No. 736,277. PATENTED AUG. 11, 1903.

N. LOMBARD.

CENTRIFUGAL GOVERNOR.

APPLICATION FILED AUG. 11, 1902.

NO MODEL. 3 SHEETS—SHEET 1.

Fig. 1.

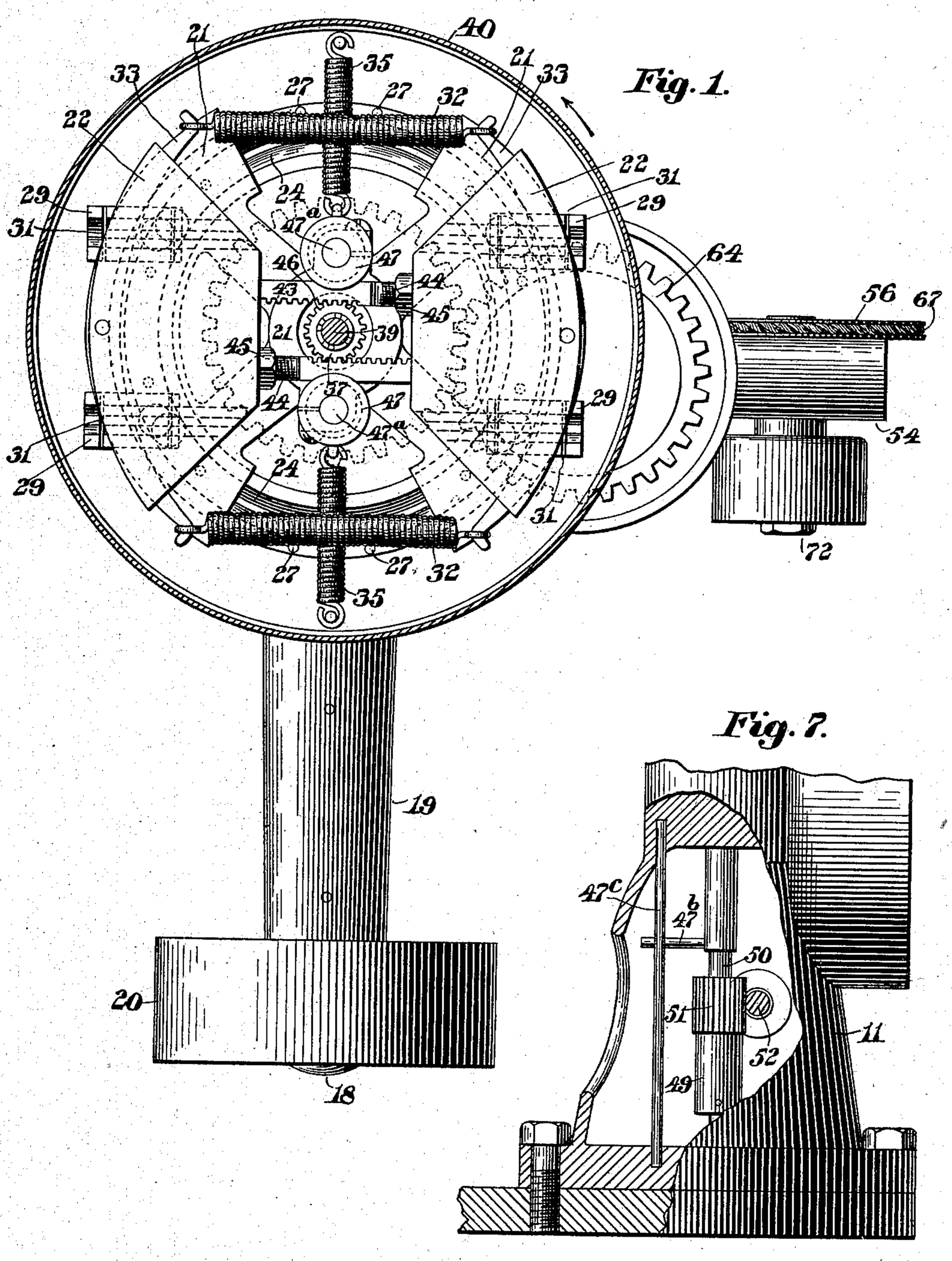

Fig. 7.

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THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

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NO MODEL. 3 SHEETS—SHEET 2.

Fig. 6.

