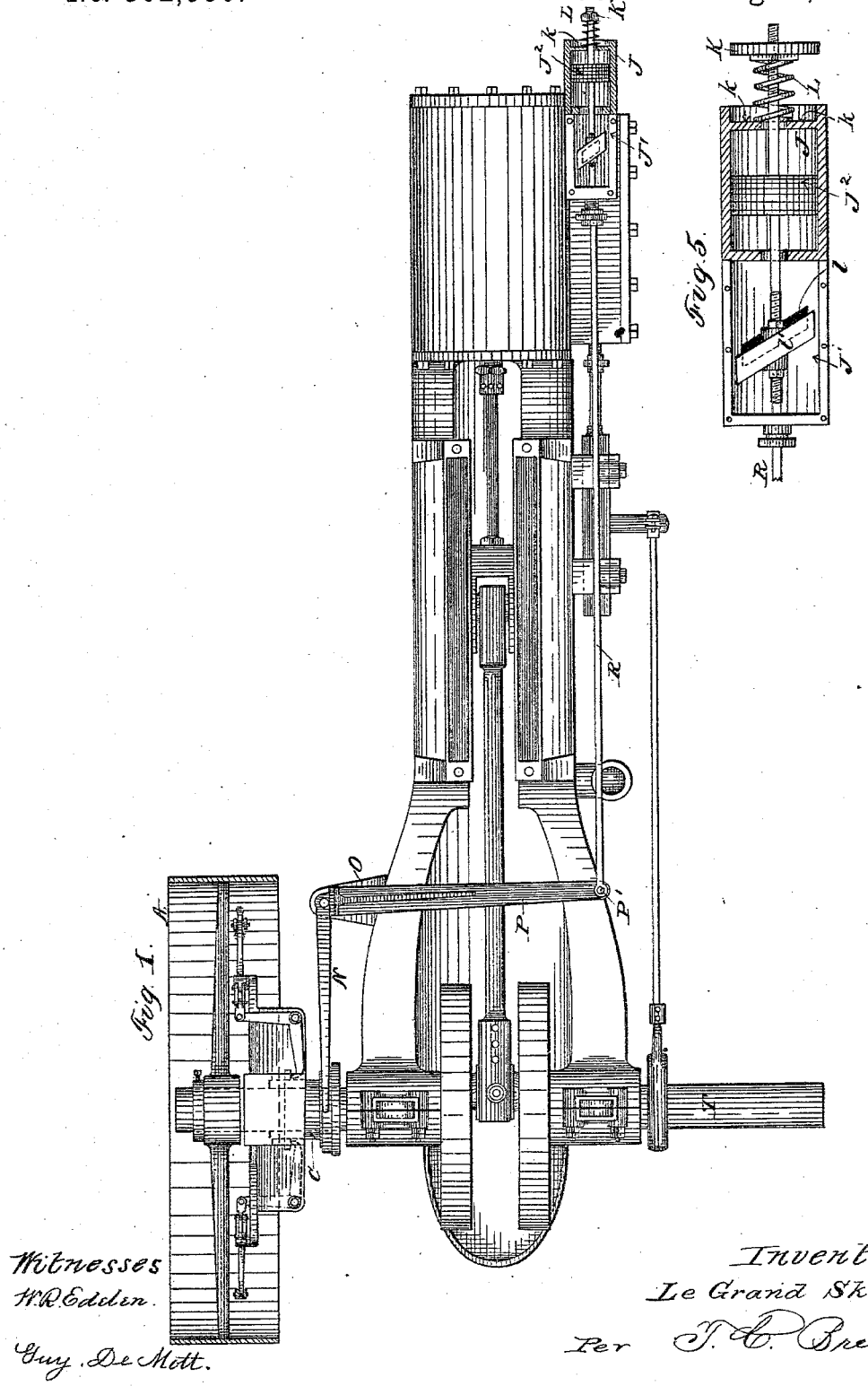
(No Model.) 3 Sheets—Sheet 1.

# LE GRAND SKINNER.

## STEAM ENGINE VALVE GEAR.

No. 302,950. Patented Aug. 5, 1884.




Witnesses
W. R. Edden.
Guy. De Mott.

