial correction of the governor, which is continued more gradually by the mechanism previously described until the desired movement is attained. If the weights acted alone upon the controlling mechanism, they would tend to cause too great a movement or to overcorrect. To obviate this difficulty and partially check the movement of the connectors 68, the gear 71 on the latter is operated by the rack 104 and moved quickly at the beginning of its movement; but this movement is gradually decreased as the roller 99 moves diametrically across the disk 100 and away from its center. The action of the revoluble sleeve 95 on the controlling-rod 98 is constant, while the rotation of the roller 99 is increased with its distance from the center of the disk 100. This gradually-decreasing effect of the rack 104 upon the gear 71 is due to the increase of speed of the roller 99 as it moves away from the center of the disk 100, which permits the threaded end of the controlling-rod 98 to more rapidly screw into the sleeve 95, and thereby more effectually offset the movement of said rod in the opposite direction effected by the action of said revoluble sleeve upon said threaded end. In other words, during the revolution of the member 95 the action of the threads on its bore is to effect a constant movement of the rod 98 toward the connector 68. At the beginning of this movement the rotation of the roller 99 causes only a very slight turning of said threaded end of the rod 98 in the same direction; but as the roller moves farther from the center of the disk 100 and gradually increases in speed the threaded end will turn faster in a direction to practically offset the operation of the revoluble sleeve 95 thereon in the opposite direction. It is evident, therefore, that the initial action of the weights will cause the controlling mechanism to effect a quicker

movement of the clutches and regulating mechanism than could be secured if the weights acted alone, and this action on the part of the controlling mechanisms gradually decreases, so that there is no opportunity for the various devices to overcorrect. When the speed decreases and the weights return to their normal operative position, the clutch members are released and the revolution of the operating member 32 and member 95 stops. The disk 100 continues to revolve, however, and act upon the roller 99, rotating it and causing the rod 98 to be screwed into the sleeve 95, and this movement of said rod will turn the connector 68 in its nut 76 to decrease the distance between said nut and the lever 61, thereby returning said lever to its normal position, when all of the mechanisms forming a part of the governor will be ready to care for any further increase or decrease in the speed of the motor.

It is obvious that in the operation of the various controlling mechanisms as described the roller 99 will remain at rest at the center of the disk 100 while the centrifugal weights occupy their normal position; but as soon as the controlling-rod carries the roller off the center to a point having rotary travel the roller and rod upon which it is mounted will be operated thereby in the sleeve 95 until it again reaches the axis of the revoluble disk 100. It will be evident that the farther the weights depart from the normal the farther the roller 99 will be carried from the center of the disk and the more rapidly the shaft upon which said roller is mounted will be rotated, and therefore the neutralizing of the return of the weights will be at a rate varying with the extent of their movement and the distance which the rod has been moved, being at first most rapid, then gradually decreasing as the roller returns to the center. The neutralizing effect will, moreover, be substantially proportional to the rate of return of the weights to the normal.

Should any sudden load be put upon the governor which would tend to injure the various mechanisms, the increase or decrease would be cared for by the tension devices 70, which permits of the movement of the connector 68 independent of the lever 61 under abnormal conditions, as is obvious.

The dash-pot mechanism secured to the valve 50 prevents too sudden an action of this valve, and thereby prevents injury to the various mechanisms.

The action of this improved governor will be to secure a more rapid or greater correction for changes of speed of the motor governed arising from change of load or the like without permitting this correction to overrun and produce a seesawing of the speed in opposite directions. This governor mechanism, moreover, secures an almost absolutely constant rotation of the motor system driven

thereby, while applying at all times ample power to overcome any resistance to movement of the gate or other regulating system.

It is believed that with the foregoing description the operation of this governor will be fully understood without further description.

Having thus described my invention, I claim—

10 1. In a governor, the combination with a hollow actuating-shaft, of means including a driving-pulley for rotating the actuating-shaft in opposite directions, connectors between the rotating means and actuating-shaft located
15 in part within said actuating-shaft, a power-cylinder acting upon the connectors, means for controlling the application of power, and a centrifugal mechanism for actuating the controlling means located within said pulley.

