(No Model.)

J. M. SMITH.

GOVERNOR FOR STEAM ENGINES.

No. 282,789. Patented Aug. 7, 1883.

Fig 1

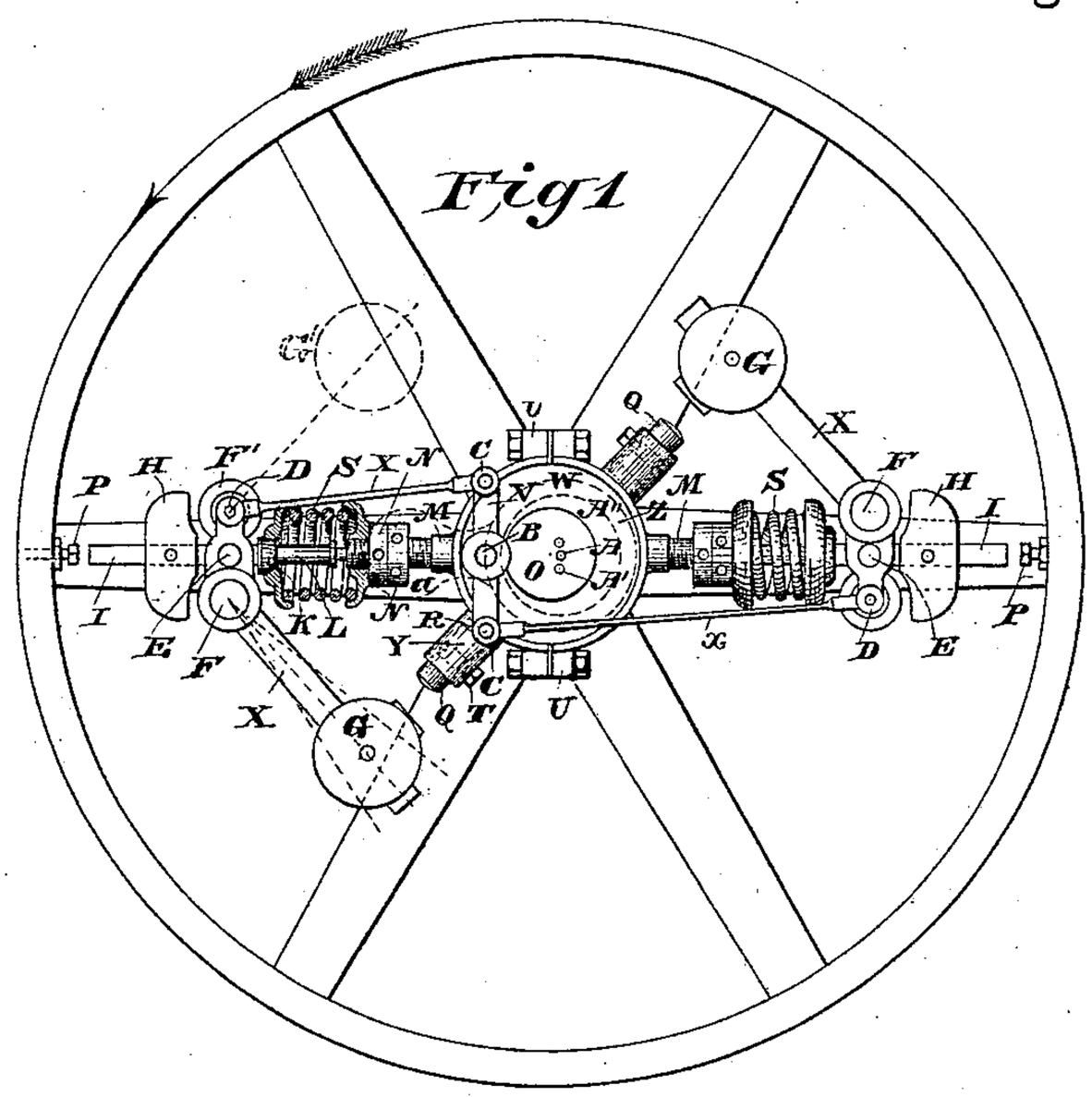


Fig 2.