Inventor:
Le Grand Skinner,
Per T. A. Brecht
Atty

(No Model.) 3 Sheets—Sheet 2.

# LE GRAND SKINNER.

## STEAM ENGINE VALVE GEAR.

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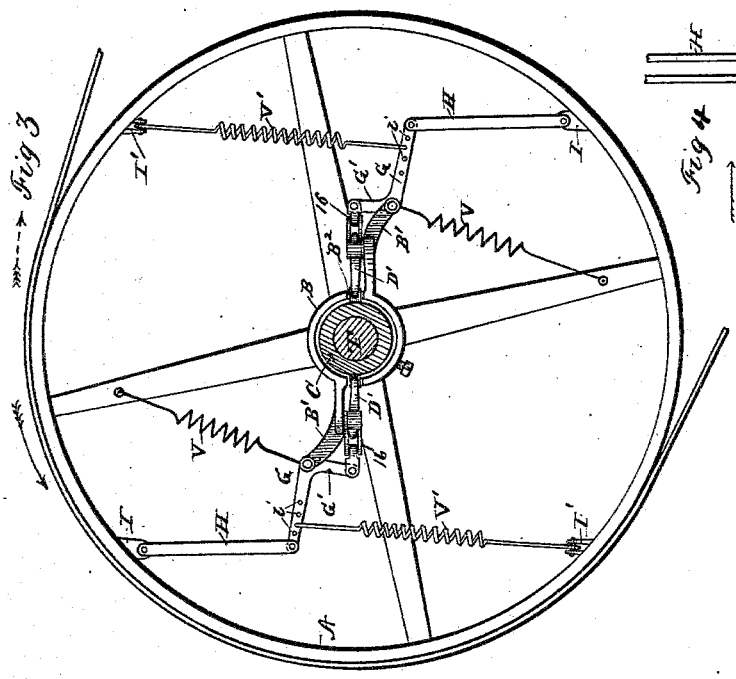