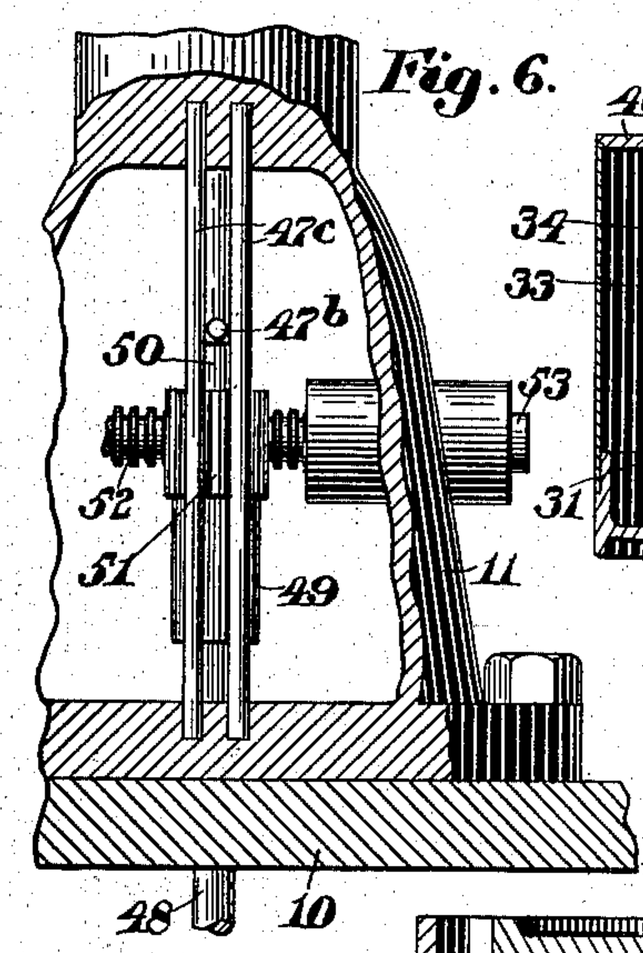
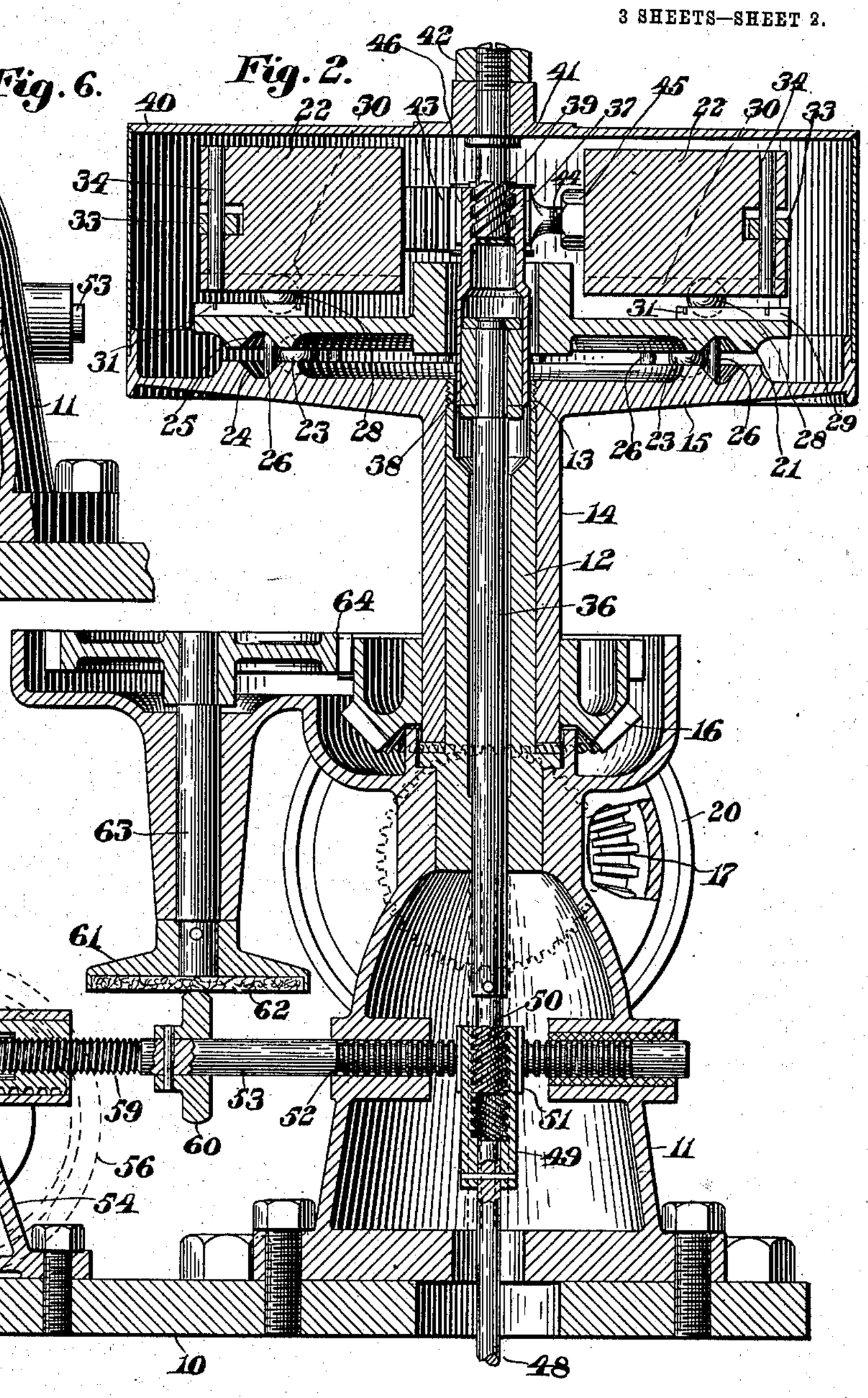


Fig. 2.



