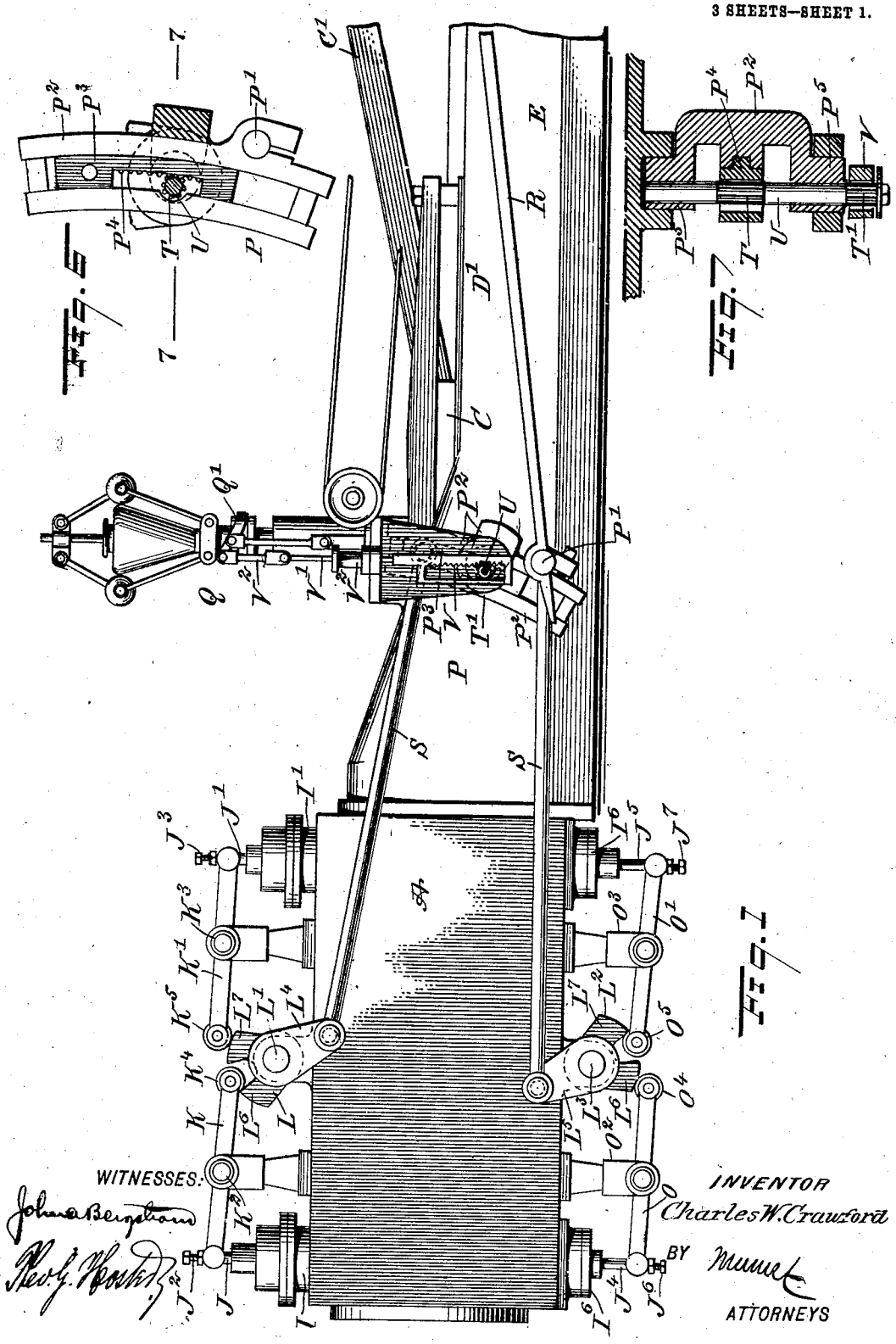
No. 833,583. PATENTED OCT. 16, 1906.

C. W. CRAWFORD.

VALVE GEAR FOR STEAM ENGINES.

APPLICATION FILED JULY 17, 1905.

3 SHEETS—SHEET 1.



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Fig. 2.