20 2. In a governor, the combination with a hollow actuating-shaft, of means including a driving-pulley for rotating the actuating-shaft in opposite directions, connectors between the rotating means and actuating-shaft located
25 in part within said actuating-shaft, a power-cylinder acting upon the connectors, means for controlling the application of power, centrifugal mechanism located within said pulley for actuating the controlling means, and mech-
30 anism for counteracting the effect of the centrifugal mechanism upon the valve.

3. In a governor, the combination with a hollow actuating-shaft, of means including a driving-pulley for rotating the actuating-shaft
35 in opposite directions, connectors between the rotating means and actuating-shaft located in part within said actuating-shaft, a power-cylinder acting upon the connectors, a valve for controlling the admission of pressure to the
40 cylinder, centrifugal mechanism located within said pulley for actuating said valve, and mechanism operated by the element moved by the power-cylinder for counteracting the effect of the centrifugal mechanism upon the valve.

45 4. In a governor, the combination with a hollow actuating-shaft, of means for rotating the actuating-shaft in opposite directions, connectors between the rotating means and actuating-shaft, a power-cylinder acting upon the
50 connectors, a valve for controlling the admission of fluid-pressure to the cylinder, a rod therefor, revoluble weights operating upon said valve-rod, a pivoted lever between said weights and valve-rod, and yielding means for
55 retaining said lever normally in central position.

5. In a governor, the combination with a hollow actuating-shaft, of means for rotating the actuating-shaft in opposite directions, con-
60 nectors between the rotating means and actuating-shaft located in part within said actuating-shaft, a rod slidable within said actuating-shaft, a lever connected intermediate its ends to said rod and provided with a roller at its
65 pivoted end, guides for said roller, and power

mechanism acting upon the outer end of said lever.

6. In a governor, the combination with a hollow actuating-shaft, of means for rotating the actuating-shaft in opposite directions, con- 70
nectors between the rotating means and actuating-shaft, located in part within said actuating-shaft, a rod slidable within said actuating-shaft, a lever connected intermediate its ends to said rod, and provided with a roller at one 75
end, guides for said roller, power mechanism acting upon the other end of said lever, and means for controlling the application of power.

7. In a governor, the combination with a motor-controlling shaft, of a hollow actuat- 80
ing-shaft therefor, means for rotating the actuating-shaft in opposite directions, connectors between the rotating means and actuating-shaft located in part within said actuating-shaft, a rod slidable within said actuating- 85
shaft, a fulcrumed lever connected intermediate its ends to said rod, means providing for a vertical movement of said fulcrum, and power mechanism acting upon the outer end of said lever. 90

8. In a governor, the combination with a hollow actuating-shaft, of means for rotating the actuating-shaft in opposite directions, con-
nectors between the rotating means and actuating-shaft located in part within said actuat- 95
ing-shaft, a rod slidable within said actuating-shaft, a pivoted lever connected intermediate its ends to said rod, a power-cylinder acting upon the outer end of said lever, a valve for controlling the admission of pressure to the 100
cylinder, a lever, a connector between said lever and valve, and centrifugal mechanism for operating said lever.

9. In a governor, the combination with a motor-controlling shaft, of a hollow actuat- 105
ing-shaft therefor, two oppositely-rotating driving-shafts, pairs of coacting clutch-members carried by the actuating-shaft and driving-shafts, an operating member for the clutches movable within the actuating-shaft, 110
a pivoted lever connected intermediate its ends with said operating member, a power-cylinder acting upon said lever, and means having provision for the vertical movement of the pivoted end of said lever. 115

10. In a governor, the combination with a motor-controlling shaft, of a hollow actuating-shaft therefor, two oppositely-rotating driv-
ing-shafts, pairs of coacting clutch members carried by the actuating-shaft and driving- 120
shafts, an operating member for the clutches movable within the actuating-shaft, a pivoted lever connected intermediate its ends with said operating member, a power-cylinder act- 125
ing upon said lever, a valve controlling the admission of pressure to the cylinder, a lever, a connector between said lever and valve, and centrifugal mechanism controlling the operation of said lever.