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NO MODEL. 3 SHEETS—SHEET 3.

Fig. 3.

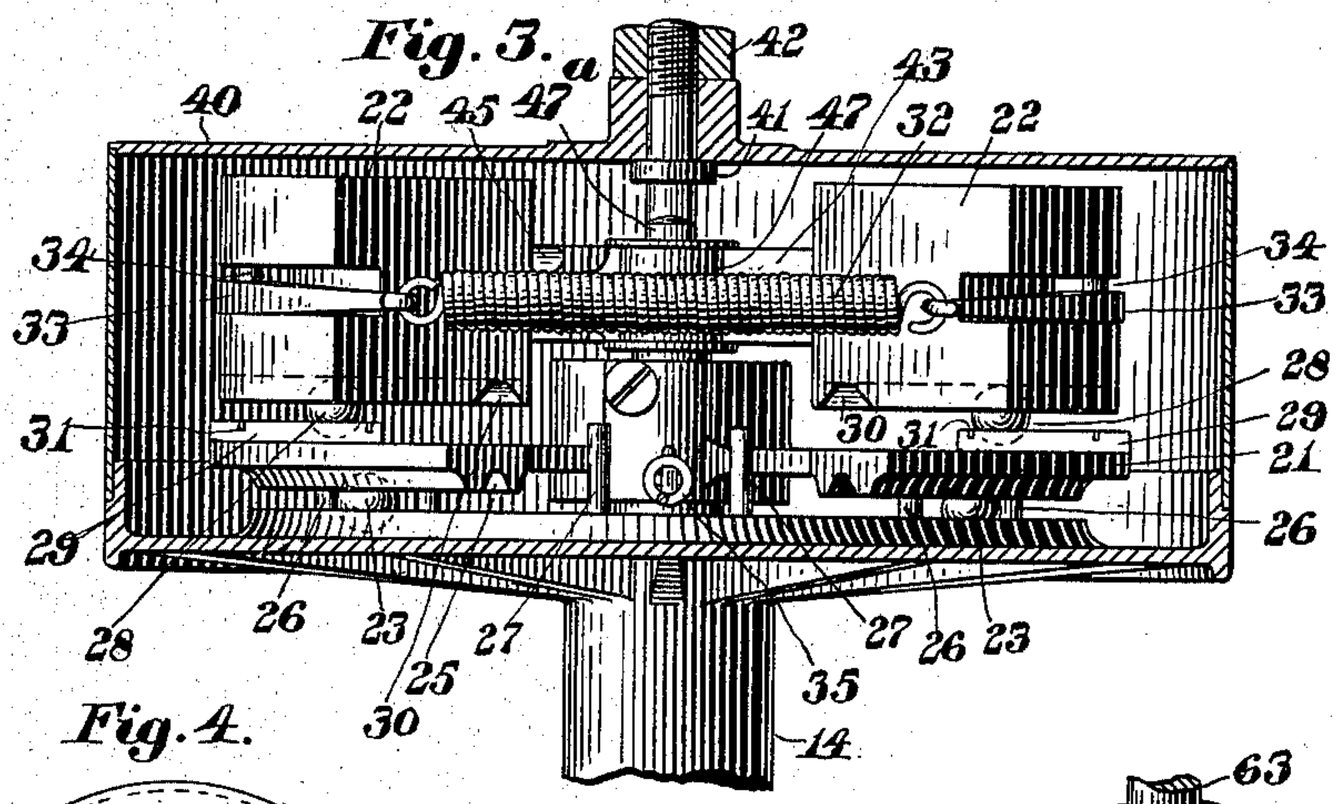


Fig. 4.