Fig 3

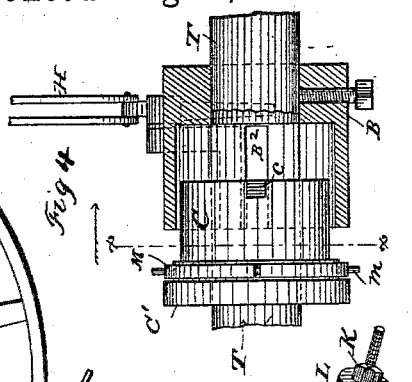

Fig 4

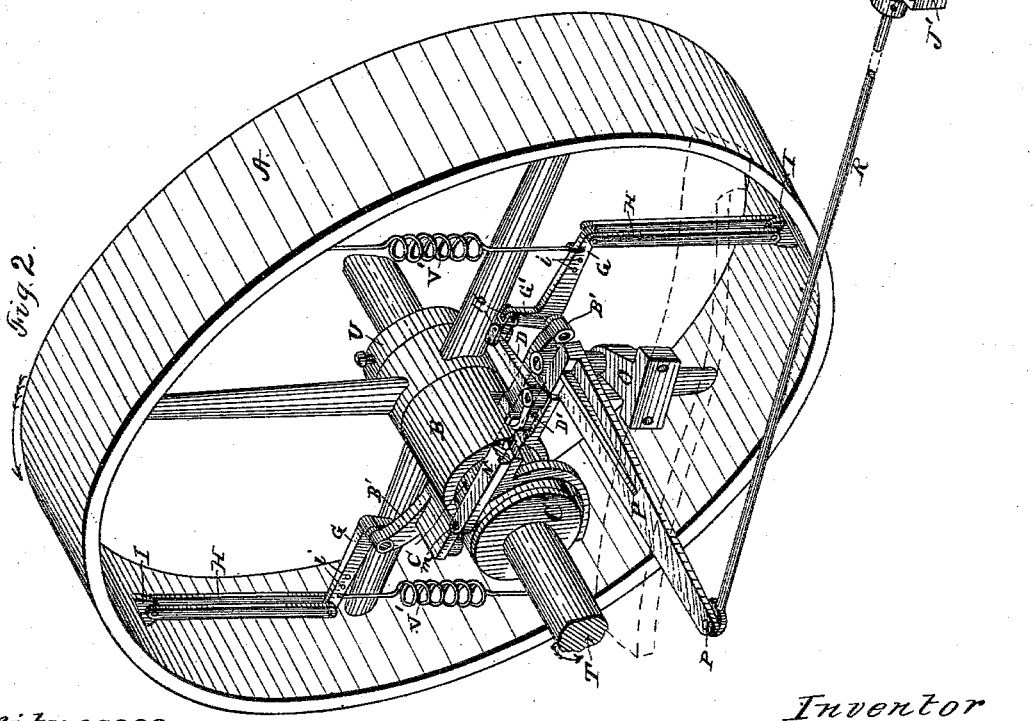

Fig 2.

Witnesses
W. R. Edelen.
Guy. De Mott.

Inventor
Le Grand Skinner,
Per T. C. Brecht
Atty

(No Model.) 3 Sheets—Sheet 3.

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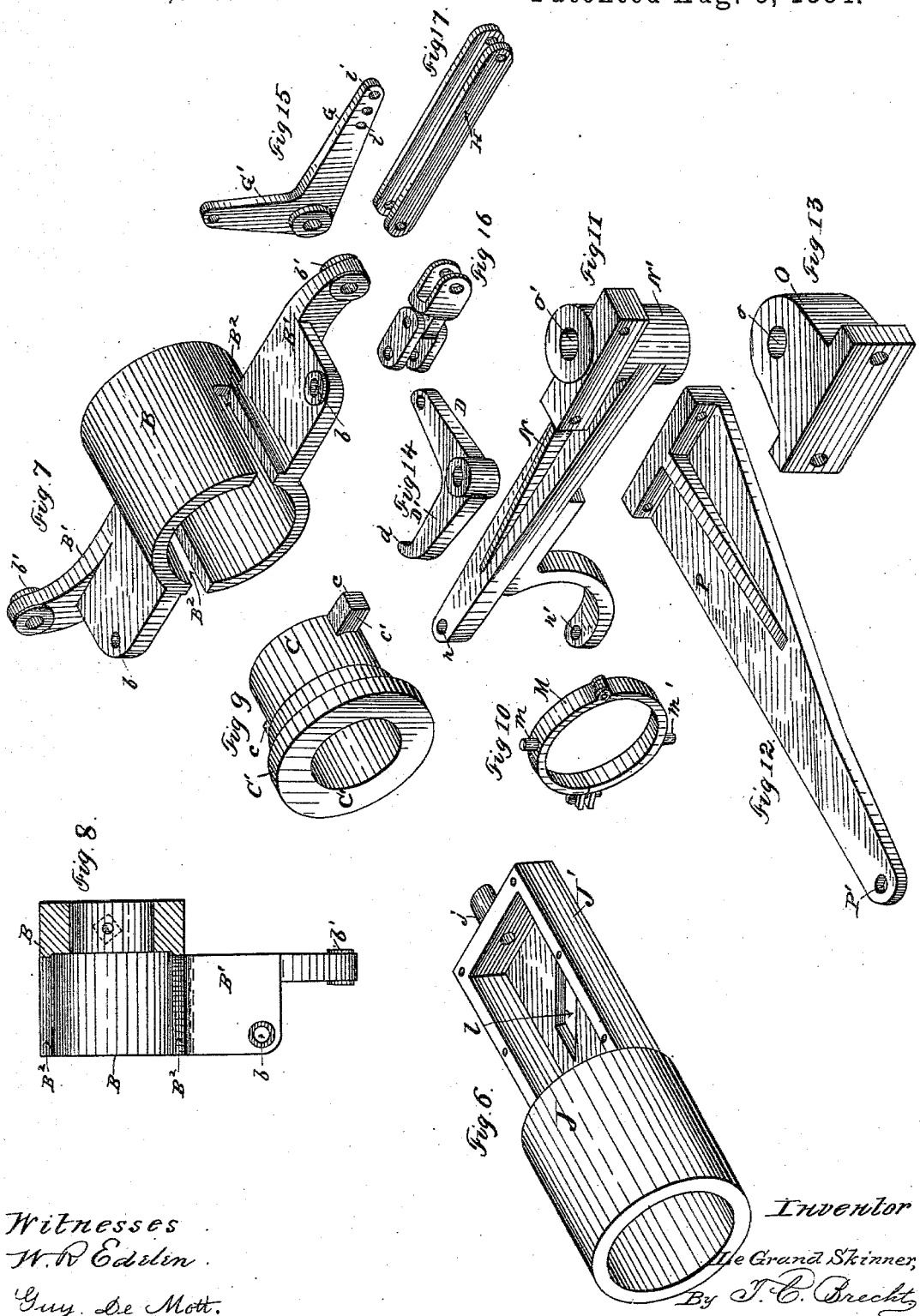


