(No Model.) 3 Sheets—Sheet 1.

D. ASHWORTH.

VALVE GEAR FOR STEAM ENGINES.

No. 470,343. Patented Mar. 8, 1892.

Fig. 1.

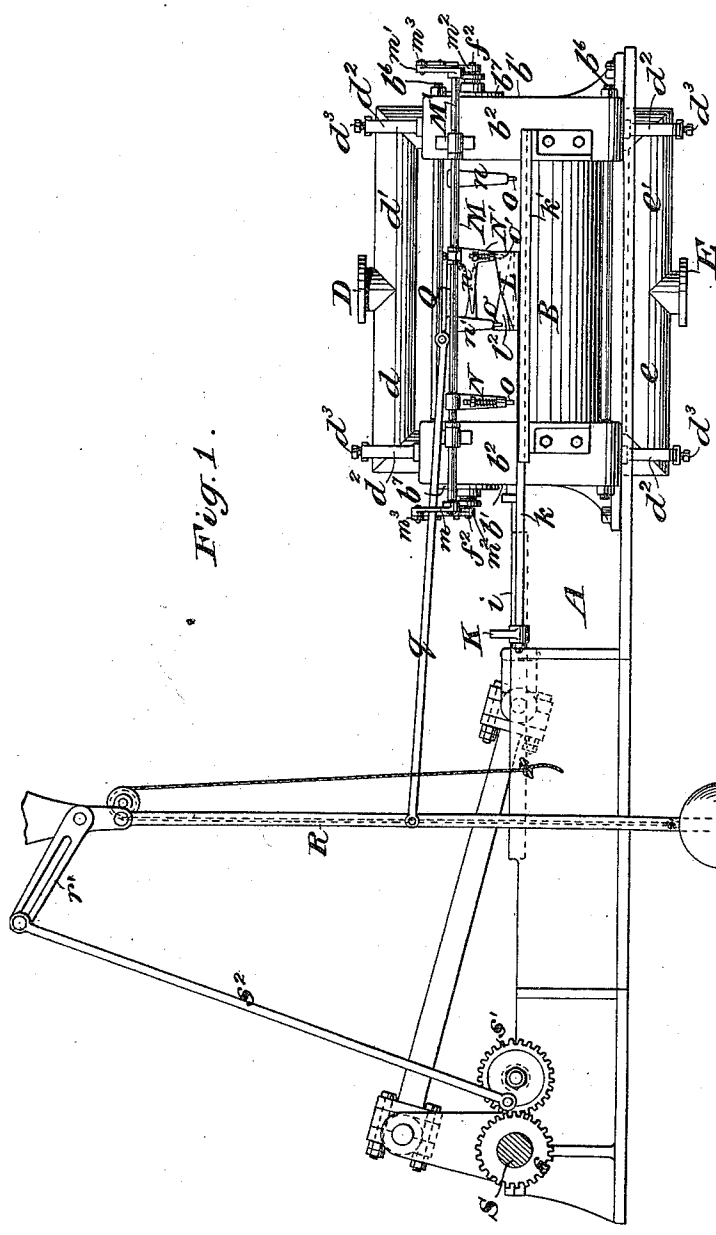
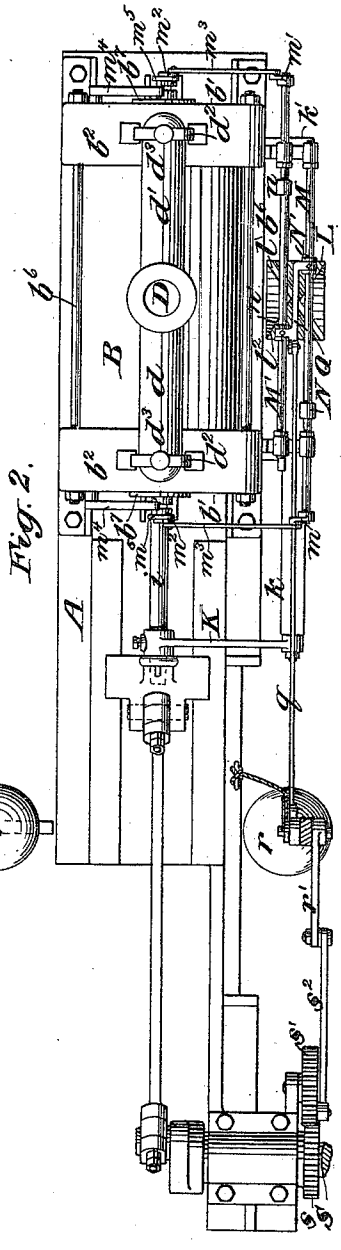