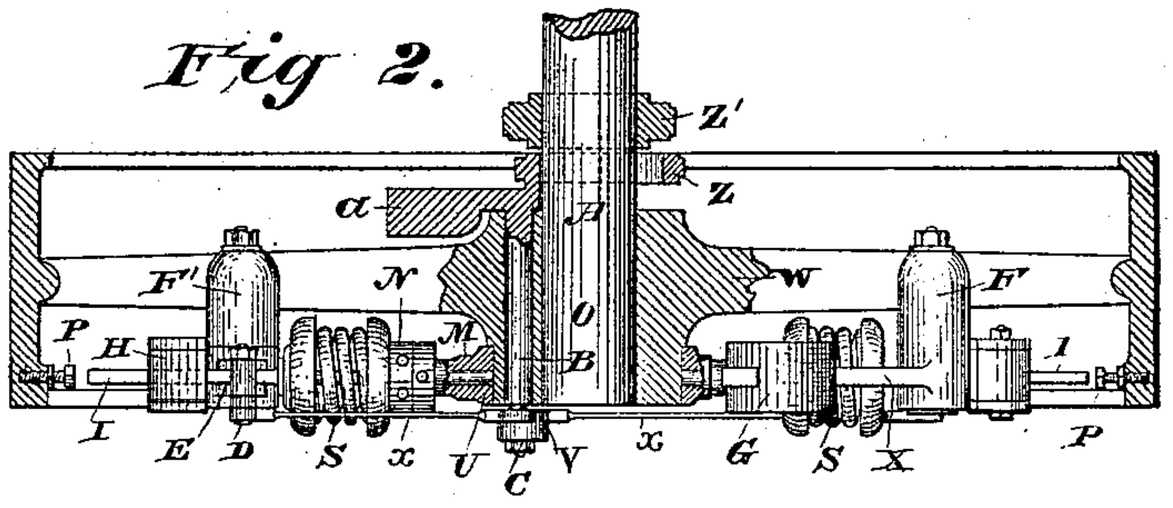


Fig 3.