Witnesses.
W. R. Edelin.
Guy. De Mott.

Inventor
Le Grand Skinner,
By T. C. Brecht
Atty.

# UNITED STATES PATENT OFFICE.

LE GRAND SKINNER, OF ERIE, PENNSYLVANIA.

## STEAM-ENGINE-VALVE GEAR.

SPECIFICATION forming part of Letters Patent No. 302,950, dated August 5, 1884.

Application filed July 3, 1883. (No model.)

*To all whom it may concern:*

Be it known that I, LE GRAND SKINNER, a citizen of the United States, residing at the city of Erie, in the county of Erie and State of Pennsylvania, have invented a new and useful Improvement in Governors for Steam-Engine-Valve Gears, of which the following is a specification.

My invention relates to improvements in that class of governors for steam-engines in which pressure-governors operate in conjunction with automatic steam-pressure cylinders for moving the throttle-valve and regulating the supply of steam to the engine, the steam at boiler-pressure being utilized for governing the speed of the engine.

The objects of my invention are, first, to govern the movement of the engine by the steam-pressure, so that its speed will not be varied either by suddenly increasing or decreasing the load carried or by variations in the boiler-pressure; second, to govern the engine entirely by the load it is carrying, acting, in conjunction with the steam-pressure, for this purpose by means of mechanism controlling the movement of the throttle-valve; third, to accomplish these results by mechanism simple in its construction and operation. I attain these objects by the mechanism illustrated in the accompanying drawings, consisting of three sheets, and forming part of this specification, in which drawings—

Figure 1 shows a plain top view of a steam-engine with my improved governor, portions of the driving-pulley and steam-pressure cylinder being broken away. Fig. 2 is a perspective view of my improvement detached from the engine, with parts broken away to show the mechanism, and the cover of the throttle-valve steam-chest removed. Fig. 3 is a side elevation of a portion of my improvement, modified in form, with the engine-shaft and trunnion-sleeve sectioned through dotted lines *x x* in Fig. 4. Fig. 4 illustrates a portion of my improvement, showing a section of the main engine-shaft with a section of the fixed collar thereon, to which collar the fixed arms are attached and the loose turnnion-sleeve in place in their positions relative to each other. Fig. 5 shows in detail my improved automatic steam-pressure cylinder and throttle-valve steam-chest, and the arrangement of the throttle-valve therein, and manner of its operation. Fig. 6 is a perspective view of the combined steam-pressure cylinder and throttle-valve steam-chest with the cover removed, showing the port through which steam is admitted into the main steam-chest. Fig. 7 is a perspective view of the fixed collar, with the fixed arms referred to in the description of Fig. 4. Fig. 8 shows the fixed collar with one of its fixed arms, the collar being sectioned through its center, showing when it is attached to the main shaft, and also the recess to receive the loose trunnion-sleeve shown as Fig. 9. Fig. 9 is a perspective view of the winged trunnion-sleeve, which slides into the recess in the fixed collar shown as Fig. 7. Fig. 10 is a perspective view of a split trunnion-ring fitting upon the trunnion-sleeve shown as Fig. 9. Fig. 11 is a perspective view of a portion of a yoke bell-crank lever operating on the trunnion-ring shown as Fig. 10; and Fig. 12 is a perspective view of the other arm of the same, the two parts, when joined, forming a yoke bell-crank lever. Fig. 13 is a perspective view of a bracket to be attached to the engine-frame as a support for the axis of the bell-crank lever shown as Figs. 11 and 12. Figs. 14 and 15 are perspective views of bell-crank levers used in my improvement for connecting the loose pulley with the winged trunnion-sleeve shown as Fig. 9. Fig. 16 is a perspective view of a jointed coupling for connecting together the bell-crank levers shown as Figs. 14 and 15. Fig. 17 is a perspective view of the links connecting the bell-crank lever shown as Fig. 15 with the driving-pulley.