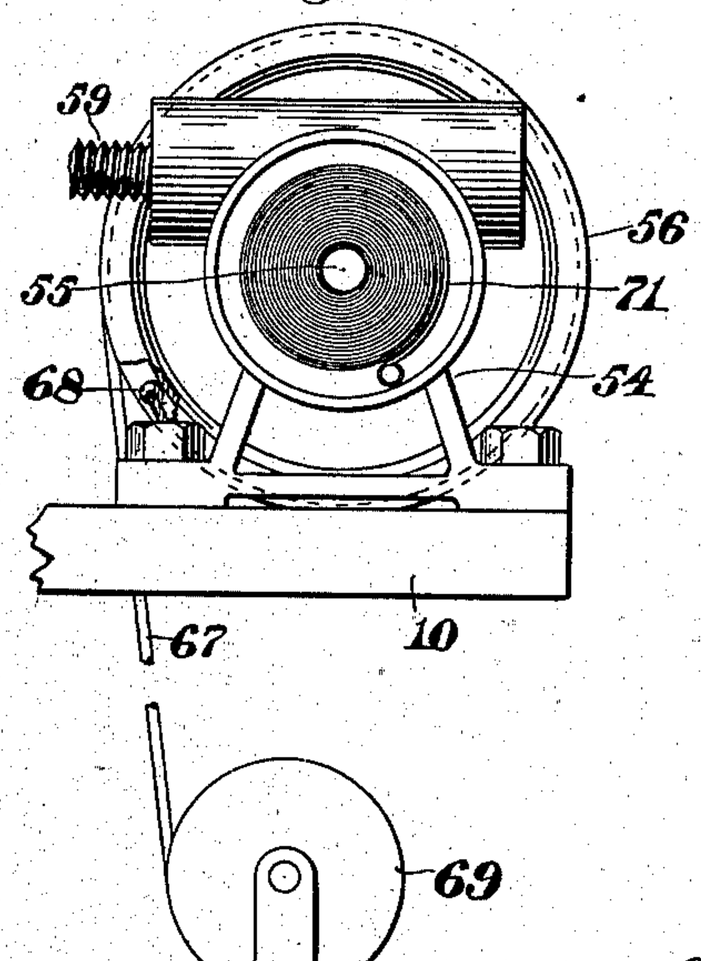
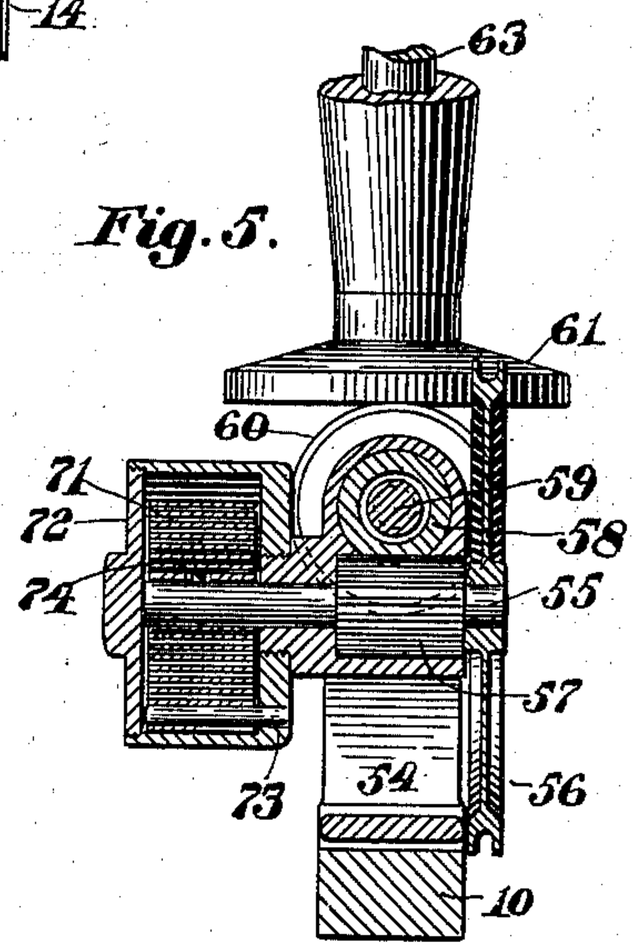
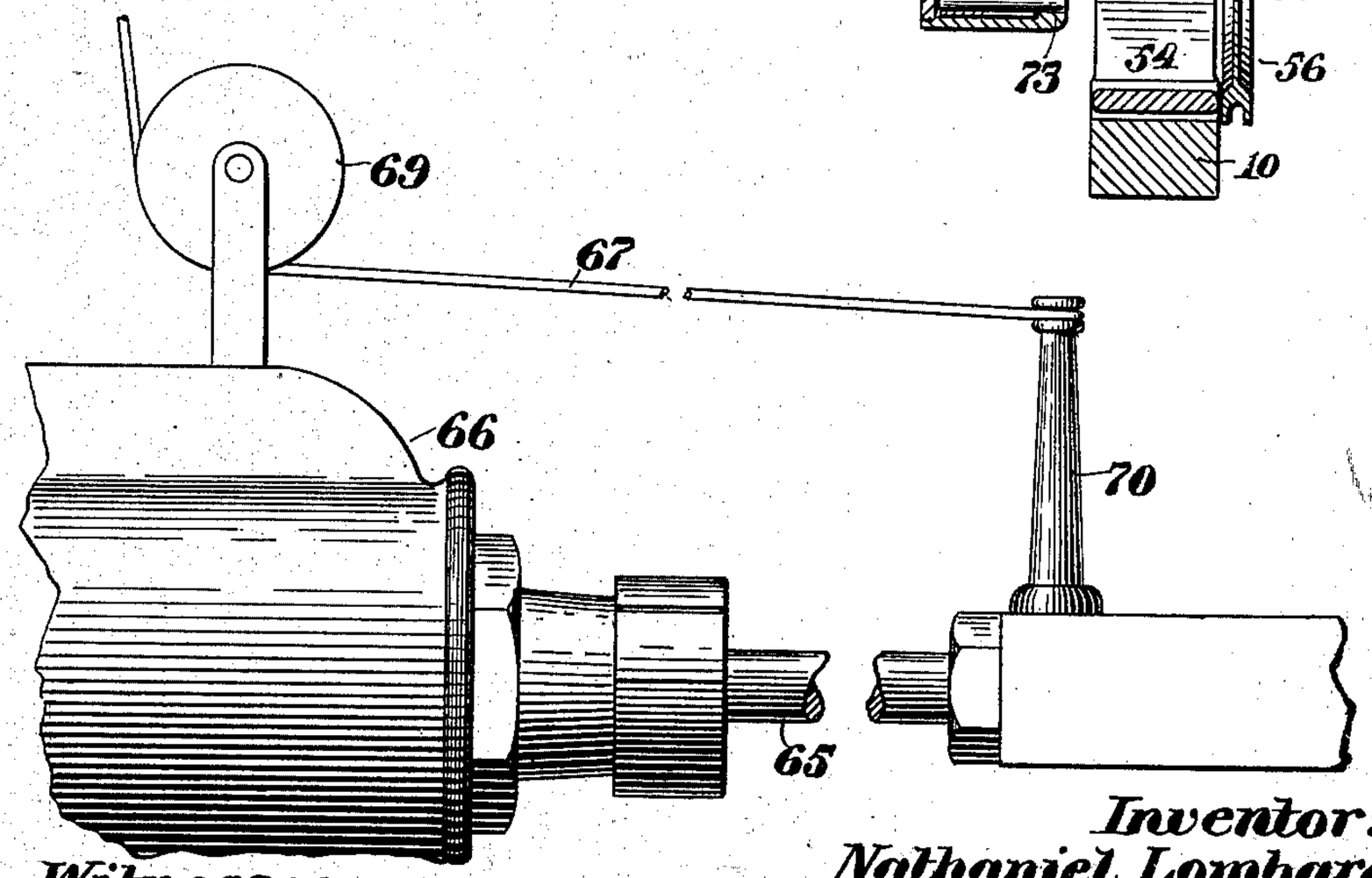


