No. 778,249. PATENTED DEC. 27, 1904.

O. JUNGGREN.

CENTRIFUGAL GOVERNOR.

APPLICATION FILED APR. 27, 1904.

2 SHEETS—SHEET 1.

Fig. 1.

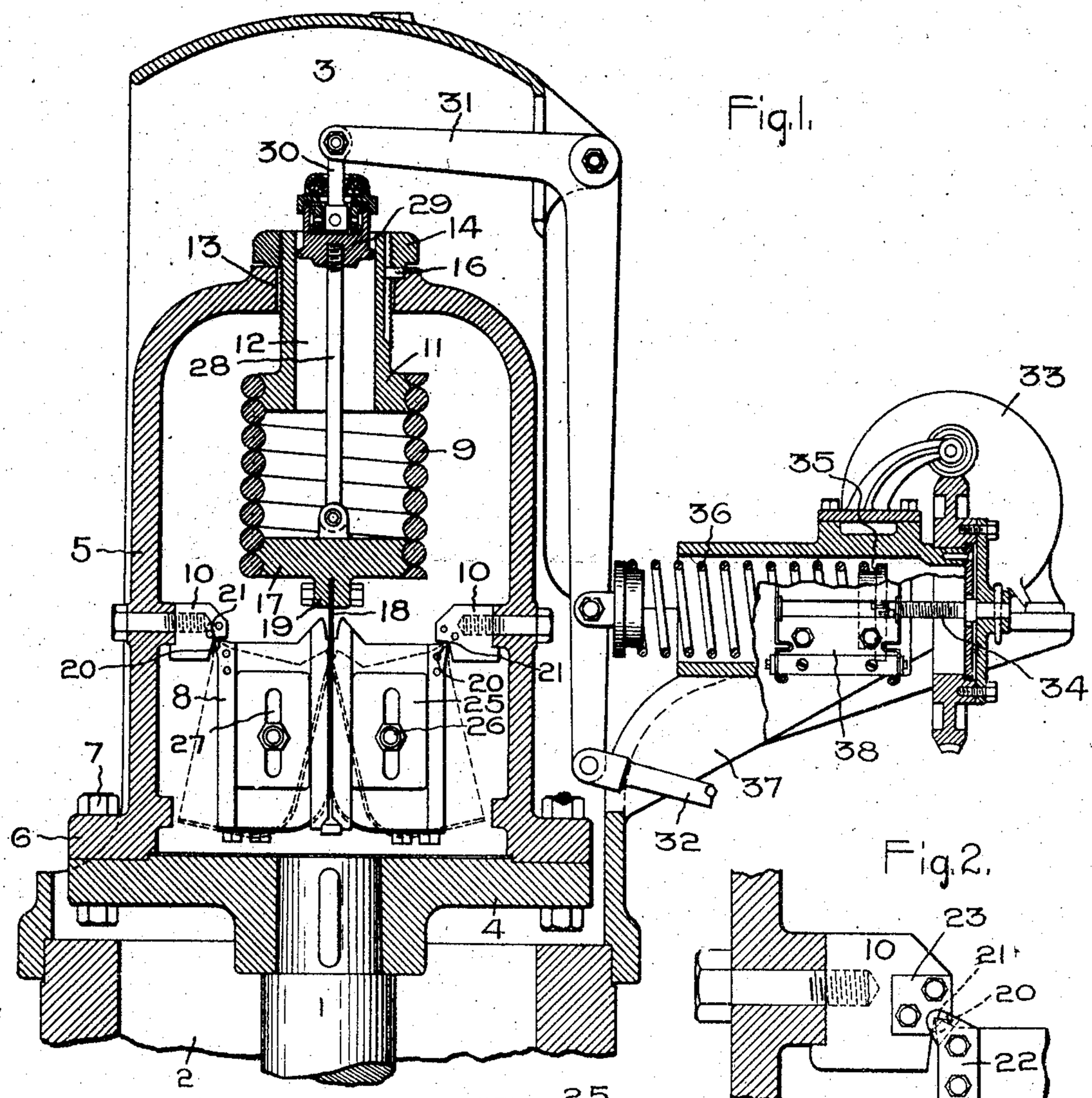
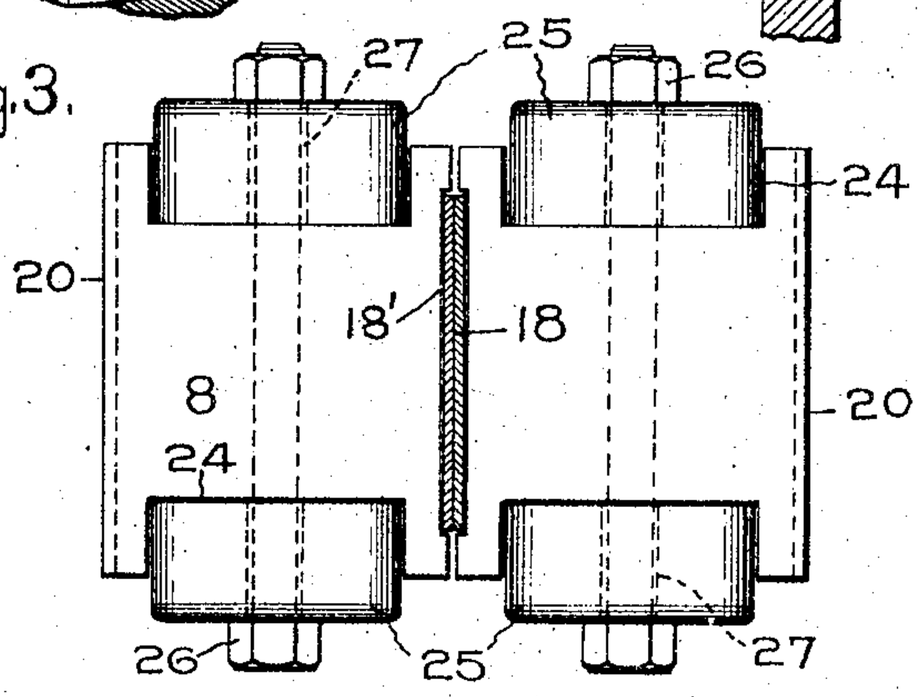