Similar letters refer to like parts in all the figures.

The engine to which my improvements are applied is essentially an ordinary steam-engine, my improvements being solely devices for governing the speed of the engine by utilizing the steam-pressure and load carried by the engine to control and adjust the steam-supply to the engine. Ordinarily steam is furnished directly to the main steam-chest of the engine through a pipe or pipes from the boiler, and the amount of steam used by the engine controlled either by an ordinary throttle-valve or by devices for varying the throw of the main valve, thereby cutting off the

steam-supply earlier or later in the stroke, according to the load being carried by the engine. In my device, however, I use an ordinary main valve operated by a common eccentric on the main shaft of the engine; but instead of supplying the steam directly to the main steam-chest I admit it first to an auxiliary steam-chest or a throttle-valve steam-chest, and from there to the main steam-chest through a suitable port, with a valve for closing it, as may be required. Attached to and connected with this auxiliary steam-chest I have a steam-pressure cylinder provided with a suitable piston, which is attached to and operates on the valve closing the port to the main steam-chest. The steam is admitted into this auxiliary steam-chest and pressure-cylinder at full boiler-pressure. When the steam is admitted to the auxiliary steam-chest and pressure-cylinder, it immediately acts upon the piston, which, being connected to the valve, closes or tends to close the port connecting the auxiliary steam-chest with the main steam-chest of the engine, and thereby cuts off its steam-supply. To counteract the tendency of the steam-pressure to close this port, I connect the valve with an automatic governor on the main shaft of the engine, the driving-pulley being an integral part of this governor. This governor, acting on the valve in opposition to the pressure of the steam on the piston in the pressure-cylinder, tends to move the valve back and open the port to the main steam-chest. This governor acts instantly when the load upon the driving-pulley is increased or diminished, as when the load bears heavily upon the driving-pulley (it being connected to the main shaft by a system of levers) it tends to stop the driving-pulley, which immediately acts upon the mechanism connecting the driving-pulley with the valve, closing the port to the main steam-chest, and, counteracting the pressure of the steam in the pressure-cylinder, opens the port to the main steam-chest and admits instantly a sufficient supply of steam to the engine to overcome the resistance of the additional load carried, the valve remaining in this position until the load on the driving-pulley is decreased, when, the extra strain being removed, the pressure of the steam on the piston again closes the valve so much as is necessary to equalize the power with the diminished load carried by the engine, and, vice versa, any increase or decrease of the load on the driving-pulley instantly acting upon the throttle or steam-regulating valve to open or close it; and this operation of the valve takes place without regard to variations in the boiler-pressure. For example, if the boiler-pressure is light, the force exerted by the load on the driving-pulley, being greater than that exerted by the steam in the pressure-cylinder, tends to open the throttle-valve and supply more steam to the engine, as the load may require. When, however, the boiler-pressure increases, the pressure of the steam in the pressure-cylinder is greater and closes the valve so far as may be necessary, as a low supply at high pressure will do the same work. The steam-pressure and the governor acting in this manner together, the engine may be regulated to run at any desired speed without regard to the boiler-pressure or variations in the load being carried by the engine, as at all times the steam-supply and load carried equalize each other.