Fig. 2.



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(No Model.) 3 Sheets—Sheet 2.

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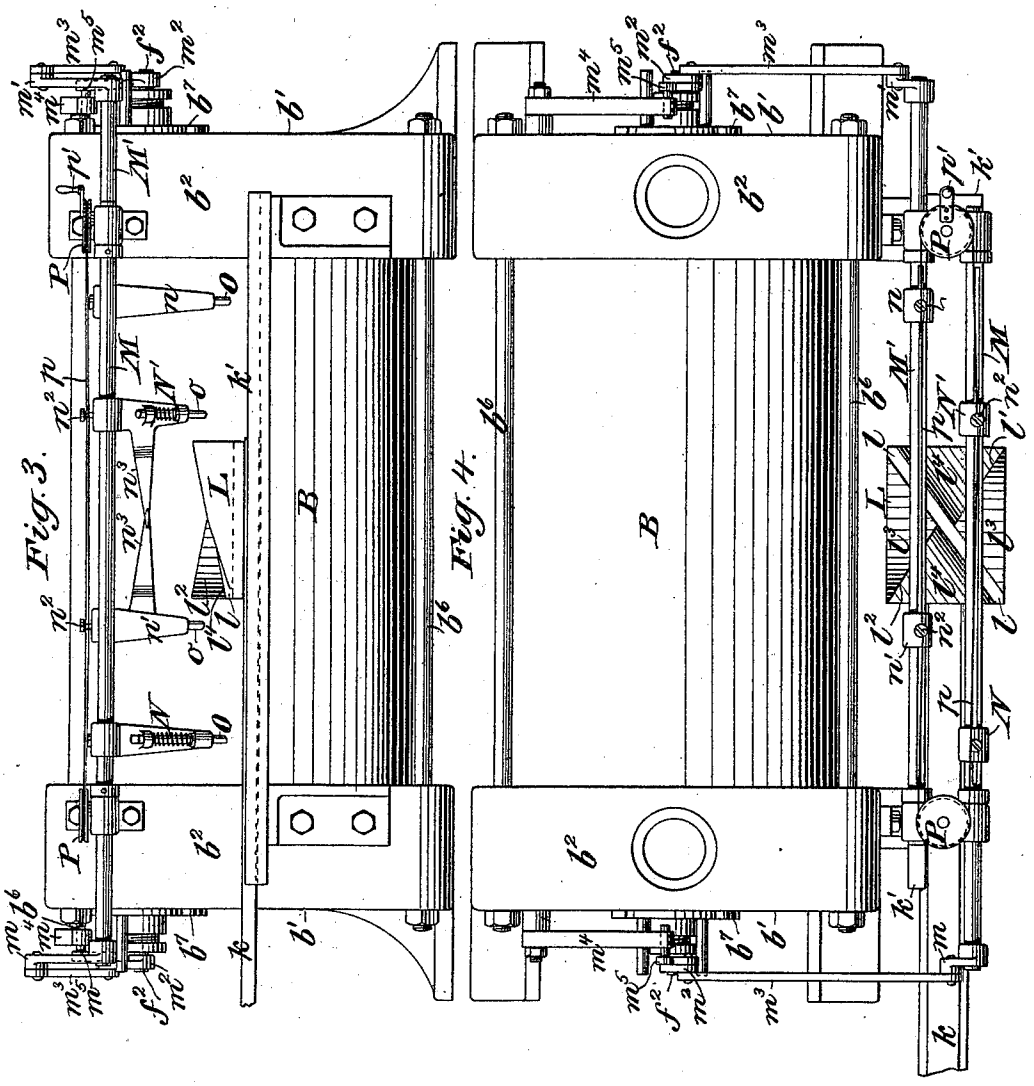