Fig. 5.





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THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 736,277. Patented August 11, 1903.

UNITED STATES PATENT OFFICE.

NATHANIEL LOMBARD, OF BROOKLINE, MASSACHUSETTS, ASSIGNOR TO THE N. LOMBARD IMPROVED GOVERNOR COMPANY, OF BOSTON, MASSACHUSETTS, A CORPORATION OF MAINE.

CENTRIFUGAL GOVERNOR.

SPECIFICATION forming part of Letters Patent No. 736,277, dated August 11, 1903.

Application filed August 11, 1902. Serial No. 119,150. (No model.)

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 Brookline, in the county of Norfolk and State of Massachusetts, have invented certain new and useful Improvements in Centrifugal Governors, of which the following is a specification.

My invention relates to mechanism for controlling the speed of various motors, and more particularly to such governors which are of the centrifugal type, having for its objects the provision of certain novel features and combinations hereinafter described and claimed.

In the accompanying drawings, Figure 1 is a top plan view of one form of my invention with the casing and screw supported thereby in section. Fig. 2 is an irregular vertical longitudinal section. Fig. 3 is a front elevation of the upper portion of the governor with the casing and flange on which it is supported in section. Fig. 4 is a detail in side elevation of a portion of actuating mechanism for the controlling-rod of the governor with the head of its spring-inclosing casing removed and showing its connection with a reciprocating element. Fig. 5 is a vertical transverse section thereof; and Figs. 6 and 7 are broken front and side elevations, respectively, of a device for preventing the rotation of the controlling-rod.

The numeral 10 designates some suitable base, upon which is supported a standard 11, having stepped in it a hollow shaft 12. Fastened upon the shaft, preferably by a thread 13 at its upper end, is a sleeve or hollow shaft 14, here shown as integral with a disk or platform 15, serving as a primary support for the governor members to be hereinafter described. The sleeve may have upon it a bevel-pinion 16, meshing with a bevel-gear 17 upon a shaft 18. This shaft is journaled in a bearing 19 in the standard 11 and continuously rotated at the desired speed through a pulley 20, belted to any rotating portion of the system driven by the motor to be controlled.

