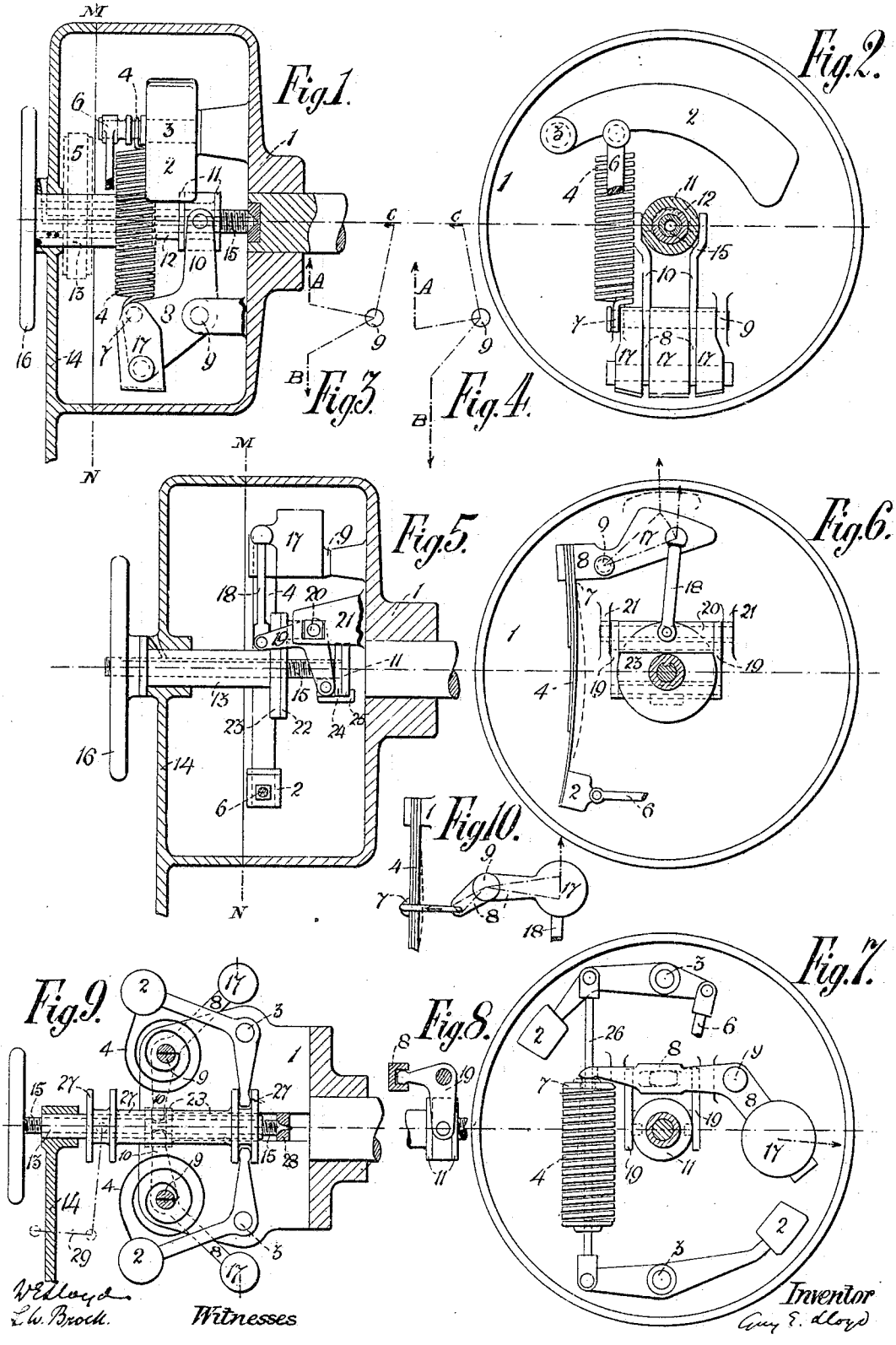
No. 781,833. PATENTED FEB. 7, 1905.