Fig. 2.

Fig. 3.



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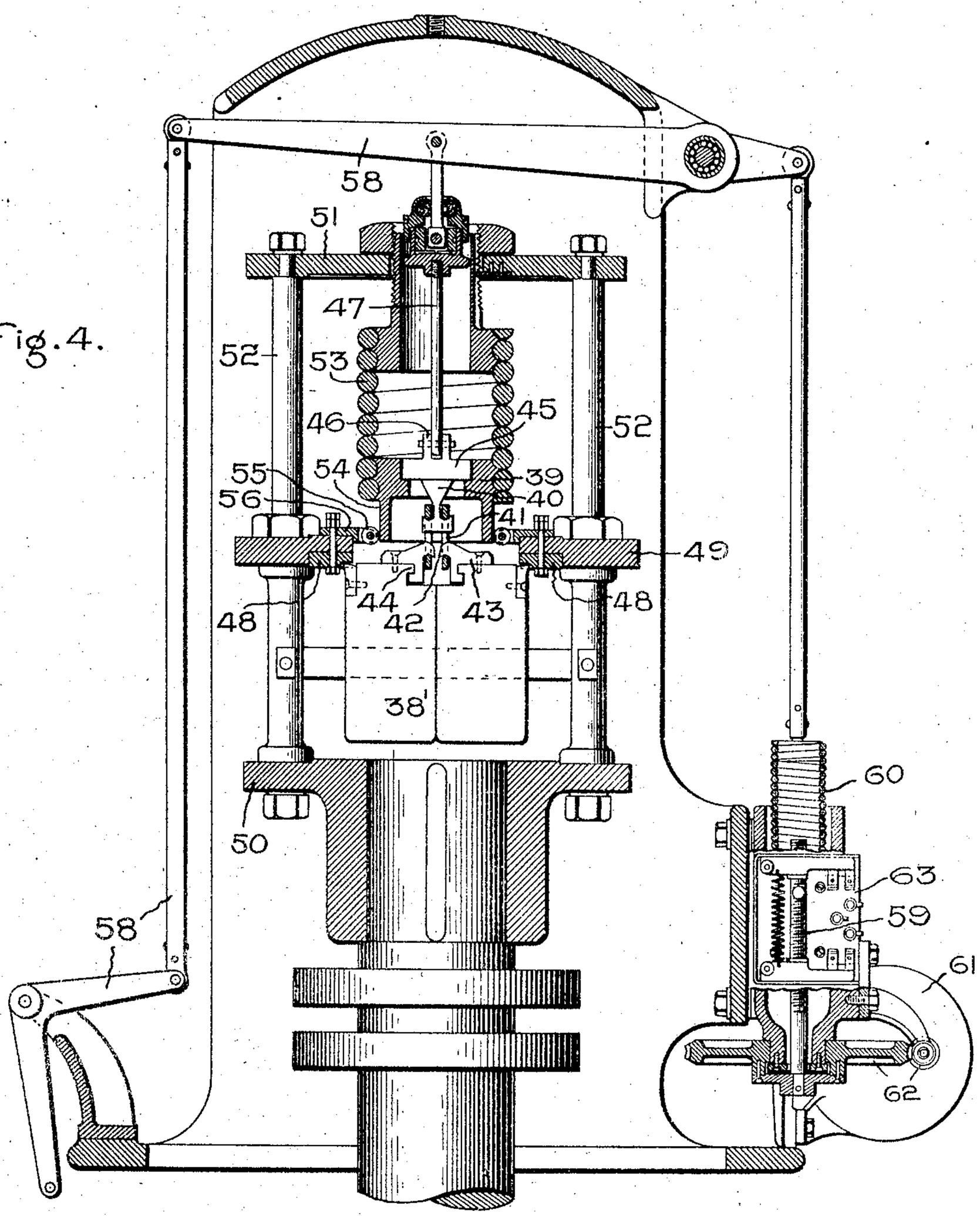
2 SHEETS—SHEET 2.