In constructing my improvement I hang the driving-pulley A upon the main shaft T of the engine loose between collars U and B, which collars are firmly secured to the shaft T. The collar B (shown as Fig. 7) has fixed arms B′ B′ on either side of it, which project outward toward the periphery of the driving-pulley, with bearings *b b* on the ends of the arms B′ B′, to receive and support the axes of the bell-crank levers D D′, (shown as Fig. 14,) and also bearings *b′ b′*, to receive and support the axes of the bell-crank levers G G′, (shown as Fig. 15,) the operation of which bell-crank levers will be hereinafter fully described. The bell-crank levers G G′, Fig. 15, are hung on the fixed arms B′ B′ by means of stud-pins passing through their axes, and the holes *b′ b′* to the arms G of these bell-crank levers. I attach one end of the links H H, the other ends of the links being fastened to the lugs I I on the inner surface of the periphery of the driving-pulley A. To the same arms, G, of these bell-crank levers I attach the equalizing-springs V′ V′, the opposite ends of these springs being fastened to lugs I′ I′ on the inner surface of the periphery of the driving-pulley in such position that the equalizing-springs V′ V′ will act against the links H H, as shown in Figs. 2 and 3. I also hang the bell-crank levers D D′, Fig. 14, on the fixed arms B′ B′ on stud-pins passing through their axes and the holes *b b*. I then couple the arms D of the bell-crank levers, Fig. 14, to the arms G′ of the bell-crank levers, Fig. 15, by means of jointed couplings, Fig. 16. I place the loose trunnion-sleeve C, Fig. 9, upon the main shaft T, so that the wings *c c* will pass into the slots $B^2$ $B^2$ in the fixed collar B, the fixed collar B being recessed out sufficiently to receive the trunnion-sleeve C, Fig. 9. This being so placed, the curved arms D′ of the bell-crank levers D D′, Fig. 14, engage at their ends *d* with the wings *c* on the trunnion-sleeve C at the points *c′ c′*.

Around the trunnion-sleeve C, behind the collar C′, I place the split trunnion-ring M, Fig. 10, the trunnions *m m′* thereon engaging the holes *n n′* in the yoke on the arm N of the bell-crank lever shown as Figs. 11 and 12, the axis *o′* of this bell-crank lever being hung upon a stud-pin passing through the hole *o* in the bracket O, Fig. 13, (which bracket O is fastened to the engine-frame.)

To the end of the arm P of the bell-crank lever N P, Figs. 11 and 12, I attach a connecting-rod, R, by a stud-pin, P′, which connecting-rod R extends to the throttle-valve *l′*

and piston-head $J^2$, working inside of the pressure-cylinder J.

Attached to the main steam-chest of the engine, and connected therewith by a suitable port, *l*, I construct an auxiliary steam or throttle-valve chest, J′, having attached thereto and communicating therewith a steam-pressure cylinder J (shown as Fig. 6.) To the auxiliary steam-chest J′, I connect the pipe for supplying steam from the boiler to the engine upon the connecting-rod R, which passes into the auxiliary steam-chest J′ through a stuffing-box, *j*. I fix a suitable valve, *l*′, for closing the port *l*, and within the pressure-cylinder J, I attach to the connecting-rod R a steam-tight piston-head, $J^2$, and on the end of the connecting-rod R, which passes through the cylinder J, I place a spiral spring, L, one end of which rests upon lugs or bosses *k k* (see Fig. 2) on the end of the pressure-cylinder J, and the other end of the spring L being secured by a collar and nut, K, upon the end of the connecting-rod R, so that the spring L can be tightened or loosened, as may be desired, to regulate the speed of the engine.

In operation the steam-pressure in the pressure-cylinder J, acting upon the piston $J^2$, tends to draw the valve *l*′ over the port *l* and close it, cutting off thereby the steam from the engine. This tendency, however, is resisted by the action of the governor on the main shaft of the engine, to which the valve *l*′ is connected by means of the mechanism heretofore described, the pressure of the steam on the piston $J^2$ tending to move the trunnion-ring out of the recess in the fixed collar B. However, the ends *d d* of the bell-crank levers D′ D, engaging the wings *c c*, as hereinbefore described, resist this movement of the trunnion C, and the strain of this is, by the system of levers and mechanism hereinbefore described, communicated directly to the driving-pulley A. It is therefore manifest that the strain of the load on the driving-pulley A acts directly upon the piston $J^2$ in the pressure-cylinder J, and at the same time also acting upon the cut-off valve *l*′. Therefore the greater the load applied to the driving-pulley A the more it overcomes the steam-pressure on the piston $J^2$, thereby opening the port *l* and admitting more steam, and the less the load applied to the driving-pulley the more the steam-pressure overcomes it, thereby closing the port *l*, and admitting the less steam. This action of the governor is caused by the tendency of the driving-pulley A to stop when an additional load is applied to it, and this tendency to stop acts upon the mechanism connected with the valve *l*′, opening it, and the load being decreased, vice versa, and by its automatic action in thus supplying steam to the engine the speed of the engine is at all times the same, regardless of changes in the load carried or the variations of the boiler-pressure. This action of the governor is instantaneous, a sudden increase of load at once opening the port so as to admit steam sufficient to equalize the load, and the throwing off the load producing the opposite effect.