The platform 15 preferably carries a secondary support or platform 21 for centrifugal members or weights 22, these weights being conveniently two in number, of sector shape, and the platform 21 may be of similar shape, being only of sufficient extent to furnish the proper support. As here illustrated, this secondary support is mounted for independent rotation upon the platform 15 by means of balls or other antifriction members 23, moving in circular ways 24 25 in the primary and secondary supports, respectively. Contact-pins 26 are fixed in the ways 24 to limit the movement of the balls therein, while pins 27 act as stops for the support 21. The weights are mounted for radial movement upon balls 28, rolling in pairs of ways 29 30, provided in any convenient manner in the support 21 and weights, respectively, and retained against displacement by contact-pieces 31. To oppose centrifugal force and hold the weights at the limit of inward movement when the primary support is stationary, springs 32 are provided, here shown as two in number, of spiral form and extending between the weights on each side. To compensate for differences in tension and permit the weights to run smoothly without cramping or throwing uneven pressure upon the balls, these springs are connected to the opposite ends of yokes 33, pivoted at 34 upon each weight. The secondary support is yieldably connected with the primary support to resist the movement of the former, for a purpose to be later explained, by springs 35, in the present instance shown as spiral tension-springs fixed at their ends and extending radially between the two supports. To enable the movements of the weights under varying speeds of rotation to be utilized for governing the motor causing said rotation, a portion of the controlling mechanism is shown, including a rod 36, extending through the hollow shaft 12. This rod is preferably supported at or near its upper end by an internally-threaded sleeve or member 37, swiveled to the rod at 38, the thread of which sleeve coacts with a screw 39, fixed with regard thereto. A convenient means of supporting the screw 39 is upon an inclosing casing 40, secured to the primary support, it extending therethrough and being held against longitudinal movement by a collar 41, abutting against the under side

of the top of the casing, and a nut 42, threaded upon the shank of the screw on the upper side. The setting of this nut also holds the screw from rotation in the casing, but when loosened permits a rotary adjustment to raise or lower the controlling-rod thereon. The weights are geared to the sleeve 37 preferably by racks 43, shown as adjustably mounted upon the weights by the shanks 44, threaded into the openings therein and held in place by check-nuts 45. These racks mesh with teeth 46, forming an elongated pinion upon the exterior of the sleeve, and since the racks are on opposite sides the opposite movement of the weights toward or from one another acts to rotate the sleeve in one direction. Rolls 47, preferably turning on studs 47^a, carried by the secondary support, coact with the back of the racks to retain them in proper relation to the sleeve. Rotation of the controlling-rod under the influence of the rotation of the sleeve may be prevented by a pin 47^b, extending from the rod between a pair of guide-pins 47^c, fixed in the standard 11. The controlling-rod has a separate section 48, which may be connected with the valve or other element it is desired to operate, and this section is shown as connected with the main rod by an internally-threaded sleeve 49, fixed to or integral with the former and coacting with a threaded end 50, formed with or secured to the rod. The exterior of the sleeve 49 is provided with gear-teeth 51, forming an elongated pinion meshing with rack-teeth 52, preferably of circular form, or extending entirely around a shaft 53, journaled both for rotation and reciprocation conveniently in the standard 11. Upon the base-plate 10 may be secured a small standard 54, in which is journaled a shaft 55, having fast upon it a drum or pulley 56 and a pinion 57. In a bore adjacent to this pinion slides a sleeve 58, having at one side a rack 58^a, meshing with the pinion. The sleeve is internally threaded to receive a thread 59 upon one end of the shaft 53. This shaft also has secured to it a roll 60, having its outwardly-curved face contacting with a disk or member 61, which may, if desired, be provided with a renewable surface, of leather or other suitable material, 62. The disk 61 is carried by a shaft 63, conveniently journaled in a bearing formed in the standard 11 and continuously rotated during the revolution of the weights by gearing 64 to the sleeve 14. The pulley 56 may be rotated in one direction by connection with some movable element, as a part of the governing mechanism. This element is here shown as a reciprocatory piston-rod 65 of a cylinder 66, the connection being by means of a flexible member or cord 67, fastened at 68 in a groove in the pulley and extending over a guide-roll 69 to a post 70 upon the piston-rod. Opposite movement of the shaft 55 may be secured by a coil-spring 71, conveniently located within a casing 72, carried by the standard 54 and pinned at 73 and 74 to the casing and shaft, respectively. The rotation of the shaft by the cord acts to wind up or put tension upon the spring, which upon the slackening of the cord serves to impart a reverse rotation to the shaft.

