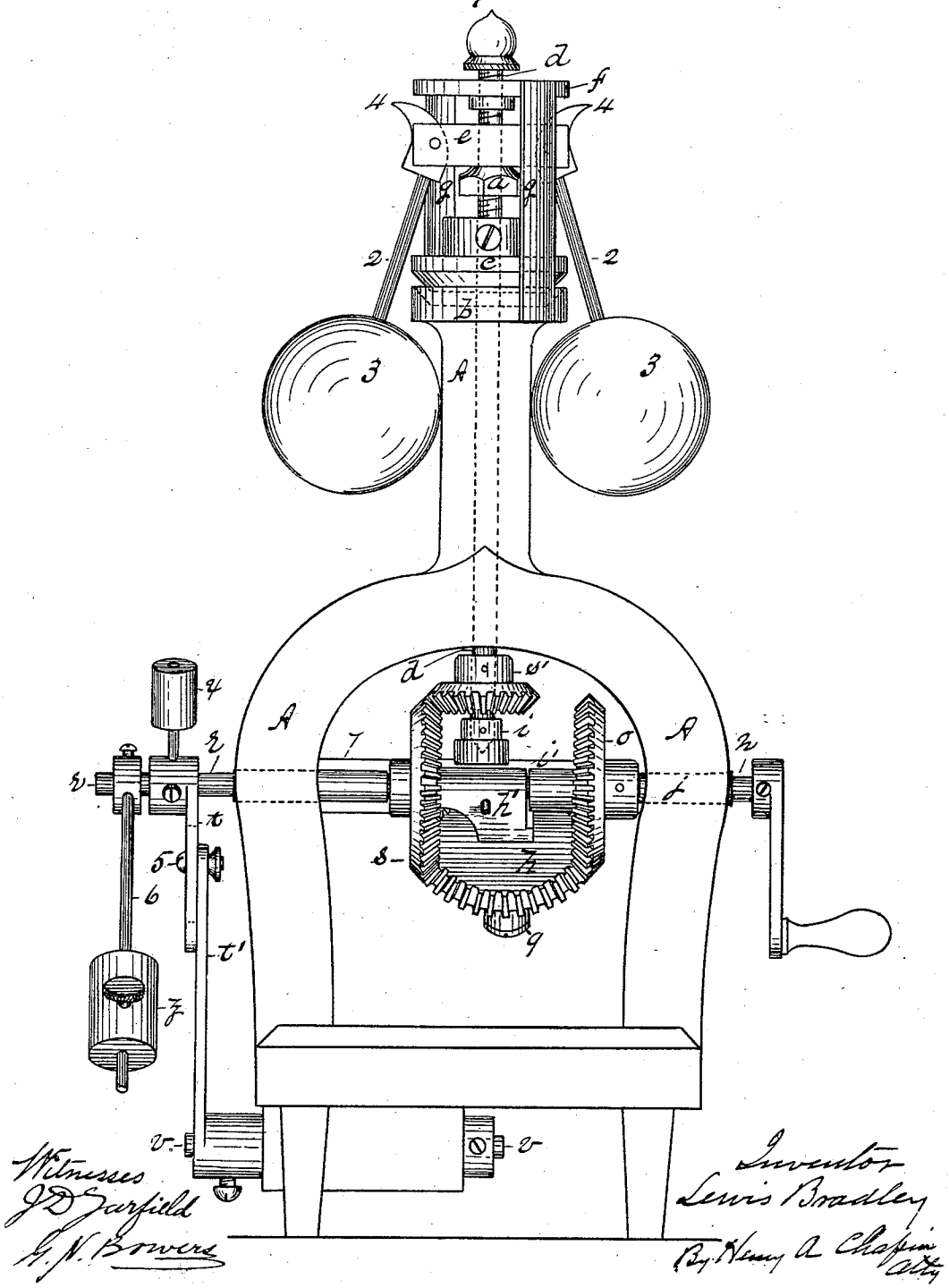
(No Model.) 2 Sheets—Sheet 1.

L. BRADLEY.

STEAM ENGINE GOVERNOR.

No. 245,773. Patented Aug. 16, 1881.

Fig 1



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(No Model.) 2 Sheets—Sheet 2.