G. E. LLOYD.

CENTRIFUGAL GOVERNOR.

APPLICATION FILED JULY 16, 1903.



No. 781,833. Patented February 7, 1905.

UNITED STATES PATENT OFFICE.

GUY E. LLOYD, OF SUTTON, ENGLAND.

CENTRIFUGAL GOVERNOR.

SPECIFICATION forming part of Letters Patent No. 781,833, dated February 7, 1905.

Application filed July 16, 1903. Serial No. 165,793.

To all whom it may concern:

Be it known that I, GUY ERNEST LLOYD, a subject of the King of Great Britain and Ireland, residing at Sutton, England, have invented an Improved Construction of Centrifugal Governors, of which the following is a specification.

My invention relates to improved means of adjusting the revolving springs of centrifugal governors, such springs as are used to apply centrifugal or centripetal force to the revolving balls or fliers and are carried on and revolve with the governor-frame; and the objects of my improvements are to enable the force exerted by such a revolving spring upon the flier to be easily varied at will or by an automatic apparatus while running by direct connection to an adjustable device which does not itself revolve, so that the flier may occupy the same position at different speeds, or to lessen the work to be done by any revolving adjustable device that may be employed for this purpose. The point of such a revolving spring being connected to the flier and free to move with it, the force exerted by it on the flier depends upon the displacement of another point in the spring; and my invention relates more particularly to means for effecting the displacement of this second point by what is hereinafter termed an "adjustable abutment." The force to be exerted at the abutment in order to control its position is in many cases too great to be easily transmitted directly through a rubbing-surface, such as a collar on the axis, to a non-revolving adjustable device, although I am aware that such an arrangement has already been proposed; but according to my invention the centrifugal force of one or more suitable revolving masses, hereinafter termed "abutment-fliers," is brought into play on the revolving governor itself, which force is applied to act on the adjustable abutment of the spring in such a manner that the setting of the latter is very easily controlled so long as the governor is running at its intended speeds, control being applied from a non-revolving adjusting device or from a revolving device actuated, as has been proposed, by fluid-pressure, friction-gear, or electric current while running.

The spring or springs used may be of any convenient form. Springs in which the material is subjected to bending, such as flat, curved, and spiral leaf-springs, can be restrained at two points when a load is applied at a third or can be restrained at one point if loads are applied at two others, and with such springs if one point is connected to a flier, a second point fixed or pivoted to the governor-frame, a third point can be constrained by an adjustable abutment arranged according to my invention. Helical springs twisted round and not extended or compressed along their axes come under this head. Helical springs loaded along their axes resist by torsion stresses, and with such springs one end is connected to the flier and the other to the adjustable abutment.

The arrangement of the abutment flier or fliers and adjustable abutment connected to it or them necessarily varies very much with the design of the governor to which my invention is applied. In some cases the abutment-flier may conveniently slide in a guide of suitable form and may actuate the abutment through a cam-shaped lever; but where the design permits of the simplest arrangement I usually prefer to mount the abutment-flier on a carrier pivoted to the revolving governor-frame, and the pivot preferably lies across the axis of the governor, so that a radial arm of the carrier may carry the revolving element of a thrust-bearing to be engaged by the non-revolving element, which can be set at desired positions along the axis of rotation by hand or automatic apparatus.

It is desirable to produce as perfect a balance as is practicable between the moment of the abutment force round the carrier-pivot and the opposing moment of the centrifugal force of the abutment-flier at all speeds within the intended range of adjustment, so that the force borne by the thrust-bearing may be minimized. With a given spring and pivoted carrier and a given position of the flier (or governor-ball) the positions of the carrier for any two speeds are fixed and the moments of