11. In a governor, the combination with a 130

motor-controlling shaft, of a hollow actuating-shaft therefor, two oppositely-rotating driving-shafts, pairs of coacting clutch members carried by the actuating-shaft and driving-shafts, a rod provided with a recess movable within the actuating-shaft, a rigid connector one end of which rests within the recess and the other end of which rests in one of each pair of clutch members, a pivoted lever connected intermediate its ends with said rod, and a power-cylinder acting upon said lever.

12. In a governor, the combination with an actuating-shaft, of two oppositely-rotating driving-shafts, clutches connecting the driving-shafts and actuating-shaft, a pivoted lever, a member to which said lever is pivoted, means for vertically moving said member, a power-cylinder for operating the free end of said lever, a threaded bearing swiveled to said lever intermediate its ends, and a threaded rod coacting with said bearing and operated by said actuating-shaft to change the relative positions of said lever and rod.

13. In a governor, the combination with an actuating-shaft, of two oppositely-rotating driving-shafts, clutches connecting the driving-shafts and actuating-shaft, a pivoted lever, a member to which said lever is pivoted, means for vertically moving said member, a swiveled block mounted on said lever intermediate its ends, a rod connected with the clutches and threaded into said swiveled block, and power mechanism acting upon the outer end of the lever.

14. In a governor, the combination with an actuating-shaft, of two oppositely-rotating driving-shafts, clutches connecting the driving-shafts and actuating-shaft, a pivoted lever connected with the clutches at a point intermediate its ends, power mechanism acting upon one end of the lever, a member to which said lever is pivoted, and vertical guides for said member.

15. In a governor, the combination with an actuating-shaft, of two oppositely-rotating driving-shafts, clutches connecting the driving-shafts and actuating-shaft, a lever, a swiveled block mounted on said lever, a rod connected with the clutches and threaded into said swiveled block, power mechanism acting upon one end of the lever, a roller upon the other end of said lever, and guides for said roller.

16. In a governor, the combination with an actuating-shaft, of means for rotating said actuating-shaft in opposite directions, connectors between the rotating means and actuating-shaft, a power-cylinder acting upon the connectors, a valve for controlling the application of power, a dash-pot, and a piston in said dash-pot movable with said valve.

17. In a governor, the combination with an actuating-shaft, of means for rotating said actuating-shaft in opposite directions, connectors between the rotating means and actuating-

shaft, a power-cylinder acting upon the connectors, a valve for controlling the application of power, a dash-pot, a piston in said dash-pot movable with said valve, and means regulating the movement of liquid contained within said dash-pot from one side of said piston to its opposite side.

18. In a governor, the combination with an actuating-shaft, of means for rotating said actuating-shaft in opposite directions, connectors between the rotating means and actuating-shaft, a power-cylinder acting upon the connectors, a valve for controlling the application of power, a dash-pot, a piston in said dash-pot movable with said valve, a reservoir above said dash-pot, and a passage from said reservoir communicating with either end of said dash-pot.

19. In a governor, the combination with an actuating-shaft, of means for rotating said actuating-shaft in opposite directions, connectors between the rotating means and actuating-shaft, a power-cylinder acting upon the connectors, a valve for controlling the application of power, a dash-pot, a piston in said dash-pot movable with said valve, a reservoir above said dash-pot, a passage communicating with either end thereof, and means for regulating the size of opening of one of said passages.

20. In a governor, the combination with an actuating-shaft, of means for rotating said actuating-shaft in opposite directions, connectors between the rotating means and actuating-shaft, a power-cylinder acting upon the connectors, a valve for controlling the application of power, a dash-pot, a piston in said dash-pot movable with said valve, a reservoir above said dash-pot, a passage communicating with either end thereof, and a threaded member above one of said passages and adapted to regulate the opening therethrough.

21. In a governor, the combination with an actuating-shaft, of means for rotating said actuating-shaft in opposite directions, connectors between the rotating means and actuating-shaft, a power-cylinder acting upon the connectors, a valve for controlling the application of power, a dash-pot in axial line with said valve, a valve-stem extending through said dash-pot, a piston secured to said valve-stem within said dash-pot, and means secured to said valve-stem for moving said valve.