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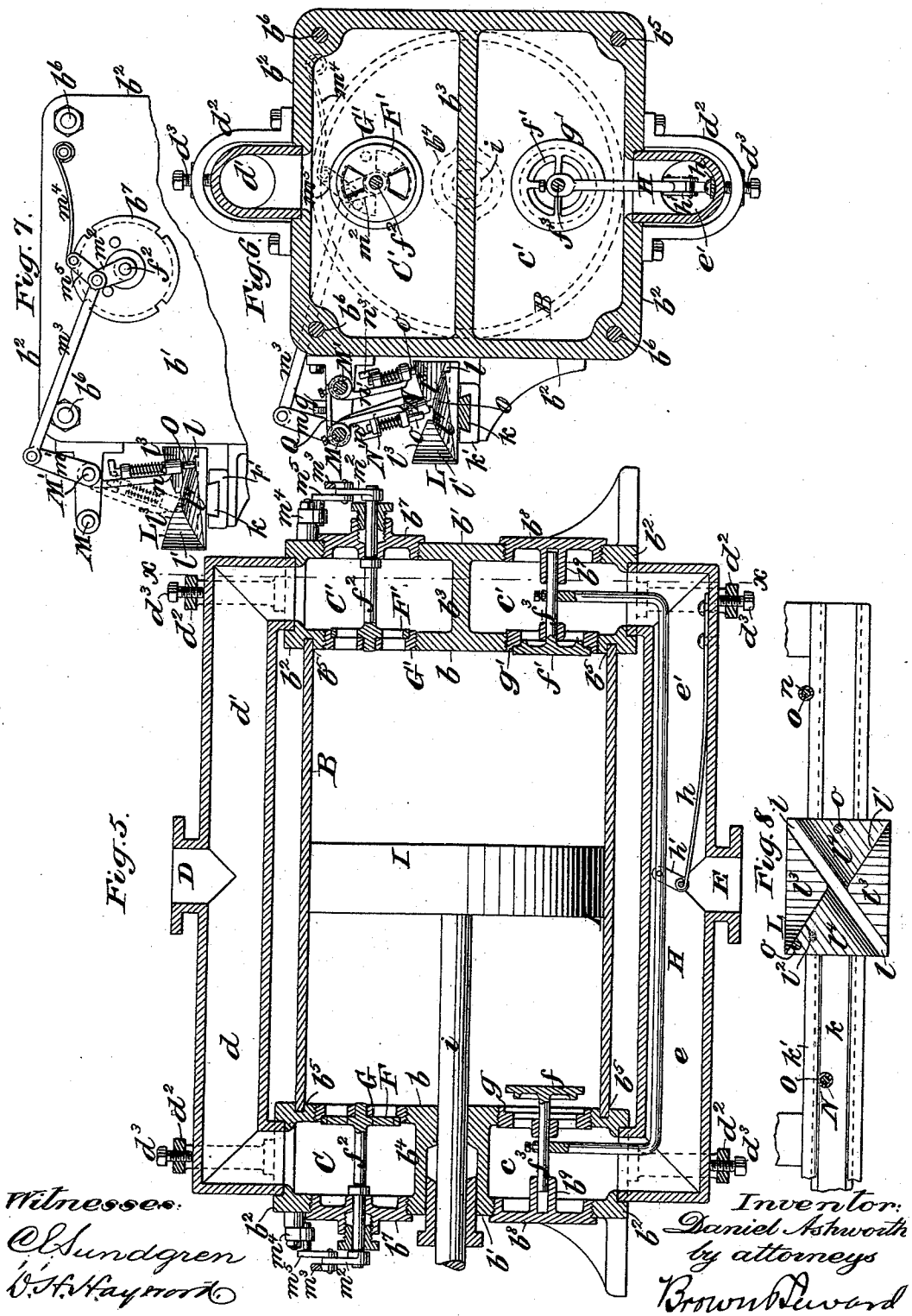

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UNITED STATES PATENT OFFICE.