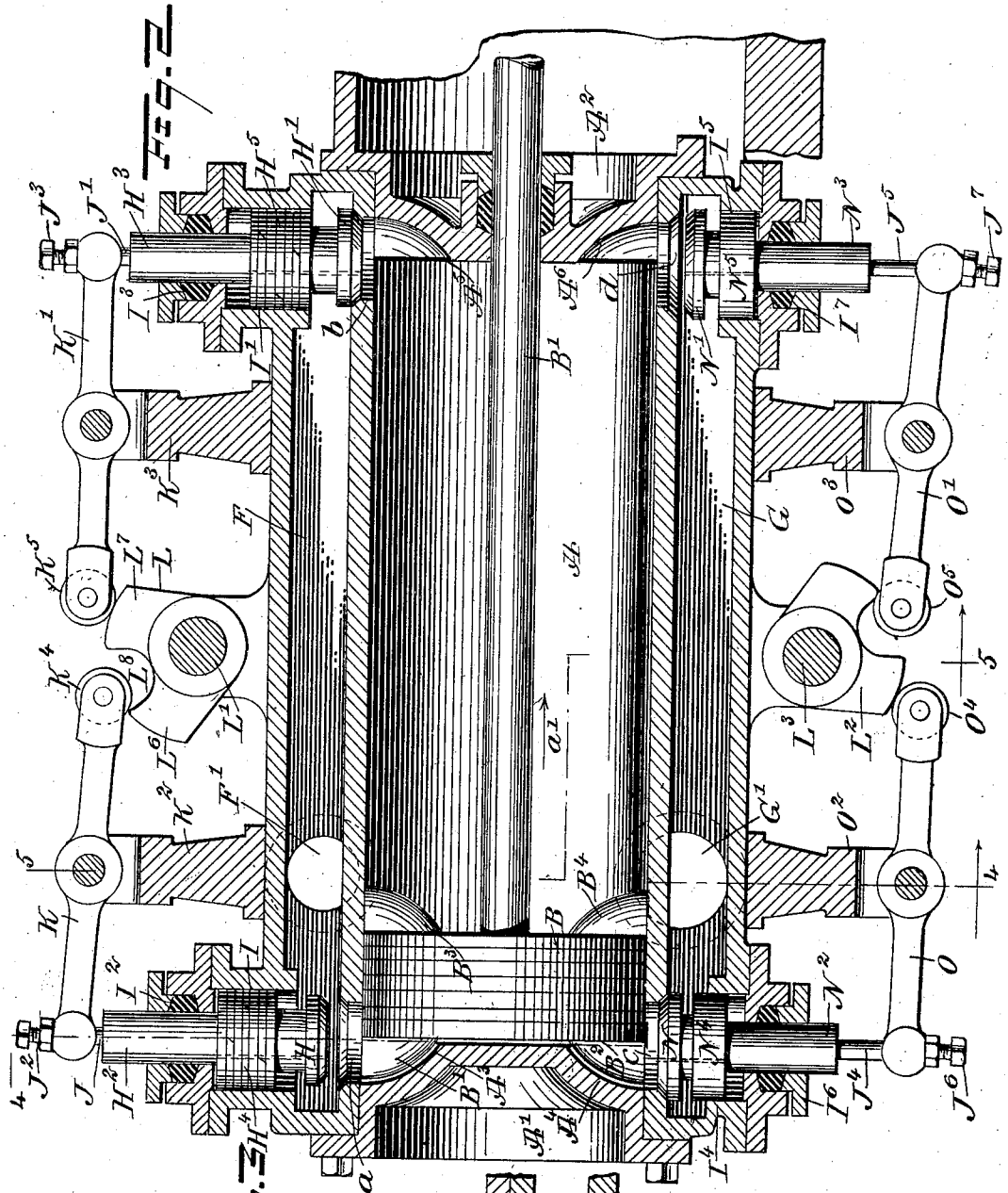
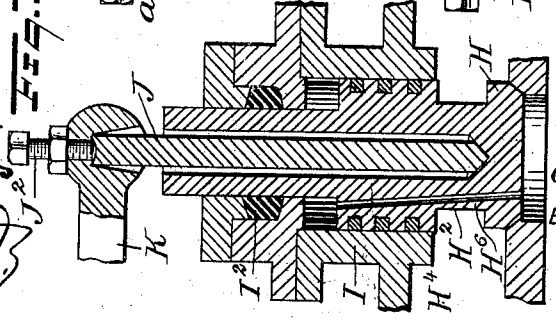


Fig. 3.