In operation, with the parts in the relation here illustrated, the primary support is driven left-handedly at such a rate through the pulley 20 that normally for the desired speed of rotation of the motor the weights are substantially at the center of their range of movement, and the various screws, racks, and the roll 60 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 the primary support rotating more rapidly, causing the weights to move outwardly upon the secondary support under the increased centrifugal force generated, and their racks, moving by the sleeve 37, rotate it so that it moves down the screw 39 and lowers the rod to effect the desired controlling action; but before this movement of the weights occurs the secondary support, lagging behind the primary support upon the increase of speed because of its inertia, produces a very quick movement of rotation between the weights and the screw 39, the secondary support turning against the tension of the springs 35. This results in a movement of the rod in the same direction as that secured by the outward travel of the weights, but more promptly, thus effecting an immediate partial correction by the governor, which is continued more gradually by the mechanism previously described until the desired amount 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 check the gate-operating piston or whatever element is actuated by the governor, the pulley 56 is rotated in such a direction by the element to which it is connected by the cord or by the spring 71 that the shaft 55 is moved by the pinion and rack to the left, Fig. 2. This rotates the sleeve 49 and causes it to ascend the thread 50, so that the controlling-rod as a whole is shortened, this continuing until the section 48 is restored to its initial position and with it the controlling mechanism actuated thereby.

As the above operations will restore the motor system to its normal speed, the weights will return to the position they occupied before the change occurred, and unless their effect upon the controlling mechanism is neutralized they would move the rod in the opposite direction and destroy the balance of forces just attained. The mechanism actuated by the roll 60 will prevent this. While the weights occupy their normal position the roll will be at the center of the disk 61 and will remain at rest; but as soon as the shaft moves longitudinally in acting to shorten the

controlling-rod it carries the roll off the center to a point having rotary travel. This rotates the roll and the shaft, and the thread of the latter turning in the sleeve 58 moves the shaft to the right, causing the sleeve 49 to be lowered upon the screw 50, moving the section 48 downward an amount equal to that which the rod is moved by the return of the weights. It will be evident that the farther the weights depart from the normal the farther the roll will be moved from the center of the disk and the more rapidly will the shaft 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 shaft has been moved, being at first most rapid then gradually decreasing as the roll approaches the center of the disk. The neutralizing effect will, moreover, be substantially proportional to the rate of return of the weights to the normal.

The action of my improved governor will be to secure extremely rapid or prompt corrections for changes of speed of the motor governed arising from changes of load or the like without permitting this correction to overrun and produce a seesawing of the speed in opposite directions, thus securing an almost absolutely constant rotation of the motor and system driven thereby.

Having thus described my invention, I claim—

1. In a centrifugal governor, the combination with a rotatable primary support, of a secondary support mounted to rotate independently upon the primary support, a weight movable upon the secondary support under the influence of centrifugal force, and controlling mechanism actuated by the weight.

2. In a centrifugal governor, the combination with a rotatable primary support, of a secondary support mounted to move upon the primary support and yieldably connected therewith, a weight movable upon the secondary support under the influence of centrifugal force, and controlling mechanism actuated by the weight.

3. In a centrifugal governor, the combination with a rotatable primary support, of a secondary support mounted to move upon the primary support, springs extending between the primary support and secondary support, a weight movable upon the secondary support under the influence of centrifugal force, and controlling mechanism actuated by the weight.

4. In a centrifugal governor, the combination with a rotatable primary support, of a secondary support rotatably mounted upon the primary support and yieldably connected therewith, a weight movable upon the secondary support under the influence of centrifugal force, and controlling mechanism actuated by the weight.

5. In a centrifugal governor, the combination with a horizontally-movable weight, of antifriction members to support said weight, a rack mounted upon the weight, a controlling-rod, and a gear carried by the controlling-rod and meshing with the rack.

6. In a centrifugal governor, the combination with a horizontally-movable weight, of antifriction members to support said weight, a rack mounted upon the weight, a controlling-rod, a gear carried by the controlling-rod and meshing with the rack, and means for adjusting the position of the rack upon the weight relatively to the gear.

7. In a centrifugal governor, the combination with a horizontally-movable weight, of antifriction members to support said weight, a rack mounted upon the weight, a controlling-rod, a sleeve carried by said rod provided with an internal thread and with external teeth meshing with the rack, and a threaded member with which the thread of the sleeve coacts.

8. In a centrifugal governor, the combination with a horizontally-movable weight, of antifriction members to support said weight, a rack mounted upon the weight, a controlling-rod, a sleeve carried by said rod provided with an internal thread and with external teeth meshing with the rack, and a threaded member fixed with regard to the sleeve with which the thread of said sleeve coacts.

9. In a centrifugal governor, the combination with a horizontally-movable weight, of antifriction members to support said weight, a rack mounted upon the weight, a controlling-rod, a sleeve carried by said rod provided with an internal thread and with external teeth meshing with the rack, a threaded member fixed with regard to the sleeve with which the thread of said sleeve coacts, and means for adjusting the threaded member with regard to the sleeve.

10. In a centrifugal governor, the combination with a rotatable casing, of a screw fixed to the casing, a weight movable in the casing, a controlling-rod, and a threaded member swiveled to the rod, said threaded member coöperating with the screw and being geared to the weight.