the abutment force round the carrier-pivot are known. Each of the abutment-fliers, if more than one are employed, require to be of such a mass and so located upon the carrier with reference to, first, its mass; second, the angular velocity; third, its radius of revolution; fourth, the perpendicular distance from the carrier-pivot to the radius through its center, or, more strictly, to the line of the resultant of its centrifugal force, that the resultant moments of centrifugal force, including that of the carrier and parts connected to it, balance the moment of the abutment force round the carrier-pivot at each of two speeds selected as giving the best general approximation over the whole range of the adjustment. It is evident that by a suitable arrangement of cams, links, and levers the moment of the abutment force round the carrier-pivot may be made to increase, decrease, or remain practically constant over portions of the adjustment, and also by suitable disposition of the abutment flier or fliers on the carrier the resultant moment of their centrifugal force may be made to do likewise. Where the spring applies centripetal force to the flier, an upward speed adjustment involves more deflection of the spring and an increase in the radius of revolution of the abutment-flier; but where springs are adjusted according to my invention they may act alone or with other non-adjustable springs or any other means of applying force to the fliers, such as weights or fluid-pressure, and then the adjustable spring may apply either centripetal or centrifugal force. In the latter case an upward speed adjustment involves less deflection of the spring and a decrease in the radius of revolution of the abutment-flier.

Where adjustment of the spring-abutment is effected by moving the non-revolving element of a thrust-bearing along the axis, so as to turn the carrier round its pivot by contact of the revolving element of the thrust-bearing, it is necessary that the angle of the carrier should not be seriously affected by end play of the governor, and when necessary I prefer to arrange either, first, that both the pivot and the non-revolving part of the thrust-bearing shall have the same end play, or second, that the thrust-bearing has no end play and shall engage the end of bell-crank arm whose pivot has no end play, such bell-crank either serving as the pivoted carrier or being connected thereto through a link approximately in a plane normal to the axis or through a surface parallel to the axis, so that the transmission is unaffected by end play. In arrangement 1 the non-revolving piece bears on a convenient center in the governor, and the thrust-bearing tends toward the shaft. In arrangement 2 the pivot is free to abut against a fixed face, and the thrust-bearing pulls away from the shaft. In both cases the abutment-flier should always either overcome or be overcome by the abutment force at all speeds within the range of adjustment sufficiently to insure constant thrust in the mechanism.

Figure 1 shows a part section and part side elevation of a shaft-governor having a pivoted flier restrained by a tension helical spring whose abutment is on a carrier pivoted to the frame and is adjusted by an arm engaging a collar set along the axis. Fig. 2 shows an end view of the same, the section being taken on the line M N of Fig. 1. Figs. 3 and 4 are diagrams of the forces acting on the carrier of Fig. 1. Fig. 1 shows the type of adjusting-gear in which both the carrier-pivot and thrust bearing or collar have the end play of the governor. Fig. 5 is a part section and part side elevation of a shaft-governor having a flier carried on the free end of a leaf-spring whose root is fixed to a pivoted carrier adjusted by a pivoted bell-crank engaging a thrust-collar set along the axis. Fig. 6 shows a cross-section on the line M N, Fig. 5. Figs. 5 and 6 show the type of adjusting-gear in which neither pivot nor the thrust-collar of the bell-crank have the end play of the shaft. Fig. 7 is a similar view to Figs. 2 and 6 of a well-known governor having two fliers balancing each other for gravity and both restrained by a single compression helical spring. Fig. 8 shows a detail in elevation. The foregoing figures show governors more particularly adapted to actuate eccentrics or cams revolving with them. Fig. 9 shows a side elevation, with part in section, of a type of governor more particularly adapted to control a non-revolving piece, such as a throttle-valve. Fig. 10 is a modification of Fig. 6. In Figs. 2, 5, 6, 7, and 9 the piece to be controlled by the governor-flier is not shown; but an eccentric is indicated in position in Fig. 1 by the dotted lines. It is usual in such governors to duplicate the parts and connect them so that gravity is neutralized; but such duplication is omitted from Figs. 1 to 6 for the sake of greater clearness.

In the different views similar parts are designated by the same characters.