DANIEL ASHWORTH, OF WAPPINGER'S FALLS, NEW YORK.

VALVE-GEAR FOR STEAM-ENGINES.

SPECIFICATION forming part of Letters Patent No. 470,343, dated March 8, 1892.

Application filed May 4, 1891. Serial No. 391,463. (No model.)

To all whom it may concern:

Be it known that I, DANIEL ASHWORTH, of Wappinger's Falls, in the county of Dutchess and State of New York, have invented a new and useful Improvement in Valve-Gear for Steam-Engines, of which the following is a specification.

My invention relates to an improvement in valve-gear for steam-engines in which the valves are located at the ends of the cylinder and are actuated by means of a cam which has a sliding movement, together with the piston, the effect of the cam being transmitted to the valves through suitable crank-arms and rock-shafts.

A practical embodiment of my invention is represented in the accompanying drawings, in which—

Figure 1 is a view of an engine in side elevation, showing the valve-gear in position as in use. Fig. 2 is a top plan view of the same. Fig. 3 is an enlarged view, in side elevation, of the cylinder and the valve-gear in proximity thereto. Fig. 4 is a top plan view of the same. Fig. 5 is a vertical longitudinal section through the cylinder steam-chest, steam and exhaust inlets, and valves. Fig. 6 is a transverse section through the steam-chests at one end of the cylinder, the view being taken upon line x x of Fig. 5. Fig. 7 is a partial end elevation of the cylinder-head; and Fig. 8 is a top plan view in detail of the valve-operating cam, its support, and operating-bar.

A represents the bed-frame of the engine, which may be of any well-known or suitable form adapted to the purpose.

The cylinder is represented by B and may consist of a piece of plain tubing of suitable length, the heads of the cylinder being formed by hollow structures, in which are formed the steam-chambers for the reception of the live and exhaust steam. The inner faces of the cylinder-heads are represented by b and the outer faces by b', the inner and outer faces being united by a rim portion b^2 and also by partition-webs b^3 and b^4, the former simply forming a division between the live and exhaust steam chambers, while the latter is thickened sufficiently to form a bearing for the piston-rod and the suitable stuffing-box through which the piston-rod extends. The inner faces b of the cylinder-heads are provided with annular grooves b^5 for the reception of the ends of the tubular cylinder B, and the said heads and cylinder are held in assembled adjustment by means of draw-bolts b^6, which extend through the opposite heads at points exterior to the cylinder B.

The steam-chambers for the reception of the live steam are denoted by C and C', one located at each end of the cylinder, and the exhaust-chambers are denoted by c and c', also located one at each end of the cylinder.

Steam is admitted to the two steam-chambers through a common inlet-pipe D, having branches d and d', the one communicating with the steam-chamber C and the other with the steam-chamber C', the said common inlet and branch pipes being conveniently held in position by means of U-shaped brackets d^2, bolted to the cylinder-heads and provided with set-screws d^3, seated in the crowns of the brackets and adapted to bear against the branch pipes d and d' at the point where they extend within the brackets.

A common exhaust E connects by means of branch pipes e and e' with the exhaust-chambers c and c', and is secured to the cylinder-heads in a manner quite similar to that just described with respect to the common steam-inlet and its branches.