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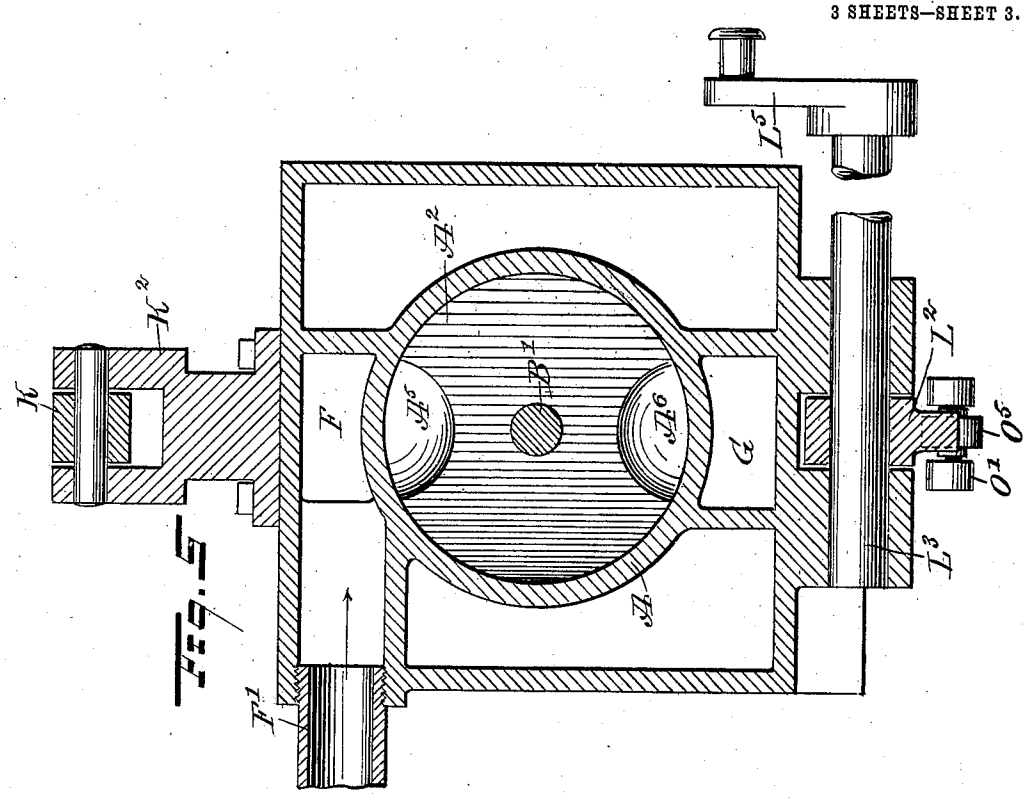


Fig. 5.