22. In a governor, the combination with an actuating-shaft, of means for rotating said actuating-shaft in opposite directions, connectors between the rotating means and actuating-shaft, a power-cylinder acting upon the connectors, a valve for controlling the application of power, a valve-stem provided with a threaded end, a nut upon said threaded end, means for turning said stem within said nut, and means for moving said nut to reciprocate said valve.

23. In a governor, the combination with an

actuating-shaft, of means for rotating said actuating-shaft in opposite directions, connectors between the rotating means and actuating-shaft, a power-cylinder acting upon the
 5 connectors, a valve for controlling the application of power, a valve-stem provided with a threaded end, a nut upon said threaded end, a head for turning said stem within said nut, and means for moving said nut to reciprocate
 10 said valve.

24. In a governor, the combination with an actuating-shaft, of means for rotating said actuating-shaft in opposite directions, connectors between the rotating means and actuating-shaft, a power-cylinder acting upon the
 15 connectors, a valve for controlling the application of power, a valve-stem therefor, a pivoted member connected to said valve-stem for moving said valve, and means for adjusting the position of said valve relative to said pivoted member.

25. In a governor, the combination with an actuating-shaft, of means for rotating said actuating-shaft in opposite directions, connectors between the rotating means and actuating-shaft, a power-cylinder acting upon the
 25 connectors, a valve for controlling the application of power, a valve-stem therefor provided with a threaded end, a nut upon said threaded end, means for adjusting said stem relative to said nut, a bifurcated member supporting said nut and provided with a shank, and a pivoted lever provided with a socket to receive said shank.

26. In a governor, the combination with an actuating-shaft, of means for rotating said actuating-shaft in opposite directions, connectors between the rotating means and actuating-shaft, a power-cylinder acting upon the
 30 connectors, a valve for controlling the application of power, a valve-stem therefor, a lever connected thereto and provided at its lower end with a pin, and guides for said pin extending longitudinally of said lever.

27. In a governor, the combination with an actuating-shaft, of means for rotating said actuating-shaft in opposite directions, connectors between the rotating means and actuating-shaft, a power-cylinder acting upon the
 45 connectors, a valve for controlling the application of power, a valve-stem therefor, a pivoted lever connected thereto and provided intermediate its ends with a pivoted block, a rod passing through said block, shoulders secured to said rod on either side of said block, springs interposed between said block and shoulders, and means for moving said rod longitudinally.

28. In a governor, the combination with an actuating-shaft, of means for rotating said actuating-shaft in opposite directions, connectors between the rotating means and actuating-shaft, a power-cylinder acting upon the
 50 connectors, a valve for controlling the application of power, a valve-stem therefor, a piv-

oted lever connected thereto, a block pivoted to said lever intermediate its ends, a rod passing through said block provided with shoulders, washers upon said rod normally bearing against said shoulders on either side of said
 70 block, other shoulders on either side of said block secured to said rod, springs interposed between each pair of shoulders on either side of said block, and means for moving said rod longitudinally.

29. In a governor, the combination with an actuating-shaft, of means for rotating said actuating-shaft in opposite directions, connectors between the rotating means and actuating-shaft, a power-cylinder acting upon the
 80 connectors, a valve for controlling the application of power, a valve-stem therefor, a pivoted lever connected thereto, a block pivoted to said lever intermediate its ends, a rod passing through said block provided with shoulders, washers upon said rod normally bearing against said shoulders on either side of said block, other shoulders on either side of said block secured to said rod, springs interposed between each pair of shoulders on either side
 85 of said block, centrifugal mechanism, and mechanism connecting said centrifugal mechanism with said rod.

30. In a governor, the combination with an actuating-shaft, of means for rotating said actuating-shaft in opposite directions, connectors between the rotating means and actuating-shaft, a power-cylinder acting upon the
 95 connectors, a valve for controlling the application of power, a valve-stem therefor, a pivoted lever connected thereto and provided intermediate its ends with a pivoted block, a rod passing through said block, shoulders secured to said rod on either side of said block, springs interposed between said block and shoulders,
 100 and centrifugal mechanism for moving said rod longitudinally.