The inner walls of the cylinder-heads are each provided with a steam-inlet and steam-exhaust valve, the former being of the rocking or register type and denoted by F and F' and the latter being of the puppet type and denoted, respectively, by f and f'. The valves F and F' are seated in suitable removable seats G and G', (shown in the present instance as screwed into the inner walls of the cylinder-heads,) the valve-stems f^2 extending outwardly through suitable bearings in removable hand-hole covers b^7 (also shown herein as screwed into the outer walls of the cylinder-heads) and provided with suitable stuffing-boxes. The puppet-valves f f' are provided with suitable seats g g', removably secured to the inner walls of the cylinder-heads, and their stems f^3 have a sliding movement in suitable sockets b^9, formed in hand-hole covers b^8, removably secured in the outer walls of the cylinder-heads. The valves f and f' open inwardly and are intended to be oper-

ated by the piston as it nears the end of its stroke. The said valves are yoked together by means of a rod H, which is fastened at its opposite ends to the valve-stems f^3 and extends from one to the other through the exhaust-pipe e e'. The connection is such that when one of the said valves is closed it will force the opposite valve open, and vice versa. In order to assist the completion of the throw of the valves f and f' and to hold them in their respective adjustments, one open and the other closed, I provide a bar-spring h, fixed at one end to the inner face of one of the branch pipes e e' and connected at its opposite end with the bar H by means of a link h', the tension of the spring being at all times exerted toward the bar H and the point of connection of the link with the bar H bearing such a relation to its point of connection with the end of the spring h that the link will be thrown past center shortly after the valves have been started in either direction, the pressure of the spring after the said link has been thrown past center tending to complete the throw of the bar H in the direction in which it is at the time moving.

The piston is represented by I and its rod by i. The laterally-extending arm K is fixed to the piston-rod i at a suitable point beyond the head of the cylinder, the said arm having fixed to its outer end a cam-operating bar k, the latter being seated in a suitable guideway k', fixed to the cylinder-heads or to any other suitable support in proximity to the side of the cylinder. To the bar k there is fixed the valve-operating cam L, which, together with the bar k, is caused to travel along the guideway k' in unison with the movement of the piston and its rod. The cam L (shown clearly in Fig. 8) is provided with a diagonal groove l, vanishing at its opposite corners, and with ledges forming abrupt shoulders l' l^2, extending in a direction diagonally across the groove l. The faces l^3 of the cam rise from the opposite sides of the cam gradually up to the abrupt shoulders l' l^2, being higher at the outer ends of said shoulders. The faces l^4 of the cam rise gradually from the opposite ends of the cam up to the point where the shoulders l' and l^2 meet the sides of the groove l. The purposes of the groove l and the several faces of the cam L will be more fully explained further on.

Seated in suitable supports above the sliding cam L are rock-shafts M and M', the former for operating the steam-inlet valve F and the latter for operating the steam-inlet valve F'. The shafts M and M' are provided, respectively, with crank-arms m and m', which latter are connected with crank-arms m^2, fixed to the valve-stems f^2, by connecting-rods m^3. Bar-springs m^4, fixed at one end to the cylinder-heads, have their free ends connected with the crank-arms m^2 on the valve-stems by means of links m^5 (see Fig. 7) in a manner and for a purpose quite similar to that shown and described with respect to the spring h for completing the throw of the exhaust-valves.

Each of the rock-shafts M and M' is provided with a pair of tappets, those on the former being denoted by N N' and those on the latter being denoted by n and n'. The two tappets upon each shaft are for the purpose of opening and closing the steam-inlet valves as the piston makes its strokes in each direction. Each of the tappets is provided with a spring-actuated plunger, which extends below the end of the fixed portion of the tappet sufficiently to engage the cam L as the latter is slid back and forth on its guide. The spring-actuated plungers for the tappets N and n, which effect the opening of the valves, are represented by O, while those in connection with the shorter tappets N' and n' for effecting the cut-off are represented by o. The tappets for opening the valve to admit steam are here located near the ends of the stroke of the cam L, and their engagement with the cam L is as follows:

Suppose the cam L, as represented in Figs. 3, 4, and 5, to be moving toward the left, the valve F' being full open. As the cam L reaches the tappet n' the shoulder l^2 will engage it, and thereby rock the shaft M' over sufficiently to throw the link m^5 past center, and thereby cause the closure of the valve F' under the action of the spring m^4. As the cam L nears the limit of its stroke toward the left the plunger on the tappet N will ride up the inclined face l^4 of the cam L, finally engaging the shoulder l^2 and being thereby moved to one side before it reaches the groove l sufficient to partially open the valve F and admit steam into that end of the cylinder to cushion the piston in that direction. As soon, however, as the piston starts on its return stroke, the plunger O of the tappet N, having now dropped into the groove l in the cam, will ride along said groove out to the left-hand corner of the same, and in so doing will throw the valve F full open. In this position it will remain until the said cam L engages the plunger of the cut-off tappet N', which by its engagement with the shoulder l' on the cam will throw the valve sufficient to carry the link m^5 past center in the opposite direction, and so close the valve F and cut off the steam from that end. The cam L will then engage the plunger of the tappet n, and will first partially and then fully open the valve F' at that end of the cylinder in the same manner as that already described with respect to the valve F.

From the above arrangement it follows that the nearer the cut-off tappets N' n' are located to their respective valve-opening tappets N and n the sooner will the cut-off occur after the opening of the valve. In order to regulate this to suit the different speeds at which it may be desirable to run the engine, I have secured the tappets N' and n' to their respective shafts in such a manner that they may be slid and adjusted toward and away from the tappets N and n. Their adjustment

may either be made by hand and the said adjustable tappets fixed in their adjusted positions, as shown in Figs. 3 and 4, or they may be adjusted by means of a governor, as shown in Figs. 1 and 2.

When it is intended to adjust by hand, I find it convenient to provide pulleys P, located one at each end of the cylinder above the rock-shafts M and M′, and pass a band *p* around the said pulleys, connecting one part of it to one of the cut-off tappets and the other part to the other cut-off tappet, so that when the band is caused to travel by the rotation of one of the pulleys in one direction it will slide the said cut-off tappets simultaneously toward their respective valve-opening tappets to effect an earlier cut-off and when moved in the opposite direction will slide the said cut-off tappets away from their respective valve-opening tappets, and thereby cause a later cut-off. The belt may be operated by means of a crank *p′*, attached to one of the pulleys P, and the cut-off tappets may be secured in their positions in which they have been for the time being adjusted by means of set-screws n^2. Where the said cut-off tappets are operated by means of a governor, they are connected by means of a suitable bar Q, (see Fig. 2,) so as to be simultaneously slid, and the bar Q is connected by a rod *q* with the governor. I have shown in the present instance a pendulum-governor R, the ball *r* of which may be raised up or down along the pendulum-rod to shorten or lengthen the pendulum to cause it to vibrate in unison with the predetermined speed of the engine. The means which I have employed in the present instance to communicate the motion of the engine to the pendulum-governor consists in a spur-wheel *s*, fixed to the engine-shaft and geared with a crank-wheel *s′*, connected with a slotted arm *r′* on the pendulum-rod by means of a link or connecting-rod s^2. The pendulum being set to vibrate naturally in unison with the rotation of the engine-shaft when the engine is running at the desired speed, it follows that if the engine shall run faster than the desired speed it will accelerate the strokes of the cam, so as to cause an earlier cut-off by the cam passing the cut-off tappets nearer to their respective valve-opening tappets at each end of the stroke, while if the engine run too slow the said cut-off tappets will be passed farther from the valve-opening tappets to cut off later.

For the purpose of lifting the spring-actuated plungers O on the valve-opening tappets, so that they may escape from the groove *l* in the cam and not open or but partially open and quickly close the valve under the impulse of the springs m^4 without traveling to the ends of the said groove in the cam when the cut-off tappets are adjusted quite near the valve-opening tappets, I provide bevel-faced arms or tongues n^3, fixed to the cut-off tappets N′ and *n′*, so as to take under the heads of the plungers O and lift them a slight distance above their normal positions.