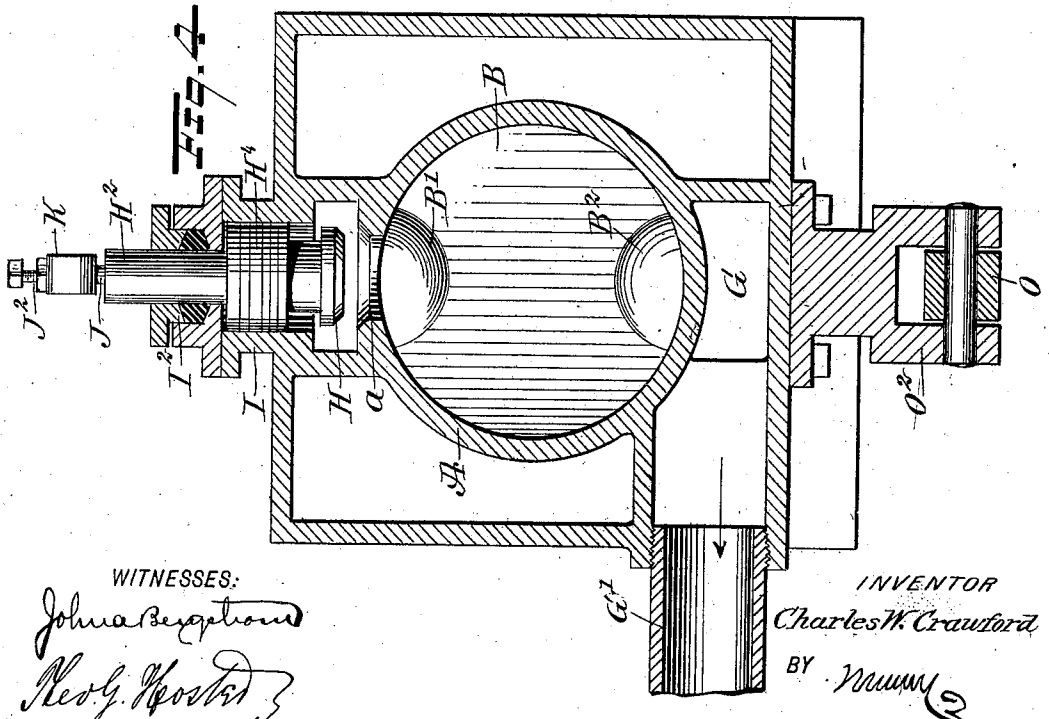


Fig. 4.

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UNITED STATES PATENT OFFICE.

CHARLES W. CRAWFORD, OF BRAZIL, INDIANA.

VALVE-GEAR FOR STEAM-ENGINES.

No. 833,583. Specification of Letters Patent. Patented Oct. 16, 1906.

Application filed July 17, 1905. Serial No. 270,092.

To all whom it may concern:

Be it known that I, CHARLES W. CRAWFORD, a citizen of the United States, and a resident of Brazil, in the county of Clay and State of Indiana, have invented a new and Improved Valve-Gear for Steam-Engines, of which the following is a full, clear, and exact description.

The object of the invention is to provide a new and improved valve-gear for steam-engines arranged to permit of running the engine at a high rate of speed, to insure a proper working of the inlet and exhaust valves without danger of undue wear, and to reduce to a minimum the clearance-space of the piston relative to the admission and exhaust ports.

The invention consists of novel features and parts and combinations of the same, which will be more fully described hereinafter and then pointed out in the claims.

A practical embodiment of the invention is represented in the accompanying drawings, forming a part of this specification, in which similar characters of reference indicate corresponding parts in all the views.

Figure 1 is a side elevation of the improvement. Fig. 2 is an enlarged longitudinal central section of the same. Fig. 3 is an enlarged sectional side elevation of one of the valves and connections. Fig. 4 is a cross-section of the improvement on the line 4 4 of Fig. 2. Fig. 5 is a similar view of the same on the line 5 5 of Fig. 2. Fig. 6 is an enlarged sectional side elevation of the link-motion; and Fig. 7 is a sectional plan view of the same, substantially on the line 7 7 in Fig. 6.

In the cylinder A of the engine reciprocates a piston B, having its piston-rod B′ connected with a cross-head C, mounted to slide on suitable guideways D, arranged on the bed E of the engine, and the said cross-head C is connected in the usual manner by a pitman C′ with the main or crank shaft of the engine. The cylinder A is provided at its ends with the usual inlet or admission ports *a* and *b* and with the outlet or exhaust ports *c* and *d*, of which the admission-ports *a* and *b* open into a steam-chest F, connected by a pipe F′ with a boiler or other steam-generator. The exhaust-ports *c* and *d* open into an exhaust-chest G, from which leads an exhaust-pipe G′ for conducting the exhaust-steam from the engine to a suitable place of discharge.

The admission-ports *a* and *b* are adapted to be closed and opened by valves H and H′, adapted to be seated on the said ports from within the steam-chest F, and the reduced trunks or stems H^2 and H^3 of the said valves H and H′ are provided with pistons H^4 and H^5, mounted to reciprocate in cylinders I and I′, opening at their inner open ends into the steam-chest F, as plainly shown in Fig. 2, so that steam-pressure is at all times against the under side of the said pistons H^4 and H^5 to move the same outward, thus moving the valves H and H′ off their seats through the medium of the pressure of the motive agent, or, in other words, the valves H and H′ are moved into an open position by the pressure of the motive agent. The outer ends of the stems H^2 and H^3 pass through stuffing-boxes I^2 and I^3, held on the cylinder-heads for closing the outer ends of the cylinders I and I′, and the said stems H^2 and H^3 are preferably recessed, as plainly indicated in Fig. 3, for the reception of pins J and J′, seated at their inner ends in the bottoms of the said recesses and seated at their outer ends on set-screws J^2 and J^3, screwing in the ends of rocking levers K K′, mounted to rock on brackets K^2 K^3, attached to the top of the steam-chest F, as plainly indicated in the drawings. The outer ends of the levers K K′ are recessed for the free reception of the outer ends of the pins J J′, as plainly shown in Fig. 3. The levers K and K′ extend toward each other, and their inner or adjacent ends are provided with friction-rollers K^4 K^5 in peripheral engagement with a cam L, secured on a rock-shaft L′, extending transversely and journaled in suitable bearings attached to the top of the steam-chest F between the brackets K^2 and K^3.