In the construction and operation of my device the steam-pressure cylinder takes the place of and produces a similar effect to the weights and springs used in dynamo-governors for steam-engines, the steam-pressure on the piston $J^2$ acting as a cushion, against which the strain of the load on the driving-wheel A is constantly acting.

I regulate the speed at which the engine is to be run by tightening or loosening the spring L on the end of the pressure-cylinder J, as it is manifest that this spring acts with the steam-pressure on the piston-head $J^2$, and the greater the tension of the spring L the greater the tendency of the valve *l*′ to close the port *l*, and, vice versa, the less the tension the greater the effect of a given load on the driving-pulley A to open the port *l* and furnish an excess of steam, and correspondingly increasing the speed of the engine.

In Fig. 3 I have shown an alternative arrangement of a part of my governing mechanism. In this form of construction I put in a pair of tension-springs, V V, one end of which springs is attached to the fixed arms B′ B′ and the opposite ends to the arms of the driving-pulley A. In this form of construction the governor acts in all respects as that hereinbefore described, the tension-springs V V acting, however, with the steam-pressure in the pressure-cylinder J, to overcome the resistance of the load on the pulley A; and in constructing my governor in this form I can use a smaller pressure-cylinder than in case the springs V V are dispensed with; otherwise the operation of this form is the same as hereinbefore described.

In the foregoing description of my improvement I have described fully all its parts and their operation and the results attained. Portions of the mechanism herein described I have heretofore described and claimed in an application for a patent heretofore filed by me for improvements in governors for steam-engines. Therefore I do not claim, broadly, in this specification each and every part of the mechanism herein described; but

I do claim and desire to secure by Letters Patent of the United States—

1. In a steam-engine, a dynamic governor, in combination with a steam-pressure cylinder, said governor operating a throttle-valve in opposition to the pressure of the steam in said steam-pressure cylinder, as and for the purpose set forth.

2. A steam-pressure cylinder moving the throttle-valve of a steam-engine, in combination with and governed in its action by a dynamic governor actuated by the load upon the driving-pulley of said engine, substantially as and for the purpose set forth.

3. In a steam-engine, a dynamic governor, in combination with a steam-pressure cylin-

der, said steam-pressure cylinder receiving and sustaining the tension of the load upon the driving-pulley of said engine, said dynamic governor and steam-pressure cylinder operating together and governing the speed of the engine, substantially as and for the purpose set forth.

4. In combination with the main valve of a steam-engine, a throttle-valve controlling the supply of steam to the engine, said throttle-valve being moved in one direction by steam-pressure and in the opposite direction by a governor actuated by the engine, said steam-pressure and said governor operating together in opening and closing said steam throttle-valve, substantially as and for the purpose set forth.

5. A dynamic governor for steam-engines, consisting of the driving-pulley A, the fixed collar B, sustaining the fixed arms B′ B′, the bell-crank levers G G′ and D D′, hung upon the fixed arms B′ B′, and connecting the driving-pulley A with the trunnion-sleeve C, the trunnion-sleeve C, the bell-crank lever N P, and the connecting-rod R all operating together as described, in combination with the auxiliary steam-chest J′ and throttle-valve therein, l′, the steam-pressure cylinder J, and piston $J^2$, operating therein, and the regulating-spring L, all operating together substantially as and for the purpose set forth.

6. In a steam-engine, a dynamic governor actuated by the load carried by the engine moving the throttle-valve of said engine in one direction and a steam-pressure cylinder moving said throttle-valve in the opposite direction, in combination with an adjustable spring on said pressure-cylinder for adjusting the speed of the engine, and operating substantially as and for the purpose set forth.

In witness whereof I have hereunto set my hand.

LE GRAND SKINNER.

Witnesses:
J. C. STURGEON,
C. SWALLEY.