In Figs. 1 and 2, 1 is the revolving governor-drum on the end of a shaft. 2 is the flier pivoted to 1 at the pin 3, constrained by the tension coil-spring 4 and actuating an eccentric 5 or other piece by means of the link 6. The abutment 7 of the spring is a pin on the carrier 8, which is pivoted to the drum 1 at 9. The position of the carrier is controlled by the bifurcated arm 10, engaged by the thrust-bearing 11 on a sleeve-nut 12, which can slide but not turn in a socket 13 in the fixed frame or casing 14. Within the sleeve-nut is a screw 15, turned by the hand-wheel 16 or by any automatic device, and this screw abuts against the end of the shaft and partakes of its end play, together with the pivot 9, so that the angle of 10 is not altered by end play. The screw may be hollow, as

shown, so that oil may be fed from the casing to the nose of the screw. The abutment-flier is shown at 17 in three parts.

Figs. 3 and 4 are diagrams indicating the balance of moments at low and at high speed adjustment, respectively. A is the force due to the pull of the spring on its abutment 7. B is the centrifugal force of the abutment-flier 17, (and carrier 8.) With the increased angular velocity and radius of revolution the increase of B in Fig. 4 over that in Fig. 3 is greater than the increase of A; but 17 being arranged so that the perpendicular from 9 on to B is less in Fig. 4 than in Fig. 3 the moment of B is exceeded by that of A round 9 by the same amount in the two cases—as represented by C the thrust on the bearing 11. If the moment of A is always slightly greater than that of B, we have constant thrust maintained in the adjusting mechanism; but the screw 15 should be prevented from leaving the shaft more than a small amount, which it would tend to do in the event of racing or a broken spring.

In Figs. 5 and 6, 1 is the revolving drum. 2 is the flier clamped to the free end of a sheaf of leaf-springs, which is clamped at its root to the carrier 8, pivoted at 9. The flier actuates the piece it has to control by the link 6. The adjustable abutment is the root 7 of the spring. The position of the carrier and its abutment-flier 17 is controlled by the link 18 from the bell-crank 19. The pivot 20 of the bell-crank can slide in the wings 21 to allow for end play; but it bears against a revolving disk 22, rubbing against a fixed disk 23, carried on the fixed socket 13. Through 13 slides the screw 15, having a collar 11 bearing against the disk 24, which revolves with and abuts on the end of the bell-crank arm. The hook 25 prevents the bell-crank moving away from the collar 11 in the event of racing, and the wheel 16 is prevented from moving away from the frame 14. The boss of the wheel 16 forms the nut through which the screw is drawn. The groove in the top of the screw engages a feather in the socket 13, which prevents it from turning, and the groove forms an oil-channel to the collar 11. Since the link 18 is practically always in a plane normal to the arms, relative axial play at the inner end does not produce radial disturbance at the outer end on the carrier consequent on end play of 1 and 17.

In Fig. 7 the two fliers 2 are pivoted at 3 and their arms connected together, through a link 26, to one end of a compression coil-spring 4, whose abutment 7 is a washer free of the link 26 and whose position is determined by a lever extension of the pivoted carrier 8, pivoted at 9 and carrying the abutment-flier 17, the adjustment being effected from an axially-adjusted thrust-bearing 11 by a bell-crank 19. The link 6 connects the fliers to the piece to be controlled by them.

Fig. 8 shows a part section and part side elevation of the bell-crank 19, which is bifurcated, the bearing 11, which engages it, and a section of the carrier 8, controlled by it.

In Fig. 9 the two symmetrically-disposed fliers 2 are pivoted at 3 and move in a plane containing the axis, and radial arms engage an axially-movable sleeve 27, sliding on the socket 13, which is fixed to the frame 14. Each flier is restrained by a leaf-spring 4, formed in a spiral, the inner end being fixed in the pivot 9, which passes through the side plates of the revolving frame 1, the bearer of which is shown removed for clearness. On the outside of each plate is a carrier 8, bearing an abutment-flier 17, and an arm 10, engaging a yoke 28, which guided in the side plates is pressed toward the shaft by the nose of the screw 15, threaded through the fixed spindle or socket 13, this illustrating a case where end play is supposed to be unimportant. By means of a bell-crank (indicated at 29) this governor may actuate a non-revolving piece, such as a throttle-valve.