When the cam L is rocked, its peripheral surface remains in contact at all times with the friction-rollers K^4 and K^5, and the said cam is arranged to actuate the levers K and K′, with a view to cause the pins J and J′ to act on the valves H and H′ and their pistons H^4 and H^5 to move the same inward until the valves H and H′ are seated on their seats, hence closing the ports *a* and *b*. Thus by the arrangement described the valves H and H′ are opened by pressure of the motive agent and are closed by mechanical contrivances. It is understood that the valves H and H′ are in the form of puppet-valves, having the pistons H^4 and H^5 rigidly attached thereto to balance the valves, and the latter are also provided with the trunks H^2 and H^3, open at their outer ends to the atmosphere for the

purpose of providing an upward pressure when the valves are open. It will also be noticed that owing to this upward pressure after the valve is opened the latter is perfectly balanced, and it requires but the trunk area to gain sufficient pressure to hold the valve open forcibly against its lever and cam to prevent noise.

The exhaust-ports *c* and *d* are adapted to be closed and opened by valves N and N′, carrying on their stems N^2 N^3 pistons N^4 and N^5, mounted to slide in cylinders I^4 and I^5, opening with their inner ends into the exhaust-chest G. The outer ends of the stems N^2 and N^3 extend through stuffing-boxes I^6 and I^7, arranged on the heads for closing the outer ends of the cylinders I^4 and I^5, and the said stems N^2 and N^3 are recessed for the reception of pins J^4 and J^5, engaged at their outer ends by set-screws J^6 and J^7, held on levers O and O′, extending through each other and fulcrumed on brackets O^2 and O^3, attached to the exhaust-chest G. The adjacent ends of the levers O and O′ carry friction-rollers O^4 and O^5, in peripheral contact with a cam L^2, secured on a rock-shaft L^3, journaled in suitable bearings attached to the exhaust-chest G.

By the arrangement described the exhaust-steam in the cylinder A acts on the valves N and N′ to push the same into an open position to allow the exhaust-steam to pass from the cylinder A by way of the corresponding ports *c* and *d* into the exhaust-chest G, from which the steam can escape through the exhaust-pipe J′. The cam L^2 acts on the levers O and O′ so as to close the valves N and N′ at the proper time—that is, the said valves N and N′ are positively closed by mechanical contrivances, but are opened by pressure of the exhaust-steam.

In each of the valves H and H′ and pistons H^4 and H^5 is a by-pass H^6 (see Fig. 3) to allow steam to pass from the closed ends of the cylinders I and I′ to the under sides of the valves H and H′, thus permitting proper working of the pistons H^4 and H^5 in the said cylinders I and I′. Similar by-passes are arranged in the valves N and N′ and pistons N^4 and N^5 for the same purpose.

