(No Model.)

2 Sheets—Sheet 1.

M. A. REPLOGLE.

SPEED GOVERNOR.

No. 605,014. Patented May 31, 1898.

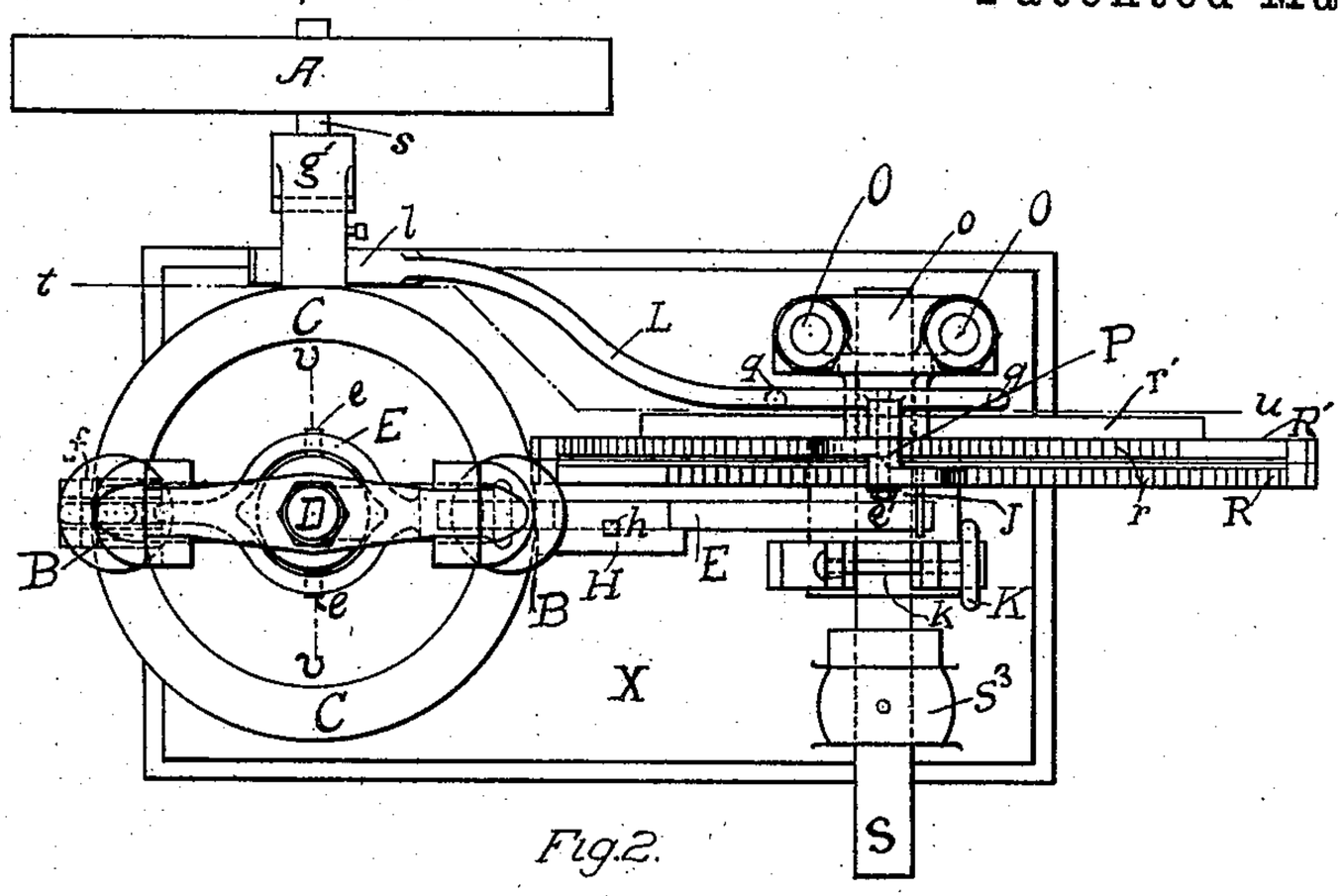

Fig. 2.