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Fig 4

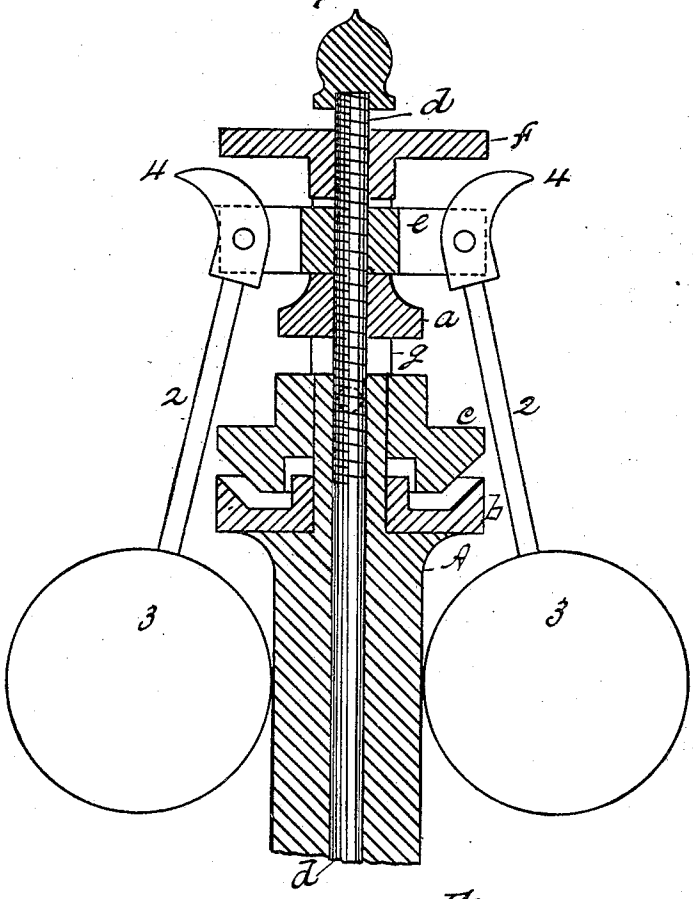


Fig 3

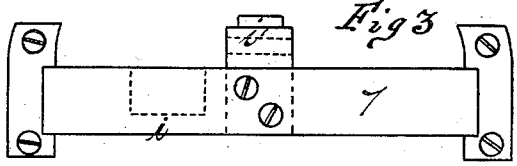
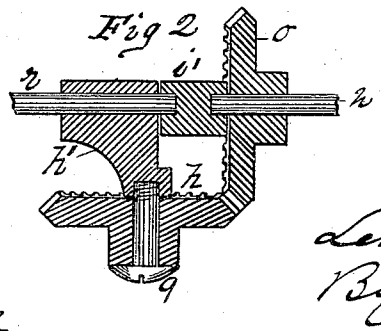


Fig 2



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UNITED STATES PATENT OFFICE.

LEWIS BRADLEY, OF SPRINGFIELD, MASSACHUSETTS.

STEAM-ENGINE GOVERNOR.

SPECIFICATION forming part of Letters Patent No. 245,773, dated August 16, 1881.

Application filed June 24, 1880. (No model.)

To all whom it may concern:

Be it known that I, LEWIS BRADLEY, a citizen of the United States, residing at Springfield, in the county of Hampden and State of Massachusetts, have invented new and useful Improvements in Steam-Engine Governors, of which the following is a specification.

My invention relates to governors for regulating the flow of steam to steam-engines; and the object thereof is to so regulate said flow that, provided there is sufficient steam at command, the speed of the engine may be uniformly maintained with greatly varied and intermittent labor to perform.

I attain the above-named objects by the construction and devices illustrated in the accompanying drawings, in which—

Figure 1 is a front elevation of my improved governor. Fig. 2 is a vertical section of the main driving-gear, the oscillating gear, with its pivot, and their shafts and supports. Fig. 3 is a rear view of the vertical shaft step and of the central support for the horizontal shaft. Fig. 4 is a view, partly in section, of the upper portion of the governor.

Like letters refer to like parts in the several figures.