It should be understood that the arrangements illustrated are chosen as simple examples of types, but that many modifications may be made in order to comply with the exigencies of design. For example, if it is not convenient to place the pivoted carrier 8 so that the adjustable abutment can form one part of it, the axially-controlled arm another part, and the abutment-flier another part it may be replaced by a similarly-pivoted bell-crank in one part having a radial arm engaging the axially-adjustable thrust-bearing and the other arm linked to the adjustable abutment, which in its turn may be connected to the abutment-flier, mounted in yet another convenient part of the governor, and the connections may in some cases be advantageously arranged with leverages which vary as the adjustment progresses in order to produce the final result sought—viz., that the resultant of the forces acting on the adjusting mechanism due, respectively, to the spring-adjustable abutment and the adjusting-flier shall be as small as is convenient. Thus Fig. 10 shows a modification of Fig. 6, in which the spring 4 is rigidly clamped at the root and deflected between the root and flier by an adjustable abutment 7, linked to a carrier 8, pivoted at 9 and bearing an abutment-flier 17. Here the leverage of the centrifugal force of 17 varies but little; but the leverage of the link to the abutment varies greatly, so that the resultant moment on the carrier and the adjusting-gear is small.

It should be remembered in reference to the desirableness of keeping the adjusting-gear in constant thrust, and yet that thrust a minimum, that uneven rotation causes the inertia of the abutment-flier to act with slightly-varying force on the adjusting-gear when its pivot or its guide is arranged so that it moves

in a plane not containing the axis of revolution.

I am aware that it has before been proposed to adjust revolving coil-springs by a bell-crank taking onto a non-revolving axially-adjustable collar, and I therefore do not claim such an arrangement when not combined with a centrifugal mass which shall relieve the said collar of most of the spring load when running; but

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

1. In a centrifugal governor a flier connected to the part to be controlled, a spring revolving with and acting on said flier, an abutment acting on said spring and revolving therewith, and an adjusting device adapted to control said abutment while revolving, in combination with a revolving mass or abutment-flier acting on said abutment in opposition to said spring, substantially as described.

2. In a centrifugal governor, a flier connected to the part to be controlled, a spring revolving with and acting on said flier, an abutment acting on said spring and revolving therewith, a thrust-bearing adapted to control said abutment by motion along the axis of revolution and an adjusting device controlling said thrust-bearing, in combination with a revolving mass or abutment-flier acting on said abutment in opposition to said spring substantially as described.

3. In a centrifugal governor a flier connected to the part to be controlled, a tension helical spring revolving with and acting on said flier, an abutment acting on said spring and revolving with it and an adjusting device adapted to control said abutment while revolving, in combination with a revolving mass or abutment-flier acting on said abutment in opposition to the said spring substantially as described.

4. In a centrifugal governor, a flier 2 connected to the part to be controlled, a tension helical spring 4 revolving with and acting on said flier, in combination with a carrier 8 pivoted on the revolving governor-frame 1, an abutment 7 borne on said carrier and acting on said spring, a revolving mass or abutment-flier 17 borne on said carrier and acting on it in opposition to said spring, a thrust-bearing borne on said carrier, and an adjusting device adapted to control said thrust-bearing along the axis of revolution substantially as described.

5. In a centrifugal governor the combination of a flier connected to the part to be controlled, a leaf or plate spring revolving with and acting on said flier, an abutment acting on said leaf-spring and revolving therewith, and an adjusting device adapted to control said abutment, with a revolving mass or abutment-flier acting on said abutment in opposition to said spring substantially as described.

6. In a centrifugal governor, a flier 2 connected to the part to be controlled, a leaf or plate spring 4 revolving with and acting on said flier, in combination with a carrier 8 pivoted on the revolving governor-frame 1, an abutment 7 borne on said carrier and acting on the said spring, a revolving mass or abutment-flier 17 borne on said carrier and acting on it in opposition to said spring, a thrust-bearing, a revolving bell-crank and link connecting said thrust-bearing with said carrier and an adjusting device adapted to control said thrust-bearing along the axis of revolution substantially as described.