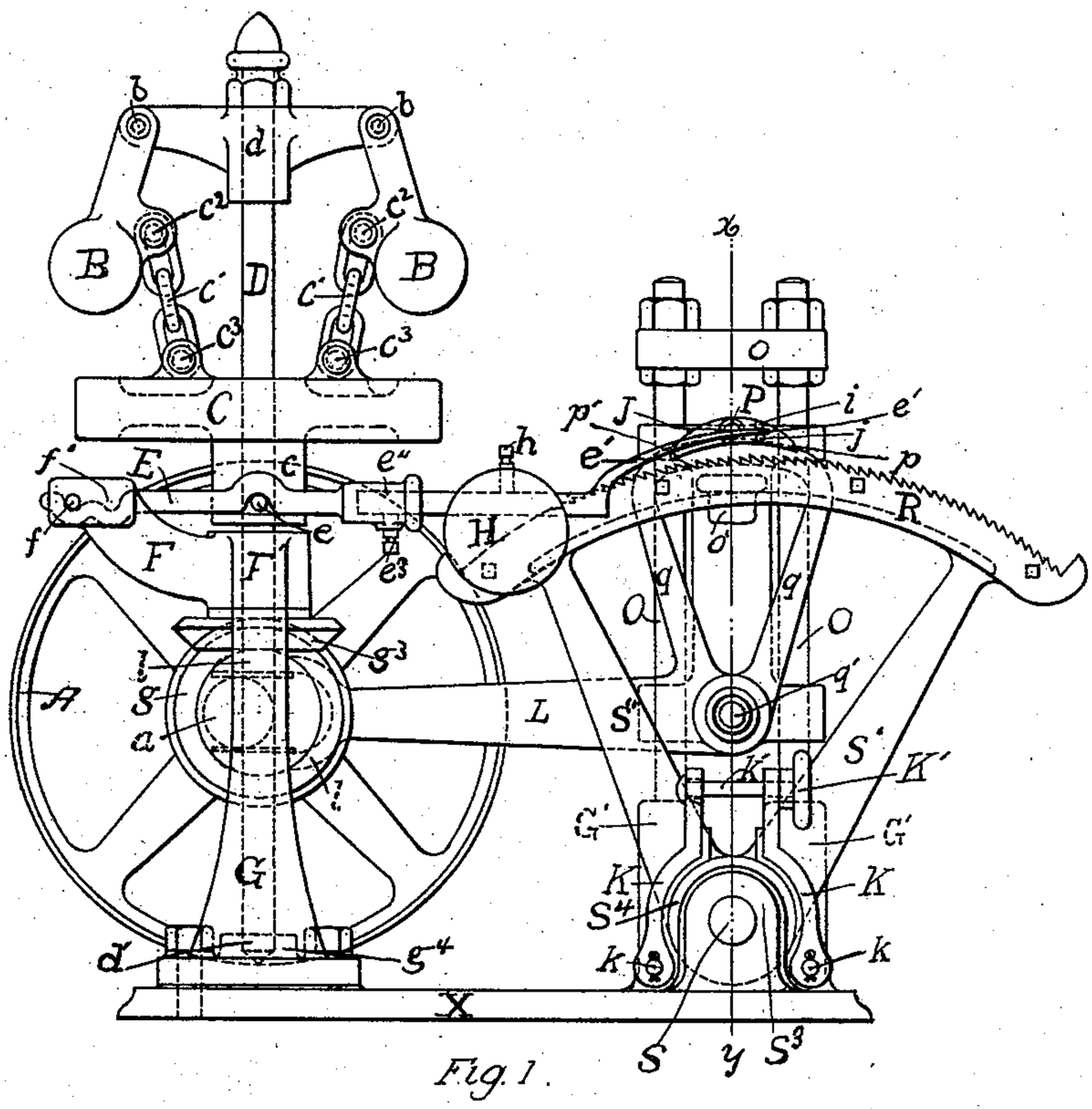

Fig. 1.

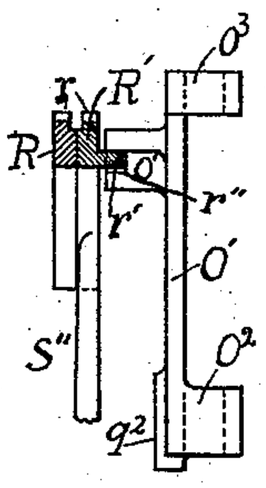

Fig. 3.

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(No Model.) 2 Sheets—Sheet 2.

M. A. REPLOGLE.

SPEED GOVERNOR.

No. 605,014. Patented May 31, 1898.