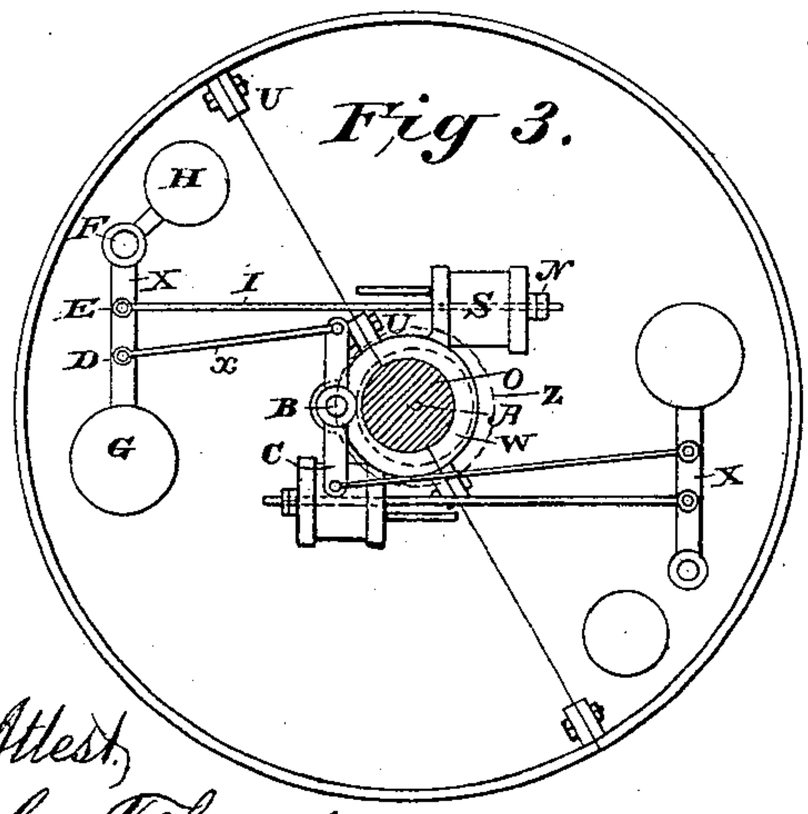
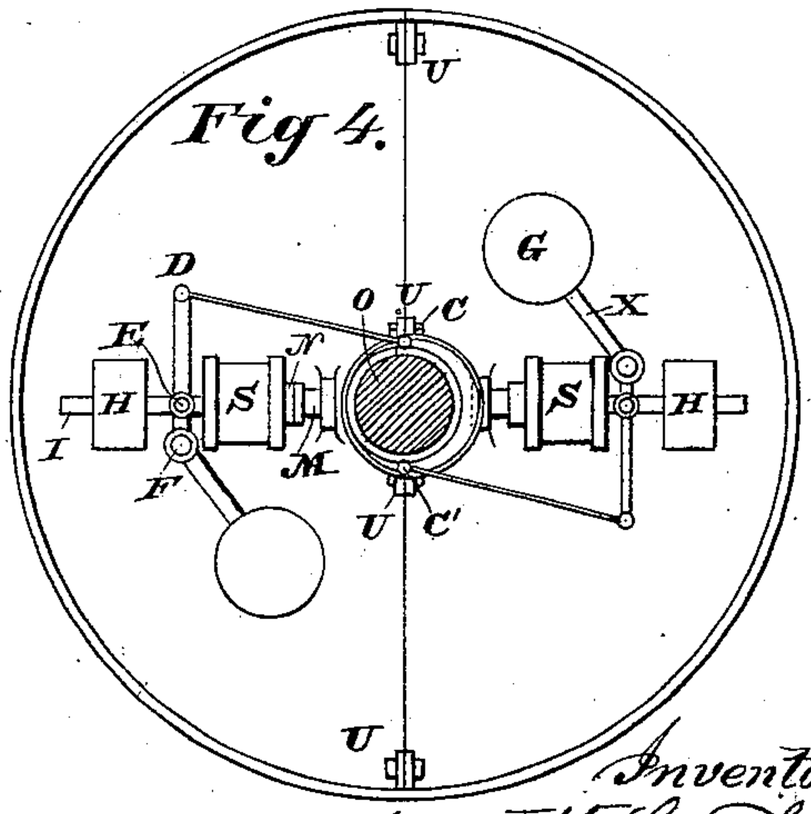


Fig 4.



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JESSE M. SMITH, OF DETROIT, MICHIGAN.

GOVERNOR FOR STEAM-ENGINES.

SPECIFICATION forming part of Letters Patent No. 282,789, dated August 7, 1883.

Application filed May 11, 1883. (No model.)

To all whom it may concern:

Be it known that I, JESSE M. SMITH, of Detroit, in the county of Wayne and State of Michigan, have invented a new and useful Improvement in Governors for Steam-Engines, which improvement is fully set forth in following specification.

This invention relates more particularly to that class of speed-governors in which the governor is connected with the shaft in a positive manner, and comprises weights movable toward and away from the axis of the shaft under the varying centrifugal force, and operating to shift an eccentric or eccentrics carried by said shaft.

Ordinarily the governor consists of a lever having one arm weighted and the other connected with the eccentric and an antagonistic spring. This apparatus, if made with a light weight and spring, is too sensitive to variations in the resistance or load on the shifting eccentric by reason of the little inertia of the weight, and if the weight be large it is not sensitive to variations in the speed, because the antagonistic spring must also be large and strong, and therefore not very sensitive. The present invention remedies this defect by using, in addition to the flying weight, an equalizing-weight so connected therewith that the centrifugal force of one antagonizes that of the other. The connection preferably employed is a lever, and the lever-arms are of such relative length that the centrifugal moment of the flying weight—that is, the product of its centrifugal force into the length of the corresponding lever-arm—is greater than the centrifugal moment of the equalizing-weight. The difference in the moments is balanced by a spring, which, as it is not required to resist the amount of either weight, but only the difference between the two, may be comparatively light and sensitive, while at the same time the inertia of the two weights may be quite large. This application of the two weights is believed to be new, broadly, whether the connection be a lever or other mechanical device or devices, which obviously may be used in place of a lever, and the combination, broadly, is a part of the invention; but the use of a lever as the connecting means, and certain other particular constructions and arrangements of parts, as hereinafter explained, whereby the operation is improved, also form a part of the invention, and are claimed as subordinate improvements.