Fig. 4.



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No. 778,249. Patented December 27, 1904.

UNITED STATES PATENT OFFICE.

OSCAR JUNGGREN, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

CENTRIFUGAL GOVERNOR.

SPECIFICATION forming part of Letters Patent No. 778,249, dated December 27, 1904.

Application filed April 27, 1904. Serial No. 205,123.

To all whom it may concern:

Be it known that I, OSCAR JUNGGREN, a citizen of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Centrifugal Governors, of which the following is a specification.

This invention relates to automatic governing devices of the centrifugal type, such as are used for governing steam, gas, or other engines or turbines.

The object of the invention is to provide a governor of improved construction which will maintain the speed of rotation within the desired limits over a wide range of load, and this without undue vibration.

For an understanding of what I regard as my invention I have set forth the novel features thereof with particularity in the following description and the claims appended thereto, which are to be construed in connection with the accompanying drawings, illustrating embodiments of the invention.

In the accompanying drawings, Figure 1 is a vertical section of a governor adapted to be used with a vertical rotary shaft, as of a turbine. Fig. 2 is an enlarged detail of a bearing for the centrifugally-acting weights. Fig. 3 is a plan view, drawn on an enlarged scale, of the weights; and Fig. 4 is a vertical section of another form of governor, showing modifications of detail parts.

My invention contemplates a governor of compact and substantial construction, dispensing with a number of parts usually found in centrifugal governors. The form of the weights and the manner of their suspension obviate the need of many parts. They fulcrum on axes at some portion of their dimension and have their centers of gravity close to the axis of rotation, so that the total width of the governor is reduced to a minimum. The weights are attached to the governor-spring, which is of the extension type, by a flexible connection, and they depend when inactive substantially in the axis of rotation, with adjacent sides impinging upon or juxtaposed to each other. I find it preferable to use a coiled extension-spring rather than a compression-spring to oppose the movements of the weights, because it can be more accurately made and balanced than a compression-spring. It also has the advantage of exerting a more nearly even force at every point.