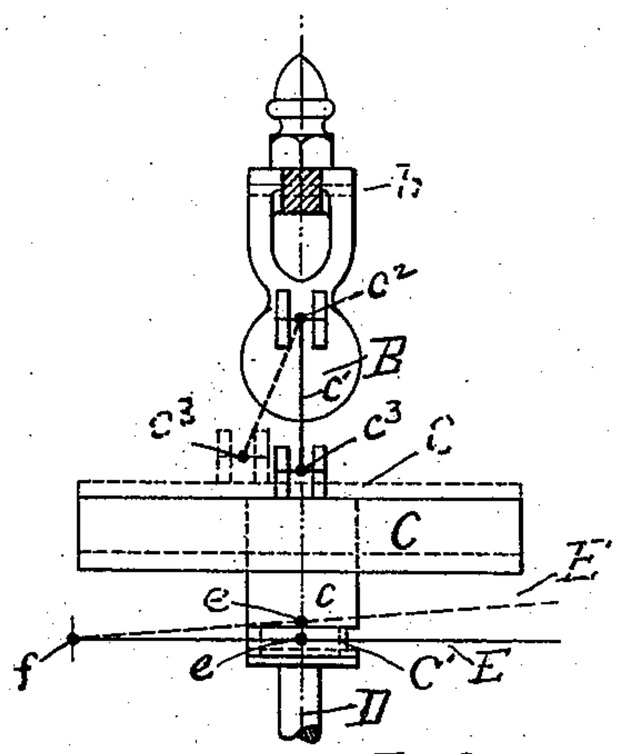
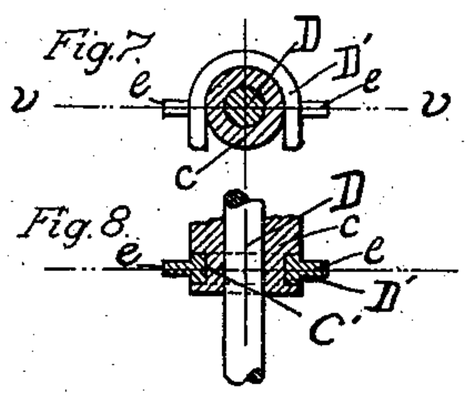


Fig. 6.



