

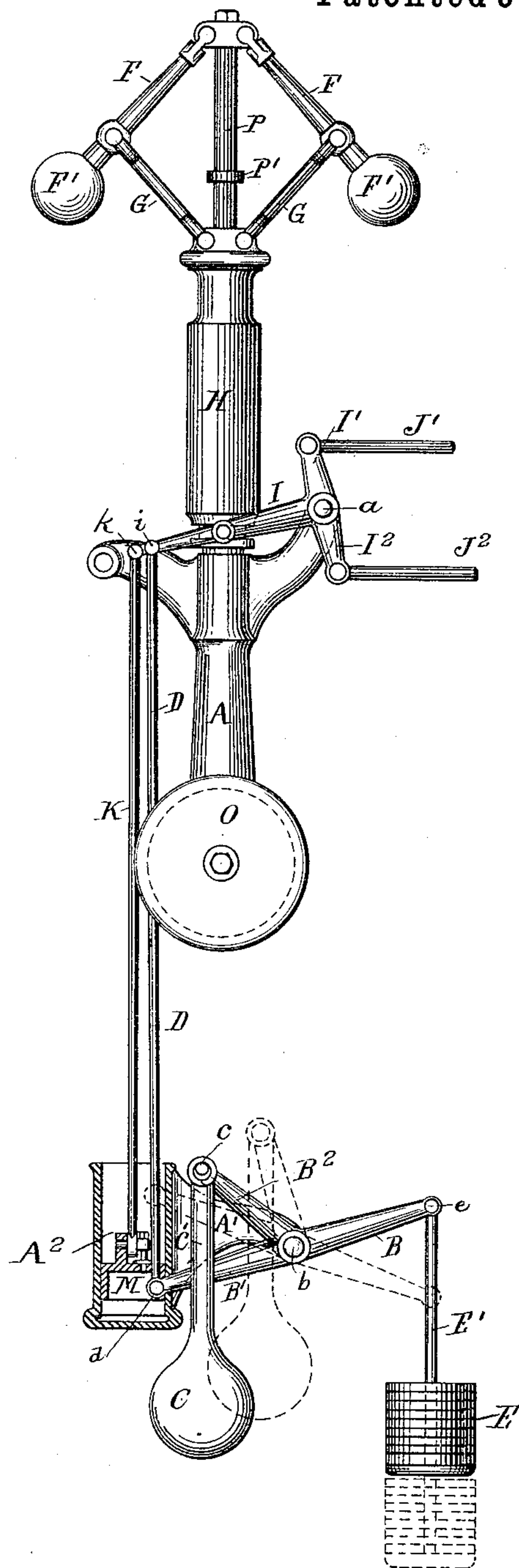
(No Model.)

G. H. CORLISS.

GOVERNOR FOR STEAM ENGINES.

No. 344,249.

Patented June 22, 1886.



Witnesses:
William B. Sherman,
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Inventor.

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UNITED STATES PATENT OFFICE.

GEORGE H. CORLISS, OF PROVIDENCE, RHODE ISLAND.

GOVERNOR FOR STEAM-ENGINES.

SPECIFICATION forming part of Letters Patent No. 344,249, dated June 22, 1886.

Application filed November 11, 1885. Serial No. 182,423. (No model.)

To all whom it may concern:

Be it known that I, GEORGE H. CORLISS, a citizen of the United States, residing in the city and county of Providence, in the State of Rhode Island, have invented certain new and useful Improvements Relating to Governors for Steam-Engines and Analogous Motors, of which the following is a specification.

The improvement may apply to all styles of fly-ball governors.

It is recognized as a difficulty in the regulation of a steam-engine by a fly-ball governor that, unless some measures are taken to prevent unequal action, a higher speed is required to maintain the balls at a high level and to properly condition the engine for using but little steam than is required to maintain the balls at a low level and properly condition the engine for using much steam.

There have been efforts by various engineers, (one of which is shown in the patent to me dated August 18, 1885, No. 324,459,) to provide for equalizing the action of the governor at different elevations of the fly-balls, by shifting the position of a weight, which is allowed to roll alternately toward one end or the other of a curved lever. I have now discovered and reduced to practice a simpler and more convenient mechanism for attaining the desired end.