Referring now to Fig. 1 of the drawings, 1 represents a vertical shaft such as may be employed in turbines or turbo generator sets, which is suitably mounted in a casing 2. Surmounting the casing and supported thereon is a dome 3, inclosing the rotating parts of the governor. The governor is a self-containing structure mounted upon the upper end of the vertical shaft 1 to rotate therewith and is removable as a unit. Keyed to the upper end of the shaft is a circular disk-shaped plate 4, which is provided with a depending hub that receives the key for securing the plate of the shaft. This plate carries a bell-shaped casing or frame 5, which is provided with a flanged base 6, that is bolted thereto in the central position by bolts 7, extending through the flange-base and the plate itself. The frame rotates with the shaft and incloses the centrifugally-acting weights, their opposing spring, and the other moving parts of the speed-responsive mechanism. The speed-responsive mechanism comprises centrifugally-acting weights 8, which are attached to the extension-spring 9 and are adapted to fulcrum on bearings 10, provided on the interior of the frame 5, at a suitable distance above the base thereof. The spring is secured to the fixed abutment 11 at its upper end, which abutment is provided with a tubular extension 12, that extends through a central opening 13 in the crown of the frame 5, and the abutment is supported by a threaded nut 14, resting upon the upper surface of the frame. This tubular extension is provided with a longitudinally-extending key-slot 15, into which engages the key 16, suitably fixed to the frame 5, whereby the abutment is prevented from independent rotation, but is capable of axial longitudinal movement relatively to the frame for adjusting the tension of the spring. The lower end of the extension-spring supports a moving abutment 17, to which the centrifugally-acting

weights are attached. The connection between the weights and the movable abutment is of a flexible nature, so as to permit the weights to fulcrum without unseating from their bearings. This flexible suspension may take the form of flat strips 18, preferably two in number, which are attached to the weights at their lower ends and secured at their upper ends in the boss 19, formed on the under surfaces of the moving abutment, which is diametrically slotted to receive the ends of the strips, wherein they are pinned or otherwise secured. The centrifugally-acting weights may with advantage take the form of parallelopipeds, which I have found possess certain desirable features—as, for instance, doing away with supporting-levers, affording large bearing-surfaces about which the weights oscillate, and providing a simple mechanical means for their suspension, while obtaining the best dispositions of the centers of gravity relative to the axis of rotation with a minimum of angular movement of the weights. I do not wish, however, to be understood as limiting the invention to the use of this particular form of weights, as other forms may be more desirable under certain circumstances. The lower ends of the weights oscillate about their upper ends, preferably their upper outer edges, which are shaped into knife-edges 20, as shown in Fig. 1 by full lines and in Fig. 2 by dotted lines. The knife-edges extend more or less of the width of the weights to provide ample bearing-surfaces and are adapted to seat in hardened bearing-blocks 10, that are each provided with an angular groove 21 for this purpose. The blocks project inwardly from the wall of the frame or casing 5, to which they are bolted, such a distance that the weights will bear at their adjacent sides upon each other when in the inert position, as shown in Fig. 1, with their abutting or juxtaposed surfaces disposed in the axis of rotation. In order to prevent lateral displacement of the weights in their bearings, removable plates 22 are secured to the ends of the knife-edges to provide projections that extend beyond the edges, whereby they form retaining-lugs engaging the ends of the bearing-blocks, as indicated in Fig. 2. The ends of the blocks are faced with removable hardened plates 23, to prevent wear due to friction between the lugs of the weights and the bearing-blocks. The extension-spring besides supporting the weights and opposing their outward or centrifugal movement also exerts a tension whereby the knife-edges are retained in their bearings. In other words, the spring alone sustains the weights against the force of gravity, and therefore its strength must be such as to oppose the resultant effect of gravity and the pull due to the centrifugal action of the weights, and this within a safe margin of the elastic limit. The flexible members 18, by which the weights are suspended from the moving abutment, may be attached to the weights at their upper inner portions or by a construction which gives a somewhat similar effect. The members may extend down along and between the abutting sides of the weights to the bottom thereof, where they are secured by bolts or otherwise. This latter means provides ample flexibility, which is desirable under certain conditions. In order to secure the members 18 in proper relation to the weights, so as to prevent torsional effects of the members under the force of gyration, the adjacent surfaces of the weights are each provided with a shallow groove 18′ of a width corresponding to that of the member and in which the latter is confined, as shown clearly in Fig. 3.

It may be found desirable in some cases to shift the centers of gravity of the centrifugally-acting weights so as to regulate the responsiveness of the governor. For this purpose the main weights are provided with supplemental weights which are capable of adjustment. As shown in Figs. 1 and 2, two opposite sides of the main weights are provided with longitudinal grooves 24, in each of which an adjustable weight 25 is secured. To secure the latter weights in place, bolts 26 are carried by the main weights and extend through elongated slots 27 in the adjustable weights. By loosening the nuts of the bolts the weights can be moved to any position and then secured in order to vary the position of the centers of gravity, and thereby the effectiveness of the leverage to the main weights.