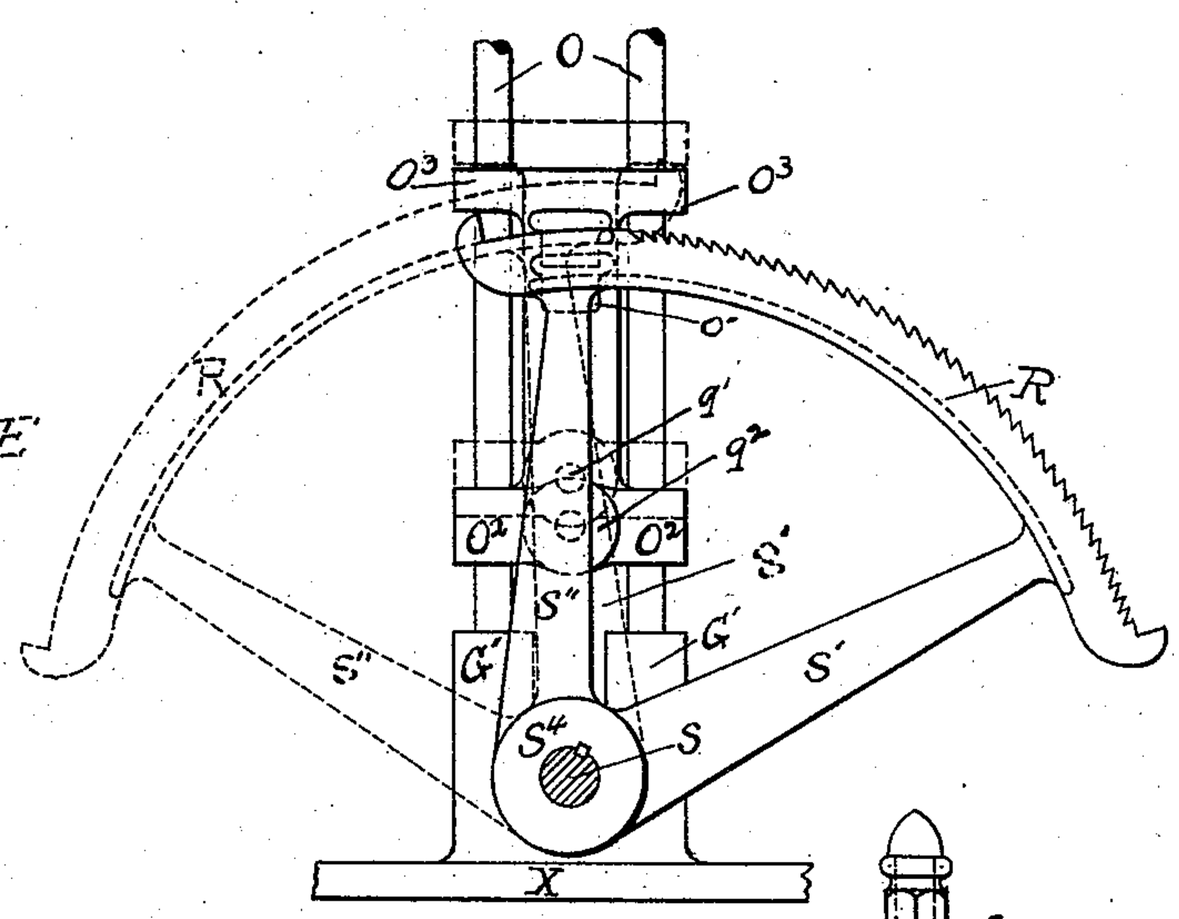


Fig. 9.

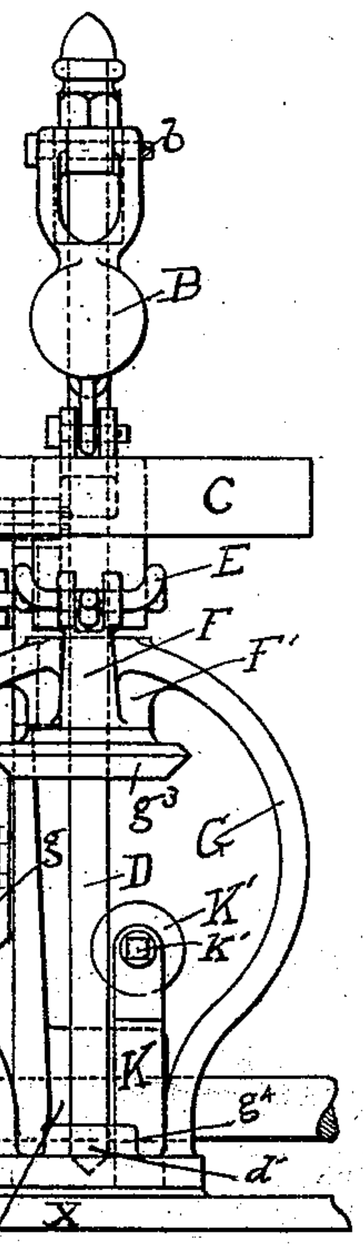


Fig. 5.