What I claim is—

1. The combination, with a tubular cylinder having hollow heads in which are formed the steam-chambers for the reception of live and exhaust steam and suitable steam-inlet and steam-exhaust pipes connected, respectively, with the live-steam chambers at each end and the exhaust-steam chambers at each end, of valves opening from the live-steam chambers into the opposite ends of the cylinder, valves opening from the exhaust-steam chambers at the opposite ends of the cylinder, a rigid connection between said valves, whereby they are simultaneously operated, and means for operating the valves, substantially as set forth.

2. The combination, with the tubular cylinder, hollow cylinder-heads provided with live-steam chambers and exhaust-steam chambers, and conduits leading from a common steam-inlet to the live-steam chambers at each end of the cylinder and from a common exhaust-outlet to the exhaust-steam chambers at the opposite ends of the cylinder, of rotary disk-valves for opening and closing communication between the live-steam chambers and the ends of the cylinder, puppet-valves for opening and closing communication between the exhaust-steam cylinders and the opposite ends of the cylinder, a connection between the puppet-valves by which they are caused to move in unison, the said connection being through the exhaust-steam chambers and exhaust-conduits, and means for operating the rotary steam-inlet valves, substantially as set forth.

3. The combination, with the puppet-valves at the opposite ends of the cylinder and the connection which unites them and causes them to move in unison, of a spring having a loose connection with the bar or rod connecting the valves, whereby the said valves are thrown under the tension of the spring in the direction to complete their stroke and are held in their position until positively operated in the opposite direction, substantially as set forth.

4. The combination, with the valves for admitting live steam to the opposite ends of the cylinder and rock-shafts each connected with one of said valves, of the piston and its rod, a cam having a sliding movement in unison with the piston, and connections between the rock-shafts and the cam, whereby the movement of the cam will alternately rock the shafts and thereby operate the valves, substantially as set forth.

5. The combination, with the valves for admitting live steam to the cylinder and rock-shafts connected with the valves to operate them, of tappets on the rock-shafts, and a cam having a sliding movement in unison with the piston and provided with faces and shoulders adapted to engage the tappets and thereby alternately rock the shafts in a direction to open and close the said valves at the opposite

ends of the cylinder, substantially as set forth.

6. The combination, with the valves for admitting live steam to the opposite ends of the cylinder and rock-shafts connected with the valves, one with each, of a cam having shoulders and inclined faces and having a sliding movement in unison with the piston, and tappets engaged with the rock-shafts and provided with spring-actuated plungers adapted to engage the shoulders and faces of the cam and thereby rock the shafts to open and close the valves, substantially as set forth.

7. The combination, with the valves for admitting live steam to the opposite ends of the cylinder and rock-shafts connected with the valves to operate them, of a cam having a sliding movement in unison with the piston, tappets fixed on the rock-shafts, one on each, in position to engage the cam and open the valves, and tappets having a sliding adjustment on the rock-shafts, one on each, in position to engage the cam and close the valves, substantially as set forth.

8. The combination, with the valves for admitting live steam to the opposite ends of the cylinder and the rock-shafts for operating the valves, of a cam having a sliding movement in unison with the piston, tappets engaged with the rock-shafts for opening and closing the valves, the tappets for closing the valves having a sliding adjustment toward and away from the tappets for opening the valves, and a governor connected with the adjustable tappets for regulating the cut-off, substantially as set forth.

9. The combination, with the rock-shafts for operating the valves, the tappets engaged with the shafts, one with each, for opening the valves, the sliding cam, and the spring-actuated plungers carried by the tappets in position to engage the cam, of adjustable valve-closing tappets engaged with the rock-shafts, one with each, and bevel-faced arms fixed to said adjustable tappets in position to elevate the said spring-actuated plungers on the tappets for opening the valves when the tappets for closing the valves are adjusted near the tappets for opening the valves, substantially as set forth.

10. The combination, with the valve-operating rock-shafts and the tappets engaged therewith, of the sliding cam provided with a diagonal groove across its face, with shoulders extending diagonally across it at an angle to the groove and inclined faces leading from its opposite edges up to the shoulders and groove, whereby the said tappets are engaged by the cam and operated, substantially as set forth.

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