The rock-shafts L′ and L^3, carrying the cams L and L^2, are rocked from a link-motion P, controlled from a governor Q, and actuated from the engine-shaft by the usual eccentric and eccentric-rod R, engaging a stud P′ on the link P^2 of the link-motion. A link-block P^3, mounted to slide in the link P^2, is connected by a link S with a crank-arm L^4 on the crank-shaft L′, and the stud P′, previously mentioned, is connected by a link S′ with the crank-arm L^5, held on the rock-shaft L^3. On the link-block P^3 is formed or secured a segmental rack P^4, in mesh with a pinion T, secured on a shaft U, journaled eccentrically in the trunnions P^5 of the link P^2, the said trunnions being journaled on the bed E of the engine to allow the link P^2 to rock by the action of the main shaft-eccentric and its eccentric-rod R. On the shaft U is secured a second pinion T′, in mesh with a rack V, disposed vertically and having a stem V′, mounted to slide in suitable bearings V^2, secured to the bed E. The stem V′ is connected by a link V^2 with the lever Q′ of the governor Q, so that when the engine runs at a rate of speed beyond the normal rate of speed then the rack V is caused to slide downward by the action of the lever Q′, link V^2, and rod V′, and the said rack V in its downward movement turns the pinion T′, and consequently the shaft U, whereby the pinion T causes the rack P^4 to slide downward to move the link-block P^3 nearer the axis of the trunnions P^5, thus diminishing the stroke given to the crank-arm L^4 by the link S. Reducing the stroke of the crank-arm L^4 causes a corresponding reduction in the rocking of the cam L, so that the valves H and H′ remain closed for a longer period, and consequently less steam is admitted to the cylinder A until the speed of the engine is reduced to a normal rate of speed. In a like manner when the engine is running below the normal rate of speed then the governor Q causes the lever Q′ to swing in the reverse direction—that is, to move the rack V upward—whereby the shaft U is turned in a reverse direction and the block P^3 is moved farther away from the axis of the trunnions P^5, and consequently the stroke of the block P^3 is increased, and likewise that of the crank-arm L^4, with a view to keep the valves H and H′ longer in an open position for the admission of more steam at each revolution of the main shaft.

The pitch-line of the two pinions T and T′ and racks P^3 and V coincides with the center of the trunnions P^5 to allow proper rocking of the link P^2 and an up-and-down sliding motion of the rack V and the link-block P^3 and its segmental rack P^4.

As illustrated in the drawings, each cam L and L^2 is provided with two arms L^6 and L^7 and an intermediate cut-out portion L^8. Now when an arm L^6 or L^7 of the cam L engages the corresponding friction-roller K^4 or K^5 then the valve H or H′ is held in a closed position; but when the friction-roller K^4 or K^5 travels into the cut-out portion L^8 then the motive agent pressing against the pistons H^4 and H^5 causes the valves H and H′ to move into an open position. The cam L^2 is similarly constructed and the admission-valves N and N′ operate similarly to the admission-valves H and H′, so that further description of the same is not deemed necessary.

The action of the exhaust-valves N N′ is not affected by the governor Q, as the levers O O′ are uniformly rocked, for the cam L^2 inlet in turn secures a uniform rocking motion from the link P^2 by the link S′.

The cylinder-heads A′ and A^2 are provided

adjacent to the ports *a c* and *b d* with cut-out portions A^3 A^4 and A^5 A^6, respectively, of which the recesses A^3 and A^4 are adapted to be engaged by offsets B′ and B^2, formed on the outer face of the piston B, and the recesses A^5 and A^6 are adapted to be engaged by offsets B^3 and B^4, formed on the inner face of the piston B. By the arrangement described the piston B when moving into an outermost position, as shown in Fig. 2, moves with its offsets B′ and B^2 into the recesses A^3 and A^4, thus reducing the clearance-space between the piston and the cylinder-head A′ to a minimum, and in a like manner when the piston B moves to the end of its inward stroke the offsets B^3 and B^4 pass into the recesses A^5 and A^6. Thus in either case the clearance between the piston B and the corresponding head A′ or A^2 is reduced to a minimum, and at the same time full provision is had for a full passage of the steam into the cylinder A by way of the ports *a* and *b* and the corresponding recesses A^3 and A^5. In a like manner a complete unobstructed exhaust is had from the cylinder A by way of the recesses A^4 A^6 and the ports *c* and *d* whenever the valves N and N′ are opened.

The operation is as follows: When the several parts are in the position as illustrated in Fig. 2, then the valves H′ and N are held in a closed position by the mechanical means previously described, while the valve H is held in an open position by the action of the motive agent in the steam-chest F, and the valve N′ is held open by the action of the exhaust-steam from the cylinder A. The motive agent from the steam-chest F passes by way of the port *a* into the outer end of the cylinder A and acts on the piston B therein to push the latter on its inward stroke in the direction of the arrow *a′*, it being understood that during this movement of the piston B the link-motion P causes the cams L and L^2 to rock, so that the valve H is positively closed to cut off the steam at the desired length in the stroke of the piston B. In a like manner the valve N′ is closed when the piston B reaches the end of its stroke, and then the valve H′ is opened by the pressure of the steam from within the steam-chest F, while the valve N is opened by the pressure of the exhaust-steam in the outer end of the cylinder A. The motive agent in the steam-chest F now passes by way of the port *b* into the inner end of the cylinder A to act on the piston B therein, with a view to send the piston B on the return or outward stroke in the inverse direction of the arrow *a′*.