In order to provide means for connecting the movable abutment with any exterior regulator device or devices which the governor is intended to control, the extension 12 of the fixed abutment for the spring 9 is made tubular, so as to provide a passage through which the connecting-rod 28 extends. The rod is rigidly connected with the moving abutment at its lower end and is guided at its upper end by a cross-head construction 29, moving in the tubular extension. The cross-head 29 is connected by a link 30 with the bell-crank lever 31, which is mounted upon the dome of the casing. As the cross-head is adapted to revolve with the moving abutment, a swivel-joint is provided between the link 30 and the cross-head, the details of which are non-essential as regards the present invention. The long arm of the bell-crank lever is connected with the rod 32, which is intended to control a valve in case the governor is applied to a reciprocating engine, or in case it is applied to an elastic-fluid turbine where a plurality of nozzles or nozzle-sections are employed it may operate a cam-cylinder when the individual nozzle-valves are mechanically operated or operate a contact-cylinder when the valves are electromagnetically operated, as set forth in my prior applications and patents.

It is often desirable in steam plants where a battery of engines or turbines are employed to be able to connect into service any idle machine when there is a demand for increased power and to do this in such a manner that the incoming machine will take its proportion of the work and the machines be in phase where alternators are connected in multiple. To accomplish this, means must be provided for regulating the speed of the incoming machine so that it will operate in synchronism with the active machines when connected in service. A governor synchronizing device is provided for this purpose which is applied to each machine and operates to control the tension of the governor-spring. This device includes an electric motor 33, which may be controlled from a suitable point and is geared to a screw-shaft 34, which, by means of a movable abutment 35, acts upon a coiled compression-spring 36, that bears upon the long arm of the bell-crank-lever, moving the latter in one direction or the other, and consequently varying the tension of the main governor-spring. The motor or synchronizing device is suitably mounted upon a bracket 37, supported on the dome of the casing. The screw-shaft 34 is also adapted to operate an electrical switch 38, which is shown partly broken away, serving to cut the motor into and out of service at predetermined conditions of operation. By this arrangement the tension of the spring 36 correspondingly varies the tension of the main governor-spring, thereby varying its effect on the weights, and consequently the speed of the engine or turbine-shaft can be changed.

Referring to Fig. 4, a construction is shown wherein the essential features of the governor are substantially similar to that hereinbefore described, but modified as to certain parts. The centrifugally-acting weights 38′ are suspended from the moving abutment 39 of the governor-spring by a link suspension. The moving abutment is provided with a depending inverted-**T**-shaped support 40, the arms of which are provided with recesses or **V**-shaped grooves for receiving the links 41, each of which is connected with a weight. These links engage in **V**-shaped grooves of overhanging bearings 42 of the blocks 43, which latter are grooved and interlock with shoulders 44, provided on the weights, and are further secured by screws. The links have their bearing-surfaces formed into knife-edges, which engage in the **V**-shaped grooves of the support on the moving abutment and of the overhanging bearings of the weights. This arrangement renders the suspension very flexible and is one which is largely free from friction incident to the movement of the weights. The support 40 is preferably a separate member from the abutment, but is carried by the latter. It comprises a plate 45 and the **T**-shaped portion, the plate being seated in a shouldered portion of the support, extending downwardly through the opening to support the links. The plate 45 is provided with lugs 46, between which is pin-jointed the lower end of the rod 47, that is adapted to actuate the regulative device controlled by the governor. The bearing-blocks 48 of the weights are carried by a plate 49 of the governor-frame, which latter in the present construction comprises a base-plate 50, a top 51, the intermediate plate 49, and interspaced columns 52, that bolt the plates together. The bottom plate is keyed to the vertical shaft in the usual manner, so that the governor as a whole can be readily removed. The intermediate plate 49 may be annular or otherwise, and in the central opening thereof the suspension means for the weights is arranged. In order to centralize the extension-spring 53 of the governor, the moving abutment thereof is provided with a cylindrical portion or sleeve 54, which is adapted to move in a vertical direction between the antifriction-rollers 55, mounted in the bearings or plates 56, which are carried by the plate 49. These plates 56 and the bearing-blocks 48 are screwed to the plate 49 by single through-bolts, as shown. The action of the weights under the centrifugal force due to rotation causes movement of the moving abutment against the tension of the opposing spring and operates the system of levers 58 for actuating a valve or other controlling mechanism. The synchronizing governor is disposed with the screw 59 and spring 60 thereof in parallel arrangement with the axis of the governor, whereby greater compactness of construction and reduction in the total weight of the governor are obtained. The screw is electrically actuated, as by a motor 61 and the intermeshing gear 62. The function and operation of the synchronizing governor, though slightly different in construction, is substantially similar to that already described, the screw-shaft being adapted to vary the tension of the spring 60 and also to operate the switch device 63.