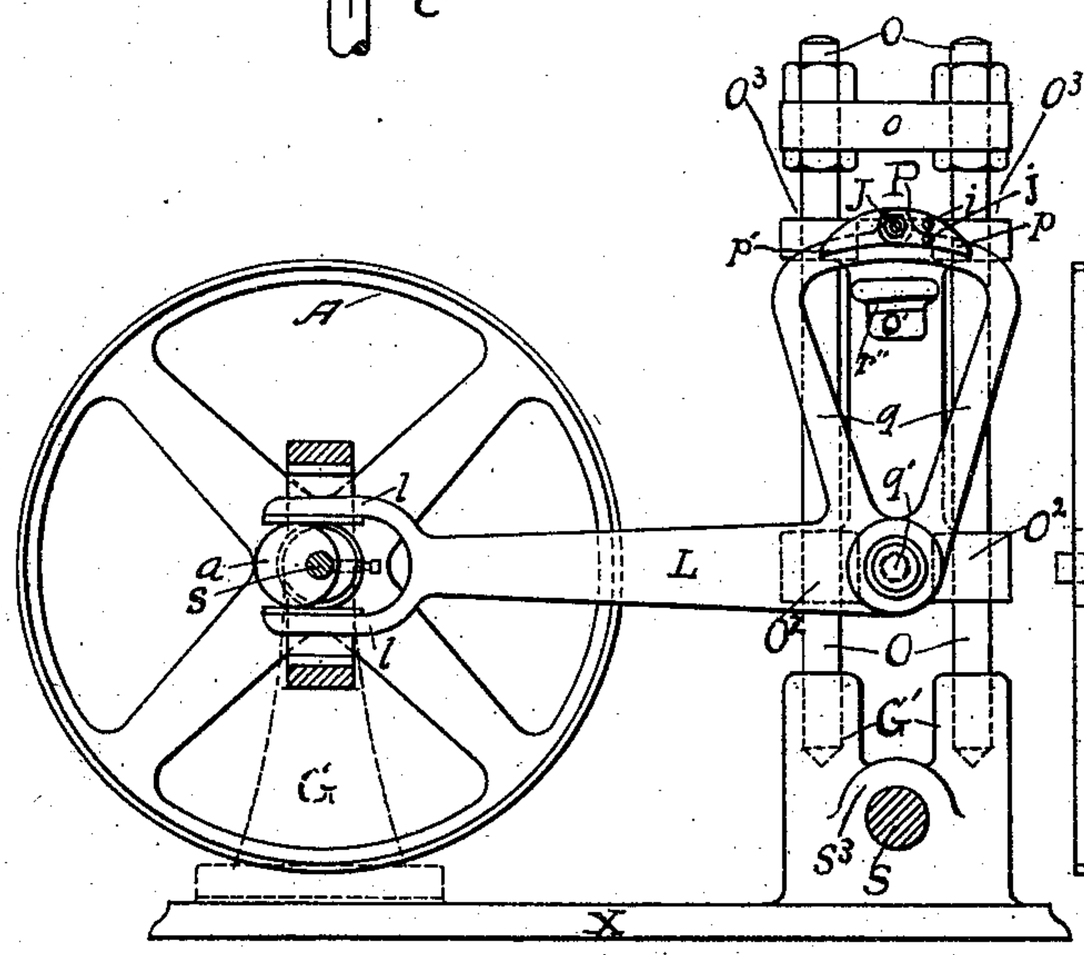


Fig. 4

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UNITED STATES PATENT OFFICE.

MARK A. REPLOGLE, OF AKRON, OHIO.

SPEED-GOVERNOR.

SPECIFICATION forming part of Letters Patent No. 605,014, dated May 31, 1898.

Application filed January 20, 1897. Serial No. 619,882. (No model.)

To all whom it may concern:

Be it known that I, MARK A. REPLOGLE, a citizen of the United States, residing at Akron, in the county of Summit and State of Ohio, have invented certain new and useful Improvements in Speed-Governors; and I declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon, which form a part of this specification.

This invention relates to that class of centrifugal governors which are used to control the speed of machinery by automatically controlling the feed or supply of power or motive force; and the objects of this invention are to render such governors more sensitive to changes of speed, to provide a relay or cut-out, so as to stop the action of the governor before it has acted too long to make the required correction, to prevent the phenomena known as "racing" in governors, and to simplify, strengthen, and improve the efficiency of such governors generally.

To this end my invention consists of the construction, arrangement, and combination of parts, as herein described, and illustrated in the accompanying drawings, in which—

Figure 1 shows a side view looking through one of my governors complete. Fig. 2 shows a top plan of the same. Fig. 3 is a side view of the sliding bracket used in my governor, showing its relation with the racks of the eccentric sector, which racks are shown in cross-section taken on the line $x\ y$ of Fig. 1. Fig. 4 is a view taken partly in cross-section on the line $t\ u$ of Fig. 2. Fig. 5 is an end view looking through one of my governors complete. Fig. 6 is a diagram illustrating the operation of the centrifugal balls and fly-wheel used in my device. Fig. 7 shows the details of the attachment of the pawl-lever to the fly-wheel and is taken partly in cross-section on the line $v\ v$ of Fig. 2. Fig. 8 is a view of the same details, taken partly in cross-section on the line $v\ v$ of Fig. 7. Fig. 9 is a diagrammatic view illustrating the operation of the eccentric sector or sectroid used in my device.

Similar letters of reference refer to similar parts throughout the several views.