Having thus described my invention, I claim as new and desire to secure by Letters Patent—

1. A steam-engine provided with a cylinder, a chest connected by a port with the said cylinder, a puppet-valve adapted to be seated in the said port and having a trunk extending to the outside of the said chest, means for opening the said valve by pressure of the steam, and mechanical means engaging the said valve by way of the said trunk for holding the valve to its seat against the pressure of the steam.

2. A steam-engine provided with an admission-valve for controlling the admission of the steam to the engine-cylinder, the said valve having a piston and a trunk, the piston and the valve being subjected to pressure of the steam to open the valve by pressure of the steam, the said trunk being subjected to atmospheric pressure and means for closing the said valve.

3. A steam-engine provided with an admission-valve for controlling the admission of the steam to the engine-cylinder, the said valve having a piston and a trunk, the piston and the valve being subjected to pressure of the steam to open the valve by pressure of the steam, the said trunk being subjected to atmospheric pressure, and mechanical means engaging the said valve by way of the said trunk to close the valve.

4. A steam-engine provided with a cylinder, a steam-chest connected by a port with the said cylinder, a valve adapted to be seated on the said port and having a trunk extending to the outside of the said steam-chest, a piston rigidly connected with the said valve, and an auxiliary cylinder opening at its inner end into the said steam-chest and in which reciprocates the said piston, the pressure of the steam exerted against the said piston causing the latter to move to open the valve by the pressure of the steam.

5. A steam-engine provided with a cylinder, a steam-chest connected by a port with the said cylinder, a valve adapted to be seated on the said port and having a trunk extending to the outside of the said steam-chest, a piston rigidly connected with the said valve, an auxiliary cylinder opening at its inner end into the said steam-chest and in which reciprocates the said piston, the pressure of the steam exerted against the said piston causing the latter to move to open the valve by the pressure of the steam, and mechanical means engaging the said valve by way of the said trunk to move the piston and the valve inward against the pressure of the steam and to seat the said valve.

6. A steam-engine provided with a cylinder, a steam-chest connected by a port with the said cylinder, a valve adapted to be seated on the said port and having a trunk extending to the outside of the said steam-chest, a piston rigidly connected with the said valve, an auxiliary cylinder opening at its inner end into the said steam-chest and in which reciprocates the said piston, the pressure of the steam exerted against the said piston causing the latter to move to open the valve by the pressure of the steam, a rocking lever having

a loose connection with the said valve by way of the trunk, and a rocking cam in engagement with the said lever to move the valve to its seat and to allow the valve to open by pressure of the steam against the said piston.

7. A steam-engine provided with a cylinder, a steam-chest connected by a port with the said cylinder, a valve adapted to be seated on the said port and having a trunk extending to the outside of the said steam-chest, a piston rigidly connected with the said valve, an auxiliary cylinder opening at its inner end into the said steam-chest and in which reciprocates the said piston, the pressure of the steam exerted against the said piston causing the latter to move to open the valve by the pressure of the steam, a rocking lever, a pin connecting the outer end of the said lever with the said valve by way of the said trunk, and a rocking cam having an arm and a recess, of which the said arm is adapted to act on the inner end of the said lever to move the valve to its seat, and the said recess permits the lever to rock freely to allow the said valve to move off its seat by pressure of the steam against the said piston.

8. A steam-engine provided with a cylinder, a steam-chest connected by a port with the said cylinder, a valve adapted to be seated on the said port and having a trunk extending to the outside of the said steam-chest, a piston rigidly connected with the said valve, an auxiliary cylinder opening at its inner end into the said steam-chest and in which reciprocates the said piston, the pressure of the steam exerted against the said piston causing the latter to move to open the valve by the pressure of the steam, and a by-pass in the said valve and piston to connect the outer end of the auxiliary cylinder with the under face of the valve.

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

CHARLES W. CRAWFORD.

Witnesses:
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