11. In a centrifugal governor, the combination with a rotatable casing, of a screw fixed to the casing, a weight movable in the casing, a controlling-rod, a threaded member carried by the rod, said threaded member coöperating with the screw and being geared to the weight, and means for adjusting the screw in the casing to vary the position of the threaded member thereon.

12. In a centrifugal governor, the combination with a rotatable casing, of a screw fixed to the casing, a weight movable in the casing, means for permitting the weight to lag behind the casing when changes in its speed of rotation occur, a controlling-rod, and a threaded member carried by the rod, said threaded member coöperating with the screw and being geared to the weight.

13. In a centrifugal governor, the combination with a pair of horizontally-movable weights, of antifriction members to support said weights, a controlling-rod geared to the weights, and springs extending between the weights.

14. In a centrifugal governor, the combination with a pair of weights, of a controlling-rod geared to the weights, a yoke pivoted to each weight, and springs connecting the yokes on each side of their pivotal points.

15. In a centrifugal governor, the combination with a rotatable platform provided with ways, of balls situated in the ways, weights supported by the balls, a controlling-rod, and a connector between the weights and controlling-rod.

16. In a centrifugal governor, the combination with a rotatable platform provided with ways, of balls situated in the ways, weights supported by the balls, a yoke pivoted to each weight, springs connecting the yokes at each side of the pivotal points, a controlling-rod, and a connector between the weights and controlling-rod.

17. In a centrifugal governor, the combination with a rotatable platform provided with ways, of balls situated in the ways, a secondary platform provided with ways supported on the balls, balls in the ways of the secondary platform, weights supported by these latter balls, a controlling-rod, and a connector between the weights and controlling-rod.

18. In a centrifugal governor, the combination with a rotatable primary support, of a secondary support mounted to rotate independently upon the primary support, a weight movable upon the secondary support under the influence of centrifugal force, a rack mounted upon the weight, and a gear carried by the controlling mechanism and meshing with the rack.

19. In a centrifugal governor, the combination with a rotatable casing, of a screw fixed thereto, a support mounted to move in the casing, a weight movable upon the support, a controlling-rod, and a threaded member swiveled to the rod, said member coöperating with the casing-screw and being geared to the weight.

20. In a centrifugal governor, the combination with a rotatable primary support, of a secondary support mounted to rotate independently upon the primary support, a pair of weights movable upon the secondary support under the influence of centrifugal force, springs extending between the weights, and controlling mechanism actuated by the weights.

21. In a centrifugal governor, the combination with a rotatable casing, of a screw fixed to the casing, a weight movable in the casing, a controlling-rod, an internally-threaded member provided with teeth swiveled to the rod and coöperating with the screw, and racks mounted upon the weights meshing with the teeth of the threaded member.

22. In a centrifugal governor, the combination with a pair of horizontally-movable weights, of antifriction members to support said weights, springs extending between the weights, a rack mounted upon the weights, a controlling-rod, and a gear carried by the controlling-rod and meshing with the rack.

23. In a centrifugal governor, the combination with a revoluble weight, of a controlling-rod actuated thereby, a threaded sleeve carried by the rod, a shaft coöperating with the sleeve, means for moving the shaft to rotate the sleeve, and means for returning the shaft to its normal position at a rate varying with the distance to which it has been moved.

24. In a centrifugal governor, the combination with a revoluble weight, of a controlling-rod actuated thereby, a threaded sleeve carried by the rod, a shaft coöperating with the sleeve, means for moving the shaft longitudinally to rotate the sleeve, and means for rotating the shaft to return it to its normal position at a rate varying with the distance to which it has been moved.

25. In a centrifugal governor, the combination with a revoluble weight, of a controlling-rod actuated thereby, a threaded sleeve carried by the rod, a shaft coöperating with the sleeve, means for moving the shaft longitudinally to rotate the sleeve, a roll carried by the shaft, and a continuously-rotatable member with which the roll contacts.

26. In a centrifugal governor, the combination with a revoluble weight, of a controlling-rod actuated thereby, a threaded sleeve carried by the rod, a shaft coöperating with the sleeve, means for moving the shaft longitudinally to rotate the sleeve, a roll carried by the shaft, and a continuously-rotatable member with the center of which the roll normally contacts.

27. In a centrifugal governor, the combination with a revoluble weight, of a controlling-rod actuated thereby, a threaded sleeve carried by the rod, a shaft coöperating with the sleeve, and a flexible member connected with some reciprocating element and serving to move the shaft to rotate the sleeve.

28. In a centrifugal governor, the combination with a revoluble weight, of a controlling-rod actuated thereby, a threaded sleeve carried by the rod, a shaft coöperating with the sleeve, a flexible member connected with some reciprocating element and serving to move the shaft in one direction to rotate the sleeve, and a spring for moving the shaft in the opposite direction.

Signed by me at Boston, Massachusetts, this 8th day of August, 1902.

NATHANIEL LOMBARD.

Witnesses:

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