Governors of the class to which this invention relates have ordinarily been permanently secured to the shaft. In the present invention the principal parts are carried by a frame which is clamped upon the shaft, and can be removed and replaced when desired. The apparatus is also adapted to allow the clamp and parts carried thereby to be reversed, so that the governor may be used equally well on shafts running in either direction.

The invention further comprises certain particular constructions and arrangements of the parts immediately connected with the shifting eccentric or eccentrics.

In the accompanying drawings, Figure 1 is a side elevation, partly in section, of a governor constructed in accordance with the invention; Fig. 2, a horizontal section, partly in plan, of the same; and Figs. 3 and 4 are side elevations, partly in section, of other forms, also constructed in accordance with the invention.

In Figs. 1 and 2 the main shaft O carries a fly-wheel or pulley and two eccentrics, $z\,z'$, the latter fixed to the shaft and the former fixed to the short parallel shaft B, which passes through and is journaled in the hub W of the fly-wheel or pulley. The eccentric z' is used to reciprocate the slide-valve, thus giving an invariable lead, exhaust opening and compression, and the eccentric z to operate a separate cut-off valve. These valves may be, and preferably are, such as described in Letters Patent No. 275,725, granted to me April 10, 1883, for an improvement in slide-valves for steam-engines; but they may also be of any ordinary or suitable construction.

The eccentric z is combined with a counterbalance-weight, a, on the opposite side of the shaft B. The eccentric z is shifted to vary the cut-off by turning the shaft B, so that the center occupies different points on the arc A A′ A″. (Shown in dotted lines, Fig. 1.) In the normal running of the engine the center of the eccentric has the mid-position A. (Indicated by dotted lines, Fig. 2.) The shaft B is connected, through the lever-arms V, (fixed thereto,) the

rods *x*, and journal-pins C D, with the bent levers X, which have their fulcrums or pivot-pins supported in boxes F, fixed to the pulley or fly-wheel on opposite sides of the axis thereof. There are also additional boxes, F′, the use of which will be hereinafter described.

The arms of the levers X are of unequal length. The shorter arm is connected with one of the rods *x*. The longer arm carries the flying weight G. The shorter arm is also connected at a point between the fulcrum F and the journal-pin D with the movable rod or stem I by means of a journal-pin, E. The rod I, at its inner end, which is turned to a less diameter than the body, plays freely in a hole in the boss M or the clamp U, which latter is fastened upon the hub W. The rod I carries the equalizing-weight H. It also receives the pressure of the spiral compression-spring S, placed between cap-pieces, of which one bears against a shoulder, K, on the rod I, and the other against the nuts N, screwed on the boss M, which is threaded on the exterior. By turning the nuts N the pressure of the spring S can be regulated. The shoulder K is rounded to prevent the cap from binding thereon. Beyond the outer end of each rod or stem I is a screw-stop, P, which limits the outward movement of the said rod or stem. The shoulder L limits the movement toward the center.

The flying weight G, when the engine is at rest or running much below its normal speed, bears against a buffer formed by a wooden plunger, Q, fitting loosely within a counter-bored boss, Y, on the clamp U, and resting upon a spring or rubber cushion, R. The plunger is prevented from leaving the boss by means of a screw, T, which is tapped through the side of boss Y, and whose end fits within a groove in the periphery of the plunger, said groove being of sufficient width to give a slight play to the plunger.