In the drawings, A is the frame. *c* is a stationary bevel-edged friction-disk secured at the top of frame A. *b* is a friction-ring lying upon a flange-like projection, *e'*, around the upright part of frame A, and its inner upper edge is beveled off, as shown in dotted lines, to fit against the lower beveled edge of disk *c*. A disk, *f*, fits loosely on shaft *d* just below its upper end, and said disk and said friction-ring *b* are secured permanently one to the other by the two bars *g g;* and said four parts, *b c g g*, constitute a kind of yoke, which rests in the position seen in Fig. 1 (when the governor is not running) upon said projection *e'* on frame A, just under disk *c*, and ring *b* is adapted to be lifted against said disk and the whole of said yoke to be revolved around shaft *d* and said upper end of frame A. *e* is the ball-arm pivot-block. *a* is a lock-nut for the purpose of securing said pivot-block firmly to shaft *d*. 2 2 are the ball-arms. 3 3 are the balls. 4 4 are ball-arm cams. *i* is the upright shaft step. *i'* is a common bearing for the adjacent ends of the two horizontal shafts *n* and *r*, which shafts have their other bearings in frame A. *n* is the driving-shaft. *o* is the driving-gear. *h* is the intermediate oscillating gear. *h'* is a pivot-arm supporting the intermediate gear, *h*. *r* is the governor-valve-operating shaft, to which the pivot-arm *h'* is secured. *s* is a gear running loosely on shaft *r*. *s'* is a gear secured to the lower end of vertical shaft *d*. *t* is a slotted arm secured to shaft *r*, and connected with arm *t'* by a screw, 5, through the latter, said screw being loosely fitted in the slot in arm *t* and against the latter, so that said arms may freely swing face to face, one actuating the other, as hereinafter described. Arm *t'* is secured to a horizontal shaft, *v*, under frame A. *x* is a counter-weight to the gear *h*, and is arranged to oscillate with the motions of shaft *r*. *z* is a weight adjustable on rod 6, which is secured to shaft *r*, as shown, at varying distances from the axial line of said shaft. *r'* is an elongated bearing for shaft *r*. 7 is a support for the shaft-step *i* and part *i'*, Fig. 1, secured to the back of frame A, and may be considered a part of said frame.

The driving-shaft *n*, on which is shown a crank, has in practice a pulley or gear secured thereto, by which it is driven through suitable connections with the crank-shaft of the engine. Said shaft *n* is arranged to run in a suitable bearing in frame A, and its inner end enters a socket in the side of support *i*, Fig. 2. Between frame A and support *i*, on shaft *n*, is secured the bevel-gear *o*.

On a line with shaft *n*, and supported in the opposite side of frame A and support *i'*, is a second shaft, *r*, as seen in Figs. 1 and 2, on which a bevel-gear, *s*, is allowed to revolve freely between support *h'* and the tubular bearing *r'*, and is adapted to drive the smaller gear *s'*, which is secured to the lower end of the vertical shaft *d*, which is stepped in support *i*. Supports *i* and *i'* are secured in frame A by cross-support 7, which is secured to the rear side of the frame. The pivot-arm *h'* (seen in Figs. 1 and 2) is secured to shaft *r*, and is tapped to receive the bolt 9, which bolt passes through the hub of the intermediate bevel-gear, *h*, allowing the latter to revolve freely thereon. Shaft *r*, as seen in Fig. 1, extends beyond the side of frame A, and has secured to it a slotted arm, *t*, projecting downward,

and an arm, 6, on which is a weight, *z*, which can be adjusted thereon as above described.

On the hub of arm *t* is fixed a short upwardly-projecting arm, carrying on its end a counter-weight, *x*.

Located under frame A is a shaft, *v*, which represents one end of a shaft connected with the governor-valve in a pipe leading to the engine. This shaft *v* is caused to have the requisite oscillating movement by means of the arm *t'*, secured to it and connected with arm *t*, as shown in Fig. 1, through instrumentalities which will be hereinafter described.

Vertical shaft *d* is run by its connection with gear *s* through gear *s'*, which is secured upon it. Said shaft *d* extends up through and beyond the end of the frame A, as seen in Fig. 1. On the upper end of said frame is secured the circular bevel-edged seat *c*. The parts *b*, *f*, and *g g* (heretofore described as constituting a species of yoke) drop by their own weight, so that the ring *b* stands away from disk *c* when the governor is not in motion.

On shaft *d* is screwed a set-nut, *a*, and next above said nut, and also screwed onto said shaft, is the ball-arm pivot-block *e*, whose ends are slotted to receive the ball-arm cams 4 4, which are pivoted in said slots, as shown, and to said cams are secured the balls 3 3 by arms 2 2. Said nut *a*, being screwed firmly against the under side of block *e*, secures the latter firmly on shaft *d*.