Referring to the drawings, X designates the base-plate of one of my governors, to which is bolted the journal-standard G, provided with journals $g'\ g''$, into which is journaled the revolving shaft s, and also with the journals F′ and g^4, into which is journaled the vertical revolving shaft D. From the journal F′ the arm F extends rearwardly to afford a fulcrum at f for the lever E. At the opposite end of the base-plate X there is integrally cast therewith the journal S^3 and sockets G′ G′. Into the journal S^3 is journaled the shaft S, which is designed to be connected directly with the power-supply or motor-gate. To this shaft is rigidly attached the sectroid or eccentric sector composed of the arms S′ S″ and the curved racks R and R′, which racks have their slanting teeth r slanted in opposite directions, the one set adapted for moving the sectroid so as to turn the shaft S to close the power-supply and the other set of teeth being adapted to be used in turning the shaft S, so as to open the power-supply, all by means of the pawl P, which is vibrated by means hereinafter shown, its jaw p engaging with the teeth of the rack R and its jaw p' engaging with the teeth of the rack R′. The arm S′ of the sectroid is longer than the arm S″, and the curved rack R′ is provided with a curved flange r', extending out at right angles from its lower edge. This flange is designed to move in the notch or groove r'' in the projection o' of the sliding bracket O′. (Shown in detail in Fig. 3.) The shaft S and sectroid are prevented from turning except when operated upon by the pawl P by means of the brake K K, which clamps the drum or hub S^4, which is integrally cast with the arms of the sectroid. This brake consists of two curved members hinged at their lower ends k and k, so that their inner surfaces clutch the drum S^4 when their upper ends are drawn together by means of the bolt k' and the handle K′, which may be screwed on the outer end of the bolt k'. This brake is designed to be kept tight when the governor is in use, the action of the pawl P being strong enough to overcome the resistance of the brake.

The bracket O′ is designed to slide upward

and downward on the vertical sliding rods O O, which are parallel and rigidly fixed into the sockets G′ G′ at their lower ends and secured to each other at their upper ends by the span or cross-piece *o*. The bracket O′ is provided with holes O^3 O^3 and O^2 O^2, through which the sliding rods O O pass, so that the bracket O′ may slide on them in a vertical plane parallel to that in which the sectroid moves and at right angles to the shaft S. At q^2 on the bracket O′ the rocking lever L *q* is pivotally attached by means of the pin or wrist *q′*, and to the vertical part of said lever the pawl P is attached pivotally by the bolt J. The vertical part *q* of the rocking lever is constructed with an open middle, so that it may vibrate the pawl P directly over the projection *o′* from the sliding bracket O′, which projection extends through the end *q* of the rocking lever to engage with the flange *r′*, which operates the bracket upward and downward, carrying the rocking lever with it as the sectroid is turned in one direction or the other, the limit of its downward motion being shown by the full lines in Fig. 9 and the limit of its upward motion being shown by the dotted lines in the same figure. The horizontal part of the rocking lever L is bifurcated at its farther end into the lips *l l*, which serve as bearings for the cam *a*, which revolves between them, it being secured to the shaft *s* and designed to give an oscillating or rocking motion to the lever L, thus vibrating the pawl P in an arc directly over the racks R and R′.

The shaft *s* is provided at its outer end with the driving pulley A and at its inner end by the beveled gear *g*, which beveled gear engages with the corresponding gear g^3, rigidly attached to the vertical shaft D and designed to revolve it when power is applied to the pulley A. The shaft D extends vertically through the fly-wheel C, which turns loosely upon it and is designed to revolve in a horizontal plane, it being suspended by means of the chains C′ C′ and the arms of the balls B B from the cross-arm *d*, which is rigidly attached to the top of the vertical revolving shaft D. The centrifugal balls B B are pivotally suspended from the said cross-arm *d* at the points *b* and *b*, and the fly-wheel C is swung or supported from said balls by means of the chains aforesaid, which are pivoted to the balls at c^2 and c^2 and pivoted to the fly-wheel C at the points c^3 and c^3, which are oppositely arranged, so as to perfectly balance the fly-wheel C in a horizontal plane. The fly-wheel C is constructed with a neck or hub *c*, which has cut into it a groove C′, into which the U-shaped piece D′ is designed to fit, as shown in Figs. 7 and 8. This U-shaped piece is provided with pins or lugs *e* and *e*, oppositely disposed and adapted to form supports for the lever E, which is perforated to allow the hub or neck *c* to extend downward through it and revolve within it. The U-shaped piece D′, sliding within the groove C′, forms an attachment by means of which the fly-wheel C applies its force in raising the lever E, as will be better understood by referring to the diagram in Fig. 6, where the change of aspect in the lever E caused by raising the fly-wheel is indicated by the dotted lines. The lever E is constructed of two separate pieces joined together at *e″* by means of a socket and the set-screw e^3. The farther end *e′* terminates in a flat piece curved substantially in conformity with the curve of an arc which would be drawn from *q′* as a center, using a radius equal to the distance between *q′* and the pin J. This flattened end is disposed between the two small pins *i* and *j*, which extend outward from one of the jaws of the pawl P, so that by a pressure upward against the pin *i* by the flat piece *e′* the jaw *p′* of the pawl will be thrown into engagement with the teeth of the rack R′, and if the flat piece *e′* is pressed downward against the pin *j* the jaw *p* will likewise be thrown into engagement with the teeth of the rack R. The lever E may be weighted with a weight, as H, secured to it by means of a set-screw *h*, which weight may be shifted lengthwise of the lever to properly balance it as required in the governing to be done. If necessary to make the lever E harder to raise, the fulcrum-pin *f* may be changed to the position *f′* by drilling the hole through the arm F at that point, as shown in Fig. 1, and inserting the pin there, thus shortening the distance between the fulcrum and the lifting-lugs *e e*.