7. In a centrifugal governor a flier 2 connected to the part to be controlled, a leaf or plate spring revolving with and acting on the said flier, in combination with a carrier 8 pivoted on the revolving governor-frame 1, an abutment 7 connected to said carrier by a link and acting on said spring, a revolving mass or abutment-flier 17 borne on said carrier 8 and acting on it in opposition to said spring, a thrust-bearing, a revolving bell-crank and link connecting said thrust-bearing with said carrier 8 and an adjusting device adapted to control said thrust-bearing along the axis of revolution substantially as described with reference to Figs. 5, 6, and 10.

8. In a centrifugal governor, a flier connected to the part to be controlled, a compression helical spring revolving with and acting on said flier, an abutment acting on said spring and revolving with it and an adjusting device adapted to control said abutment while revolving, in combination with a revolving mass or abutment-flier acting on said abutment in opposition to said spring substantially as described.

9. In a centrifugal governor, a flier 2 connected to the part to be controlled, a compression helical spring revolving with and acting on said flier, in combination with a carrier 8 pivoted on the revolving governor-frame 1, an abutment borne on said carrier and acting on said spring, a revolving mass or abutment-flier 17 borne on said carrier and acting on it in opposition to said spring, a thrust-bearing, a revolving bell-crank connecting said carrier and said thrust-bearing, and an adjusting device adapted to control said thrust-bearing along the axis of revolution substantially as described.

10. In a centrifugal governor the combination of two fliers connected to the part to be controlled, a single spring revolving with and acting on the said two fliers, an abutment acting on said spring, and revolving therewith, and an adjusting device adapted to control said abutment, with a revolving mass or abutment-flier acting on said abutment in opposition to said spring substantially as described.

11. In a centrifugal governor the combination of a revolving adjustable spring-abutment 7, a revolving mass or abutment-flier 17 acting on it, a bell-crank 19 having one arm

connected to said abutment and pivoted on the revolving governor-frame 1, a thrust-bearing 11 in the axis of revolution connected to the other arm of said bell-crank, and an adjusting device not revolving with the governor but abutting on the revolving governor-frame and adapted to control said thrust-bearing 11 substantially as described.

12. In a centrifugal governor, the combination of a revolving adjustable spring-abutment 7, a revolving mass or abutment-flier 17 acting on it, a bell-crank 19 having one arm connected to said abutment, an axially-adjustable thrust-bearing connected to the other arm of said bell-crank, the said bell-crank being mounted on a pivot 20 transverse to the axis of revolution, wings 21 on governor-frame adapted to control said pivot transversely to axis, a fixed disk 23 adapted to control said pivot parallel to axis of revolution, and an adjusting device not revolving with governor, and abutting on a fixed part and adapted to control said thrust-bearing 11 substantially as described.

13. In a centrifugal governor, a flier, connected to the part to be controlled, a leaf or plate spring revolving with said flier formed in a spiral, the outer end attached to said flier, an abutment acting on the inner end of said spring and revolving therewith, and an adjusting device adapted to control said abutment in combination with a revolving mass or abutment-flier acting on said abutment in opposition to said spring, substantially as described.

14. In a centrifugal governor the combination of a flier 2 pivoted on the frame 1, a sleeve 27 engaged by an arm on said flier and revolving with it, a fixed socket 13 lying in the axis of revolution within said sleeve, a spiral leaf-spring 4 whose outer end acts on said flier, an abutment 7 on a pivot 9 acting on said spring and revolving therewith, a carrier 8 attached to said pivot and abutment, an adjusting device adapted to control said carrier and abutment at a point in the axis of revolution, and a revolving mass or abutment-flier 17 acting on said carrier in opposition to said spring, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

GUY E. LLOYD.

Witnesses:
L. W. BROCK,
W. E. LLOYD.