The operation of this governor is as follows, viz: Motion is given to shaft *n* by any suitable connection between it and the crank-shaft of the engine, and through gears *o h*, arm *h'*, shaft *r*, and arm 6 the weight *z* is raised. Said weighted arm imparts a uniform and constant force to hold gear *h* in position to act as an intermediate gear between gears *s* and *o*, and at the same time allows gear *h* to oscillate according as the varying speed of the main shaft increases or lessens the resistance to the action of the weight. With every change of speed the point of contact between *h*, *o*, and *s* varies, and this oscillating movement of gear *h* is imparted to the weighted arm 6 and to the arms that connect with the valve. Gear *s'* revolves shaft *d* and causes the balls 3 3 to be revolved in the usual manner and thrown upward by centrifugal force until the cams 4 4 impinge against the disk *f* and raise the yoke so far as to cause the friction-ring *b* to bear against the stationary friction-disk *c*, when the balls can rise no higher. The gravity of the weight *z* being just sufficient to keep the balls at that height, a uniform rotary motion of said balls in one horizontal plane is thereby established. The required speed of the engine being just sufficient to maintain the revolution of said balls in a given plane, the frictional contact of the ring *b* and disk *c* is not changed while said balls so revolve, and weight *z* is adjusted to such a place on arm 6 as will prevent gear *h* from swinging while said required speed is maintained; but the slighest inclination of the engine to run slower or faster is instantaneously felt by ring *b* and disk *c*, and results in such a slight variation of the friction between them as to cause said weight *z* to rise or fall, and, through shaft *r*, to operate the steam-valve. By means of the thread within the ball-arm pivot-block *e*, the lock-nut *a*, and thread on shaft *d*, the block *e* can be adjusted to any desired point on shaft *d*, thus causing the balls to revolve at any desired level and producing within the mechanical limits of construction any desired rapidity of uniform rotary motion in one plane; but when upon starting the engine its speed has increased to such a point as to cause an equilibrium between it and the speed of the balls, the weight *z* will remain balanced between said speeds and constantly maintain said equilibrium. Therefore, as long as nothing occurs to disturb the uniform action of the engine this equilibrium will be maintained; but whenever, from diminished pressure of steam or increased load, or similar cause, the engine begins to lag, the weight *z* immediately drops, since a portion of the power which supported it has fallen off, and through the arm 6, shaft *r*, arms *t t'*, and shaft *v* the steam-valve is instantly opened to a point which will allow the admission to the engine of an increased amount of steam sufficient to restore immediately and then maintain the equilibrium, there having been in the meantime no change whatever in the speed of the balls.

It is also obvious that when from any cause the engine attempts to accelerate its speed the weight *z* is raised as the power which supports it has increased, and the valve is instantly closed to a point which restores and then maintains the equilibrium; but in neither case is there any increase or diminution of the power applied to revolve the balls

The oscillating gear *h*, attached to shaft *r* by arm *h*, the balance-weight *z*, and the isochronously-revolving balls 3 3 act in conjunction to govern the volume of steam entering the engine-cylinder. To cause said parts to so operate the following conditions require to be fulfilled, and are provided for by the construction as described and shown herein, viz: the pivot-block *e* to be adjusted on shaft *d* so as to allow the balls 3 3, when propelled at their determined speed, to extend outward and upward by their centrifugal force to a point which will just cause the revolving friction-ring *b* and stationary friction-disk *c* to touch, the weight *z* to be of such an amount as to produce just the power necessary to revolve the balls at their determined speed.

The weight *x*, which is shown in Fig. 1 attached to shaft *r* by an arm, is so placed to counterbalance the weight of gear *h* when it swings to either side of the center of shaft *r* that the weight of said gear shall not affect the proper operation of weight *z*.

It will be seen that when the frictional surfaces of *c* and *b* meet, the balls 3 3 can go outward and upward no farther without producing

friction, and to retain them at that point the weight *z* is set at a proper distance from shaft *r* on arm 6, and secured there by a set-screw or other convenient means. Therefore, when the speed of the engine-shaft attempts to increase or diminish, it does not act upon the balls to accelerate or retard them, but swings the right-hand side of gear *h* in the direction which gear *o* is propelling it, or the reverse, and the gear *h* may be considered as a lever with its fulcrum where the pitch-lines of gears *s* and *h* meet, its power being applied at the junction of the pitch-lines of gears *o* and *h*, and its weight attached midway between these points on the axial line of its revolution. Thus when the engine attempts to increase or diminish its speed shafts *r* and *v* are caused to rock and cause steam to be fed to the engine in greater or less volume instantly that such attempts occur, thereby maintaining a perfectly regular motion in the engine.

In contradistinction to the operation of other ball-governors, this one operates the steam-valve without changing the plane of revolution of the balls, which would necessarily involve a change in their motion. Thus, in order to let on more steam to the engine, the balls in ordinary governors must revolve slower, and in so revolving the speed of the engine is reduced, and must so continue at a reduced rate.

What I claim as my invention is—

1. In a steam-engine governor, the combination, with shaft *r*, provided with arm *h'* and gear *h*, of the counter-weight *x*, substantially as and for the purpose described.

2. In a steam-engine governor, the combination, with the ball-arms 2 2, provided with the cams 4 4, of the yoke composed of the parts *f g g b* and seat *c*, substantially as and for the purpose described.

LEWIS BRADLEY.

Witnesses:
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