The operation of the device may be explained as follows: The pulley A is belted to a suitable shaft of the machinery in the plant to be governed and kept continually revolving in either direction suitable. The pawl P, which is pivotally attached to the arm *q* of the rocking lever, is vibrated back and forth through its arc once in every revolution of the pulley A and the shaft *s* by means of the cam *a* and lips *l l* at the end of the horizontal arm of the rocking lever. Through the gears *g* and g^3 the revolutions are conducted to the vertical shaft D, which has as its main bearing *d′* in the bearing-cup g^4 at the foot of the bracket G. This revolution throws the balls B B outward by centrifugal force and lifts on the chains *c′ c′*, thus supporting the fly-wheel C and raising it directly upward when the balls are speeded sufficiently. The adjustment in this device should be such that at normal speed the governing-balls B B should be revolved rapidly enough so that the chains *c′ c′* will not only lift up the fly-wheel C, but also, by means of the groove C′ and supports *e e*, secured therein as a part of the piece D′, the lever E, which is fulcrumed at *f*, is lifted up and held suspended with its flat part *e′* between the two pins *i* and *j* of the pawl. At strictly normal speed this end of the lever is thus held suspended, so that it neither presses upward nor downward, and it holds the pawl P out of engagement with either of the racks; but the pawl is vibrated

continuously and the pins *i* and *j* are slid loosely over the flat piece *e'*, which conforms to the arc in which the pawl is vibrated. When this normal speed exists, and also at a time when there is a normal load on the plant to be governed, the sectroid should stand about in the position shown in Fig. 1—that is, the pawl should be vibrating at near the middle of the racks and the gate of the motor or the power-supply should be open at the medium position. Now if a heavy load is thrown on the plant, so that the speed is checked, a depression will take place in the centrifugal balls, which depression will be communicated to and amplified at the farther end of the lever E, which by the means described presses down on the pin *j*, so as to bring the jaw *p* of the pawl into engagement with the teeth of the rack R and forces the sectroid in the direction which opens the power-supply by turning the shaft S. Likewise, if the plant is suddenly relieved of a part of its load, so that the speed is accelerated and the lever E is lifted by means of the centrifugal force of the balls B, the outer end of the lever lifting at the pin *i* will disengage the jaw *p*, if engaged, and bring into engagement the jaw *p'* with the teeth of the rack R', thus at every vibration driving the sectroid in a direction to turn the shaft S so as to close the power-supply. It must be observed that at every thrust of the sectroid in the direction which turns on power the short arm S'' is brought nearer to the projection *o'*, which rides on the flange *r'* of the sectroid, and thus lets down the bracket O' to a lower position, and consequently to a position in which the lever E will require a less speed to raise it out of engagement than when the sectroid was at the medium position, and the aspect of the lever E will have changed, when the sectroid is moved to the opposite position, so that it will take less variation to depress the lever onto the pin *j* when the sectroid is in that position than when it is in the medium position. This feature is of vital importance in my device and constitutes one of its main points of superiority. It must be specially noticed that when the pawl has moved the gates or power-supply in one direction or the other it will not act again unless the cause which produced its action remains on the increase—in other words, if this speed does not continue to raise or lower after the governor has acted it will not continue to act—so that when the cause which created the variations is removed and the change of speed resulting from the removal is reflected in the governor-balls the lever E will operate the pawl so as to set back the sectroid to the medium position again. It must also further be noticed that if a more permanent change of work—as, for example, an extra load of work—is to be carried for a considerable time the first depression of the lever E will cause a turning on of power, and if the cause remains on the increase it will continue to turn on power until there is sufficient to do the work required, while for sudden changes in that work the governor will continue to act to effectively resist variations as it would at the medium position. However, it should be borne in mind that the governor should be adjusted so as to keep the speed required with the average load required when the sector is at the medium position. This means of cutting the governor out of action unless the cause which produces the variations remains on the increase is a preventive from overdoing or making greater change in the power-supply than is just necessary to make the corrections in speed, and thus completely eliminates the continual running above and below normal speed which often occurs in attempts at governing, and is usually known under the name of "racing." A further important point is gained in my device by suspending the fly-wheel C to the centrifugal balls and attaching the lever E, which is to be raised or lowered, to it. The operation of this part of my device is as follows: As the wheel C is revolved by means of its attachments to the balls B B there will be a slight tendency for the wheel to lag or hang back on account of the resistance in the air and also in the neck C', where the weight of the lever E and its weight H are supported. The effect of this lagging is to raise upward on the lever, as shown by the diagram in Fig. 6, so that if the point of attachment c^3 lags to the position of c^3 in dotted lines, which is an exaggerated amount, the lever E would be held in the aspect shown in the dotted line designated by the open letter E, and at the slightest slowing of the speed of the governor-balls B B the fly-wheel C would overtake the governor-balls until the supports c^3 c^3 arrive into the same vertical plane with the supports c^2 c^2, thus allowing the lever E to drop farther by the slightest slowing of speed and at the earliest possible moment than it would do without the use of the said fly-wheel, and in like manner when the speed of the governor-balls is suddenly accelerated they are pressed forward so as to twist on the chains or supports c^2 c^2 and thus raise upward on the lever E, so that the first effect is greatest, and it is also produced at the earliest possible moment.