The operation is as follows: The shaft O being revolved in the direction of the curved arrow, and the resistance of the valve tending to turn the eccentric *z′* in the direction of the arrow *f*, the resistance of the valve is variable from zero to a maximum, but alway tends to turn the eccentric in the same direction. This tendency to turn the eccentric is resisted, first, by the push of the springs S, acting on the rods or stems I through the journals E, and, second, by the centrifugal force of the equalizing-weights H. The flying weights G, by their centrifugal force, place all the forces in equilibrium. The resistance of the valve, being variable, will cause a fluctuation of the governor. To render this fluctuation small as may be desired, the equalizing-weights H are made large as compared with the tension or rods *x*. The said weights H move in as weights G move out. When the speed of shaft O increases, the centrifugal force of weights G overbalances the other forces and turns the shaft B so as to move the center of the eccentric *z* toward the point A′, so as to vary the angular advance and stroke of the cut-off valve in the direction for diminishing the supply of steam to the engine. When the speed diminishes, the other forces overbalance the centrifugal force of the flying weights G and move the shaft B and eccentric *z* in the opposite direction. When the engine stops the buffer Q R Y receives the impact of the weight G, which is moved to the center by the spring S. The weight and position of the weights H are so chosen that the increase of centrifugal force due to increased speed of the shaft O is just equal to the decrease of centrifugal force due to the decrease of the distance of the center of gravity of weights H and their connected parts, (rods or stems I, springs S, and their caps, and the shorter arm of lever X,) so that the centrifugal force of the said parts is constant within the limits of the travel of rods or stems I. The office of springs S is, first, to have sufficient initial tension to overcome the resistance of the valve when the engine starts, and, second, to equalize the difference in centrifugal force of the flying weight when in its extreme positions.

The springs may be so proportioned that the centrifugal force of the weights G will be exactly balanced in every position, and the governor will then be isochronal and sensitive to the slightest change of velocity.

The springs S, having to resist only the difference of centrifugal forces of the weight G, (instead of all that force,) may be made very small, and, acting only by compression, it can be confined between two caps which work or ball-joint, and thus equalize any uneven pressure of the spring. This spring is the simplest and cheapest form to make and the least liable to break.

It is very desirable in a governor to have a constant force much larger than the resistance to be overcome in the valve and connections. This force is supplied by the weights H, which, within the range of the least to the greatest cut-off, is constant, and may be made of any intensity by changing the weights H. The speed may be changed by changing the weights G and H in the same proportion. Adding weights will decrease the speed and taking off will increase it.

The direction of revolution of shaft O may be changed by removing the fulcrum-bolt from boxes F and the journal-pins C. Then, by taking out the bolts of clamp U, the governor is entirely free from the fly-wheel or pulley. The governor is then turned over so that the weight G is at G′, and fulcrum-bolts are secured in the boxes F′. The bolts of clamp U are then replaced and tightened, and rods X are connected with the opposite ends of the arms U by the journal-pins C. The fly-wheel is then set to the proper angle of advance.

The weights, springs, and other operating devices are duplicated on opposite sides of the shaft O in order that each may balance the

other. Levers are used as the means of connecting the flying weights with equalizing-weights and springs, because attended in use with least friction and because the simplest and strongest connection. The levers are bent, as shown, in order that the movement of the weights and spring may be as nearly radial as possible. A similar form of lever could be used when there is not an equalizing-weight. The equalizing-weights are connected with the levers X near the fulcrum, so that they may be large and have a comparatively small movement. The flying weight is placed at the end of a comparatively long lever-arm, in order to give it a considerable travel. The power of the spring is applied between the journal-pin D and fulcrum F, in order to multiply the effect upon the eccentric of the springs' movement. The rods *x* are connected with the levers X independently of the springs and weights, so that the frictional resistance of springs and weights does not affect the journal-pins C D.

The counter-weight *a* of eccentric *z*, beside counterbalancing the weight of the eccentric, acts as a moderator for the governor. The weight *a* tends to get away from the center of the shaft as far as it can. When the eccentric moves to one side or the other of its mid-position, it forces the weight *a* out of its central position, and the centrifugal force of weight *a* tends to keep the center of gravity of said weight, the shaft B, and the shaft O all in the same plane.