It will be noted from the construction specified that the governor is compact and dispenses with the usual system of levers for supporting the weights and is a construction that renders the responsive parts very sensitive to speed variations in view of the arrangement of the weights and minimum of friction of the parts.

In accordance with the provisions of the patent statutes I have described the principle of operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof; but I desire to have it understood that the apparatus shown is only illustrative and that the invention can be carried out by other means.

What I claim as new, and desire to secure by Letters Patent of the United States, is—

1. In a governor, the combination of a shaft or rotating element, centrifugally-acting

weights juxtaposed in a plane common to the axis of the shaft, and suspension means for the weights which opposes their action and also retains them in their bearings.

2. In a governor, the combination of a shaft or rotating element, centrifugally-acting weights juxtaposed in a plane common to the axis of the shaft, and an opposing means attached to the shaft which suspends the weights against the force of gravity.

3. In a governor, the combination of a shaft or rotating element, centrifugally-acting weights juxtaposed in a plane common to the axis of the shaft, a frame mounted on the shaft at one end, and an opposing means adjustably attached at its upper end to the frame which suspends the weights at its lower end in a superposed position to the shaft.

4. In a governor, the combination of a shaft or rotating element, centrifugally-acting weights juxtaposed in an axial plane of the shaft, a spring for opposing the action of the weights and the total force of gravity on the same, and means for flexibly suspending the weights from the spring.

5. In a governor, the combination of a shaft or rotating element, centrifugally-acting weights superposed to the end of the shaft which are free to oscillate at their lower ends, means above the centers of gravity of the weights which suspend the latter with two sides juxtaposed in contact and coinciding with the axis of rotation, and means for opposing the action of the weights.

6. In a governor, the combination of a shaft or rotating element, centrifugally-acting weights which are fulcrumed and suspended at corresponding ends, and a spring attached to the fulcrumed ends of the weights which oppose the resultant effect of gravity and the centrifugal action.

7. In a governor, the combination of a shaft or rotating element, weights which are suspended and fulcrumed at one side of their centers of gravity and have their opposite sides free to oscillate, and means under tension which alone supports the weights and tends to oppose centrifugal action thereof.

8. In a governor, a weight which is provided with a knife-edge and means of suspension both at one side of the center of gravity.

9. In a governor, the combination of a weight which is provided with a knife-edge or bearing and a means of suspension at the same side of the center of gravity, with an adjustable weight or weights for changing the position of the center of gravity.

10. In a governor, the combination of a weight provided with a knife-edge or bearing and a means of suspension both at the same end, with movable weights secured thereto which are adjustable between the ends.

11. In a governor, the combination of a weight, a knife-edge therefor, a bearing for the knife-edge, and means carried by the weight for preventing lateral movement in the bearing.

12. In a governor, the combination of a weight, a knife-edge therefor, a bearing-block for the knife-edge, and lugs secured at the ends of the knife-edge which engage with bearing-blocks thereof.

13. In a governor, the combination of centrifugally-acting weights, a spring for opposing them, a movable abutment between the spring and weights, bearings for the weights, means for guiding the abutment, and a common support for said means and bearings.

14. In a governor, the combination of centrifugally-acting weights, a spring for opposing them, a movable abutment attached to the weights and spring, bearings for the weights, means for centralizing the moving abutment, a plate supporting said means and bearings, and a single means for securing said means and bearings to the plate.

15. In a governor, the combination of weights, an opposing spring therefor, a movable abutment carried by the spring and attached to the weights, a sleeve provided on the abutment, antifriction means which engage the sleeve for guiding the abutment, a supporting-plate for said antifriction means, and bearings for the weights which are also carried by said supporting-plate.