I mount on the framing adjacent to the governor a horizontal wrist-pin, on which is mounted an arm extending obliquely upward, with liberty to turn. I connect to the free end of this arm a weight in such manner that through the intervention of a link it is pendulous. The gravity of the pendulous weight pulls directly downward on the extremity of the arm. The arrangement is such that the weight is of less effect in turning the lever on its axis, according as the arm is, by the working of the governor, brought into a more nearly upright position. The arrangement makes the weight effective by its gravity in the required varying degrees for the different positions of the fly-balls without exerting any appreciable influence by its inertia. The fact that the weight, instead of being mounted directly on the inclined arm, is hung at a considerably lower level and connected thereto by a light link, which link has but little weight, allows the arm when in the nearly upright position to be

shifted to the right and left, subject only to the slight inertia of the upper end of the link, the pendulous weight below contributing its gravity without its inertia. It is important that the motion be easy. I can use knife-edges to reduce the resistance to a minimum. I use a dash-pot to avoid a vibrating motion. This part may be in all respects similar to the corresponding part set forth in a patent to me bearing date August 18, 1885, and numbered 324,459.

In what I esteem the most complete mode of carrying out the invention I employ a considerable weight attached to a nearly horizontal arm of the same lever, or to an arm fixed to the same horizontal axis, which additional weight shall lift on the fly-balls or on the connections thereto with practically uniform force in all positions. This weight should be sufficient to exactly counterbalance all the mechanism connected with the governor below its sleeve. The pendulous weight attached to the inclined arm is sufficient in its lowest position—that which gives it the greatest leverage—to prevent the fly-balls of the governor from rising at all until exactly the desired number of revolutions is attained. The conditions attained by my arrangement enable that number of revolutions to maintain the balls in any position, either the highest or lowest, or any intermediate position. In other words, the relations of the parts are such that the pendulous weight acts with such varying force that the velocity required to maintain the fly-balls in any position within its whole range of action is exactly the same. Consequently, whether the steam is following at the shortest or longest point of cut-off, in order to overcome the resistance as the load on the engine or the pressure of the steam may vary, the velocity of the engine continues exactly the same. Any change in speed will be only momentary. The change in speed is immediately felt by the governor, causing a shifting of the elevation of the balls and a corresponding change in the point of cut-off, and thus increasing or diminishing the quantity of steam used. The easy motion of the joints allows the governor to be very sensitive, the dash-pot prevents sudden changes, and in a brief period the several parts assume positions which give exactly the

required quantity of steam to conform to the new conditions, and the engine continues to work at the desired uniform velocity as before. Thus the engine practically maintains a certain and unvarying velocity through the whole range of the movement of the governor.

The accompanying drawing forms a part of this specification, and represents what I consider the best means of carrying out the invention. It is an elevation, partly in section.

The drawing shows the novel parts with so much of the ordinary parts as is necessary to indicate their relations thereto.

A is a fixed frame-work, certain portions being designated, when necessary, by additional marks, as A' A², &c.

A' is a bracket cast in one with or firmly attached to the hollow cylinder A² of the dash-pot. The bracket A' supports the horizontal wrist-pin *b*. The arrangement of the arms and weights attached and the connection to the governor perform important functions.

B is an arm which, in the ordinary position of the fly-balls, is nearly or quite horizontal. I will designate it as a horizontal arm extending in one direction. B' is an arm extending horizontally in the opposite direction. B² is an arm which extends obliquely upward. These three arms are rigidly connected to form a three-armed lever, which turns freely on the horizontal wrist-pin *b*.

C is a pendulous weight connected by a light link, C', to the upper end of the arm B². The junction is effected by a freely-turning joint, *c*.

D is a rod extending up from the arm B', to which it is connected by a freely-turning joint, *d*. E is a weight preferably composed, as shown, of a number of separate parts, which may be applied and removed, as required. The weight is connected by a link, E', to the arm B, the junction being effected by a freely-turning joint, *e*.

P is the shaft of the governor, receiving motion through suitable gearing (not represented) from the pulley O, which latter receives motion from the engine (not shown) by a belt, in any ordinary or suitable manner.

F F are the arms, and F' F' the balls, of a fly-ball governor. G G are the links connecting the arms F to H, which is a sleeve free to slide up and down to a limited extent on the shaft P. The motion downward is limited by the contact of its lower end with the fixed frame-work A. The motion upward is limited by the contact of its upper end with a collar, P'. The rising and sinking of this sleeve H by the changes of velocity of the governor communicates motion by the well-known means to the horizontal arm I of a compound lever pivoted to the fixed frame-work at *a*, the upper arm, I', of which is connected by a horizontal rod, J', to the valve-gear (not represented) for one end of the steam-cylinder. The lower arm, I², correspondingly communicates motion through the rod J² to the valve-gear for the other end of

the cylinder. The arm I extends past the connection to the sleeve H, and connects with the rod D by a freely-turning joint, *i*. The same arm I, or an arm rigidly fixed thereto, is connected by a joint, *k*, to a rod, K, which extends downward and connects to a piston, M, working in the cylinder A². This piston and cylinder may be in all respects similar to the corresponding parts in the patent to me, dated August 18, 1885, before cited.