31. In a governor, the combination with an actuating-shaft, of means for rotating said actuating-shaft in opposite directions, connectors between the rotating means and actuating-shaft, a power-cylinder acting upon the
 110 connectors, a valve for controlling the application of power, a valve-stem therefor, a pivoted lever for actuating the same, a rod passing through said lever, means for moving said rod lengthwise, and tension devices interposed between said rod and said lever adapted normally to cause said rod and lever to move together but under abnormal conditions to permit one to move independently of the other.

32. In a governor, the combination with an actuating-shaft, of means for rotating said actuating-shaft in opposite directions, connectors between the rotating means and actuating-shaft, a power-cylinder acting upon the
 120 connectors, a valve for controlling the application of power, a valve-stem therefor, a pivoted lever for actuating the same, a rod passing through said lever, centrifugal mechanism
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ism for moving said rod lengthwise, and tension devices interposed between said rod and said lever adapted normally to cause said rod and lever to move together but under abnormal conditions to permit one to move independently of the other.

33. In a governor, the combination with an actuating-shaft, of means for rotating said actuating-shaft in opposite directions, connectors between the rotating means and actuating-shaft, a power-cylinder acting upon the connectors, a valve for controlling the application of power, a valve-stem therefor, a pivoted lever for actuating the same, a rod connected to said lever intermediate its ends and provided with a bearing at one end and with a threaded shank at its opposite end, a pivoted nut for said shank, a lever in which said nut is mounted, and centrifugal mechanism for operating said lever.

34. In a governor, the combination with an actuating-shaft, of means for rotating said actuating-shaft in opposite directions, connectors between the rotating means and actuating-shaft, a power-cylinder acting upon the connectors, a valve for controlling the application of power, a valve-stem therefor, a pivoted lever for actuating the same, a rod connected to said lever intermediate its ends and provided with a bearing at one end and with a threaded shank at its opposite end, a pivoted nut for said shank, a lever in which said nut is mounted, centrifugal mechanism for operating said lever, and tension devices interposed between said pivoted lever and said rod causing the two normally to operate together but permitting each to operate independently of the other under abnormal conditions.

35. In a governor, the combination with an actuating-shaft, of means for rotating said actuating-shaft in opposite directions, connectors between the rotating means and actuating-shaft, a power-cylinder acting upon the connectors, a valve for controlling the application of power, a valve-stem therefor, a pivoted lever for actuating the same, a rod connected to said lever intermediate its ends and provided with a bearing at one end and with a threaded shank at its opposite end, a pivoted nut for said shank, a lever in which said nut is mounted, centrifugal mechanism for operating said lever, a block fulcrumed in said pivoted lever and provided with a bearing through which said rod passes, and springs on said rod on either side of said block adapted to cause said rod and lever to normally move in unison but permitting each to move independently of each other under abnormal conditions.

36. In a governor, the combination with an actuating-shaft, of means for rotating said actuating-shaft in opposite directions, connectors between the rotating means and actuating-shaft, a power-cylinder acting upon the connectors, a valve for controlling the applica-

tion of power, a valve-stem therefor, a pivoted lever for actuating the same, a rod connected to said lever intermediate its ends and provided with a threaded end, a nut upon said threaded end, a bifurcated lever supporting said nut, centrifugal mechanism for actuating said bifurcated lever, and means for rotating said threaded rod to vary the distance between said pivoted lever and said nut.

37. In a governor, the combination with an actuating-shaft, of means for rotating said actuating-shaft in opposite directions, connectors between the rotating means and actuating-shaft, a power-cylinder acting upon the connectors, a valve for controlling the application of power, a valve-stem therefor, a pivoted lever for actuating the same, a rod connected to said lever intermediate its ends and provided with a threaded end, a nut upon said threaded end, a bifurcated lever supporting said nut, centrifugal mechanism for actuating said bifurcated lever, means for rotating said threaded rod to vary the distance between said pivoted lever and said nut, and tension devices interposed between said pivoted lever and said rod causing the two to normally operate together but permitting each to operate independently of the other under abnormal conditions.