16. In a governor, the combination of centrifugally-acting weights, an opposing spring therefor, a movable abutment for the spring, a support carried by the moving abutment, and separate links connecting the support with the weights.

17. In a governor, the combination of centrifugally-acting weights, an opposing spring therefor, a movable abutment attached to the spring, an inverted-T-shaped support carried by the abutment, overhanging bearings provided on the weights, and separate connecting members between the overhanging bearings and the support.

18. In a governor, the combination of centrifugally-acting weights, an opposing spring therefor, a moving abutment attached to the spring, a hanger carried by the moving abutment which comprises a plate and inverted-T-shaped member, bearing-blocks provided on the weights, V-shaped grooves or bearings provided in said member and bearing-blocks, and links having knife-edges which engage in the V-shaped grooves.

19. A governor comprising a shaft, centrifugally-acting weights and their opposing spring, in combination with a frame carried by the shaft, an adjustable means on the frame for supporting the spring, and bearings mounted on the frame in which the weights are maintained in engagement solely by the tension of the spring.

20. A governor comprising a shaft or rotating element, centrifugally-acting weights and their opposing spring arranged in axial

alinement one with another, in combination with a frame removably mounted on the shaft, and adjustable means on the frame which supports the weights and spring in alinement and within the frame.

21. A governor comprising a shaft or rotating element, centrifugally-acting weights and their opposing springs arranged in axial alinement one with another, in combination with a frame removably mounted on the end of the shaft which supports the weights and spring in alinement, and means actuated by the weights which is guided at that end of the frame opposite to that attached to the shaft.

22. A governor comprising a shaft or rotating element centrifugally-acting weights and their opposing spring which are arranged in axial alinement one with another, in combination with a frame mounted on the shaft that supports the weights and spring in alinement, a fixed abutment for the spring which is mounted on the frame and is hollow at its center, a moving abutment for the spring, an actuator attached to the moving abutment, guiding means in the hollow portion of the fixed abutment for said actuator, and a means adapted to be actuated by the governor.

23. In a governor, the combination of a shaft or rotating element, a frame mounted thereon, a plate intermediate of the ends of the frame, a spring carried by the frame on one side of the plate, and centrifugally-acting weights secured to the spring which are disposed on the other side of the plate.

24. In a governor, the combination of a shaft or rotating element, a frame on the shaft extending axially from one end thereof, a spring carried by and arranged within the frame, and centrifugally-acting weights attached to the lower end of the spring and arranged within the frame intermediate of the spring and the shaft.

25. In a governor, the combination of a shaft or rotating element, and a frame mounted on the shaft which comprises a base-plate, a top plate, superimposed columns, and an intermediate plate attached to the columns, with a spring secured to the top plate, and centrifugally-acting weights suspended by the spring between the base and intermediate plates.

26. In a governor, the combination of a shaft or rotating element, and a frame carried thereby which comprises a base-plate, a top plate, an intermediate plate with an opening therein, and interspacing columns, with a spring supported by the top plate, centrifugally-acting weights arranged between the base and intermediate plates, and means connecting the weights with the springs which extend through the opening of the intermediate plate.

27. A governor comprising a shaft or rotating element, centrifugally-acting weights, and a spring for the weights which opposes their action and retains them in their bearings, in combination with a frame carried by the shaft, means for securing the spring and weights in axial alinement with each other and with the shaft, and a supplemental governing device for varying the tension of the governor-spring.

28. A governor comprising a shaft or rotating element, centrifugally-acting weights, and a spring for the weights which opposes their action and retains them in their bearings, in combination with a frame carried by the shaft, means for securing the spring and weights in axial alinement with each other and with the shaft, and an electrically-controlled supplemental governing device for varying the tension of the governor-spring.

29. In a governor, the combination of a shaft or rotating element, a support attached to and rotating with the shaft, centrifugally-acting weights engaging seats on the support, and a spring which forms the means for holding the weights on their seats and opposes their movements due to centrifugal force.

In witness whereof I have hereunto set my hand this 26th day of April, 1904.

OSCAR JUNGGREN.

Witnesses:
BENJAMIN B. HULL,
HELEN ORFORD.