The weights C and E should be carefully determined, according to the proportions and weights of the other parts. The weight E should be exactly sufficient to balance the weight of the piston M and the rods K and D. It thus makes the weight of those parts of no effect on the position of the governor, and allows the dash-pot to exert its regulating influence without becoming a disturbing element in the computations for the other parts.

The weight C exercises an important influence on the action of the governor. It pulls downward on the fly-balls, but not uniformly in all positions. When the balls F' are revolving in their lowest plane, the arm B² diverges to the greatest extent from the perpendicular, and the weight C exerts the greatest leverage. In this position the weight C pulls on the arms F with the greatest force. When the fly-balls F' are revolving in a more elevated plane, the arm B² is brought into a more nearly perpendicular position, and consequently the weight C acts with less leverage. It continues to pull down on the fly-balls, but with less force than before. By properly determining the weights of all the parts and the angle of the arm B², I am able to attain a theoretical uniformity in the action of the governor in all positions. My experiments indicate that I also practically attain this condition. The figure shows the correct proportions for ordinary practice.

I attach importance to the fact that the weight C is not mounted directly on the arm B². The fact that it is pendulous, the mass of the weight being below, and the connection to the arm being made by a light link, materially affects the influence of its inertia. Its inertia has no influence on the horizontal element of the motion of the arm B²—that is to say, when the arm B² is nearly upright, so that any movement of the joint *c* is practically horizontal to the right or left, the shifting of its position in one direction or the other is not resisted by the inertia of the weight C, and what is still more important the inertia of this weight exerts no influence to continue the motion. The arrangement allows the gravity of the weight C to be available in the manner desired while leaving the sensitive mechanism practically uninfluenced by the inertia of this weight.

Modifications may be made in the forms and proportions without departing from the principle or sacrificing the advantages of the invention.

I can attach the weight E directly to the

arm B. I prefer the attachment of this weight by the link shown, although the pendulous condition in this weight does not perform the same function as in the other weight, C.

5 The proportion of the weight of the fly-balls F' to the sleeve H and the other parts may be varied; but such change will necessitate a corresponding change in the weight C. An increase in the weight of the fly-balls necessitates an increase in the weight C, in order to
10 attain the perfect balance desired, so as to allow the governor to regulate with absolutely uniform motion, whether the steam is cut off short or allowed to follow further on the stroke
15 of the piston.

I can, if desired, use knife-edges for the several joints in the same manner as such pivots are made and used in weighing machinery. Such may reduce the frictional resistance to the changes of position of the parts
20 to an almost inappreciable amount; but I do not deem such generally necessary.

Parts of the invention can be used without the whole. I can dispense with one of the
25 rods J², and effect the required changes of the valve-gear of the engine by the other arm, J'. I can dispense with the arm B and the weight E E', and allow the gravity of M and its connections to depend on the governor unbalanced. I can dispense with the cylinder A²
30 and the piston M and the connection K; but such omission will render the governor more liable to fluctuate or oscillate, going first above and then below the proper adjustment after

each sudden change of speed. I prefer the whole as shown. 35

I claim as my invention—

1. The inclined arm B², rocking on a center, b, so connected to the governor, as specified, that its inclination is changed by each change
40 of the plane of rotation of the fly-balls of a governor, in combination with such governor and with the weight C, connected by a link, as C', so as to be pendulous, and arranged to be thrown to the same vertical plane as the
45 pivot b, substantially as and for the purposes herein specified.

2. The cylinder A², piston M, and connection K, in combination with a fly-ball governor and with the pendulous weight C C',
50 rocking inclined arm B², wrist-pin b, arm B', and connection D, all arranged for joint operation, as herein specified.

3. The combination, with a fly-ball governor, of a weight, E, and arm B, arm B' and connection D, piston M and connection K, and
55 inclined rocking-arm B² and weight C, arranged for joint operation, substantially as and for the purposes herein specified.

In testimony whereof I have hereunto set my
60 hand, at Providence, Rhode Island, this 31st day of October, 1885, in the presence of two subscribing witnesses.

GEORGE H. CORLISS.

Witnesses:

HENRY MARSH, Jr.,

WILLIAM B. SHERMAN.