38. In a governor, the combination with an actuating-shaft, of means for rotating said actuating-shaft in opposite directions, connectors between the rotating means and actuating-shaft, a power-cylinder acting upon the connectors, a valve for controlling the application of power, a valve-stem therefor, a pivoted lever for actuating the same, a rod connected to said lever intermediate its ends and provided with a threaded end, a nut upon said threaded end, a bifurcated lever supporting said nut, centrifugal mechanism for actuating said bifurcated lever, means for rotating said threaded rod to vary the distance between said pivoted lever and said nut, a block fulcrumed in said pivoted lever and provided with a bearing through which said rod passes, and springs on said rod on either side of said block adapted to cause said rod and lever to normally move in unison but permitting each to move independently of each other under abnormal conditions.

39. In a governor, the combination with an actuating-shaft, of means for rotating said actuating-shaft in opposite directions, connectors between the rotating means and actuating-shaft, a power-cylinder acting upon the connectors, a valve for controlling the application of power, a valve-stem therefor, a pivoted lever for actuating the same, a rod connected to said lever intermediate its ends and provided with a threaded end, a nut upon said threaded end, a bifurcated lever supporting said nut, centrifugal mechanism for actuating said bifurcated lever, means for rotating said threaded rod to vary the distance between said

pivoted lever and nut, a pinion upon said rod, a rack meshing with said pinion, and controlling mechanism actuated by the centrifugal mechanism for operating said rack.

5 40. In a governor, the combination with an actuating-shaft, of means for rotating said actuating-shaft in opposite directions, connectors between the rotating means and actuating-shaft, a power-cylinder acting upon the connectors, a valve for controlling the application of power, a valve-stem therefor, a pivoted lever for actuating the same, a rod connected to said lever intermediate its ends and provided with a threaded end, a nut upon said
10 threaded end, a bifurcated lever supporting said nut, centrifugal mechanism for actuating said bifurcated lever, means for rotating said threaded rod to vary the distance between said pivoted lever and nut, a pinion upon said rod,
15 a rack meshing with said pinion, a revoluble rod on which said rack is mounted, a roller secured to said revoluble rod, a revoluble disk with which said roller coacts, means for moving said controlling-rod lengthwise to actuate
20 said pinion, and means for causing said roller to return to its normal position.

41. In a governor, the combination with an actuating-shaft, of means for rotating said actuating-shaft in opposite directions, connectors between the rotating means and actuating-shaft, a power-cylinder acting upon the connectors, a valve for controlling the application of power, a valve-stem therefor, a pivoted lever for actuating the same, a rod connected to said lever intermediate its ends and provided with a threaded end, a nut upon said threaded end, a pinion on said rod, a rack meshing therewith, a revoluble rod supporting said rack adapted for endwise movement and having its opposite end threaded, a roller secured to said revoluble rod, a revoluble disk coacting with said roller, a revoluble member coöperating with the threaded end of said revoluble rod, and means for revolving said revoluble member.
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42. In a governor, the combination with an actuating-shaft, of means for rotating said actuating-shaft in opposite directions, connectors between the rotating means and actuating-shaft, a power-cylinder acting upon the connectors, a valve for controlling the application of power, a valve-stem therefor, a pivoted lever for actuating the same, a rod connected to said lever intermediate its ends and provided with a threaded end, a nut upon said threaded end, a pinion on said rod, a rack meshing therewith, a revoluble rod supporting said rack adapted for endwise movement and having its opposite end threaded, a roller secured to said revoluble rod, a revoluble disk coacting with said roller, a revoluble member coöperating with the threaded end of said revoluble rod, a sprocket-wheel secured to said revoluble member, a sprocket-wheel secured to the actuating-shaft, and a

chain interposed between said sprocket-wheels.