I do not wish to be confined to the exact details of construction shown, as it is evident that many of the details may be greatly varied without departing from the general spirit of my invention.

What I claim, and desire to secure by Letters Patent, is—

1. In a governor of the kind described having centrifugal weights adapted to set into and out of operation power increasing and decreasing mechanisms, the combination of the cam *a*, the rocking lever L *q q* pivoted to the sliding bracket O' with an eccentric sector provided with the eccentric flange *r'* adapted

to slide in the groove *o'* of the said bracket for the purpose set forth substantially as specified.

2. In a governor, the combination of centrifugal governor-balls and a fly-wheel suspended therefrom revolving on a vertical axis, the lever operated thereby, the said lever being provided at its one end with the curved strip *e''* and fulcrumed at the other end, and intermediate of the fulcrumed and curved ends aforesaid attached to the neck of a fly-wheel adapted to be raised and lowered by the said centrifugal balls aforesaid substantially as specified and for the purpose set forth.

3. In a governor, the combination of an eccentric sector adapted to control the supply of power, by turning the shaft to which it is keyed, the said sector being provided with curved racks and an eccentric flange, which flange slides in a groove on a sliding bracket, carrying a rocking lever having a pawl vibrated thereby and the said pawl adapted to engage with the racks of the eccentric sector and operate it so as to turn off, or turn on the supply of power substantially as shown and set forth.

4. In a governor of the kind described, the combination of a sliding bracket having a rocking lever pivoted thereto, the one end of the said rocking lever being adapted to be operated by a cam, and the other end thereof being furnished with a pawl adapted to be vibrated over a pair of curved racks, which racks when moved in one direction raise the said sliding bracket and rocking lever therewith, and when moved in the opposite direction lower the said sliding bracket and rocking lever by means of the eccentric flange slid in a groove on the side bracket substantially as specified and for the purpose set forth.

5. In a governor of the kind described an eccentric sector provided with a flange also eccentric therewith and the said sector being also provided with the racks R and *r* having their teeth disposed in opposite directions; the double-acting pawl P adapted to engage with either of said racks, means for vibrating the pawl and means for tilting it into engagement with either one or the other of said racks according as the governor is affected by increased or decreased speed together with the sliding bracket O' adapted to be raised or lowered by the eccentric flange aforesaid for the purpose of throwing the pawl out of reach of engagement, substantially as specified.

6. In a speed-governor the combination of vertical sliding rods O O having the sliding frame or bracket O' adapted to slide upward or downward thereon with a rocking lever pivoted to the said bracket and said rocking lever carrying a vibrating and double-acting pawl adapted to operate the mechanism by which the said bracket is lifted or lowered, means for vibrating said rocking lever and means for throwing into and out of engagement said pawl according as the speed of the governor increases or subsides substantially as specified and for the purposes set forth.

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

MARK A. REPLOGLE.

Witnesses:
H. C. PARSONS,
D. L. MARVIN.