In Fig. 3 the governor is arranged in a casing, U′, made in two parts, bolted together around the shafts O. The levers X are fulcrumed and fastened to the wall of the casing at F. The equalizing-weights H are attached directly to the levers. The springs S are placed near the shaft. The adjusting-nuts N′ are on the ends of the rods or stems I, which, as well as the rods *x*, are connected with their respective levers X on the same side of the fulcrum as the flying weights G. The shaft B, to which the eccentric *z* is fixed, has its bearing in the hub W of casing U′. The operation is as described with reference to Figs. 1 and 2, except, of course, as to the details which have been modified.

In Fig. 4 the weights, springs, adjusting-nuts, and tension-rods are like those shown in Figs. 1 and 2, only they are secured in a casing, U′, as is the governor shown in Fig. 3. The eccentric *z*, however, instead of being carried by a parallel short shaft, B, is loose upon the shaft O, and the tension-rods are connected by means of the journal-pins C directly with said eccentric, so that the governor acts to roll the eccentric around the shaft; otherwise the operation is as described for the governor shown in Figs. 1 and 2.

Although it is preferred to have the different parts so proportioned that the centrifugal force of the equalizing-weight and the devices on the same side of the fulcrums at F should be a constant quantity, yet this arrangement or special combination is not necessary to a successful operation of the governor. One or more eccentric or other regulating devices, supported and moving in any ordinary or suitable way, may be combined with the equalizing and flying weights and regulating-spring. The flying weight is that which flies out when the speed of the shaft increases, and it is preferably lighter than the equalizing-weight and connected with the longer arm of the lever; but it could be heavier, if desired, the connections being properly proportioned.

Having now fully described my said invention and the manner of carrying the same into effect, what I claim is—

1. In a governor, the combination, with a shifting eccentric or similar regulating means, of the equalizing-weight, flying weight, and spring, connected and operating substantially as described.

2. The combination of the equalizing-weight, flying weight, connecting-lever, and spring, substantially as described.

3. In a governor, the combination, with a flying weight and spring, of a lever bent, as explained, so that the movements of said weight and spring are as nearly radial as may be.

4. The combination of the flying weight, equalizing-weight, bent lever, and spring, substantially as described.

5. The combination of the flying weight, equalizing-weight, lever having arms of unequal length, and spring, substantially as described.

6. The combination, with the lever carrying the flying weight, of the spring and rod, separately connected with said lever, said rod serving to communicate the motion of the lever to the shifting eccentric or similar governing device, substantially as described.

7. The combination of the lever carrying the flying weight, the equalizing-weight, the spring, and the rod for communicating motion to the shifting eccentric or other governing device, the connection of said rod with said lever being at a greater distance from its fulcrum than the connection of the spring or equalizing-weight with the same, substantially as described.

8. The combination, with the flying weight and equalizing-weight, of connections, as explained, whereby the centrifugal force of the equalizing-weight becomes a constant quantity within its limits of movement, substantially as described.

9. The combination, with the spring, of the equalizing and flying weights and connections proportioned, substantially as described, so that the greater part of the centrifugal force of the flying weight is balanced by the centrifugal force of said equalizing-weight, substantially as described.

10. The combination, with a lever of unequal arms, of a flying weight carried by the long arm of the lever, and the spring arranged

to act against the short arm of the same, substantially as described.

11. The combination, in a speed-governor of the character described, of a clamp for attaching the same to a shaft or wheel-hub, substantially as described.

12. The combination of the shifting eccentric, the shaft carrying the same, and the counter-weight, substantially as described.

13. The combination of the shifting eccentric, the shaft carrying the same, the counter-weight, and the governor, substantially as described, so that the said counter-weight tends to maintain the governor in its mid-position, which corresponds with the normal speed of the engine.

14. The combination, with the main shaft, of the parallel short shaft, the shifting eccentric at one end of said shaft, and the governor-connections at the opposite end, substantially as described.

15. The combination, with the governor and clamp for attaching the same to a shaft or hub, of a buffer or buffers carried by said clamp, so that when the governor is turned over to reverse the motion of the engine the buffer remains in the proper position, substantially as described.

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

JESSE M. SMITH.

Witnesses:
F. F. CAMPAN,
ROBERT M. CHAMBERLAIN.