43. In a governor, the combination with an actuating-shaft, of means for rotating said actuating-shaft in opposite directions, connectors between the rotating means and actuating-shaft, a power-cylinder acting upon the connectors, a valve for controlling the application of power, a valve-stem therefor, a pivoted lever for actuating the same, a rod connected to said lever intermediate its ends and provided with a threaded end, a nut upon said threaded end, a pinion on said rod, a rack meshing therewith, a revoluble rod supporting said rack adapted for endwise movement and having its opposite end threaded, a roller secured to said revoluble rod, a revoluble disk coacting with said roller, a revoluble member coöperating with the threaded end of said revoluble rod, and means for operating said revoluble member by the rotation of said actuating-shaft.
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44. In a governor, the combination with an actuating-shaft, of means for rotating said actuating-shaft in opposite directions, connectors between the rotating means and actuating-shaft, a power-cylinder acting upon the connectors, a valve for controlling the application of power, a piston within said power-cylinder, a rod therefor, an indicating-pointer on said rod, an indicator-plate coöperating with said pointer to indicate the operation of said governor, a revoluble shaft provided with a spiral thread, and a nut thereon coöperating with said indicator-plate to indicate the position of the gate being regulated.
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45. In a governor, the combination with an actuating-shaft, of means for rotating said actuating-shaft in opposite directions, connectors between the rotating means and actuating-shaft, a power-cylinder acting upon the connectors, a valve for controlling the application of power, a revoluble shaft provided with a spiral thread, a nut mounted on said shaft, means for revolving said shaft to move said nut lengthwise thereof, and an indicator-plate coöperating with said nut.
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46. In a governor, the combination with an indicator-plate having a straight side, of a pointer movable in a straight line and coöperating with said indicator-plate, means for moving said pointer to indicate the operation of the governor, a revoluble shaft provided with a spiral thread, a nut coacting therewith, and means for revolving said shaft to move said nut lengthwise thereof to indicate upon said plate the position of the gate or other device being regulated.
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47. In a governor, the combination of an indicator-plate, a pointer coöperating therewith to indicate the operation of the governor, and a second pointer coöperating therewith to indicate the position of the gate or other device being regulated.

48. In a governor, the combination of an

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indicator-plate, a movable member, a pointer secured thereto and coöperating with said plate to indicate the operation of the governor, and a second pointer operated by the gate-operating device coöperating with the same plate to indicate the position of the gate.

49. In a governor, the combination of an indicator-plate, a pointer therefor controlled by the governor mechanism and a second pointer therefor controlled by the gate-operating mechanism, and means for operating said pointers in unison during the operation of the governor.

50. In a governor, the combination with an actuating-shaft, of means for rotating said actuating-shaft in opposite directions, connectors between the rotating means and actuating-shaft, a power-cylinder acting upon the connectors, a valve for controlling the application of power, a dash-pot, a piston therein operating with said valve, a reservoir at one side of said dash-pot, means permitting the passage of liquid from one side of said dash-pot to its opposite side, and means for deflecting the current of said liquid.

51. In a governor, the combination with an actuating-shaft, of means for rotating said actuating-shaft in opposite directions, connectors between the rotating means and actuating-shaft, a power-cylinder acting upon the connectors, a valve for controlling the application of power, a dash-pot, a piston therein operating with said valve, a reservoir at one side of said dash-pot, passages communicating between said reservoir and dash-pot on either side of said piston, and a deflector above one of said passages.

52. In a governor, the combination with an

actuating-shaft, of means for rotating said actuating-shaft in opposite directions, connectors between the rotating means and actuating-shaft, a power-cylinder acting upon the connectors, a valve for controlling the application of power, a dash-pot, a piston therein operating with said valve, a reservoir at one side of said dash-pot, passages communicating between said reservoir and dash-pot on either side of said piston, a deflector above one of said passages, and means for deflecting the current from one of said passages toward the other passage.

53. In a governor, the combination with an actuating-shaft, of means for rotating said actuating-shaft in opposite directions, connectors between the rotating means and actuating-shaft, a power-cylinder acting upon the connectors, a valve for controlling the application of power, and fluid-controlled mechanism for regulating the movement of said valve.

54. In a governor, the combination with an actuating-shaft, of means for rotating said actuating-shaft in opposite directions, connectors between the rotating means and actuating-shaft, a power-cylinder acting upon the connectors, a valve for controlling the application of power, a fluid-controlled device for regulating the movement of said valve, and means for varying the movement of said device.

Signed by me at Boston, Massachusetts, this 2d day of June, 1904.

NATHANIEL LOMBARD.

Witnesses:

WALTER E. LOMBARD,
EDNA C. CLEVELAND.